Quantitative Studies on the Monetary and Financial History of Denmark

by

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Abstract of the thesis

Quantitative Studies on the Monetary and Financial History of Denmark

The thesis consists of an introduction with a brief discussion on the nature and evolution of quantitative economic history followed by ten essays with quantitative studies on the monetary and financial history of Denmark. The first objective of the research project behind the thesis has been an attempt to close some of the gaps in the existing monetary and macroeconomic historical statistics for Denmark, and several new data sets are presented: Financial accounts 1875-2008 (essay 1), interest rates 1875-2008 (essay 2), nominal and real effective krone-rate indices 1875-2003 (essay 3), a detailed input-output table for 1934 (essay 4), the general government budget balance 1875-2005 (essay 5), an input-output based underlying inflation measure 1903-2002 (essay 6), cross-border portfolio flows 1984-2004 (essay 7), credit by sector and industry 1951-2008 (essay 8), time series on labour market structures 1875-2007 (essay 9) and a consumer price index 1502-2007 (essay 10). The second objective of the research project behind the thesis has been an attempt to enhance our insight into the monetary and financial history of Denmark through several new empirical analyses of a range of specific key issues based on the new data sets presented in the thesis. The topics covered are: Monetary trends and business cycles (essay 1 and 8), interest rates and inflation expectations (essay 2), exchange controls, exchange-rate behaviour and capital flows (essay 3, 4 and 7), the cyclical impact on the government budget balance (essay 5), inflation dynamics (essay 6 and 10) and the monetary-regime dependence of labour market structures (essay 9).

Dansk resumé af afhandlingen (Danish abstract of the thesis)

Kvantitative studier af Danmarks monetære og finansielle historie

Afhandlingen indledes med nogle refleksioner omkring karakteren og nytten af kvantitative økonomisk-historiske analyser efterfulgt af ti artikler indeholdende kvantitative studier af Danmarks monetære og finansielle historie. Det første mål med forskningsprojektet bag afhandlingen har været et forsøg på at lukke nogle af de huller, som findes i den eksisterende monetære og makroøkonomiske historiske statistik for Danmark, og i afhandlingen præsenteres adskillige nye datasæt: Finansielle statuskonti 1875-2008 (artikel 1), renter 1875-2008 (artikel 2), nominelle og reale effektive kronekursindeks 1875-2003 (artikel 3), en detaljeret input-output tabel for 1934 (artikel 4), den offentlige sektors budgetsaldo 1875-2005 (artikel 5), et input-output baseret underliggende inflationsmål 1903-2002 (artikel 6), grænseoverskridende porteføljebevægelser 1984-2004 (artikel 7), udlån fordelt på sektor og branche 1951-2008 (artikel 8), tidsserier for strukturerne på arbejdsmarkedet 1875-2007 (artikel 9) og et forbrugerprisindeks 1502-2007 (artikel 10). Det andet mål med forskningsprojektet bag afhandlingen har været et forsøg på at øge vores indsigt i Danmarks monetære og finansielle historie via nye empiriske analyser af en række specifikke problemstillinger baseret på de nye datasæt, som præsenteres i afhandlingen. De emneområder, som behandles, er : Monetære tendenser og konjunkturcykler (artikel 1 and 8), renter og inflationsforventninger (artikel 2), valutakontrol, valutakursadfærd og kapitalbevægelser (artikel 3, 4 and 7), den cykliske påvirkning af den offentlige sektors budgetsaldo (artikel 5), inflationsdynamik (artikel 6 and 10) og arbejdsmarkedsstrukturernes afhængighed af det monetære regime (artikel 9).

Table of contents

Preface and acknowledgements

This thesis consists of an introduction with a brief discussion on the nature and evolution of quantitative economic history followed by ten essays with quantitative studies on the monetary and financial history of Denmark.

The essays are based on the following journal articles:

Essay 1: Abildgren, K., A 'First Go' on Financial Accounts for Denmark 1875-2005, *Scandinavian Economic History Review*, Vol. 56(2), 2008, pp. 103-121.

Essay 2: Abildgren, K., Interest-Rate Development in Denmark 1875-2003 – A Survey, *Danish Journal of Economics*, Vol. 143(2), 2005, pp. 153-167.

Essay 3: Abildgren, K., Real Effective Exchange Rates and Purchasing-Power-parity Convergence: Empirical Evidence for Denmark, 1875-2002, *Scandinavian Economic History Review*, Vol. 53(3), 2005, pp. 58-70.

Essay 4: Abildgren, K. & Nørskov, A., Were the Results of Danish Import Allocation in 1934 Optimal for Reducing Unemployment?, *Danish Journal of Economics*, Vol. 130(4), 1992, pp. 591-604 (in Danish with an English summary).

Essay 5: Abildgren, K., Estimates of the Danish general government budget balance and the cyclical budget volatility 1875-2005, *Danish Journal of Economics*, Vol. 144(3), 2006, pp. 287-303.

Essay 6: Abildgren, K., Input-Output Based Measures of Underlying Domestic Inflation: Empirical Evidence from Denmark 1903-2002, *Economic Systems Research*, Vol. 19(4), 2007, pp. 409-423.

Essay 7: Abildgren, K., Short-term impacts on exchange rates from portfolio flows to and from Denmark 1984-2004, *Danish Journal of Economics*, Vol. 146(2), 2008, pp. 156-177.

Essay 8: Abildgren, K., Credit Dynamics in Denmark since World War II, *Danish Journal of Economics*, Vol. 147(1), 2009, pp. 89-119.

Essay 9: Abildgren, K., Monetary Regimes and the Endogeneity of Labour Market Structures – Empirical Evidence from Denmark 1875-2007, *European Review of Economic History*, Vol. 13(2), 2009, pp. 199-218.

Essay 10: Abildgren, K., Consumer Prices in Denmark 1502-2007, *Scandinavian Economic History Review*, Vol. 58(1), 2010, pp. 2-24.

The concise style of modern journal articles forces the author to focus on the new and original elements of his research and do not leave much space to describe the historical setting, summarise the more general historical and institutional background or list and document all the data sets. Although some of the essays in this thesis have been elaborated slightly compared to the journal versions, the level of details is still moderate for space-saving reasons. However, the following published background studies offer more supplementary material and documentation:

Essay 1: Abildgren, K., Monetary Trends and Business Cycles in Denmark 1875-2005 – New Evidence Using the Framework of Financial Accounts for Organising Historical Financial Statistics, *Danmarks Nationalbank Working Paper*, No. 43, November 2006.

Essay 2: Abildgren, K., A historical perspective on interest rates in Denmark 1875-2003, *Danmarks Nationalbank Working Paper*, No. 24, February 2005.

Essay 3: Abildgren, K., A chronology of Denmark's exchange-rate policy 1875-2003, *Danmarks Nationalbank Working Paper*, No. 12, April 2004.
Abildgren, K., Nominal and real effective krone rate indices for Denmark 1875-2002, *Danmarks Nationalbank Working Paper*, No. 13, April 2004.
Abildgren, K., An empirical examination of the purchasing-power-parity hypothesis for Denmark 1875-2002, *Danmarks Nationalbank Working Paper*, No. 14, April 2004.

Essay 4: Abildgren, K., Compilation of an input-output table for Denmark 1934, *Statistics Denmark Working Paper*, No. 36, May 1992 (in Danish).
Abildgren, K., *Compilation of an input-output Table for Denmark 1934 by the commodity flow method*, paper presented at the 22nd General Conference of the International Association for Research in Income and Wealth, Session 6a: Comparability of Historical National Accounting Data: Across Countries and Across Time, held at the Park Hotel Waldhaus in Flims, Switzerland, 30 August - 5 September 1992.

Essay 5: Abildgren, K., Estimates of the Danish general government budget balance and the cyclical budget volatility 1875-2003, *Danmarks Nationalbank Working Paper*, No. 30, October 2005.

Essay 6: Abildgren, K., An Input-Output Based Measure of Underlying Domestic Inflation in Denmark 1903-2002, *Danmarks Nationalbank Working Paper*, No. 34, March 2006.

Essay 7: Abildgren, K., Short-Term Exchange-Rate Effects of Capital Flows in a Small Open Economy With Pure Exchange-Rate Targeting – Empirical Evidence from Denmark's Recent Exchange-Rate History 1984-2004, *Danmarks Nationalbank Working Paper*, No. 45, March 2007.

Essay 8: Abildgren, K., Financial Liberalisation and Credit Dynamics in Denmark in the Post-World War II Period, *Danmarks Nationalbank Working Paper*, No. 47, October 2007.

Essay 9: Abildgren, K., Are Labour Market Structures Endogenously Dependent on the Monetary Regime? – Empirical Evidence from Denmark 1875-2007, *Danmarks Nationalbank Working Paper*, No. 52, April 2008.

Essay 10: Abildgren, K., Consumer Prices in Denmark 1502-2007, *Danmarks Nationalbank Working Paper*, No. 60, February 2009.

Although all the essays in the thesis are tied together by a common theme – quantitative studies on the monetary and financial history of Denmark – each essay is self-contained and can be read independently. They all begin with a short abstract and have a separate list of references at the end of each essay. A Danish summary is included at the end of the thesis.

Looking back, my interest in monetary and financial history was founded in the early 1990s when I together with Anders Nørskov wrote a Master Degree thesis at the University of Copenhagen on the Danish exchange control in the 1930s. After graduation in 1991 I joined the staff of Statistics Denmark and since late 1992 I have worked at Danmarks Nationalbank, where I previously during 1988-1989 had been a part-time research assistant (studentship). Even though the main activities in a central bureau of statistics or a central bank are centred on more contemporary issues, my "soft spot" for economic history never disappeared, and a large part of my spare time during my professional carrier has been devoted to economic-historical studies.

During the years I have accumulated a considerable debt of gratitude to others. I would like to take the opportunity to thank those many individuals who took the time to read draft versions of the various working papers and journal articles behind this thesis.

I am especially grateful to Mr. Jesper Berg, Assistant Director at Danmarks Nationalbank, for his encouragement in relation to my historical research and for convincing me to collect and convert my papers into the thesis at hand. I am furthermore in debt to Mr. Anders Møller Christensen, Assistant Governor at Danmarks Nationalbank, who generously during the years has allocated time for reading and discussing preliminary versions of my historical research output. Most – if not all – of his invaluable and constructive comments and drafting proposals have been incorporated and have significantly improved upon the work.

Furthermore, I am thankful to all the current and former members of the Review Board of Danmarks Nationalbank's Working Paper series. Besides Mr. Jesper Berg and Mr. Anders Møller Christensen they include Mr. Hugo Frey Jensen, Mr. Karsten Biltoft and the late Mr. Bjarne Skafte. The major part of the work presented in this thesis was first published as Danmarks Nationalbank Working Papers and the advice and criticism from the Review Board members has been very helpful.

I owe a special debt to Mr. Peter Ejler Storgaard for numerous comments and suggestions for improvements on several of the background studies behind the thesis. I have consulted Mr. Storgaard several times for encouragement and advice in relation to the work on reshaping working papers into forms suitable for journal articles and during the subsequent submission-resubmission processes.

A special thanks also goes furthermore to Mr. Anders Nørskov for excellent co-operation on a journal article in 1992 on the Danish exchange control in the 1930s. Essay 4 is based on this joint work with Mr. Nørskov. Furthermore, thanks goes to a number of former colleagues at Statistics Denmark – in particular Mr. Bent Thage, Mr. Ole Berner, Mr. Tim Folke and Mr. Søren Larsen – for their interest in my Statistics Denmark Working Paper on an input-output

table for Denmark 1934 published in 1992, which forms the core of annex 4.A (also based on the joint work with Anders Nørskov in our Master Degree thesis).

Finally, I am grateful to the evaluation committee, Ingrid Henriksen (chairman), Lars Jonung and Lennart Schön, for many constructive and helpful comments and suggestions in the evaluation report and at the public defence of the thesis at the University of Copenhagen on 5 March 2010.

All the essays in this thesis are based on information, which is now within the public domain. Views and conclusions expressed in this thesis are those of the author and do not necessarily represent those of Statistics Denmark or Danmarks Nationalbank. The author alone is responsible for any remaining errors and shortcomings.

March 2010
Kim Abildgren

Introduction

The definition of "quantitative economic history"

Quantitative economic history can be seen as an interdisciplinary field on the borderline between the humanities (history) and the social sciences (economic theory and applied econometrics).

There is probably no universally accepted definition or delimitation of the discipline, and it may also well be argued that quantitative economic history is not a distinct branch of economics or history as such. It might rather be seen as an approach or "research strategy" that emphasises the use of quantitative data processing and applied econometrics as "heuristic tools" for gaining new insights into particular economic-historical issues.

Quantitative studies on economic history are, however, normally characterised by emphasising the following elements:

- constructions of economic-historical data sets[1] that were previously not available or reconstructions of existing economic-historical data sets in order to improve on their quality or enrich their information content

and/or

- applications of theoretical statistics and econometric methods in relation to empirical analyses of economic-historical issues and the economic-historical development.

The historical evolution of quantitative economic history

Econometric research was founded in the first part of the 20th century and became formally established as separate discipline with the foundation of the Econometric Society in 1930.[2] The debate about application of econometric methods soon spread to the field of economic history. At the meeting of the Economic History Association in December 1940 the economist Simon Kuznets called for a closer co-operation between economic history and econometrics:

> "Although both these branches of economic study derive from the same body of raw materials of inquiry – the recordable past and present of economic society – each has developed in comparative isolation from the other. Statistical economists have failed to utilize adequately the contributions that economic historians have made to our knowledge of the past; and historians have rarely employed either the analytical tools or the basic theoretical hypothesis of statistical research."[3]

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[1] For the thesis at hand a historical data set is defined as a data set which has been compiled retrospectively at a time distant from the reference period as part of a historical analysis and not as part of contemporary statistics

[2] Cf. e.g. Gilbert & Qin (2007).

[3] Quotation from p. 26 in Kuznets (1941).

However, the introduction of econometric techniques in an economic-historical context by the "new economic history" school in the late 1950s[4] was received with a considerable amount of scepticism, both among economists:

> "The economists among the group ... were rather sceptical of the value of greater integration of economic theory and economic history, and particularly of the use of econometric models and statistical tests ... And perhaps there is a simple explanation for this somewhat paradoxical situation. Scholars working in the field of economic analysis are all too aware of the limitations of their tools..."[5]

as well as among historians:

> "... there is a mounting tendency to abandon other kinds of history to the social scientists, many of whom are brilliant men but who are even more culturally impoverished than we are. Their greatest deficiency is their lack of human understanding, which is the first requirement of the good historian; they do not understand or care about chaps. They deal in statistics, with units and trends, hoping to deduce laws of society; their works are primarily systematic, reveal little if any historical sense, and they ignore chronology. ... Realization that historical facts are unique in character, space, and time restrains the historian from trying to fit them into a rigid theory or fixed pattern – and here he can render emergency yeoman service to his unhistorical colleagues in other disciplines."[6]

Around thirty years later – shortly after the award in 1993 of the Nobel Prize in Economics[7] to Robert W. Fogel and Douglass C. North for their works within the cliometric research programme – the original hostility among historians and economic historians against the use of econometric methods was summarised as follows:

> "In most of empirical economics, more precise estimation of economic relationships and more precision about what one was estimating were viewed as progress. But in economic history there was considerable resistance. Those who were formalizing the field were viewed as outsiders. They were economists, not historians or economic historians. The insiders claimed the outsiders were theorists with little knowledge of the facts and with no sense of history."[8]

After the "linguistic turn" within historical departments in the 1970s[9] even non-econometric economic history appears to have become a discipline without much appreciation among mainstream historians:

> "Today, priority in history, where they are not focused upon military and political narrative, have turned to cultural phenomena and to the use of literary and dramatic metaphors and

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[4] Cf. e.g. the survey on econometric history in McCloskey (1987).

[5] Quotation from p. 550 in Kuznets (1957). This paper by Kuznets summarises the panel discussion at the Conference on Income and Wealth in Williamstown, Massachusetts, in September 1957 co-organised by the National Bureau of Economic Research and the Economic History Association.

[6] Quotation from p. 325 in Bridenbaugh (1963). This paper is a reproduction of the oral presidential address given by Mr. Bridenbaugh at the American Historical Association Annual Meeting, the Conrad Hilton Hotel, Chicago, Illinois, December 29, 1962.

[7] Or more formally, the Swedish Riksbank's Prize in Economic Science in Honor of Alfred Nobel.

[8] Quotation from p. 194 in Goldin (1995).

[9] For a survey on the "linguistic turn" in historical studies, cf. e.g. Fay *et al.* (eds.) (1998).

methods of analysis rather than using the mechanical or causative reasoning that economists and economic historians generally employ. Textual sources have been increasingly privileged over quantitative data that was traditionally favoured by economic historians. Some would say that these trends, taken together, have left economic history stranded."[10]

The use of databases and simple computer-aided data processing in economic-historical research have been much less controversial among historians than the use of econometrics:

> "The particular appeal of database-oriented research is not difficult to understand. Data gathering, organisation, sorting and searching, are tasks routinely carried out by historians... An important factor encouraging the launch of fresh projects is the essentially non-threatening nature of database technology. Historians must create and interrogate sets of data whether or not these take the form of a computer database. Thus, in using a database system, the historian is not adopting a fresh research paradigm, but merely a technology which, on the face of it at least, supports traditional methods of research and analysis."[11]

However, today many historians may even view data reconstruction as a time-consuming, old-fashioned and non-glorious side-track:

> "... although I personally love these statistical exercises, I have to acknowledge that ... too focused a concern with data reconstruction will condemn us to a quit, increasingly neglected corner of undergraduate and post-graduate teaching and research."[12]

The negligence of economic history and quantitative methods within the history profession has lately been so significant that an element of concern has been raised among non-economic historians:

> "I would not say that fashion is a bad thing – that would be a waste of breath – but I would say that it is in the interest of the discipline to keep a wide range of activities going, including ones that may seem obsolete or boring to some practitioners. ... Obviously it is good for newer forms and styles of history to be available to students, but it should not be at the expense of established ones. In my opinion, economic history, and areas that demand familiarity with quantitative methods, continue to be particularly vulnerable in this respect. ... I argue that the discipline should be keeping alive and actively promoting areas such as economic history because they contribute not just to the substance of history, but to thinking about structural issues within societies."[13]

A comprehensive and intense debate on the relationship between history and economics and the value of quantitative economic history went on in Denmark during the late 1980s and first half of the 1990s.[14] More recently a heated discussion took place in Sweden – a country with one of the largest economic-history communities of the world. The debate was initiated by an article by Danial Waldenström who remarked that the:

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[10] Quotation from p. 224 in Hudson (2003).

[11] Quotation from pp. xi-xii in Harvey & Press (1996).

[12] Quotation from p. 20 in Griffiths (1998).

[13] Quotation from pp. 6-9 in Jordanova (2006).

[14] Cf. Kærgård (1988, 1989, 1991a, 1991b); Hyldtoft (1992); Nilsson (1991, 1992); Christensen (1991); Mogensen (1991); Henriksen & Kærgård (1994); Perregaard (1994); and Olesen (1995).

> "Swedish economic historians are reluctant to use modern economic theories and statistical analysis to complement the traditionally dominant qualitative research methods."[15]

and that the:

> "... one-sided methodological focus in Swedish graduate programme that train economic historians often leaving them less knowledgeable in economics and statistics than the average undergraduate economist."[16]

Waldenström's remarks provoked strong reactions from several people within the economic-historical research community, including the following remarks from Sverre Knutsen:

> "Waldenström's cry for further efforts to make economic history a sub-field of mainstream economics is a blind alley, clearly demonstrated by the crisis within economic history. In my view, history and historical methods should constitute the core elements of economic history. Moreover, business history and the history of technology should be seen as integral parts of economic history studies. Within an eclectic approach, economics must be an important part of the historical analysis of past economics. This applies particularly to economic theory. In addition, economic history should also draw on other social sciences such as economic sociology and economic psychology. The analysis of cultural, technological and institutional aspects of evolving economics must be the main focus of modern economic history."[17]

Judged from the description above one could get the impression that studies within the field of cliometrics or quantitative economic history are rare "endangered species" close to extinction. However, this is actually not the case. In the United States the cliometric approach to economic history has been dominating for decades.[18] Whaples (1991) presents e.g. an account on the content in the US-based *Journal of Economic History* in the period 1941-1990. He finds that more than 80 per cent of the pages in the regular articles in the Journal in the period 1986-1990 could be classified as cliometric articles. For tasks articles the corresponding number was around 60-75 per cent.

The last couple of decades or so the quantitative approach to economic history seems also to have gained a stronger foothold in Europe. As the editors of the new European-based journal *Cliometrics* noted in the first issue in 2007:

> "Fact is that cliometrics exists, closes the gap between traditional economic history and economics per se. By the way, it has reestablished a role for history in economics, by expressing it in the language of the discipline. Today one can even say that it is an expanding domain in economics, contributing to new debates or challenging old conventional wisdom. The use of econometric techniques and economic theory has not solely contributed to rejuvenating economic history debates and made quantitative

[15] Quotation from p. 50 in Waldenström (2005).

[16] Quotation from p. 66 in Waldenström (2005).

[17] Quotation from p. 86 in Knutsen (2005).

[18] Cf. e.g. Toninelli (2007).

arguments unavoidable; it has also contributed to the slow emergence of a new historical awareness among economists."[19]

The revival of quantitative economic history within mainstream macroeconomics and finance

Within mainstream applied macroeconomic and financial research quantitative historical studies have also had something of a revival during the last couple of decades. Articles following this line of research are now regularly published in top-ranking general economic and finance journals as well as in more specialised field journals, cf. the lists of references to the essays in the thesis at hand.

Some of the main factors driving the renewed interest in quantitative historical studies among economists seem to be the following:

- The development of user-friendly data processing programs (like spreadsheets and database management systems) as well as mathematical, statistical and econometric software packages has facilitated the use of quantitative methods in studies of the economic past. The user no longer has to be a specialist in advanced algorithmic programming in order to carry out computer-aided research. Furthermore, the broadening availability of more powerful computers now allows the users to handle larger bodies of data and make use of more sophisticated statistical techniques that previously were computationally prohibitive.
- The developments within time-series econometrics since the mid-1980s with focus on non-stationarity and cointegration have created a renewed interest in long historical time series within a broad range of areas, including the study of the long-run behaviour of financial market rates.
- More generally, the focus on long-span historical time series has increased in the wave of the Lucas (1976) critique of econometric modelling. Lucas, *op.cit.*, noted that:

  > "Within the theory of economic policy, more observations always sharpen parameter estimates and forecasts, and observations on 'extreme' x_t values particularly so; yet even the readily available annual series from 1929-1946 are rarely used as a check on the post-war fits"[20].

  Data from different periods with different economic-policy regimes, other institutional differences and variations in the rate of real or monetary shocks to the economy can serve as the basis for useful robustness checks in empirical investigations.
- Following almost two decades of dormation Growth Theory has since the late 1980s re-emerged as an active research field with particular focus on R&D and endogenous growth, including studies on the link between financial intermediation and economic growth. The new growth theory has paid close attention to empirical implications and made intensive use of long-span Panel Data Methods in a cross-country context.
- The period since the mid-1990s has witnessed a rapid development of statistical methods (extreme value theory and "heavy tail" distributions) useful for examining the probability of rare extreme historical events ("tail events") such as currency crises, banking crises, debt crisis or severe stock-market collapses.
- Models aiming at describing dynamic macroeconomic behaviour with an explicit microfoundation often become too complex to be solved analytically. Even relatively

[19] Quotation from p. 1 in Costa *et al.* (2007).

[20] Quotation from pp. 22-23 in Lucas (1976).

basic stochastic intertemporal Real Business Cycle models with competitive markets and flexible prices from the 1980s do often not have closed-form analytical solutions, and approximate solutions have to be found numerically. Since the mid-1990s numerical solution methods have also found widespread use in evaluating the quantitative implications drawn from New Keynesian Dynamic Stochastic General Equilibrium (DSGE) models with nominal rigidities and monopolistic competition. This development has made intertemporal general equilibrium models useful for analysis of real-world policy questions. This has triggered new research on "old controversies" such as the role played by monetary policy in the Great Depression in the United States in the 1930s[21], the degree of price level stability under alternative monetary regimes[22] or the economic effects of the French war indemnity payments to Germany 1871-1873 following the Franco-Prussian War[23].

- Economic decisions by policy makers are taken on basis of the information set available at the point of the decision. However, some kind of statistics – such as real GDP growth – can be subject to continuous and significant revisions and redefinitions over time. To an even larger extent this is true for "model-based" statistical measures such as potential output and output gap since also the statistical techniques and models used for their estimation evolves over time. If one retrospectively uses more recent data to evaluate the policy decisions of the past, one might judge the past on the basis of information that the policy makers did not have at their disposal at the point of decision. Furthermore, to the extent that economic decisions are forward looking, the decisions of the past naturally were based on the forecasts available when the decisions were made and not on the actual outcome of the future that has only become available *ex post*. This issue[24] has created an interest into establishment of so-called "real time" databases, which include different revisions of key economic statistics as well as time-stamped economic forecasts. Such databases can become very large and require sophisticated data-management systems to keep track of the many dimensions in the data sets.
- Finally, contemporary economic themes such as the introduction of a common currency (the euro) in a large number of European countries in 1999, the economic effects of globalisation and the increased focus on financial stability among central banks around the world have acted as catalyst for a renewed quantitative historical research in the relationship between monetary regimes and regulatory frameworks (institutions), asset prices, financial crises and the economic development.[25]

Limitations of the quantitative approach to economic history

Naturally, like all other approaches to economic history quantitative methods have their limitations, and economic history cannot be analysed completely and adequately solely through the lens of statistical data, economic theories and econometric techniques:

- Historical statistical data within the social sciences are always subject to questions regarding their accuracy and reliability. Frequently a number of judgements and estimations have implicitly or explicitly been made during the statistical production process in an attempt to overcome problems with missing observations, incomplete coverage and sampling biases, changes in compilation methods and statistical

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[21] Cf. e.g. Christiano *et al.* (2003). Evans *et. al.* (2004) offer a survey of the literature using DSGE models to analyse the Great Depressen.

[22] Cf. e.g. Bordo *et al* (2007).

[23] Cf. Devereux & Smith (2007).

[24] Often termed the "Orphanides critique" due to Athanasios Orphanides research into historical monetary-policy evaluation, cf. Orphanides (2003) and references therein.

[25] Cf. e.g. Bordo, Taylor & Williamson (eds.) (2003) and Reinhart & Rogoff (2009).

classifications *etc*. Even contemporary economic statistics are subject to frequent and large revisions. Sometimes historical statistical information have been collected for particular legal or political purposes, which have to be taken into account when the reliability of such data sets are assessed. Any kind of historical statistics can therefore often only be expected to give a rough picture of the topics at hand, and naturally it is always preferable if alternative data sets or other kinds of supplementary information are available for confirmation and cross-checking.

- Measurement can't take place without definition, and the information content in all kinds of statistics is strongly dependent on the conceptual definitions applied in the framework under which they have been collected and compiled. Data can therefore not be gathered without a theoretical framework of some kind, and there exists no statistics that are purely objective numerical facts free of any interpretative dimensions.[26] In particular, there may be many more general philosophical and methodological questions to consider in relation to the compilation of macroeconomic statistics: Should household production be included in the gross domestic product? Should consumption include the service flow from durable goods rather than the expenditure on durable goods? What is the most appropriate way to construct an aggregated price index (current or fixed weights, chaining or not, etc.)? Does it make sense at all to operate with an aggregated figure of production or the capital stock in the economy? Should the various components in the broad money stock be weighted after liquidity (i.e. Divisia monetary aggregates)? *Etc.* There are no universally correct answers to such questions, and the choices of both data definitions and the data model depend on both data availability and the subject of analysis.
- The use of mathematical models and methods as the foundation of applied economic research should not be misinterpreted as statements about the existence of exact economic relationships that are to hold true to the last decimal as is the case in the natural sciences. They should merely be seen as convenient tools that can be of assistance in an attempt to make the underlying economic reasoning explicit and consistent. Economic theories or models are by nature abstractions from a much more complex economic reality. Their aim is to organise thinking within a parsimonious framework in order to help the researcher to focus and better understand the subject of analysis. However, no economic model can fully incorporate all institutional details and economic events in a proper way. Furthermore, the "true" economic model (or data generating process) may vary from one time period to another and from country to country. To be of any value as an analytical framework, economic models have to be manageable and must therefore focus on a limited number of essential factors and relationships of direct interest. Usually one will therefore try to avoid complexities, which are of secondary concern in relation to the problem studied. In principle this implies that most economic models are incomplete. However many, if not most, powerful economic principles are the results of research based on very simple models or economic theories – the art of economics is to choose the right set of simplifying assumptions taking into account the objectives and goals of the analysis in a given situation.
- No economic empirical evidence can be interpreted without the use of economic theory. Most of the interesting structural parameters or economic variables are not observable and they can only be measured within the framework of a theory or a model. However, economics is a young science and at the current state our knowledge about economic behaviour and interconnections is incomplete and surrounded by uncertainty. A common problem in empirical economics is "observational equivalence", i.e. situations where the same data set can give rise to different interpretations depending on the economic model used for interpretation. It is therefore important to have an open mind for using a multiplicity of fundamentally different models in applied economic-historical analyses. Different types of models can describe different aspects of the economy and thereby in combination give a more coherent picture of the issue at hand than a single model.

[26] Cf. also the critical history on the development of statistics as "modern facts" in Poovey (1998).

- Applied empirical economic modelling often represents a compromise between data conformity, empirical relevance and theoretical consistency. There may be alternative economic theories describing the problem of interest, and often the number of variables have to be narrowed down due to practical reasons or insufficient data sources. Some variables may not be defined uniquely by economic theory, and many economic theories may make use of abstract concepts that are not directly observable (e.g. "inflation expectations", "permanent income" or "living standard") and therefore have to be represented by "proxies". Some times data sets have to be "cleaned"[27] before they can enter into a statistical analysis or transformed[28] in order to align the data with the concepts that are modelled by the theory, and there may be several different procedures to choose from. Furthermore, the precise functional forms or lag structures in dynamic models rarely emerge from theory and are left for the econometrician to decide. Finally, the frequency (daily, monthly, quarterly or annual) of available data often have to determine the model specification although the frequency with which economic agents makes decisions often must be assumed to differ from the data sampling frequency.
- Real-life data almost always turn out to be rather "messy" and do seldom follow the assumptions and "nice" statistical distributions underlying most econometric textbook methods and procedures. Even though there is often a wide battery of different statistical and econometric techniques available, the various tools have their own strengths and weaknesses in different aspect of analysis. No single quantitative approach is usually superior to others in all aspects, so trade-offs have to be made. If the same conclusions can be drawn from alternative empirical approaches the findings are more likely to be robust and less likely to be the result of pure chance. There are also often a number of more general problems to consider when inferences are drawn from observational data rather than controlled experiments (e.g. multicollinearity, simultaneity and omitted variable biases), and econometric results may not always be robust to the choice of data sample which may make inference invalid or questionable. Furthermore, estimated coefficient in econometric equations can be sensitive to e.g. policy changes if the model is not based on explicit microfoundations with focus on "deep" or "structural" parameters and take the endogeneity of private-sector expectations explicitly into account (the Lucas (1976) critique). Finally, the econometrician naturally always simultaneously face the risk of Type I[29] and Type II[30] errors when making inferential statistical conclusions.[31]

Thus clearly, the quantitative approach to economic history cannot stand-alone. However, many issues within monetary and financial history can only be further enlighted through quantitative empirical evidence. Historical data constructions and reconstructions as well as careful use of statistical and econometric methods should therefore not be excluded *apriori* from the practitioner's toolkit. Even though clear-cut answers rarely emerge from empirical studies, which usually call for further investigation and confirmation, quantitative historical studies have the potential to enhance our knowledge and understanding of important economic-historical issues. They may in some cases give some useful indications of the empirical relevance of competing economic theories in various historical time periods and

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[27] E.g. by eliminating obvious data errors like misprints or adjusted for breaks in series by multiplicative or additive chaining of old and new series.

[28] E.g. detrended, inflation-adjusted, purchasing-power-parity adjusted, seasonally adjusted or simply converted to a common data frequency (i.e. monthly frequency, annual frequency *etc*.).

[29] I.e. rejecting a null hypothesis that is in fact true.

[30] I.e. not rejecting a null hypothesis that is in fact false.

may lead to new insights and constructive discussions. Furthermore, results from quantitative historical studies may be useful to stimulate thinking on economic-historical issues and be used to cross-check, complement and inspire other methodological approaches to economic history.

The approach to quantitative economic history taken in this thesis

The approach to quantitative economic history taken in this thesis can to a high degree be summarised by the following balanced view advocated by Pat Hudson:

> "There are no easy answers these days to the question 'What is history?' But, in their effort to understand the past, historians are not helped by a polarisation of opinion about quantitative and non-quantitative methods. There is a wide spectrum of quantitative evidence, and many useful, often simple, techniques, which can be used in historical research, providing one remains aware of the pitfalls and biases of the evidence. There is a similar spectrum of sources, concepts, theories, methods and pitfalls, which underpin qualitative history. Each piece of research, whether relying heavily on numbers or not, must be judged on its own merits: by the consistency and cogency of arguments in relation to a critical use of the available evidence. A critical approach to the social construction of evidence and 'knowledge' and a reflexive attitude on the part of the historian are essential whether we are considering quantitative or qualitative history. But this involves leaving behind what has become a rather sterile and unhelpful debate about the inherent superiority of one approach over the other."[32]

The first objective of the research project behind the thesis at hand has been an attempt to close some of the gaps in the existing monetary and macroeconomic historical statistics for Denmark. Nowadays, with the development of personal computer technology, computational power becomes less and less of a problem for the quantitative economic-historical analyst. The main challenge is rather the sparse availability of reasonable consistent economic-historical data sets that fulfil the requirements demanded by modern empirical macroeconomic modelling and analysis. The thesis presents several new data sets: Financial accounts 1875-2008 (essay 1), interest rates 1875-2008 (essay 2), nominal and real effective krone-rate indices 1875-2003 (essay 3), a detailed input-output table for 1934 (essay 4), the general government budget balance 1875-2005 (essay 5), an input-output based underlying inflation measure 1903-2002 (essay 6), cross-border portfolio flows 1984-2004 (essay 7), credit by sector and industry 1951-2008 (essay 8), time series on labour market structures 1875-2007 (essay 9) and a consumer price index 1502-2007 (essay 10). For space-saving reasons only the main variables contained in these new data sets are tabulated and briefly documented in this thesis. However, the published background studies include a full listing and documentation of all the data sets in order to make them available to a wider research

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[31] Cf. page 21 in Blaug (1980).

[32] P. 44 in Hudson (2000).

audience and stimulate further analysis. All data sets are also available in electronic form on request from the author.

The second objective of the research project behind the thesis has been an attempt to enhance our insight into the monetary and financial history of Denmark through several new empirical analyses of a range of specific key issues based on the new data sets presented in the thesis. The topics covered in the thesis are: Monetary trends and business cycles (essay 1 and 8), interest rates and inflation expectations (essay 2), exchange controls, exchange-rate behaviour and capital flows (essay 3, 4 and 7), the cyclical impact on the government budget balance (essay 5), inflation dynamics (essay 6 and 10) and the monetary-regime dependence of labour market structures (essay 9). Although most of these fields are covered by a wealth of analyses in the literature, there is still a substantial lack of consensus on numerous fundamental issues at both the theoretical and empirical level. Furthermore, the number of quantitative monetary and financial historical studies on the Danish economy is also rather limited, probably partly because long-span monetary and financial time series for Denmark has been less readily available.

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Essay 1: Using the Framework of Financial Accounts for Organising Historical Financial Statistics – New Evidence on Monetary Trends and Business Cycles in Denmark 1875-2008[33]

Abstract

Financial accounts can be used in an attempt to paint a coherent picture of the development of the financial system and the financial structure. To date projects related to historical national-accounts have – both in Denmark and internationally – only focused on the real side of the economy. Essay 1 presents a first attempt to construct a set of annual financial-account stock data for Denmark 1875-2008. Furthermore, the essay addresses some of the more methodological and conceptual aspects of using financial accounts as a framework for organisation of historical financial statistics and explores some historical monetary and financial trends and cycles on the basis of the new data set.

The annual financial-account data constructed in the essay are based on a comprehensive range of historical financial statistics. The data presented are broken down by 8 institutional sectors (central bank; commercial banks and savings banks; mortgage-credit institutes; life-insurance companies and pension funds; investment associations; central government; other residents; non-residents) and 6 main types of financial instruments (gold and SDR; currency; loans and deposits; bonds, shares and mutual funds shares; insurance technical reserves; capital and reserves).

Commercial banks, savings banks and mortgage-credit institutions played a significant credit-supplying role in the Danish economy already during the late 19th century and in the beginning of the twentieth century. A turning point emerged during the early 1930s and by the middle of the 1950s the ratio of credit to GDP had declined substantially. Since then the trend has reversed but the pre-World War I level was not reached until the decade from the mid-1970s to the mid-1980s. To some extent real asset prices have displayed a similar pattern. There has been a massive growth in the assets under management by life-insurance companies and pension funds since the mid-1970s and by collective investment funds since the mid-1990s.

There has been a much stronger positive correlation between money and prices at the long-term frequencies (8-40 years cycles) than at the business cycle frequency (2-8 years), but in the post-World War II period prices seem to have led money at all frequencies. In the period

1875-1945 house prices led credit from mortgage-credit institutions with a considerable lead-time (6 years) in the long-term cycles – in the post World War II period the lead-time has been significantly shorter (1 year). During the whole post-1875 period real credit granted by banks and mortgage-credit institutions have been almost contemporaneous with real GDP, and the largest correlation coefficients have occurred in the long-term cycles.

The overall conclusion in the essay is that financial accounts constitute a useful framework for organising and analysing financial data even when data sources are somewhat fragmented and sparse, which is often the case in relation to historical financial statistics. Financial accounts can be useful in an attempt to paint a more coherent picture of the historical development of the financial system and the financial structure. Utilising accounting identities a system of financial accounts allows e.g. for the compilation of the net financial asset position of the non-financial private sector, even when no separate balance-sheet statistics covers this sector. It would therefore be interesting if future projects on historical national accounts in Denmark would make an attempt to cover long-span time series of both real-economy accounts as well as financial accounts stock- and flow-data.

Annex 1.A lists some key figures from the new historical financial-account stock data for Denmark 1875-2008. As a robustness test of the data set a post-1994 comparison between the new historical balance-sheet stock data and figures from Statistics Denmark's financial-accounts statistics is found in annex 1.B. Finally, annex 1.C outlines the main features of the Baxter-King filter used in the essay.

Key words: Financial accounts, historical financial statistics, financial sector development, financial markets history, monetary transmission, cycles, band-pass filters.
JEL Classification: C82; E3; G00; N23; N24.

[33] This essay is based on Abildgren (2006b, 2008b).

1.1. Introduction

Time series data on financial accounts with stock and flow data on all financial balance-sheet items for each main sector of the economy are often viewed as the “final stage” of the monetary and financial statistical “infrastructure” in a country. Due to consistent concepts, classifications and general accounting rules a system of financial accounts constitutes a coherent and useful way to summarise the information content of a wide range of primary financial statistics. This enhances the analytical application of the data in relation to e.g. studies of the evolution of financial intermediation processes, portfolio behaviour, monetary transmission and financial stability.

Internationally, the origin of financial-accounts statistics can be attributed to the works of Morris A. Copeland in the late 1940s and early 1950s. In 1944, Copeland received an invitation by the National Bureau of Economic Research (NBER) to carry out a study on the money flows in the United States. Copeland’s study was published by NBER in 1952 with annual flow-of-funds data covering the period 1936-1942. Copeland and his staff carried out the statistical work behind the study in office space of the Federal Reserve (FED) Board in Washington donated to the project by the Board. After the end of the project, Copeland’s staff was absorbed into FED’s own Research and Statistics Division whereby flow-of-funds accounts early became part of the official financial statistical framework of the United States. In 1955, the FED published a full set of annual stock- and flow-of-funds statistics covering the period 1939-1953, and in 1959 the FED began to publish flow-of-funds statistics on a quarterly frequency in its Federal Reserve Bulletin.[34]

The expansion of the official statistics with financial accounts occurred rather late in Denmark compared to other countries. In 2001, Statistics Denmark introduced financial-account stock- and flow-data as part of the annual national-accounts statistics for Denmark covering the period since end-1994.[35] Danmarks Nationalbank (the central bank of Denmark) began to publish quarterly financial-accounts statistics in 2004 with stock data going back to end-1998. Quarterly flow data followed in 2006.[36] These new sets of statistics have provided

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[34] For studies on the historical origin and evolution of stock- and flow-of-funds statistics, compilation methods and the analytical use of the data, cf. e.g. Roe (1973), Bain (1973), Galbis (ed.) (1991), Dawson (ed.) (1996), Green & Murinde (2003), Stockton (2004), Banca d’Italia (2008) and Breton & Duc (2009). Dawson, *op. cit.,* includes a reprint of parts of Copeland’s original 1952-study as well as reprints of many other “classical” stock- and flow-of-funds articles.

[35] Cf. Petersen (2001) and Statistics Denmark (2001). The annual financial-accounts statistics compiled by Statistics Denmark are in principle reconciled with the non-financial part of the annual national-account statistics in order to get consistent net-lending figures. Statistics Denmark’s financial-accounts statistics follows the methodological principles in the “European System of National Accounts” (ESA), i.e. the EU-version of United Nations’ “A System of National Accounts” (SNA). The SNA 1993 was the first United Nations national-accounts guideline to include a fully specified system of financial accounts, including revaluation accounts, *etc*.

[36] Cf. Olesen & Svanholt (2004) and Danmarks Nationalbank (2004, 2006). Also the Nationalbank’s quarterly financial-accounts statistics follows the methods laid out in the ESA. However, the end-of-year figures from the Nationalbank’s quarterly financial-accounts statistics are not fully consistent with the figures from Statistics Denmark’s annual financial-accounts statistics, mainly due to difference in the choice of primary statistical

the users with a comprehensive and solid basis for monetary and financial analysis of the Danish economy, but only for the last one and a half decade or so.

For selected short-span periods other authors have previously published complete or partial financial-account stock- and/or flow-data for Denmark following different compilation methods, cf. Table 1.1, but so far projects on compilation of long-span historical national-account statistics for Denmark[37] have only focused on the real side of the economy.

Table 1.1 The availability of non-official financial account data for Denmark

Data sample	Study
1955	Winding (1958).
1960 and 1965	Balling (1967).
1955-1970	Blomgren-Hansen (1974,1975).
1974-1984	Det Økonomiske Råd. Formandskabet (1985).
1976	Sørensen (1978).
1977-1987	Lauritzen (1988). This data set was later updated for 1988 on page 44 in Danmarks Nationalbank, *Report and Accounts for the Year 1988* and for 1989 on page 33 in Danmarks Nationalbank, *Report and Accounts for the Year 1989*.
1973-1987	Pedersen (1989). This data set was later updated by Statistics Denmark in relation to the macroeconomic model of the Danish economy, ADAM. The data set in Pedersen, *op.cit.*, builds on a non-published data bank (PENGE) constructed by Jesper Jespersen, cf. also Jespersen (1987).
1989	Hansen & Johansen (1994).
1980-1990	Økonomiministeriet (1992).
1980-1998	Andersen, Lyngesen & Pedersen (1999).

However, a system of financial accounts may also be a valuable framework for organisation and analysis of financial data when data sources are somewhat fragmented and sparse, which is often the case in relation to historical financial statistics. Here, the financial balance sheets offer a consistent framework into which the various bits and pieces of statistical information can be fed and processed in a systematic way. This can be of assistance in an attempt to paint an overall picture of the historical development of the financial structure of the economy. Utilising accounting identities a system of financial accounts allows e.g. for the compilation of the net financial asset position of the non-financial private sector, even when no separate balance-sheet statistics covers this sector.

This essay presents a first attempt to construct a set of historical financial-account stock data for Denmark covering the period 1875-2008 on an annual frequency. Furthermore, a

sources. In early 2010, Danmarks Nationalbank began to publish quarterly financial accounts reconciled with the non-financial part of the quarterly national-account statistics from Statistics Denmark, cf. Danmarks Nationalbank (2010).

[37] For an overview of the available historical national-accounts figures in Denmark, cf. pp. 164-179 in Mogensen (1987), Hyldtoft (1993, 1994), Christensen *et al.* (1995) and Nilsson (1991, 2004).

first exploratory analysis of the structural and cyclical financial and monetary development in Denmark since 1875 based on the new data is presented

1.2. Compilation of financial balance-sheet stock data for Denmark 1875-2008 – The "Building Blocks" approach

The last part of the 19th century was the period in which national financial markets in Denmark were being developed.[38] Before this period the financial markets were characterised by regional segmentation. The year 1875 – which also was the year when the krone was introduced as the Danish currency unit – has therefore been chosen as the stating year for the financial balance-sheet stock data constructed in this essay.

Table 1.2: Overview of the system of financial balance-sheet stock data for Denmark 1875-2008

	Residents							Non-residents (b)
	Financial sector					Central government	Other residents (i.e. non-financial private sector and local governments)	
	Central bank	Commercial banks and savings banks	Mortgage-credit institutes	Life-insurance companies and pension funds	Investment associations			
Financial assets								
Gold and SDR	D							
Currency		D						
Loans (a)	D	D	D			D		
Bonds, shares and mutual funds shares	D	D				D		
Total financial assets				D	RV			
Financial liabilities								
Currency	D					D		
Deposits (a)	D	D				D		
Bonds	D	D	RV			D		
Mutual funds shares					D			
Insurance technical reserves				RV				
Capital and reserves	RV	RV						
Total financial liabilities								
Net financial assets	0	0	0	0	0	RV	RH	D

Note: Items marked with a "RV" have been calculated on a residual basis using a vertical accounting identity whereas the item marked with a "RH" has been calculated on a residual basis from a horizontal accounting identity. A "0" indicates that the item by definition is assumed to be zero or is approximately close to zero.

(a) Covers both loans and deposits.

(b) Since the share of a domestic financial net liability not held by other residents by definition represents a corresponding net financial asset of non-residents, the absolute value of the net financial asset position for the non-resident sector is identical to the absolute value of Denmark's international investment position. A positive (negative) figure for non-residents' net financial asset position corresponds to a situation where the Danish economy has external liabilities (assets) on a net basis vis-à-vis the rest of the world.

The balance-sheet stock data have been compiled using a "building block" approach where only the major financial assets and liabilities have been taken into consideration, cf. Table

[38] Cf. e.g. Hansen & Johansen (1994) and page 41 in Hansen & Mørch (1997).

1.2. For each sector a financial balance sheet for a given end-year provides an overview of the stock of financial assets and liabilities and the net financial wealth position. All the items marked with "D" in Table 1.2 have been filled out with data. Items marked with a "RV" have been calculated on a residual basis using a vertical accounting identity whereas the item marked with a "RH" has been calculated on a residual basis from a horizontal accounting identity. A "0" indicates that the item by definition is assumed to be zero or is approximately close to zero. The rather detailed breakdown of the financial sector has been chosen in order make the financial balance-sheet data suitable for historical analysis of the development in financial structures.

1.3. Data sources, coverage and sector delimitation

This section describes the main sources and methods used to construct the data set on financial accounts for Denmark 1875-2008. Even though an attempt has been made to transform the background figures into a set of reasonable consistent long time series, the quality of a data set spanning more than 130 years is to a high degree determined by data availability. The section discusses therefore also some of the main conceptual problems related to the data sources and compilation methods applied.

Annex 1.A lists some key figures from the new data set of historical financial-account stock data for Denmark 1875-2008. More details on the sources and compilation methods used to construct the data set are available in a background paper.[39]

As with all long-span historical statistics a word of caution is in order. Even though the use of the balance-sheet framework ensures a certain degree of comparability across sectors and over time, a number of judgements and estimations have been necessary, and differences in accounting standards and practices[40] over time and across sectors imply a certain amount of statistical uncertainty. Also, as mentioned, only the major financial assets and liabilities have been taken into consideration. The historical financial-balance-sheets data presented in this essay can therefore only be expected to give a rough picture of the distribution of net financial asset positions in the period since 1875. In order to evaluate the robustness of the approach used to construct the financial balance-sheet data in the essay at hand a post-1994 comparison with figures from Statistics Denmark's financial-accounts statistics is provided in annex 1.B.

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[39] Cf. Abildgren (2006b). The data set presented in the essay at hand has been updated with more recent and slightly revised figures compared to the data set listed in Abildgren, *op.cit.*

[40] One of the most important changes in accounting principles applied in a large part of financial statistics during the last couple of decades is an increasing tendency to use market valuation for securities holdings.

The Central Bank

The data for the central bank's financial assets and liabilities are based on accounting statistics from Danmarks Nationalbank's *Annual Report and Accounts* and separate balance-sheet statements.

The German occupation forces' expenditures in Denmark during the years 1940-1945 – compulsorily financed via German accounts at Danmarks Nationalbank against a guarantee from the Danish central government – were newer paid by Germany. The amounts are included among the central government liabilities vis-à-vis the central bank as they occurred in the period 1940-1945. They are therefore not treated as a part of the foreign assets of the central bank.

In 1975 the Royal Mint was transferred from the central government to Danmarks Nationalbank. Coins in circulation are therefore treated as a liability of the central bank during the period 1975-2008. Prior to 1975 coins in circulation represents a liability of the central government.

The net financial asset position of the central bank is assumed to be zero and the liability item "capital and reserves" is calculated as the residual. Following statistical conventions it is assumed that capital and reserves of the central bank are owned by the central government in the period since 1936, when the central bank became a self-governing institution whose profits after provisions were to be transferred to the central government. For the period prior to 1936 – when the central bank was a private joint stock company – capital and reserves of the central bank were owned by resident and non-resident shareholders.

The private banking sector

For the private banking sector the information on financial assets and liabilities is mainly based on accounting statistics from the Danish Supervisory Authorities and two major Danish historical statistical abstracts.[41]

The private banking sector covers commercial banks and savings banks. Credit co-operatives are not included in the financial sector of the historical financial accounts. However, they have newer played any significant credit-supplying role in the Danish economy[42], so the bias from this omission is very limited.

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[41] Statistics Denmark (1969) and Johansen (1985).

[42] Cf. Guinnane & Henriksen (1998).

The National Postal Giro was established in 1920 and was restructured into a commercial bank in 1991.[43] Adjustment in the series has been made so the National Postal Giro is included among the financial assets and liabilities of the private banking sector during the whole period since 1920.

The net financial asset position of the private banking sector is assumed to be zero and the liability item "capital and reserves" is calculated as the residual. This reflects that the bank's net financial assets position in an economic sense "in the end" constitutes an indirect financial liability to the non-resident and resident shareholders.

The mortgage-credit institutes

For the mortgage-credit institutes the outstanding amount of mortgage-credit loans (mainly based on accounting statistics from the Danish Supervisory Authorities and the Danish historical statistical abstracts cited above) is the only type of asset included in the balance sheets for this sector. The Danish mortgage-credit institutes have to comply with the so-called "balance principle" requiring a balance between the total payments received from the borrowers on loans and the total payments made to the bondholders via the bonds financing the loans. The net financial asset position of the sector has therefore by definition been set to zero and the total outstanding amount of mortgage-credit bonds on the liability side of the balance sheet has been set equal to the outstanding amount of mortgage-credit loans. This implies that the values stated for the outstanding amount of mortgage-credit bonds in the historical financial balance sheets are not identical to the current market value of the bonds using stock-exchange prices.

Life-insurance companies and pension funds

This sector covers life insurance companies (since 1875) and pension funds (since 1938). Furthermore, the following funded social pensions funds are included: Arbejdsmarkedets TillægsPension, ATP[44] (since 1964) and Den Særlige Pensionsopsparing, SP[45] (since 1999).

[43] The history of the National Postal Giro is covered by Gregersen & Sundorph (1989) and Wind (1993).

[44] In English: Labour Market Supplementary Pension Fund. The ATP-scheme was established by law in 1964 and covers all workers with more than a 9 hours working week. The average contribution to ATP has been around 1 per cent of the average wage. The history of ATP is covered by Nelson (1984).

[45] In English: The Special Pension Fund. SP was established in 1999 and was suspended again in 2004. The contribution rate to SP amounted to 1 per cent of the gross salary. In 2009 people were given the option to withdraw their SP savings.

Finally, the following special institutions are included: Overformynderiet[46] (since 1875), Bikubens forvaltningsafdeling (since 1895) and Lønmodtagernes Dyrtidsfond[47] (since 1980).

For life-insurance companies and pension fund sector the total amount of insurance technical reserves is assumed to be equal to their total holdings of financial assets (based on accounting statistics from the Danish Supervisory Authorities and one of the volumes in the Nationalbank's "Danish Monetary History"[48]). Implicitly it is therefore assumed that the net financial wealth position of the sector is equal to zero and capital and reserves therefore owned by the insurance holders.

Investment associations

Collective investments in Denmark can be traced back to the late 1920s, but actual mutual investment funds emerged first in the late 1960s.[49] The background data for this sector consists mainly of accounting statistics from the Danish Supervisory Authorities and a jubilee publication covering the sector[50].

The total amount of assets of investments associations is assumed to be equal to the value of the outstanding amount of mutual funds shares. This also implies that the net wealth position of the sector by definition is equal to zero and capital and reserves therefore owned by the holders of mutual fund shares.

For the years 1928-1983 annual data are not readily available. For this period the value of the outstanding amount of mutual funds shares has been estimated by geometric interpolation on the basis on the value of the total financial assets of investments associations for the years 1928, 1929, 1938, 1948, 1958, 1968, 1976, 1979, 1980 and 1983.

In 2004 a new Act on investment associations entered into force, allowing for the establishment of limited-membership associations. These types of investment associations receive funds from a few large investors such as pension funds and not from the general public. The large increase in the assets under management by investment associations since 2003 can partly be attributed to the establishment of investment associations related to LD, SP and ATP.

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[46] Overformynderiet (in English: The Public Trustee's Office) was established by regulation in 1619.

[47] In English: The Employees' Wage Indexation Fund. LD was established by law in 1980 in order to manage the so-called "frozen cost-of-living allowances" from the years 1977-1979. In stead of being paid out to the employees as wages during the late 1970s these cost-of-living allowances were to be paid out as supplementary lump sum pensions upon retirement. The history of LD is covered by Lønmodtagernes Dyrtidsfond (2005).

[48] Hansen & Svendsen (1968).

[49] The joint-stock investment company "Investor" was established in 1928. It was restructures into an investment association in 1962.

[50] Danske Invest (1998).

The central government

The financial assets and liabilities of the central government is mainly based on accounting statistics from the previously cited Danish historical statistical abstracts and the publications on *Danish Government Borrowing and Debt* from the Danish Ministry of Finance and Danmarks Nationalbank. The net financial asset position is calculated as the residual.

The assets include the Social Pension Fund (since 1970)[51] and the share capital of the central bank (since 1936).

As mentioned above, coins in circulation represented a liability of central government prior to 1975. For the period 1875-1928 no annual statistics on coins in circulation is readily available. The figures has therefore been interpolated on the basis of estimates[52] of the coins in circulation in the years 1875, 1880, 1885, 1890, 1900, 1913 and 1929.

The non-resident sector

The net financial asset position of non-residents is mainly based on the statistics on Denmark's International Investment Position published by Statistics Denmark and Danmarks Nationalbank combined with historical studies of the net financial asset position of the Danish economy for the period before official statistics is available[53].

Due to missing observations a number of estimations has been necessary. For the years 1914-1919 the net financial asset of non-residents have been estimated on the basis of the end-1913, end-1916 and end-1918 figures, the Danish surplus on the balance of payments and the Danish exports of non-monetary gold 1914-1915, 1917 and 1919[54] and the proceeds from the sale of the Danish West Indies (87 million kroner) in 1917.

The German occupation forces expenditures in Denmark during the years 1940-1945 were newer paid by Germany. They are therefore not included as liabilities in the net financial asset position of non-residents, i.e. the amounts are treated as instantaneous debt write-off by the Danish central government.

The non-financial private sector and local governments

Finally, the net financial wealth position of the "non-financial private sector and local governments" has been calculated on a residual basis. By way of construction this sector also

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[51] The Social Pension Fund was established by law in 1970, when a special national retirement pension contribution was introduced. With effect from 1982 the Act was amended and the payments to the fund ceased. The Social Pension Fund continued as an asset of the central government and the resources of the fund are used to finance pension improvements.

[52] From Hansen (1970).

[53] Cf. Hansen (1996).

[54] The available pre-World War II figures for the surplus of the balance of payment in Denmark does not include net exports of non-monetary gold, cf. Jones & Obstfeld (2001).

includes financial enterprises that are not covered by the financial sectors mentioned above (i.e. credit co-operatives, non-life insurance companies, financing companies and a few special credit institutions).

1.4. Trends in financial structures in Denmark 1875-2008 – A first exploratory analysis

The financial system plays an important role for an efficient flow of funds to consumption and real investments and thereby to the monetary transmission process. Even though the causality can not be determined a priori, both theoretical and empirical studies also indicate a link between financial-system development and long-span economic growth.[55] However, the financial-system structure is not static but changes over time. New institutions emerge and old disappear, production technologies and product compositions change, and the organisation of the financial system as well as the legal framework may vary in different periods and may have the potential to influence the economic development.[56]

Structural developments of the financial system are often to a large extent a gradual process and many of the main features of today's financial system in Denmark have deep roots in the past. The central bank of Denmark was founded in 1818 as part of the initiatives to rebuild a safe and secure currency system after the bankruptcy of the state towards the end of the Napoleonic Wars, the foundation for the Danish mortgage-credit system based on the issuance of negotiable bonds was laid down in the 1850s, and some of the key principles in the current Danish banking legislation originated in the 1930s after the large number of bank failures during the 1920s.[57] Due to e.g. fixed costs of setting up financial markets and infrastructures, financial system structures may vary significantly across countries with otherwise similar economic structures.[58] Studies of the emergence and historical development of the financial system may thus contribute to enhance our understanding of the current financial-system structure and the economic-historical development.

This section reviews briefly the main structural development trends of the financial system in Denmark based mainly on the new financial balance-sheet stock data for Denmark 1875-2008 presented in section 1.2 and 1.3.

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[55] Recent surveys on the finance-growth link are provided by e.g. Levine (1997), Trew (2005), chapter 2 in Ghatal & Sánchez-Fung (2007), and chapter 1 in Knoop (2008). Rousseau (2003) offers a historical perspective through case studies of Amsterdam (1640-1794), England (1720-1850), United States (1790-1850) and Japan (1880-1913). The case of United States 1790-1850 is elaborated in Rousseau & Sylla (2005). Burhop (2006) analyses Germany 1851-1913, Ögren (2007) covers Sweden 1834-1913 and Rousseau & Wachtel (1998) covers United States, United Kingdom, Norway, Sweden and Canada in the period 1870-1929.

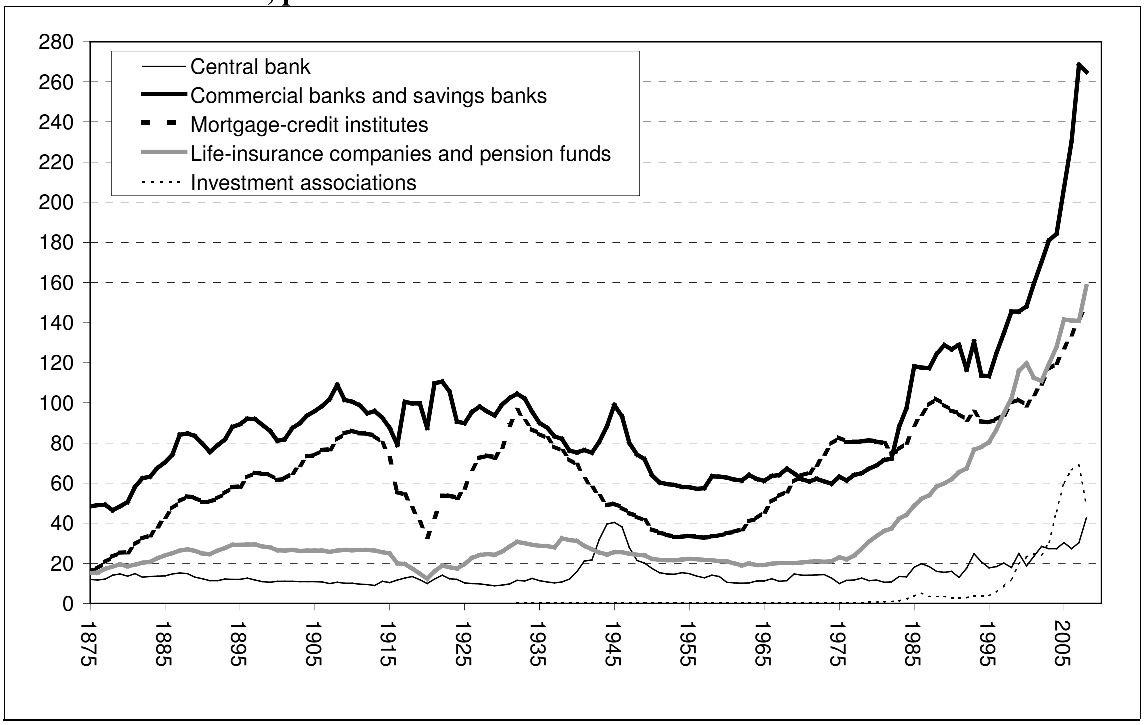
[56] Cf. e.g. Dolar & Meh (2002), Bordo & Rousseau (2006) and Ergungor (2008).

[57] Appendix A in Abildgren (2006b) offers a rather detailed account of the historical origin and development of financial markets and institutions in Denmark.

Total financial assets and total credit

Figure 1.1 shows the total financial assets in per cent of GDP at factor costs 1875-2008 by type of financial institution. Several noteworthy observations immediately leap to the eye.

Figure 1.1: The total amount of financial assets by financial sector in Denmark 1875-2008, per cent of nominal GDP at factor costs



Source: Figure 1 in Abildgren (2006b) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

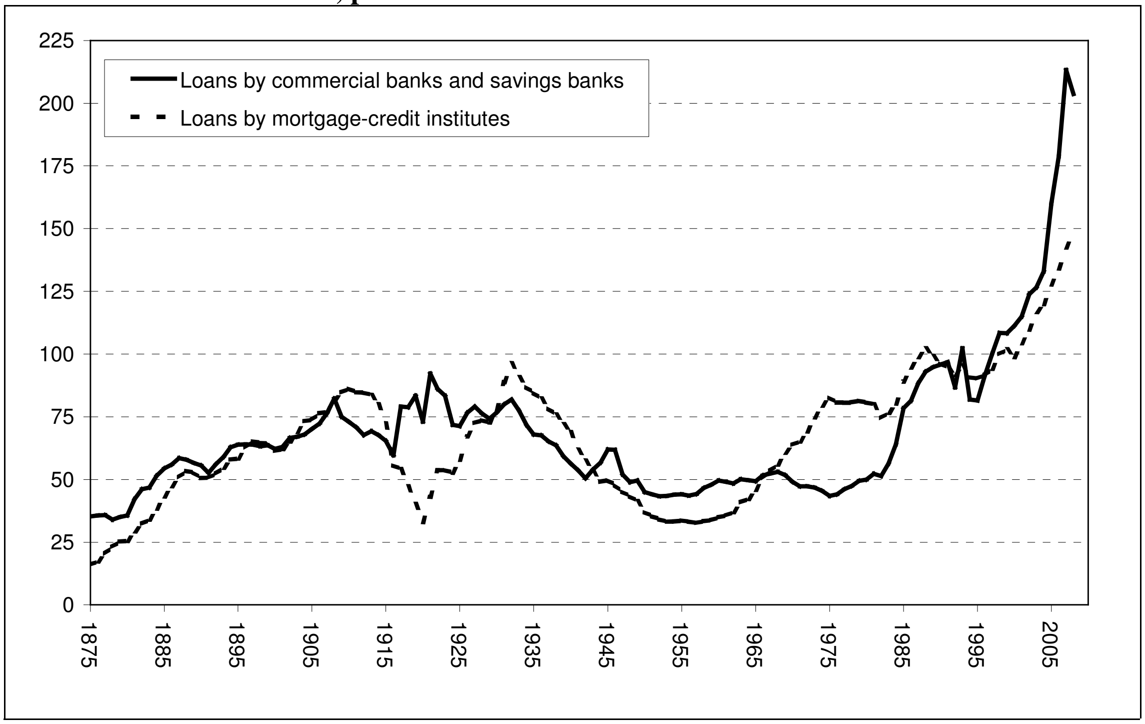
First, both the banking sector and the mortgage-credit sector played a significant credit-supplying role in the Danish economy already in the beginning of the twentieth century with financial assets for each sector amounting to around 80-100 per cent of GDP. A turning point seems to have emerged during the early 1930s, and in the middle of the 1950s the ratio of financial assets to GDP had declined to about 30 per cent for mortgage-credit institutes and 60 per cent for commercial banks and savings banks. Since then the trend has reversed but the pre-World War I levels were not reached until the decade from the mid-1970s to the mid-1980s.

The outstanding amount of loans granted by credit institutions relative to GDP at factor costs is shown in Figure 1.2. Since the main activities of these institution is the extension of credit the main development trend is similar to the development in total financial assets shown in Figure 1.1.[59]

[58] Cf. e.g. Monnet & Quintin (2007).

[59] For mortgage-credit institutes the total financial assets are by calculation method assumed to be identical to the outstanding amount of loans, cf. section 1.2 and 1.3.

Figure 1.2: Outstanding amount of loans granted by credit institutions in Denmark 1875-2008, per cent of nominal GDP at factor costs



Source: Figure 2 in Abildgren (2006b) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

Rajan & Zingales (2003) have studied the evolution in various indicators of financial development in a broad range of countries (including Denmark) for selected years during the period 1913-1999.[60] They found that by most of these measures most countries seemed to be more developed financially in 1913 than in 1980 and that only recently have the degree of financial development exceeded the 1913-level. Rajan & Zingales suggest that this may partly reflect resistance to competition in some areas in the financial sector and in industry which have only recently been overcome by deregulation of restrictions on cross-border trade and capital flows. The underlying argument put forward by Rajan & Zingales is that financial deregulation facilitates entrance of new firms and thereby enhances competition.

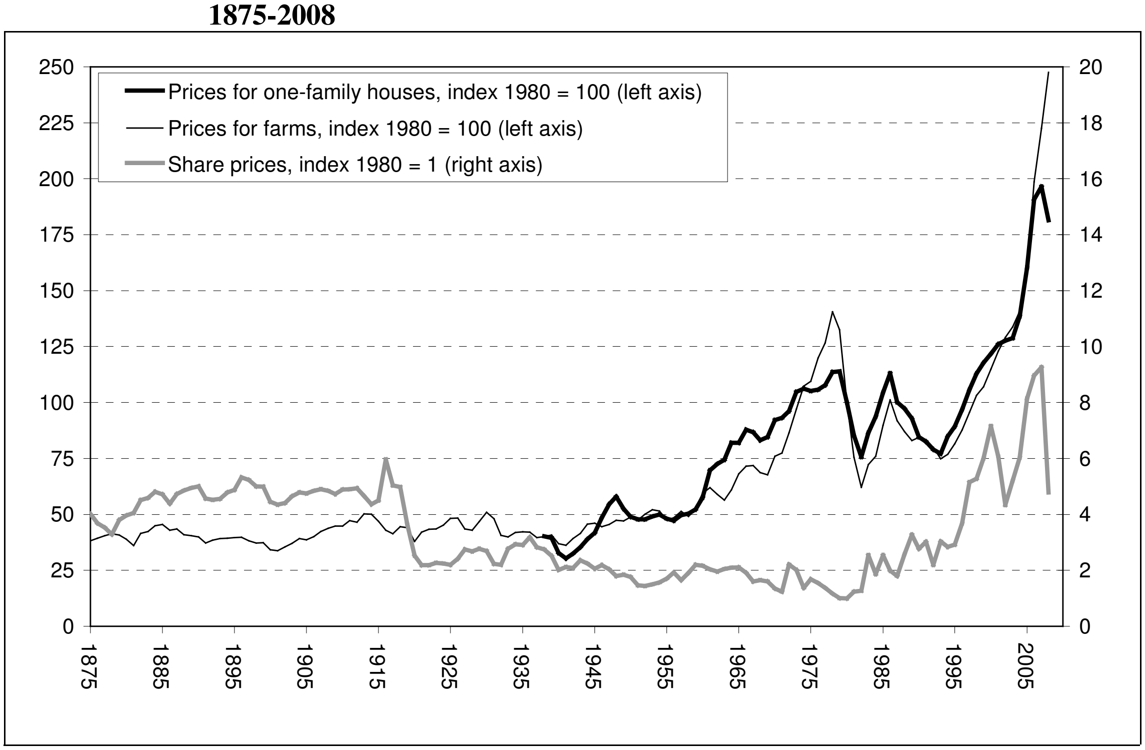
An alternative explanation might be hinted by Figure 1.3, which shows the development in share prices and property prices (all series inflation-adjusted by the CPI). To some extent real asset prices display a pattern similar to the development in total financial assets and credit relative to GDP. The long-term development trends in total financial assets and credit relative to GDP may therefore to some degree simply reflect the price development and turnover of real assets in the economy. For instance might an increase in the households' wealth caused

[60] Rajan & Zingales (2003) present four indicators: (i) The ratio of commercial bank and savings bank deposits to GDP; (ii) the ratio of the market value of equity of domestic companies to GDP; (iii) the number of domestic companies listed on the domestic stock exchange relative to the population size; and finally (iv) the ratio of funds

by rising house prices be used as collateral for loans at banks and mortgage-credit institutions ("mortgage equity withdrawal"). The turnover of real assets such as houses may in periods of rising asset prices also in itself tend to increase the overall outstanding amount of credit and deposits in the economy since the buyer will have to finance an asset acquisition at a price exceeding the outstanding mortgage debt of the seller.

Another interesting observation from Figure 1.3 can be made: The real share price index showed a downward trend in the period 1875-1980. During this period the real return from stocks came therefore from dividends rather than capital gains. Acheson *et al.* (2008) has found similar results for the London stock market 1825-1870 and notes that the return on stocks from capital appreciation rather than dividends is a phenomenon belonging to the most recent three decades.

Figure 1.3: Asset prices (inflation-adjusted by the consumer price index) in Denmark 1875-2008



Source: Figure 3 in Abildgren (2006b) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

The second major observation that can be made from Figure 1.1 is the massive growth in the assets under management by life-insurance companies and pension funds since the middle of the 1970s. The government involvement in providing old-age pension has had a significant influence on the historical development in the Danish life insurance and pension-fund industry. The establishment of a public tax-financed old-age pension scheme in 1891 and a

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raised through public equity offerings by domestic companies relative to gross fixed capital formation. The years chosen are 1913, 1929, 1938, 1950, 1970, 1980, 1990 and 1999.

tax-subsidised disability insurance system in 1921 reduced the need for private funded pension insurance. During the 1950s and 1960s funded occupational pension schemes became more common, mainly among white-collar workers, but especially during the last two decades or so privately funded labour market pension schemes have increased significantly.[61] Furthermore, the growth in the assets of the pension funds relative to GDP has been stimulated by the establishment of a number of funded social security funds, mainly the Danish Labour Market Supplementary Pension Fund (ATP, founded in 1964) and the Employees' Wage Indexation Fund (LD, established in 1980).

The third major trend visible from Figure 1.1 is the rapid growth in assets managed by collective investment funds since the mid-1990s. However, one should take in into account that the particular strong increase around 2003/2004 can partly be attributed to the establishment of investment associations related to pension funds, cf. section 1.3.

Finally, one may notice the relatively small amount of assets managed by the central bank in most of the period since 1875. During the late 19th century private banks and mortgage-credit institutes had already developed into significant credit-supplying institutions, and the central bank could therefore concentrate on being banker to the banks and (from 1914) the central government. Only the years around World War II and the years 2007-2008 following the subprime-crisis show significant fluctuations in the level of central-bank assets relative to GDP. The temporary increase in the balance sheets around World War II was caused by the German occupation forces expenditures in Denmark 1940-1945 that were compulsorily financed via German accounts at the central bank against a guarantee from the Danish central government, cf. section 1.3. The increase in the balance sheets in 2007-2008 reflects an increased level of foreign-exchange reserves as well as several new lending facilities established by the Nationalbank in order to provide the Danish banking sector with sufficient liquidity in kroner, euro and US-dollar during the subprime-crisis.

Money

Figure 1.4 shows the ratio of the stock of broad money relative to nominal GDP at factor costs 1875-2008. This broad cash ratio can be seen as the reciprocal value of the velocity of broad money. The stock of broad money grew faster than nominal GDP until the early 1920s even though the opportunity costs of holding money (proxied by the differential between the long-term government bond yield and the deposit rate[62]) remained approximately constant.

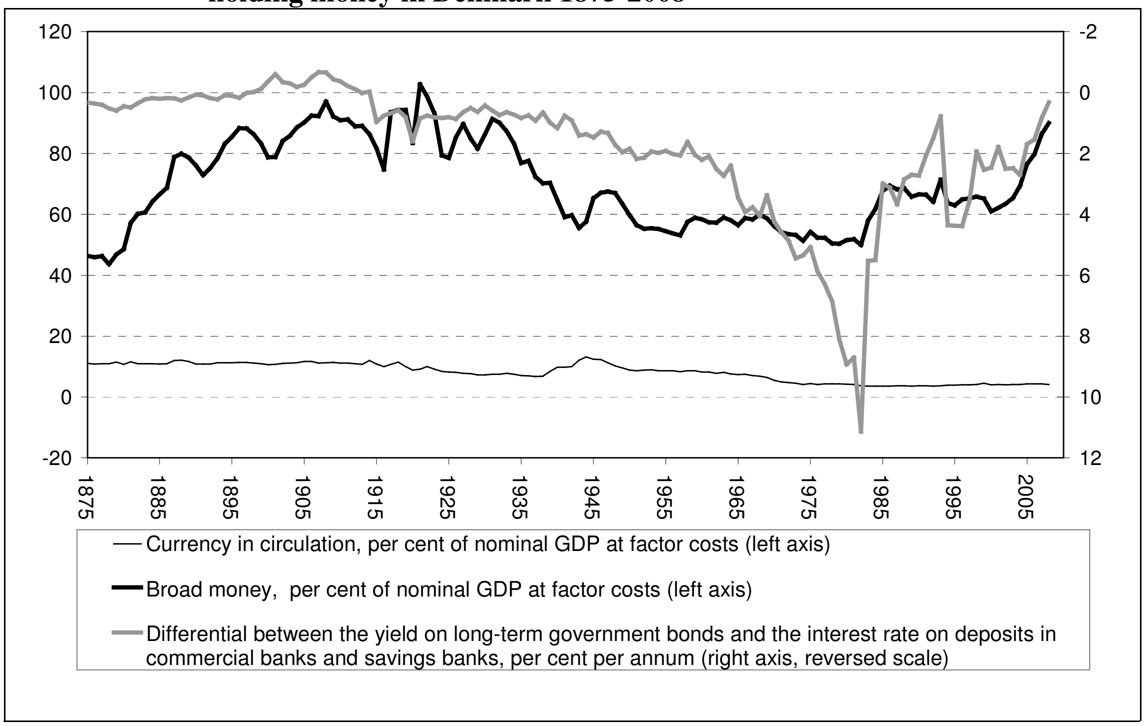
[61] When assessing the relative growth of the pension fund industry in Denmark one has to take into account the right to deduct contributions to most private and occupational pension schemes from the taxable income. Pension benefits are then subsequently subject to taxation when benefits are paid out, cf. Møller & Nielsen (2000).

[62] Some authors, e.g. Nielsen (2007), make use of a more refined measure of opportunity costs taking into account that the high-powered money part of the broad money stock (e.g. notes and coins) earns an own interest rate of zero.

From the early 1920s to the early 2000s the ratio of broad money to GDP showed generally a declining trend.[63]

The implied U-shaped pattern of the long-run velocity of broad money is also a typical finding in studies covering other countries.[64] This development may to some extent reflect an increased degree of monetisation of the economy until the early 1920s followed by an increased degree of sophistication of the public's management of their liquidity (e.g. via cheque accounts and later electronic debit cards), the development of close substitutes to money offered by the banking system (e.g. giro and overdraft facilities) and the emergence of non-bank financial intermediaries such as investment funds.

Figure 1.4: Currency in circulation, broad money stock and the opportunity costs of holding money in Denmark 1875-2008



Source: Figure 4 in Abildgren (2006b) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

Taking a closer view on the post-1930 period in Figure 1.4 one might also sense a slightly downward trend in the broad cash ratio until the early 1980s followed by a slightly upward trend. This pattern seems to mirror the development in the opportunity costs of holding money.

The ratio of currency in circulation relative to GDP at factor costs in Figure 1.4 has generally shown a downward trend during most of the post-1875 period reflecting the increased significance of bank money relative to notes and coins.

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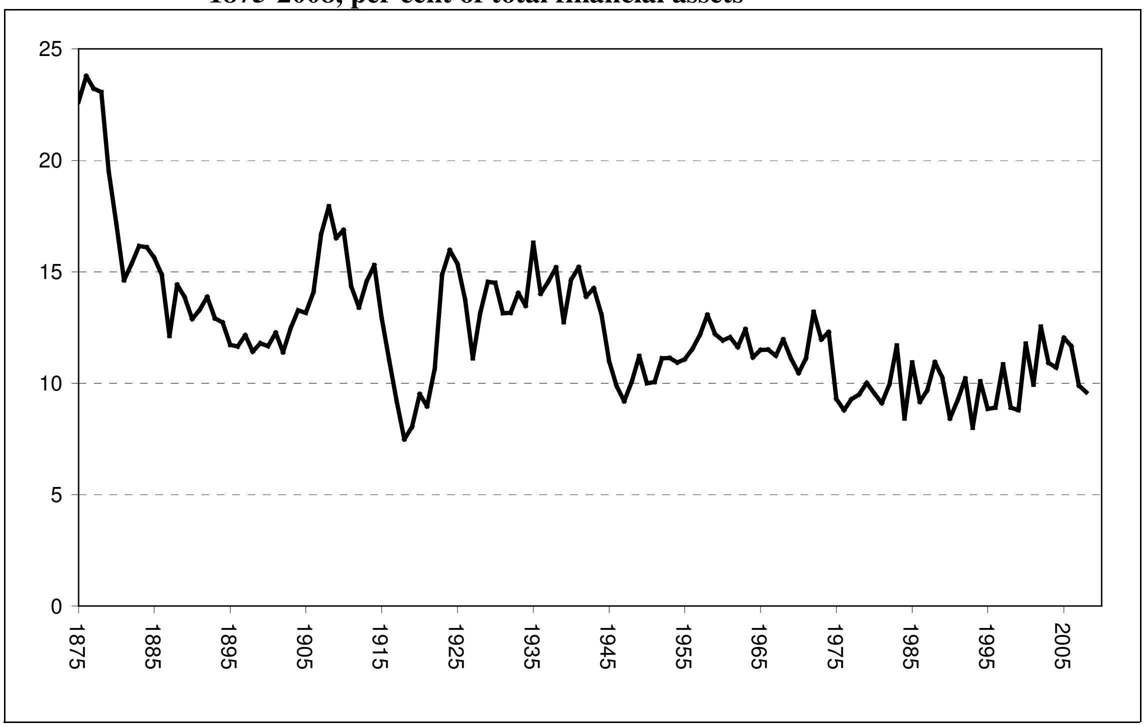
[63] Cf. also the study of the Danish money demand 1875-1985 in Kærgård (1991).

[64] Cf. e.g. Bordo (1986), Ireland (1991), Bordo & Jonung (2003) and Eitrheim *et al.* (eds.) (2004).

The capital ratio of the banking system

Figure 1.5 shows the amount of capital and reserves in commercial banks and saving banks in per cent of their outstanding amount of financial assets. Even though these data must be treated with caution[65] they indicate that the capital ratio of the Danish banking system has declined over time. In particular it is worth to notice that the capital ratio was rather high even before the first Danish Commercial Bank Act in 1919 laid out provisions on capital requirements for commercial banks. This finding is consistent with the findings in e.g. Hansen (1991) and Kjeldsen (2004) covering Danish commercial banks only.

Figure 1.5: Capital and reserves of commercial banks and saving banks in Denmark 1875-2008, per cent of total financial assets



Source: Figure 5 in Abildgren (2006b) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

According to Hansen, *op.cit.*, the high capital ratio in the initial stages of the commercial banking system in Denmark can to some degree be attributed to an underestimation of the potential scope of deposits from the public. However, a decline in bank's capital ratio over time is also found in e.g. the USA where the ratio fell from just below 55 per cent in the 1840 to around 6-8 per cent in the period 1940-1993, cf. Berger *et al.* (1995). In the early 1860s the capital ratio had already declined significantly to below 40 per cent. Berger, *op.cit.*, explains

[65] Due to the fact that the item "capital and reserves" used in Figure 1.5 has been compiled on a residual basis and that only the major financial assets and liabilities – and no fixed assets – have been taken into consideration in the calculations. Furthermore, as mentioned in section 1.3 accounting standards and practices are not fully comparable over time.

this development with reduced risk of bank failures due to the introduction of clearinghouses and improved market integration. The regulation of banks contained in the National Banking Act of 1863 limited the amount of risks that banks were allowed to assume and the capital ratio fell gradually to around 15 per cent in 1914. The creation of the Federal Reserve System in 1914 and the regulatory initiatives in the Emergency Banking Act of 1933 (deposit insurance and maximum interest-rate payments on deposits) led to a further decline in the solvency ratio of the US banking system. It seems plausible that the gradually tighter regulation of the Danish-banking sector during the 20th century in a parallel way might have contributed to the observed downward trend in the capital ratio observed in Figure 1.5.

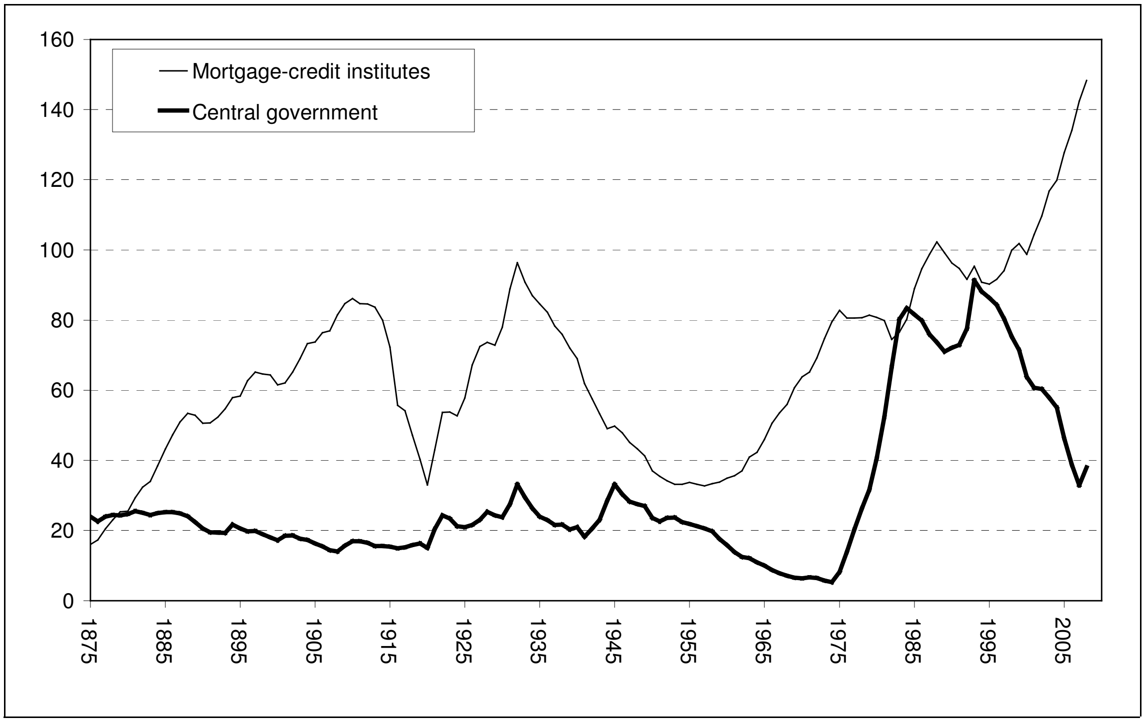
Another interesting observation from figure 1.5 is the increase in the capital ratio around the banking crisis in 1907/08 and in the first half of the 1920s. From 1906 to 1908 the capital ratio rose from 14 to 18 per cent. This increase can be attributed to an increased capital base in the banking system, which also allowed for a 24 per cent increase in the outstanding amounts of loans from 1906 to 1908. From 1921 to 1924 the capital ratio of the banking system increased from 9 to 16 per cent. This could only partly be explained by the development in the bank's capital base. The outstanding amount of loans fell also significantly – by 16 per cent from 1921 to 1924 despite a strong growth in the real economy. This should be viewed in light of the severe crisis in the Danish banking system in the 1920s. Landmandsbanken – the largest bank in Scandinavia – was reconstructed several times in the period 1922-1928 with help from the Nationalbank and the central government.[66]

Capital markets and inter-bank activity

Figure 1.6a shows the outstanding amount of bonds issued by Danish mortgage-credit institutes and the Danish central government in per cent of GDP. The Danish market for mortgage bonds dates back to the late 18th century. The expansion of the mortgage-credit system for the financing of real property in Denmark after 1850 laid the foundation for the development of a large market for mortgage bonds. The outstanding amount of government bonds was relatively small compared to the mortgage bond market until the mid-1980s. Long-term callable mortgage-credit annuity bonds served therefore as the market "benchmark" until the early 1990s where this role was taken over by 10-year government bullet bonds.

[66] Hansen, P. H. (1996) offers a thorough study of the course and causes of the Danish banking crisis in the interwar period. Mørch (1986) offers a detailed description of the crisis of Landmandsbanken in the 1920s.

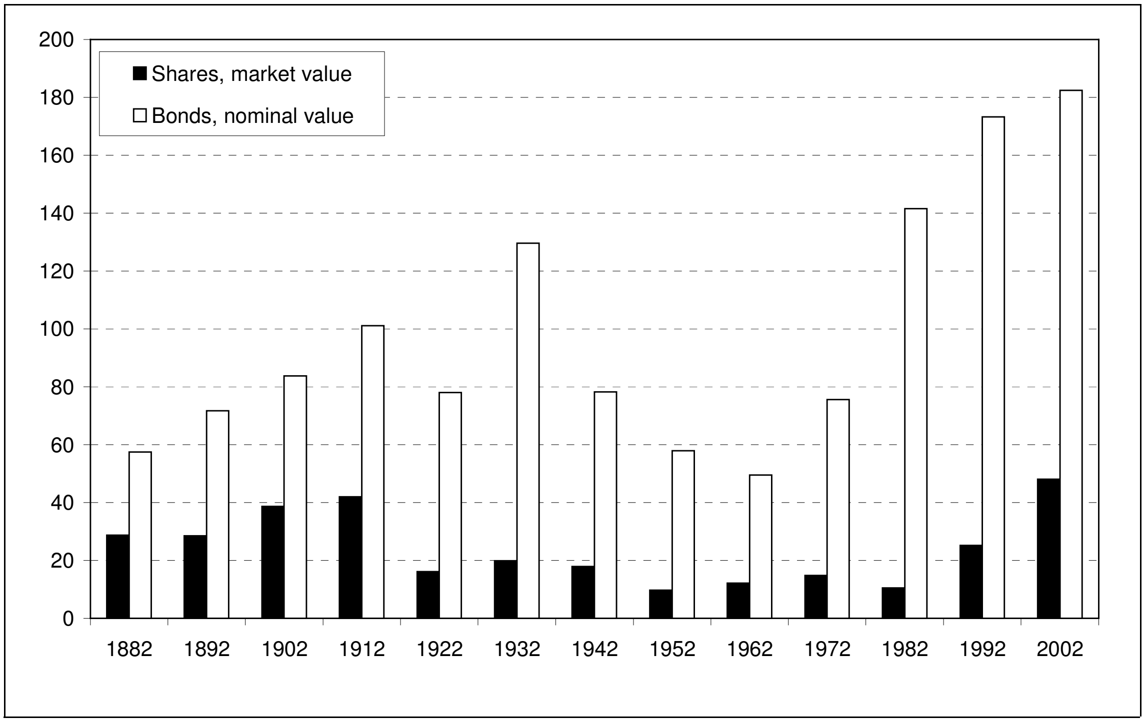
Figure 1.6a: Outstanding amount of bonds by main issuer in Denmark 1875-2008, per cent of nominal GDP at factor costs



Source: Figure 6a in Abildgren (2006b) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

The size of the Danish stock market has always been relatively small compared to the Danish bond market, cf. Figure 1.6b. This should be viewed in light of the large mortgage-credit sector that also finance buildings acquired by the Danish firms (including agricultural properties). The literature on financial structures often focuses on the degree to which a financial system is market based or intermediate based. Although the size of the direct issues of exchange-listed bonds and shares by the Danish non-financial corporate sector has always been relatively modest the financial system is actually to a high degree "indirectly" market based due to the large bond-financed mortgage-credit sector.

Figure 1.6b: Size of the Danish capital market 1882-2002, outstanding amount in per cent of nominal GDP at factor costs



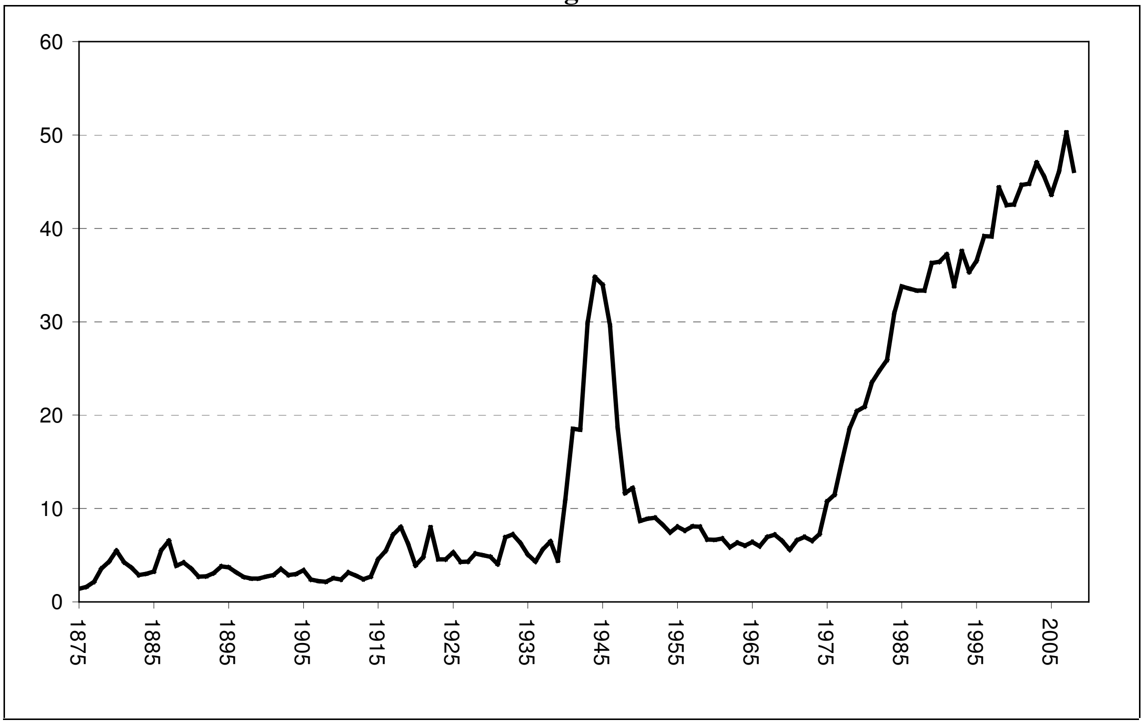
Notes: Covers Danish shares listed on the Copenhagen Stock Exchange and the total amount of bonds issued by Danish commercial banks, savings banks, mortgage-credit institutes and the Danish central government. Share capital is stated at nominal values prior to 1922.

Source: A slightly revised version of Figure 6b in Abildgren (2006b).

Figure 1.6c shows an indicator for the share of inter-bank funding in the Danish-banking sector. The figures include deposits held by non-residents, of which a large amount comes from non-resident banks. Disregarding the special liquidity situation around World War II the level of inter-bank activity was relatively moderate until the early 1970s. A krone-denominated inter-bank market was established in Denmark in the late 1960s and it took a more organised form in 1970 when an UK money-market broker began his activity in Denmark through a branch office.[67] Since the early 1970s the significance of inter-bank activity has increased markedly.

[67] Cf. page 191 in Mikkelsen (1993).

Figure 1.6c: An indicator for development in inter-bank funding (including deposits by non-residents) in Denmark 1875-2008, per cent of total assets in commercial banks and savings banks



Notes: Inter-bank funding is compiled as total deposits in commercial banks and savings banks + currency in circulation – broad money – currency held by commercial banks and savings banks. The figures include therefore non-resident deposits in Danish commercial banks and savings banks as well as non-monetary deposits in Danish commercial banks and savings banks made by residents.

Source: Figure 6c in Abildgren (2006b) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

Net financial asset positions

Figure 1.7 shows the net financial assets by main sector 1875-2008 in per cent of GDP at factor costs. During most of the period non-residents have had a positive net financial asset position vis-à-vis Danish residents, i.e. Denmark has had an external debt on a net basis.[68]

In the pre-World War II period the central government had consistently a negative net financial asset position equivalent to around 15-30 per cent of GDP and the large fluctuations in Denmark's external debt was mirrored by large fluctuations in the net financial asset position of other residents.[69]

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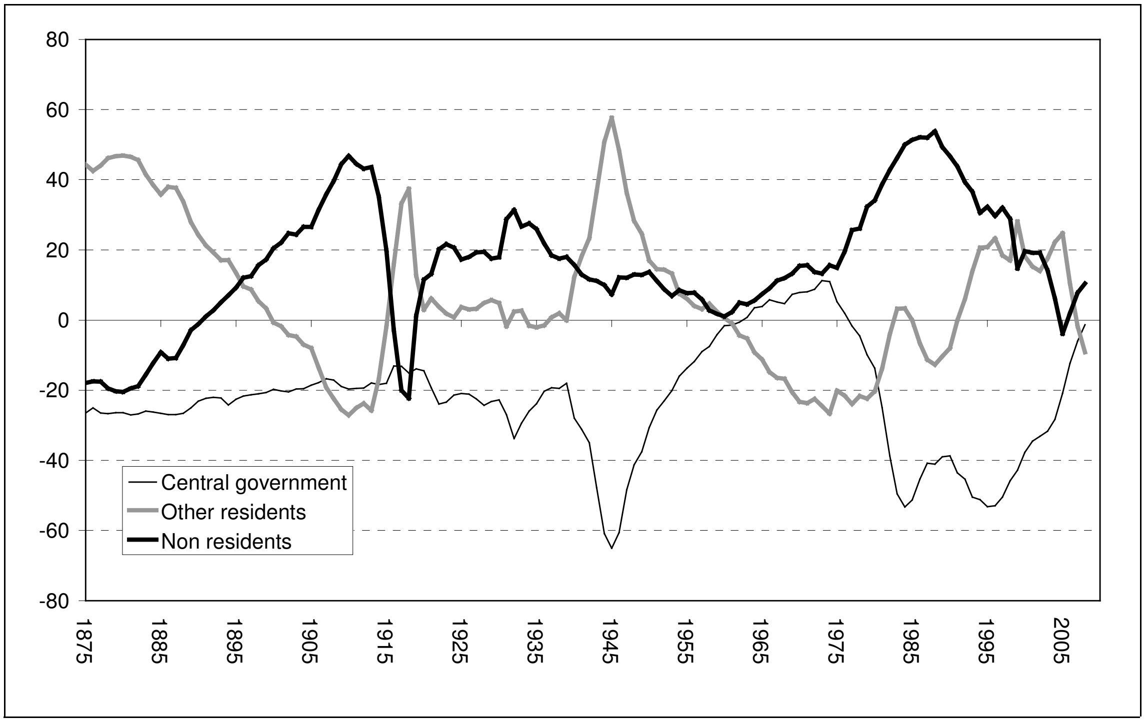
[68] For long-span studies on the development of the current account on the Danish the balance of payments and Denmark's international investment position, one may refer to Gelting (1972) and Hansen (1996). Christensen & Hald (2000) and Pedersen (2003) cover the most recent decades.

[69] Long-span studies on the development of the public finances in Denmark are found in e.g. Rasmussen (1972), Norstrand (1977) and Abildgren (2006c). To the knowledge of the author of the essay at hand no long-span studies on the development of private sector net financial assets in Denmark are available. However, for the most recent decades one may refer to e.g. Ølgaard (1992). Furthermore, for selected periods other authors have previously compiled complete or partial financial-accounts data for Denmark that may enlight this issue, cf. the references referred to in section 1.1.

Figure 1.7: Net financial assets by sector in Denmark 1875-2008, per cent of nominal GDP at factor costs



Source: Figure 7 in Abildgren (2006b) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

During World War II the net financial asset position of the central government deteriorated markedly reflecting the German occupation forces' expenditures in Denmark during the years 1940-1945 compulsorily financed via German accounts at Danmarks Nationalbank against a guarantee from the Danish central government.[70] Since there was a general shortage in the supply of goods the net financial asset position of other residents improved significantly.[71]

Since the end of World War II there have been substantial swings in the net financial asset position of the central government relative to GDP and these have to a high degree been mirrored in the net financial asset position of other residents.

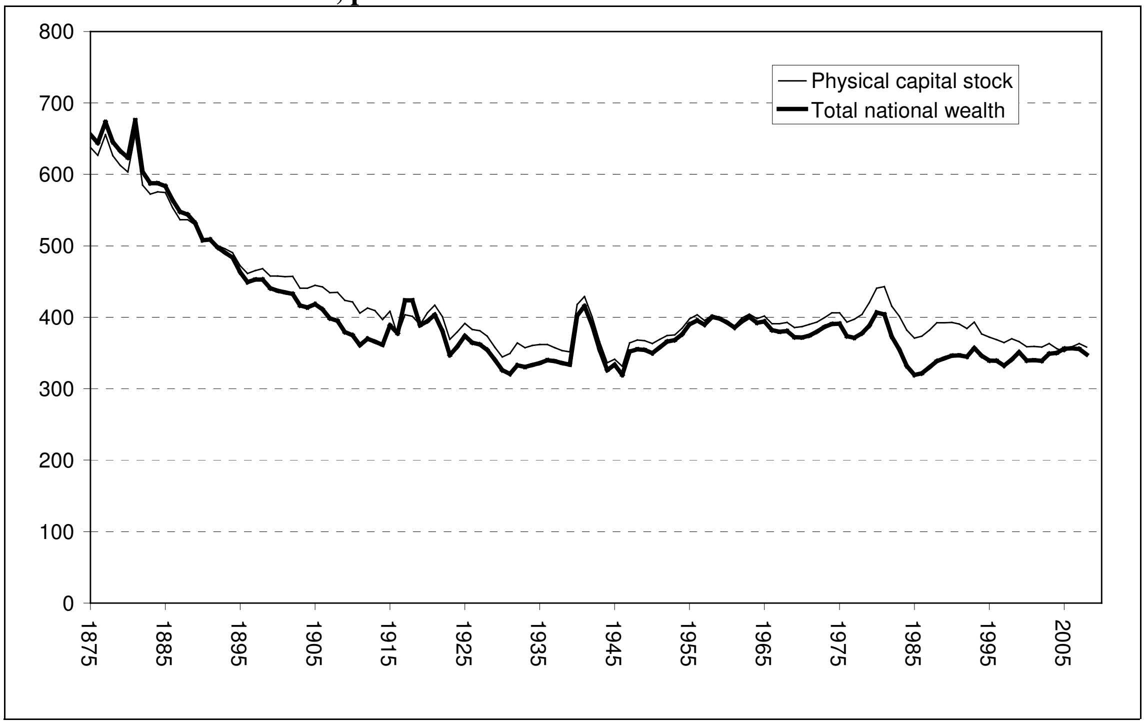
In the post-1875 period there has been a negative correlation between the central government's and other resident's net financial asset position relative to GDP. The correlation coefficient is -0.5 in the period 1875-1939 and -0.7 in the period 1940-2008. Whether this

[70] The German occupation forces expenditures in Denmark during the years 1940-1945 were newer paid by Germany. The amounts are therefore treated as instantaneous debt write-off by the Danish central government in the statistics behind Figure 1.7.

[71] Cf. also the regime-classification discussion of the Danish economy during World War II within the framework of fixed-price models (quantity rationing models) in Topp (1986).

“stylised fact” is the result of the principle of Ricardian Equivalence[72] or just reflects automatic stabilisers[73] is naturally open for debate.[74]

Figure 1.8: The size of the physical capital stock and national wealth in Denmark 1875-2008, per cent of GDP at factor costs



Source: Figure 8 in Abildgren (2006b) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

The national wealth

Figure 1.8 shows the physical capital stock and national wealth since 1875 in per cent of GDP at factor costs. The figures for the physical capital stock represent the replacement value of non-financial assets used in production[75], and the national wealth is compiled as the sum of the physical capital stock and the net financial asset position of the Danish economy.[76]

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[72] According to the Ricardian Equivalence Theorem an increased level of government debt will – under the assumption of rational expectations – be meet by increased wealth accumulation in the private sector in order to able to pay higher future taxes when the government debt has to be paid off.

[73] The line of reasoning is the following: If an increase in private sector savings surplus and wealth accumulation causes slow economic growth and increased unemployment the government’s expenditures on unemployment benefits will increase and the government’s direct and indirect tax revenue will decline and thereby reduce the government savings surplus and wealth accumulation.

[74] Cf. e.g. page 485 and forward in Sørensen & Whitta-Jacobsen (2005) for a discussion hereof in a Danish context covering the most recent decades.

[75] The delimitation of the capital stock follows the definitions from the national-account statistics. This implies that the capital stock includes residential buildings (excluding the value of land) but not e.g. consumer durable goods.

[76] It could of course, theoretically, be argued to include land values, consumer durable goods and certain other items (e.g. the capitalised value of land taxes and human capital) in the national-wealth figures. For studies on the national wealth in Denmark, cf. Sørensen (1978) and Kærgård (1992) and references therein.

During the last quarter of the 19th century and the first quarter of the 20th century the national wealth declined from around 650 to 350 per cent of GDP, mainly as a result of a lower capital-output ratio. Since then the national wealth have been broadly constant relative to GDP. During the whole post-1875 period the net financial asset position have been relative insignificant compared to the value of the physical capital stock.

The downward trend in the capital-output ratio in the period 1875-1910 may seem somewhat surprising since several authors have placed the “industrial break-through” in Denmark to this period, cf. e.g. the review in Kristensen (1989). According to Kærgård (1991) – the source behind the physical capital stock in the pre-1965 period – the capital-output ratio has also been more stable in e.g. the USA and Germany during the same period. However, one should also take into account that the capital-output ratio in Figure 1.8 uses value added as the output measure. If one instead uses production value as the output measure and a narrower sectoral delimitation, the capital-output ratio has been more stable in the period 1875-1910, cf. the calculations for the non-agricultural sector on page 145 in Kærgård, *op. cit.* The downward trend in the capital-output ratio in the period 1875-1910 may therefore partly reflect a shift in the economy towards less capital-intensive sectors (service industries).

1.5. The cyclical variation in money, credit, prices and output in Denmark 1875-2005 – A few stylised facts from band-pass filters

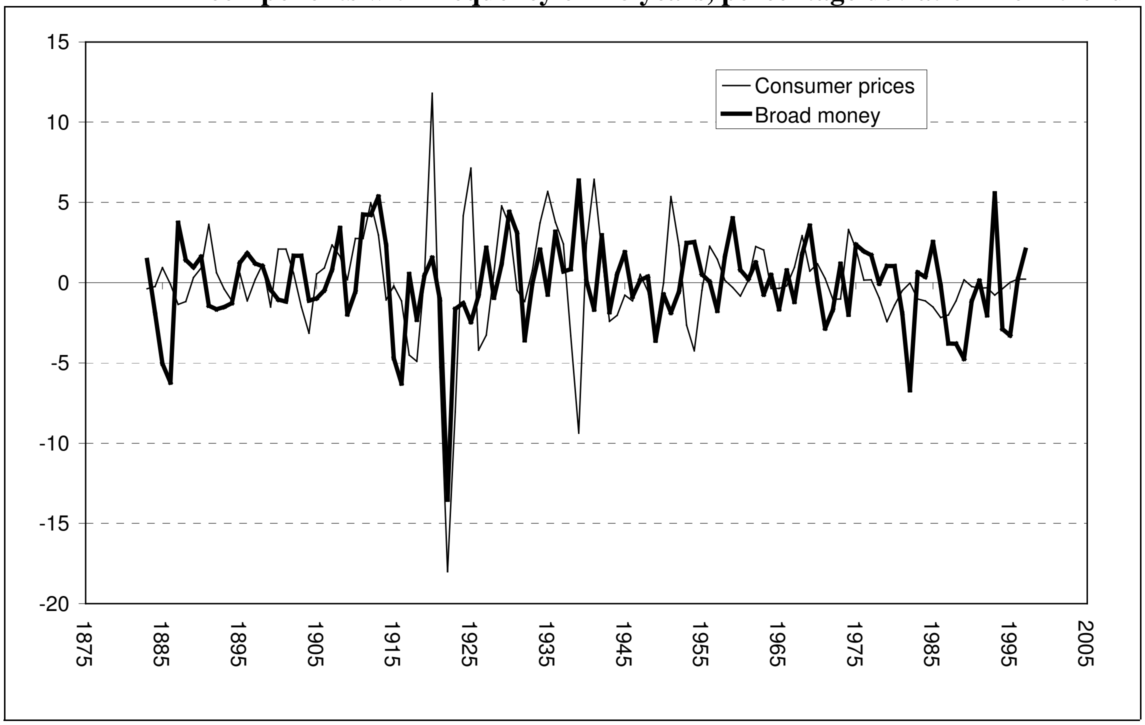
Filtering methods are commonly used in an attempt to uncover the more or less “pure” stylised facts and empirical regularities of the cyclical movements and co-movements of the variables. The co-movement between money or credit aggregates and prices or output is usually the “classical” starting point in studies on the transmission mechanism between the financial and real sectors of the economy. The results of such exercises are purely descriptive and do not explain the underlying economic causal relationships. However, they might give some useful information, which can be used in a wider structural interpretation of the monetary and financial development.

This section reviews briefly the short- and longer-term cyclical correlation pattern between money or credit and prices or output using the Baxter-King band-pass filter on some of the main time series presented in section 1.2 to 1.4. Business cycles will be delimited to 2-8 years and long-term cycles to 8-40 years. Naturally, such limitations are more or less arbitrary, but the chosen definitions follow those applied as standard in the literature, see also the discussion in annex 1.C.

Broad money and prices

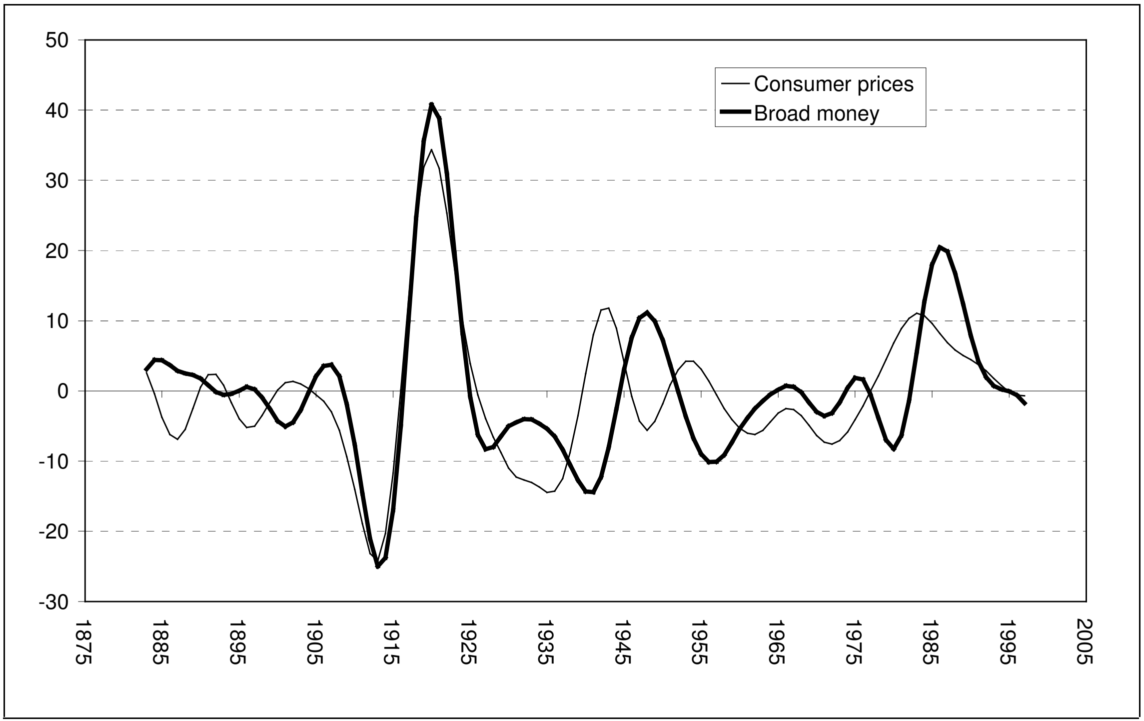
Figure 1.9a shows the extracted business cycle components from consumer prices and the stock of a broad monetary aggregate whereas Figure 1.9b covers the long-term cyclical components extracted from the two series. All the cyclical components are expressed as deviations from the trend measured in per cent. A range of dynamic cross-correlations with attached significance probabilities is reported in Table 1.3a.

Figure 1.9a: Broad money and consumer prices in Denmark 1875-2005, cyclical components with frequency of 2-8 years, percentage deviation from trend



Source: Figure 9a in Abildgren (2006b).

Figure 1.9b: Broad money and consumer prices in Denmark 1875-2005, cyclical components with frequency of 8-40 years, percentage deviation from trend



Source: Figure 9a in Abildgren (2006b).

Table 1.3a: Broad money (M) and consumer prices (P) in Denmark 1875-2005, dynamic cross-correlations between cyclical components

	1875-2005		1875-1945		1946-2005	
	Correlation coefficient between P(t) and M(t+j)	Significance probability	Correlation coefficient between P(t) and M(t+j)	Significance probability	Correlation coefficient between P(t) and M(t+j)	Significance probability
Cycles of 2-8 years						
j = -2	-0.010	0.9168	-0.006	0.9630	-0.034	0.8137
j = -1	0.162	0.0857	0.224	0.0795	-0.059	0.6824
j = 0	**0.264**	**0.0043**	**0.355**	**0.0043**	-0.063	0.6567
j = 1	0.223	0.0169	0.234	0.0667	0.208	0.1435
j = 2	0.048	0.6163	-0.037	0.7798	**0.380**	**0.0066**
Cycles of 8-40 years						
j = -8	-0,320	0,0008	-0,455	0,0005	0,108	0,4863
j = -7	-0,277	0,0038	-0,416	0,0014	0,182	0,2311
j = -6	-0,190	0,0478	-0,314	0,0175	0,246	0,0998
j = -5	-0,058	0,5460	-0,149	0,2649	0,289	0,0487
j = -4	0,111	0,2451	0,064	0,6307	0,308	0,0329
j = -3	0,301	0,0013	0,300	0,0200	0,307	0,0319
j = -2	0,486	0,0000	0,528	0,0000	0,297	0,0360
j = -1	0,638	0,0000	0,713	0,0000	0,298	0,0334
j = 0	0,731	0,0000	0,821	0,0000	0,325	0,0188
j = 1	**0,747**	**0,0000**	**0,829**	**0,0000**	0,372	0,0072
j = 2	0,682	0,0000	0,734	0,0000	0,432	0,0018
j = 3	0,548	0,0000	0,551	0,0000	0,492	0,0003
j = 4	0,370	0,0001	0,310	0,0169	0,539	0,0001
j = 5	0,176	0,0657	0,054	0,6862	**0,560**	**0,0000**
j = 6	-0,004	0,9695	-0,171	0,2033	0,550	0,0001
j = 7	-0,148	0,1260	-0,333	0,0121	0,504	0,0004
j = 8	-0,246	0,0107	-0,419	0,0015	0,425	0,0040

Notes: The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of prices and money and a constant included. The Null hypothesis is zero correlation. Bold numbers indicates peak cross-correlations in the table.

Source: Table 2a in Abildgren (2006b).

At the business cycle frequency the correlation coefficients have in general been relatively small, and Table 1.3a indicates that correlation patterns may have changed over time. In the pre-1946 period the contemporaneous correlation seems to have been positive and significant at a 5 per cent level. In the post-World War II period the contemporaneous correlation coefficient is negative and not significant different from zero. In this period the peak correlation is also positive, but prices seem to have led money with 2 years.

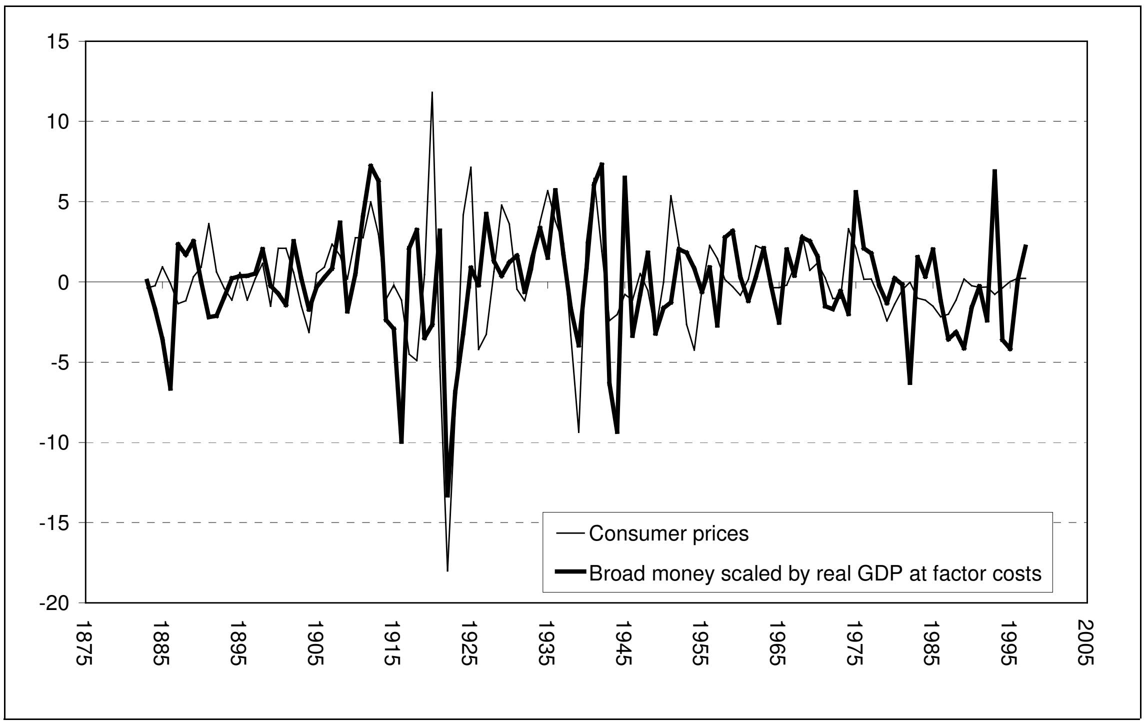
At the long-term frequency the contemporaneous correlation between money and prices has in general been positive and much higher than at the business cycle frequencies. However, measured by the peak correlations prices seem to lead money, and the lead-time have been somewhat longer in the post-World War II (5 years) period than in the pre-1946 period (1 year).[77]

[77] Naturally it is somewhat arbitrary to split the total sample 1875-2005 in two (pre-1946 and post-World War II). However, looking at Figure 1.9b and Figure 1.9d correlation patterns seem to have changed around the decades immediately prior to and after World War II.

A division of the total sample in more than 2 periods would of course be desirable. However, one have to take into account the low data frequency (annual observations) and the choice of the cut-off parameter (K=8) in the Baxter-King band-pass filter (cf. annex 1.C), which causes a loss of observations in the beginning and the end of the time series being filtered.

Figure 1.9c-1.9d shows the extracted business cycle components from consumer prices and the stock of broad money scaled with the level of real GDP at factor costs.[78] Dynamic cross-correlations are reported in Table 1.3b. When one takes into account the level of economic activity there seems to be an even closer relationship between money and prices. Prices still seem to have led money in the post-World War II period measured by the peak correlations. However, at the lowest frequencies (8-40 years cycles) there appear also to be several large and significant positive correlation coefficients between prices and the lagged values of broad money.

Figure 1.9c: Broad money scaled by real GDP and consumer prices in Denmark 1875-2005, cyclical components with frequency of 2-8 years, percentage deviation from trend

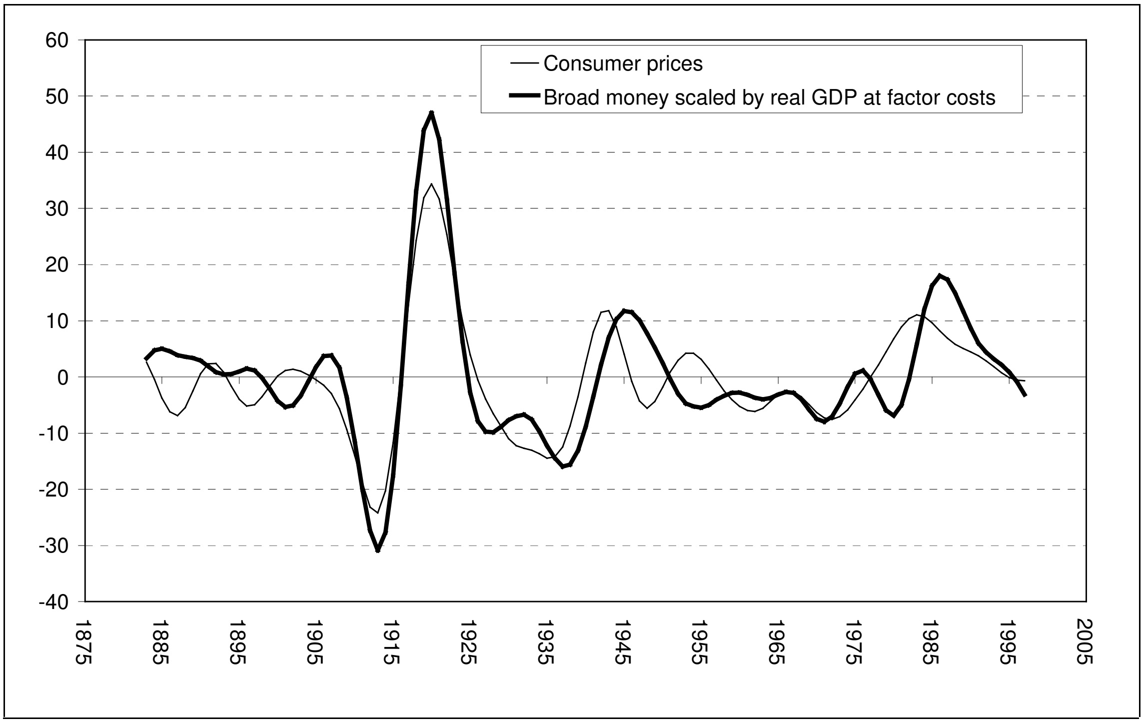


Source: Figure 9c in Abildgren (2006b).

It could be argued to exclude the periods around World War I and II from the sample due to large movements in nominal variable in those periods. However, when studying long-run relationships between nominal variables such "shocks" are in fact particularly interesting.

[78] The underlying philosophy behind this scaling is the classical equation of exchange: MV = PY where M denote the nominal stock of broad money, V the velocity of money, P the price level and Y real output. Figure 9c-9d and Table 1.3b thus study the relationship between M/Y and P.

Figure 1.9d: Broad money scaled by real GDP and consumer prices in Denmark 1875-2005, cyclical components with frequency of 8-40 years, percentage deviation from trend



Source: Figure 9d in Abildgren (2006b).

Long-span studies for other countries tend also to find a much stronger positive correlation between money and prices in the longer run than in the short run.[79] Regarding the stability of the correlation patterns the findings seem to be more mixed. However, for most other countries money seems to be contemporaneous with or to lead prices measured by peak correlations, although exceptions occur.

The results from such filtering exercises may of course be affected by the choice of filtering methods and the general uncertainty surrounding the estimation of the cyclical components, the definition of the frequency bands and the applied concept of prices and monetary aggregate. Furthermore, the data frequency (annual, quarterly or monthly) is likely to be of importance, particularly regarding the short-run relationship between money and prices. Also the type of monetary regime and the degree of openness of the economy (including the extent of restrictions on cross-border capital mobility) can play an important role. Furthermore, in a study covering more than century there is naturally also a question regarding data quality to consider.

[79] Cf. e.g. Christiano & Fitzgerald (2003a), Dewald & Haug (2004) and Benati (2005).

Table 1.3b: Broad money scaled by real GDP (M/Y) and consumer prices (P) in Denmark 1875-2005, dynamic cross-correlations of cyclical components

	1875-2005		1875-1945		1946-2005	
	Correlation coefficient between P(t) and M(t+j)/Y(t+j)	Significance probability	Correlation coefficient between P(t) and M(t+j)/Y(t+j)	Significance probability	Correlation coefficient between P(t) and M(t+j)/Y(t+j)	Significance probability
Cycles of 2-8 years						
j = -2	0.026	0.7876	0.046	0.7263	-0.127	0.3807
j = -1	0.062	0.5101	0.112	0.3878	-0.121	0.3987
j = 0	0.393	0.0000	**0.450**	**0.0002**	0.154	0.2766
j = 1	**0.397**	**0.0000**	0.400	0.0013	**0.412**	**0.0027**
j = 2	-0.020	0.8339	-0.091	0.4874	0.280	0.0489
Cycles of 8-40 years						
j = -8	-0,357	0,0002	-0,463	0,0004	0,114	0,4620
j = -7	-0,310	0,0011	-0,409	0,0018	0,201	0,1844
j = -6	-0,207	0,0304	-0,288	0,0301	0,267	0,0734
j = -5	-0,047	0,6263	-0,099	0,4611	0,307	0,0359
j = -4	0,160	0,0926	0,144	0,2776	0,327	0,0234
j = -3	0,389	0,0000	0,409	0,0012	0,337	0,0180
j = -2	0,606	0,0000	0,655	0,0000	0,353	0,0119
j = -1	0,772	0,0000	0,837	0,0000	0,396	0,0040
j = 0	**0,856**	**0,0000**	**0,918**	**0,0000**	0,474	0,0004
j = 1	0,843	0,0000	0,886	0,0000	0,571	0,0000
j = 2	0,733	0,0000	0,742	0,0000	0,658	0,0000
j = 3	0,548	0,0000	0,512	0,0000	0,721	0,0000
j = 4	0,323	0,0005	0,236	0,0723	**0,749**	**0,0000**
j = 5	0,093	0,3328	-0,040	0,7680	0,742	0,0000
j = 6	-0,108	0,2621	-0,269	0,0431	0,699	0,0000
j = 7	-0,261	0,0065	-0,426	0,0011	0,624	0,0000
j = 8	-0,355	0,0002	-0,504	0,0001	0,520	0,0003

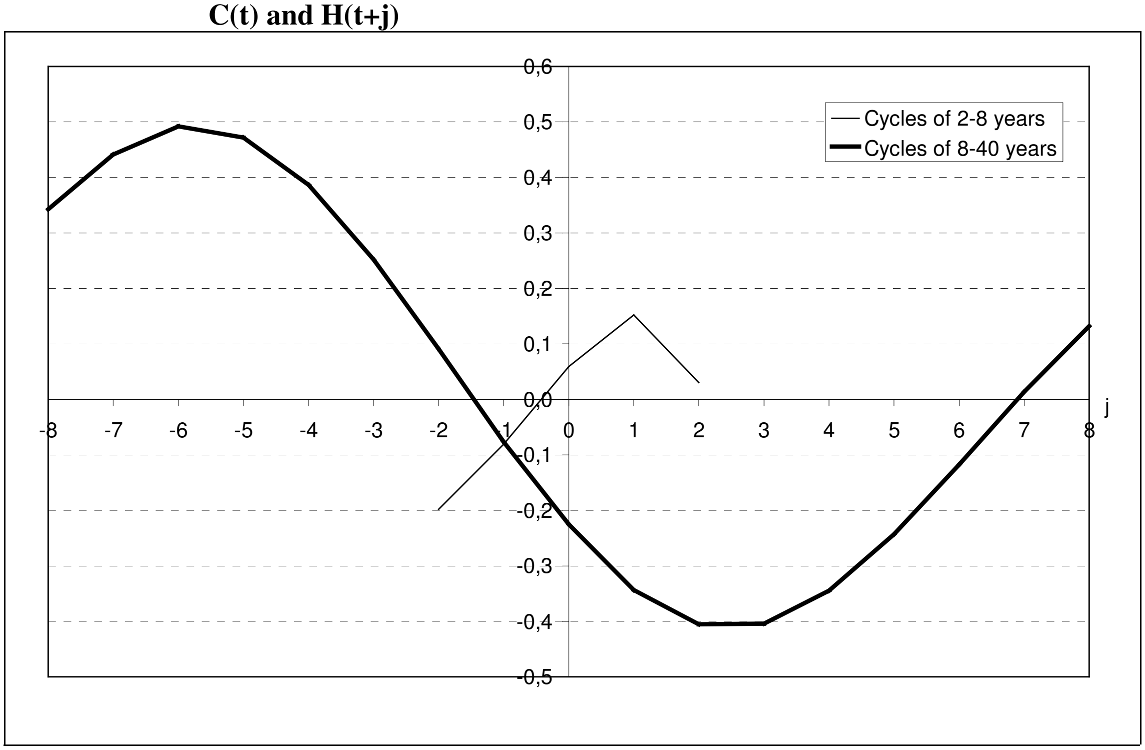
Notes: The significance probabilities relate to the slope parameter in an OLS-regression between the cyclical components of prices and money (scaled by real GDP) and a constant included. The Null hypothesis is zero correlation. Bold numbers indicates peak cross-correlations in the table.

Source: Table 2b in Abildgren (2006b).

However, the finding above – that prices measured by peak correlations seem to lead money at all frequencies in the post-World War II period, even if one takes into account the level of economic activity – is certainly not what one would have expected following conventional quantity-theoretical wisdom. Still, in a Danish context this finding may not be very controversial. Risbjerg (2006) studies medium-term and long-term cycles with duration of respectively 8-20 and 20-40 years in Danish money growth and inflation using the Christiano & Fitzgerald (2003b) filter on quarterly data from the period 1965-2005. His results also seem to indicate that inflation have tended to lead money growth in the most recent decades rather than vice versa. Knudsen (1988) studies the correlation between money and inflation in Denmark in the 1970s and 1980s. He reports that no significant link from growth in money to inflation can be found using statistical causality tests. Furthermore, Knudsen *op.cit.* notes that the introduction of fixed-exchange-rate policy in the early 1980s seems to have caused a negative contemporaneous link between money and prices. The fixed-exchange-rate policy and a general decline in the international inflation levels were followed by lower Danish inflation levels and also by a flattening of the Danish yield curve which increased the demand for money. Money and prices are thus both endogenous variables that may be determined by a number of other background variables and therefore not subject to any simple direct causality, and the degree of correlation at various lags between these endogenous variables may depend on the nature of the shocks driving the economy at a given time.

However, this does not exclude that information extracted from the development in alternative definitions of money (e.g. residuals from money demand equations – "excess liquidity") might serve as useful supplementary information in a broad-based coherent assessment of the overall inflationary pressure in an economy, in particular if one is able to detect structural shifts in money demand and analyse money demand on a sectoral rather than an aggregated level, cf. e.g. the comprehensive assessment in Klöckers & Willeke (eds.) (2001). Furthermore, information extracted from monetary aggregates and the counterparts of these (e.g. credit to the private sector) might be useful indicators of development in other economic variables than consumer prices such as economic activity or asset prices.

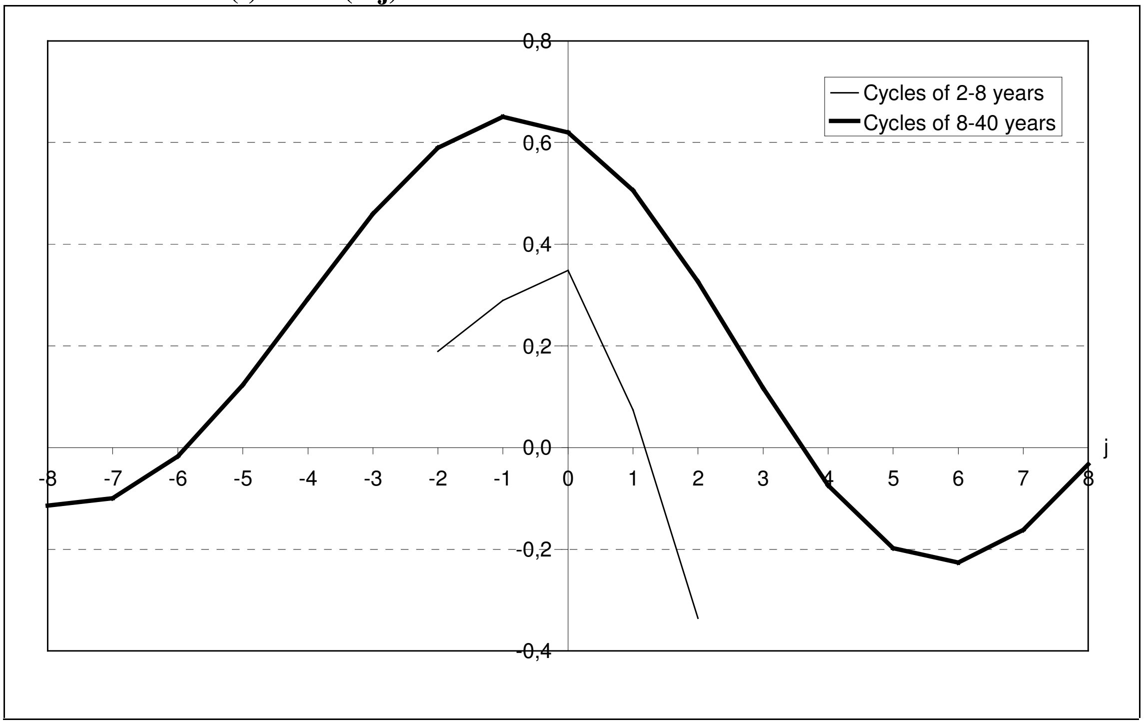
Figure 1.10a: House prices (H) and credit (C) in Denmark 1875-1945, cyclical components at different frequencies, dynamic cross-correlations between C(t) and H(t+j)



Notes: C denotes the stock of credit granted by mortgage-credit institutes. H denotes a price index for one-family houses (since 1938) and farms (prior to 1938). All peak correlations (except for cycles of 2-8 years) are significant different from zero at a 5 per cent level. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of credit and house prices and a constant included.

Source: Figure 10a in Abildgren (2006b).

Figure 1.10b: House prices (H) and credit (C) in Denmark 1946-2005, cyclical components at different frequencies, dynamic cross-correlations between C(t) and H(t+j)



Notes: C denotes the stock of credit granted by mortgage-credit institutes. H denotes a price index for one-family houses. All peak correlations are significant different from zero at a 5 per cent level. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of credit and house prices and a constant included.

Source: A slightly revised version of Figure 10b in Abildgren (2006b).

House prices and credit from mortgage-credit institutes

Figure 1.10a shows the dynamic cross-correlations between nominal house prices and the nominal value of credit granted by mortgage-credit institutions at different cyclical frequencies for the pre-1946 period.[80] Figure 1.10b covers the post-World War II period.

The correlation pattern seems to be very different in the two sub-periods. Prior to the end of World War II house prices have led credit with a considerable lead-time (6 years) in the long-term cycles. The peak correlation coefficient at the business cycle frequency is not significantly different from zero in this period. In the post World War II period house prices have been contemporaneous with credit at the business cycle frequency, and in the medium-term and longer-term cycles the lead-time of house prices relative to credit seems to have been considerable shorter (1 year) than in the pre-1946 period.

[80] No house-price index for single-family houses exist prior to 1938. A price index for farms has therefore been used prior to 1938. In the post-1938 period there has been a quite close correlation between the two series, cf. Figure 1.3.

Rising house prices may stimulate housing investments (cf. Tobin's Q-Theory). Furthermore, rising house prices may affect private consumption though a wealth effect. According to the Life-Cycle Theory of consumption an improvement in household's wealth position will have a positive effect on consumption throughout the lifetime of the household and may partly be financed via credit from mortgage-credit institutes through mortgage equity withdrawal, at least for the most recent decades with relatively liberal access to mortgage financing. Following these lines of reasoning it seems therefore plausible that house prices are positive correlated with credit from mortgage-credit institutes both in the short run and in the longer run.

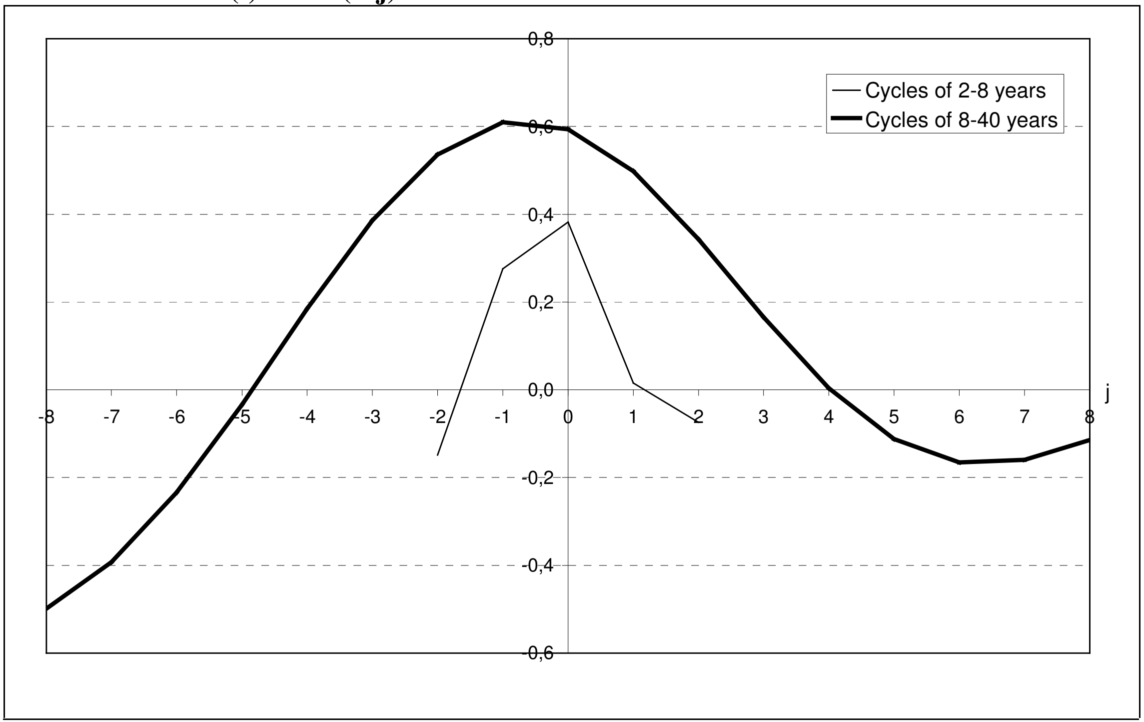
Theoretically it may be argued that rising house prices does not really increase the wealth position of homeowners since the higher house prices will be fully reflected in higher future imputed rents in owner-occupied housing, cf. e.g. Pedersen (1998) and Danmarks Nationalbank (2003). However, even in this case rising house prices may be followed by increased lending by mortgage-credit institutes in the medium and longer run in step with the turnover of existing owner-occupied houses (at the new higher price level) in the economy. Furthermore, if homeowners are subject to credit rationing rising house prices may also increase the household's borrowing from the mortgage-credit sector using the house as collateral.

The relative short lead-time between house prices and credit in the post-World War period might partly be the result of a gradual easing of the access to raise supplementary loans against free mortgageable value in owner-occupied houses during the most recent decades. Furthermore, during the high inflation in the 1970s and first half of the 1980s the real interest rate after tax were negative due to a nominal tax system with high marginal tax rates and full tax deductibility of interest payments. This may have given an incentive to mortgage equity withdrawal in step with rising house prices – particularly because the yield of savings in pension schemes were untaxed until the early 1980s, cf. Ejerskov (2000) and Pedersen (2001).

Real credit and real GDP

Figure 1.11a shows the dynamic cross-correlations between total credit granted by banks and mortgage-credit institutions (inflation-adjusted by the CPI) and real GDP at factor costs at different cyclical frequencies for the period 1875-2005. Figure 1.11b and Figure 1.11c cover the two sub-periods 1875-1945 and 1946-2005 respectively. Real credit seems in general to have been almost contemporaneous with real GDP, and the largest correlation coefficients occur in the long-term cycles. The correlation patterns between real credit and real output seem to have been fairly stable over time.

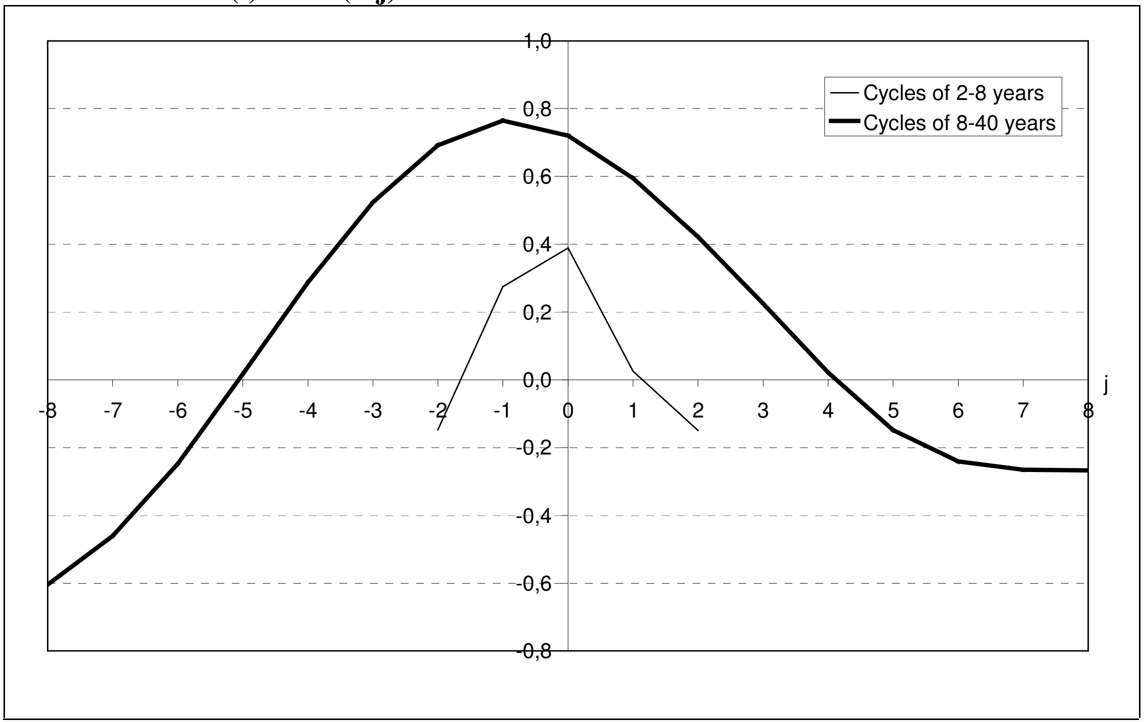
Figure 1.11a: Real credit (C) and real GDP (Y) in Denmark 1875-2005, cyclical components at different frequencies, dynamic cross-correlations between Y(t) and C(t+j)



Notes: Y denotes real GDP at factor prices while C denotes the total stock of credit granted by commercial banks, savings and mortgage-credit institutes (inflation-adjusted by the CPI). All peak correlations are significant different from zero at a 5 per cent level. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of real GDP and real credit and a constant included.

Source: A slightly revised version of Figure 11a in Abildgren (2006b).

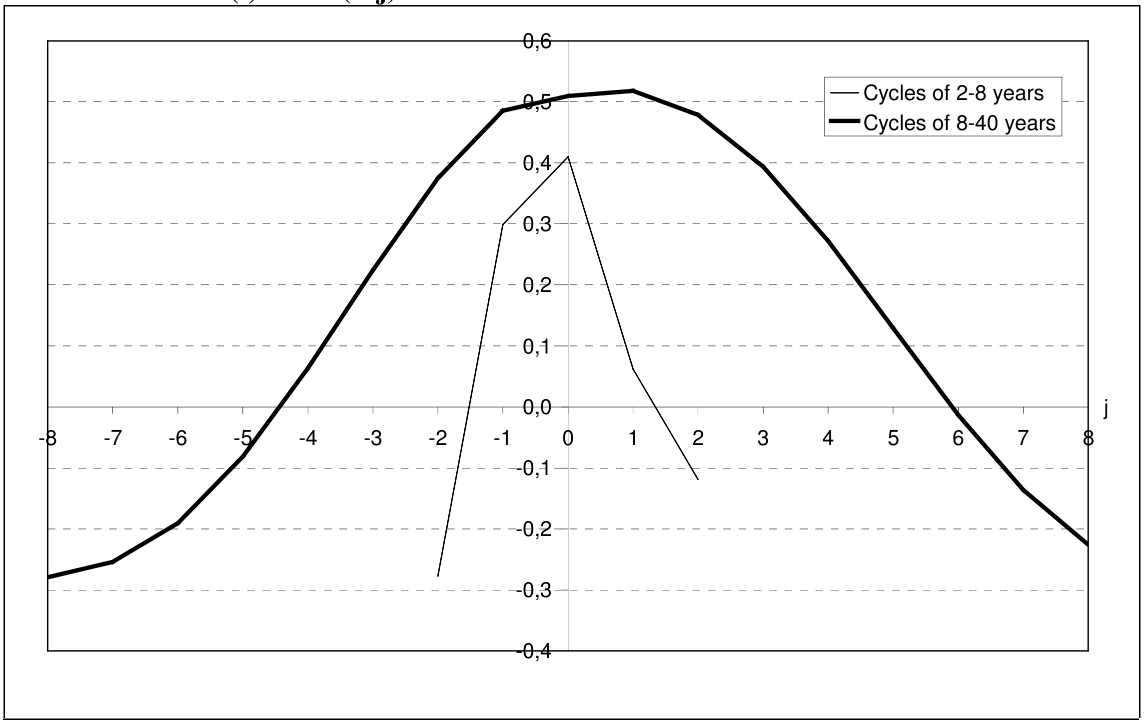
Figure 1.11b: Real credit (C) and real GDP (Y) in Denmark 1875-1945, cyclical components at different frequencies, dynamic cross-correlations between Y(t) and C(t+j)



Notes: Y denotes real GDP at factor prices while C denotes the total stock of credit granted by commercial banks, savings and mortgage-credit institutes (inflation-adjusted by the CPI). All peak correlations are significant different from zero at a 5 per cent level. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of real GDP and real credit and a constant included.

Source: Figure 11b in Abildgren (2006b).

Figure 1.11c: Real credit (C) and real GDP (Y) in Denmark 1946-2005, cyclical components at different frequencies, dynamic cross-correlations between Y(t) and C(t+j)

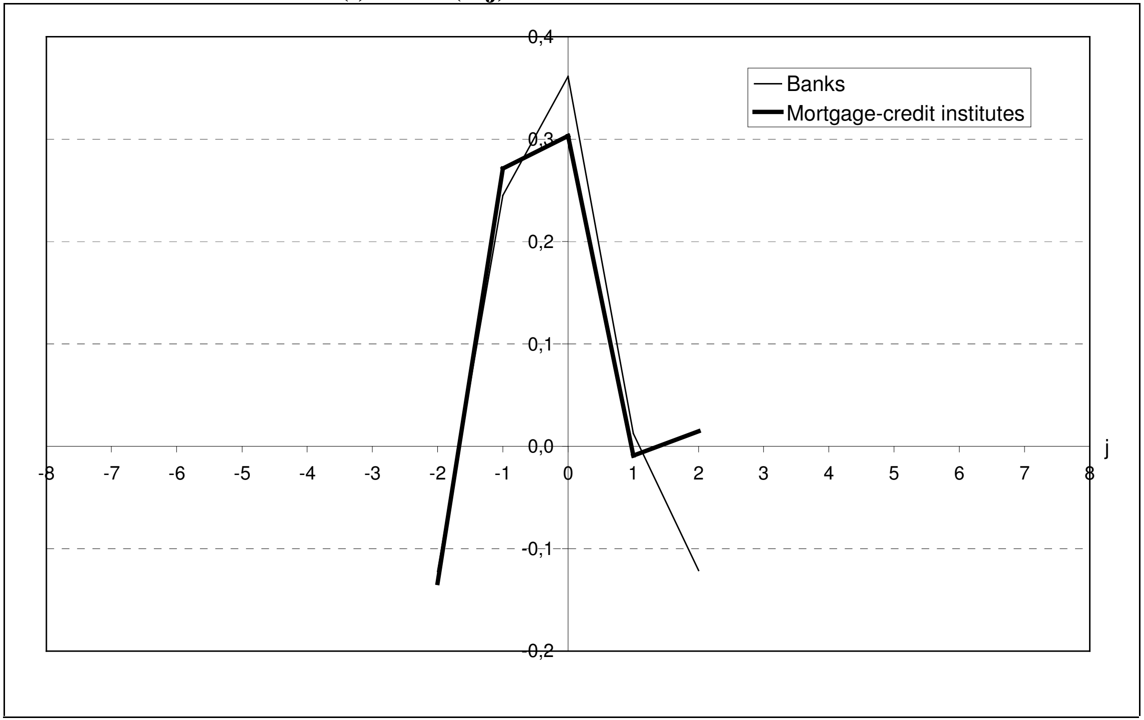


Notes: Y denotes real GDP at factor prices while C denotes the total stock of credit granted by commercial banks, savings and mortgage-credit institutes (inflation-adjusted by the CPI). All peak correlations are significant different from zero at a 5 per cent level. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of real GDP and real credit and a constant included.

Source: A slightly revised version of Figure 11c in Abildgren (2006b).

Figure 11d-11e shows the dynamic cross-correlations between real credit granted by respectively banks and mortgage-credit institutions and real GDP at factor costs at different cyclical frequencies for the whole period 1875-2005. It seems that real bank credit has tended to lead real GDP by a couple of years at the lower frequencies (8-40 years) whereas real credit from mortgage-credit institutes at the same frequencies has been contemporaneous with real GDP or slightly lagging. At the business cycle frequency the pattern of the dynamic correlations seems to have been very similar for banks and mortgage-credit institutes, both indicating that real credit at this frequency has been contemporaneous with real GDP.

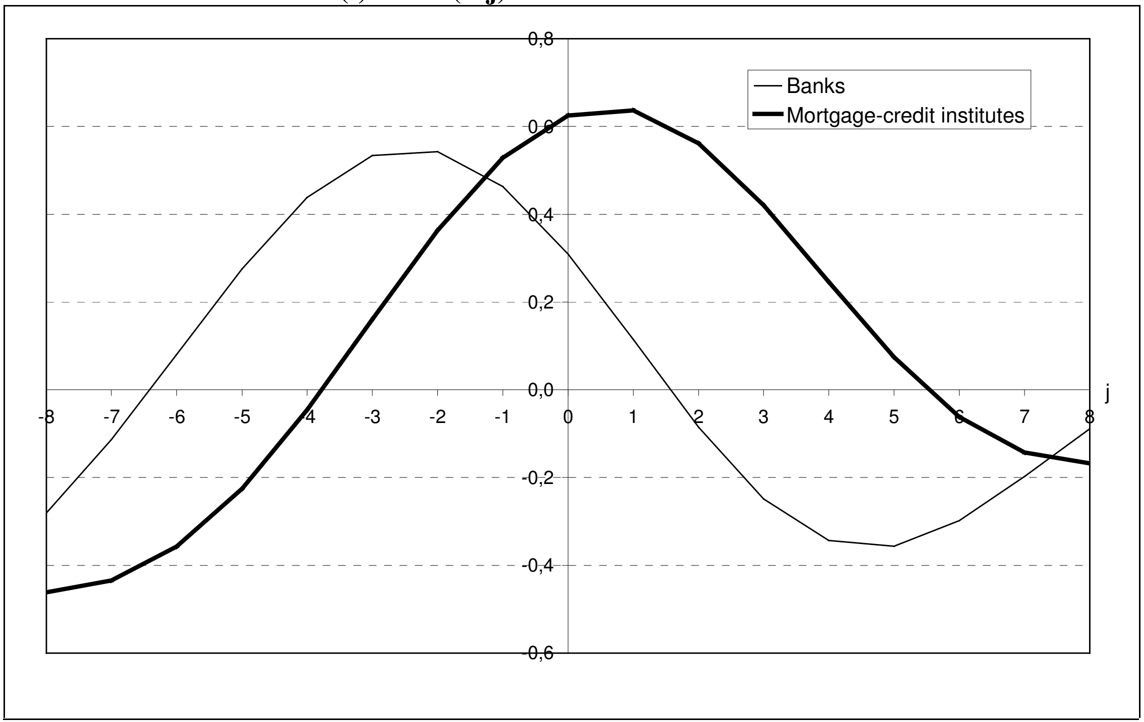
Figure 1.11d: Real credit (C) and real GDP (Y) in Denmark 1875-2005, cyclical components with frequency of 2-8 years, dynamic cross-correlations between Y(t) and C(t+j)



Notes: Y denotes real GDP at factor prices while C denotes the stock of credit granted by respectively banks or mortgage-credit institutes (inflation-adjusted by the CPI). All peak correlations are significant different from zero at a 5 per cent level. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of real GDP and real credit and a constant included.

Source: A slightly revised version of Figure 11d in Abildgren (2006b).

Figure 1.11e: Real credit (C) and real GDP (Y) in Denmark 1875-2005, cyclical components with frequency of 8-40 years, dynamic cross-correlations between Y(t) and C(t+j)



Notes: Y denotes real GDP at factor prices while C denotes the stock of credit granted by respectively banks or mortgage-credit institutes (inflation-adjusted by the CPI). All peak correlations are significant different from zero at a 5 per cent level. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of real GDP and real credit and a constant included.

Source: A slightly revised version of Figure 11e in Abildgren (2006b).

It may be difficult to interpret why cycles in real GDP occur at the long-term frequencies at all.[81] One possible explanation could be that long swings in house prices affect domestic demand, cf. the section on "House prices and credit from mortgage-credit institutes" above. Other traditionally mentioned factors relate to investments in capital-producing sectors or long waves in technological innovations.[82] However, one should also keep in mind that an attempt to track very long cycles (with a duration of up to 40 years) may be questionable even in a data sample covering a time span of more than 130 years. But if long-term cycles are present in real GDP it seems plausible that one should find cycles at the same frequencies in real credit as well as indicated by Figure 11a-11c and 11e.

[81] There may be a question regarding data quality to consider in relation to real GDP. The time series real GDP prior to 1949 comes from the historical national accounts in Hansen (1983). The earliest official national account statistics compiled by the Danish central bureau of statistics covers only the period since 1930, cf. Det Statistiske Departement (1948). The figures for real GDP prior to 1930 may therefore be surrounded by an extra amount of uncertainty.

[82] Chapter 6 in Kærgård (1991) offers a short overview of the "classical" literature on short-term and long-term cycles in economics and the Danish contributions in this area. Chapter 3 in Freeman & Loucã (2001) and Maddison (2007) offer more elaborated surveys.

1.6. Finalising remarks and scope for further research

To date projects on compilation of historical national-account statistics for Denmark have only focused on the real side of the economy. This essay has presented a first attempt to overcome this data shortage by constructing a set of historical financial-account stock data for Denmark covering the period 1875-2008 at an annual frequency.

However, the financial balance-sheet data presented in this essay have only taken the major financial assets and liabilities into consideration, and only stock figures have been compiled. It would therefore be interesting if future projects on historical-national accounts statistics in Denmark would make an attempt to cover a more complete set of financial accounts, including both stock as well as flow data.

A set of historical financial-account flow data could be a particularly interesting future milestone since the net-lending figures from such a set of statistics can be compared with net lending figures compiled from non-financial data. It is well known from modern national accounting statistics that different net-lending figures can results from the "real" and the "financial" method of calculations due to statistical uncertainty. However, such differences represent valuable information from a cross-checking point of view. They might indicate areas where there is scope for further improvements in both the financial accounts statistics and the real-economy accounts statistics. Flow data from a set of historical financial accounts could thereby also provide some interesting input to future generations of non-financial historical national-account statistics in Denmark, particularly if the latter were broken down into institutional sectors.[83] It will, however, require a substantial effort if a full set of flow-of-funds data is to be compiled. It will require a complete time-series mapping of the differences in accounting standards and practices over time and across sectors in order to assess changes in the valuation of financial assets and liabilities with a reasonable degree of precision. Furthermore, such a project will probably also require a substantial improvement in the historical statistics on financial asset prices in Denmark.

Future work could also include an attempt to single out financing companies and non-life insurance companies from the non-financial sector and include them into the financial sector. Accounting statistics for financing companies are available at least for the most recent decades where the activity within this sector has increased rapidly.[84] Non-life insurance companies might be covered by supervisory statistics and historical research in relation to jubilee publications *etc*.

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[83] None of the existing versions of Danish historical national-account statistics covering the pre-1971 period include a full split of the total economy into institutional sectors – not even a general government sector and a private sector – with corresponding net-lending figures, cf. Abildgren (2006c).

[84] Danmarks Nationalbank began in May 1986 to collect regularly balance sheet information from major finance companies and has published data dating back to 1984, cf. Kjær (1986). Later Statistics Denmark began to publish similar statistics.

It would furthermore be desirable for analytical purposes if the non-financial sector could be disaggregated into households and non-financial enterprises. Long-span time series on credit by institutional sectors are not readily available in Denmark. However, a recent paper has constructed annual time series data for credit extended by domestic banks and savings banks, domestic mortgage-credit institutions and foreign banks to respectively Danish firms and private individuals in the period 1951-2008.[85] This data set might serve as parts of the building blocks needed for a further disaggregation of the non-financial private sector in future generations of Danish historical financial accounts.

Finally, it would be useful if the central government's ownership shares of non-financial corporations located in the private non-financial sector could be included among the central government's financial assets, cf. also annex 1.B. However, it might be a considerable challenge due to the well-known problems of a fair valuation of non-marketable assets.

Internationally there has been a long-standing tradition for compilation of historical national account statistics. However, to the knowledge of the author of this essay no attempts have been made to compile long-span historical time series on financial accounts. The essay at hand has illustrated that a system of financial accounts can be a powerful framework for organisation of financial data when data sources are somewhat fragmented and sparse, which is often the case in relation to historical financial statistics. There is therefore probably also scope for interesting future projects on historical time series of financial accounts in other countries as well.

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Annex 1.A: A selected list of data from the new set of financial balance-sheet stock data for Denmark 1875-2008

Table 1.A.1: Total financial assets by sector in Denmark, end-of-year 1875-2008, million kroner

Year	Central bank	Commercial banks and savings banks	Mortgage-credit institutes	Life-insurance companies and pension funds	Investment associations	Central government	Memo: Nominal GDP at factor costs
1875	91	368	122	116	...	6	761
1876	91	383	136	120	...	6	784
1877	89	358	149	126	...	7	728
1878	100	332	165	131	...	9	714
1879	105	345	181	139	...	10	715
1880	108	400	202	146	...	12	791
1881	118	459	232	153	...	13	790
1882	105	499	259	163	...	10	801
1883	109	516	278	169	...	10	818
1884	107	534	304	178	...	13	790
1885	106	543	334	185	...	12	772
1886	113	573	365	193	...	11	771
1887	118	656	397	205	...	9	779
1888	117	672	423	214	...	8	792
1889	110	701	444	220	...	7	840
1890	112	723	460	227	...	7	909
1891	108	716	481	234	...	4	949
1892	108	745	495	249	...	6	947
1893	115	769	515	259	...	5	942
1894	111	819	540	272	...	8	932
1895	117	875	571	285	...	13	979
1896	125	919	626	292	...	14	997
1897	120	949	674	304	...	19	1033
1898	119	970	704	309	...	13	1090
1899	121	986	738	320	...	6	1146
1900	137	1010	766	329	...	3	1245
1901	142	1058	803	341	...	16	1292
1902	144	1149	857	352	...	18	1315
1903	149	1236	950	361	...	18	1377
1904	152	1306	1021	367	...	19	1393
1905	159	1406	1083	385	...	20	1467
1906	164	1509	1170	404	...	22	1532
1907	163	1667	1260	422	...	24	1638
1908	176	1820	1361	438	...	13	1670
1909	173	1748	1458	459	...	12	1722
1910	181	1819	1560	480	...	23	1810
1911	186	1906	1637	515	...	26	1932
1912	191	1925	1721	543	...	20	2033
1913	194	2077	1813	571	...	32	2167
1914	262	2202	1905	607	...	12	2382
1915	282	2380	1966	677	...	5	2719
1916	413	2803	1975	708	...	139	3548
1917	473	3791	2042	743	...	145	3770
1918	599	4477	2122	777	...	101	4489
1919	649	5469	2208	819	...	196	5483
1920	685	6094	2300	853	...	104	6966
1921	691	6265	2456	912	...	118	5705
1922	713	5631	2733	961	...	72	5092
1923	697	5998	3054	1018	...	53	5679
1924	742	5600	3260	1079	...	34	6184
1925	594	5207	3351	1138	...	48	5795
1926	511	4964	3498	1180	...	65	5207
1927	488	4909	3629	1207	...	64	5009
1928	470	4902	3771	1258	1	86	5121
1929	484	5115	3978	1322	1	90	5465
1930	490	5322	4187	1390	2	87	5373
1931	494	5181	4492	1437	2	60	5057
1932	558	5035	4638	1472	3	4	4815
1933	580	5295	4707	1554	3	36	5186
1934	700	5369	4885	1646	4	61	5620
1935	683	5402	5084	1724	5	47	6009
1936	678	5517	5183	1806	6	207	6301
1937	689	5596	5266	1877	7	199	6726
1938	752	5811	5371	2285	9	195	7077
1939	927	5824	5510	2417	9	226	7654
1940	1282	6117	5599	2519	10	133	8119
1941	1952	7047	5706	2657	10	178	9221
1942	2246	7807	5972	2802	11	183	10379
1943	3743	9474	6267	2985	11	185	11754
1944	5158	11532	6400	3197	12	193	13045

Table A.1 (continued)

Year	Central bank	Commercial banks and savings banks	Mortgage-credit institutes	Life-insurance companies and pension funds	Investment associations	Central government	Memo: Nominal GDP at factor costs
1945	5320	13012	6539	3348	12	155	13148
1946	5303	12959	6654	3540	13	146	13911
1947	4260	12256	6917	3788	13	185	15328
1948	3553	12333	7207	4025	14	181	16635
1949	3560	12800	7355	4273	14	221	17796
1950	3527	13003	7539	4531	15	185	20361
1951	3360	13290	7809	4797	15	190	22042
1952	3467	14022	8044	5077	16	245	23532
1953	3640	14768	8297	5368	16	998	24993
1954	3977	15095	8638	5703	17	1771	26012
1955	4007	15639	9105	6011	17	2327	27038
1956	3931	16468	9593	6361	18	2826	28861
1957	3918	17667	10058	6663	18	3706	30768
1958	4485	20258	10686	6918	19	4081	32005
1959	4703	22247	11909	7419	23	4889	35258
1960	4049	23917	13323	7977	28	5594	38167
1961	4413	26404	15226	8517	34	5529	42737
1962	4787	29296	17697	9115	40	5894	47816
1963	5201	32227	20596	9943	49	6793	50366
1964	6407	35655	24323	11023	59	8629	57520
1965	7156	39270	29527	12373	71	9223	64320
1966	8636	44717	35622	13895	86	10591	70394
1967	8505	49241	41220	15442	104	10395	77050
1968	9605	57069	47552	17035	126	10421	84973
1969	14229	62705	58749	19509	150	13901	96754
1970	15066	66177	68223	21846	178	15668	106946
1971	16729	72140	77219	24648	211	17922	118476
1972	19155	83892	93521	28517	251	21096	135126
1973	22645	95890	117908	32540	298	27342	157657
1974	22601	107106	142668	37834	354	29829	179484
1975	19813	126647	165869	46001	421	26870	200427
1976	26527	141548	186346	50900	500	36861	231306
1977	29697	163243	205296	60800	737	47190	254836
1978	35239	182677	227125	77000	1086	61602	281384
1979	34858	208297	252090	95400	1600	67468	309914
1980	39516	230895	270882	112400	2000	89904	335531
1981	38891	263193	294021	132800	2962	101240	368076
1982	45246	306044	316473	158800	4388	118846	424879
1983	62345	412280	357996	198000	6500	143506	467634
1984	67865	501358	413302	228000	11800	154977	515226
1985	100378	656929	494379	270400	20200	168881	555579
1986	116615	692546	556829	307300	30500	202922	588479
1987	113778	729315	614349	335900	22100	218860	622104
1988	103860	807111	663748	378188	22600	211174	648999
1989	106968	890906	686273	413583	24400	222055	691997
1990	116504	921958	700387	450358	20300	242831	727665
1991	98119	977331	718175	496105	21500	222814	758706
1992	139637	923965	726585	533633	22500	255419	793284
1993	197053	1037470	758100	608795	30409	325125	795099
1994	175202	963200	769700	661057	32419	313586	847850
1995	157373	1001600	797800	710858	34390	293383	884237
1996	169109	1151600	846300	800028	52535	290566	923502
1997	194096	1301100	909400	916220	84704	289242	966539
1998	176825	1438100	988100	1011449	119833	292045	988812
1999	256903	1503300	1051400	1196683	203300	296427	1032880
2000	207725	1644679	1097800	1329802	257000	289902	1111428
2001	269045	1823849	1194100	1287348	282100	299752	1144437
2002	332762	1999852	1289100	1302580	284100	318880	1174977
2003	328618	2170154	1400900	1432418	364000	314690	1199771
2004	342745	2305139	1499000	1600152	571800	333855	1250792
2005	398248	2713884	1675300	1856049	789600	333864	1312077
2006	376396	3178512	1848800	1945079	917800	363903	1378886
2007	432790	3841021	2037000	2015127	985600	385597	1430184
2008	630547	3921192	2195500	2340618	730100	543444	1480189

Sources and calculation methods: See Abildgren (2006b, 2008b).

Table 1.A.2: Net financial assets by main sector in Denmark, end-of-year 1875-2008, million kroner

Year	Central government	Other residents	Non residents	Year	Central government	Other residents	Non residents
1875	-201	337	-136	1945	-8552	7584	968
1876	-196	333	-137	1946	-8421	6720	1701
1877	-193	321	-128	1947	-7408	5552	1856
1878	-191	330	-139	1948	-6863	4704	2159
1879	-189	334	-145	1949	-6669	4367	2302
1880	-209	371	-162	1950	-6245	3460	2785
1881	-214	368	-154	1951	-5655	3198	2457
1882	-214	365	-151	1952	-5420	3364	2056
1883	-212	339	-127	1953	-5033	3322	1711
1884	-207	304	-97	1954	-4173	1959	2214
1885	-206	277	-71	1955	-3710	1630	2080
1886	-208	293	-85	1956	-3422	1175	2247
1887	-210	294	-84	1957	-2758	962	1796
1888	-210	267	-57	1958	-2402	1500	902
1889	-210	234	-24	1959	-1463	857	606
1890	-210	220	-10	1960	-614	213	401
1891	-212	202	10	1961	-600	-409	1009
1892	-209	183	26	1962	-302	-2049	2351
1893	-209	161	48	1963	401	-2661	2260
1894	-226	160	66	1964	2047	-5258	3211
1895	-221	131	90	1965	2492	-7243	4751
1896	-216	96	120	1966	4073	-10438	6365
1897	-220	90	130	1967	3972	-12673	8701
1898	-229	59	170	1968	3980	-14185	10205
1899	-236	38	198	1969	7082	-19886	12804
1900	-247	-8	255	1970	8441	-24931	16490
1901	-261	-24	285	1971	9561	-28042	18481
1902	-270	-55	325	1972	11887	-30435	18548
1903	-271	-64	335	1973	17735	-38600	20865
1904	-273	-97	370	1974	19671	-47804	28133
1905	-273	-117	390	1975	10397	-40385	29988
1906	-273	-207	480	1976	4483	-49802	45319
1907	-273	-314	587	1977	-4354	-61065	65419
1908	-286	-374	660	1978	-12658	-60894	73552
1909	-325	-440	765	1979	-30618	-69425	100043
1910	-356	-491	847	1980	-46199	-68107	114306
1911	-376	-484	860	1981	-91657	-50951	142608
1912	-394	-483	877	1982	-164282	-17428	181710
1913	-387	-558	945	1983	-231500	15159	216341
1914	-438	-401	839	1984	-274538	16911	257627
1915	-489	-50	539	1985	-284701	-433	285134
1916	-464	564	-100	1986	-267081	-39146	306227
1917	-497	1252	-756	1987	-253726	-69686	323412
1918	-678	1678	-1000	1988	-266559	-82617	349176
1919	-763	697	66	1989	-269518	-71882	341400
1920	-1005	205	800	1990	-281634	-58144	339778
1921	-1102	352	750	1991	-330533	-1467	332000
1922	-1217	192	1025	1992	-359562	47562	312000
1923	-1330	105	1225	1993	-401299	110299	291000
1924	-1322	47	1275	1994	-433976	174976	259000
1925	-1212	212	1000	1995	-469982	183982	286000
1926	-1099	159	940	1996	-488659	214659	274000
1927	-1128	163	965	1997	-488068	178068	310000
1928	-1245	250	995	1998	-452713	167713	285000
1929	-1269	310	959	1999	-442177	290177	152000
1930	-1223	262	961	2000	-419302	201302	218000
1931	-1360	-91	1451	2001	-395030	175030	220000
1932	-1627	115	1512	2002	-389763	164763	225000
1933	-1523	141	1382	2003	-380166	210166	170000
1934	-1456	-90	1546	2004	-354632	277632	77000
1935	-1432	-122	1554	2005	-273296	324296	-51000
1936	-1276	-98	1374	2006	-170338	143338	27000
1937	-1295	54	1241	2007	-85085	-25915	111000
1938	-1379	140	1239	2008	-19157	-135843	155000
1939	-1375	-4	1379				
1940	-2271	995	1276				
1941	-2872	1675	1197				
1942	-3631	2429	1202				
1943	-5621	4307	1313				
1944	-7932	6633	1299				

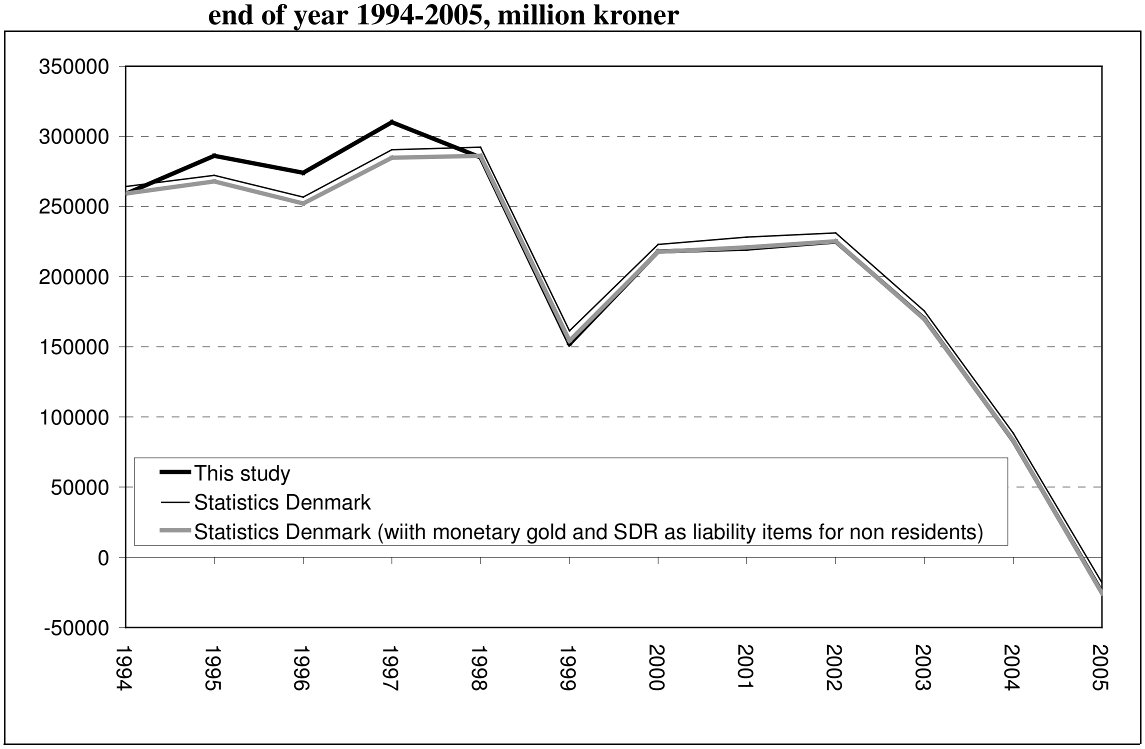
Sources and calculation methods: See Abildgren (2006b, 2008b).

Annex 1.B: A post-1994 comparison with Statistics Denmark's financial-accounts statistics

The historical financial-balance-sheets data presented in this essay do not make use the official financial-account statistics that are available from Statistics Denmark (since end-1994) or from the Nationalbank (since end-1998). This annex compares the figures for the net financial asset positions of three main sectors in the historical financial-balance-sheet data presented in section 1.2 with the corresponding figures from Statistics Denmark's financial-accounts statistics.

Figure 1.B.1 shows the net financial asset position of the non-resident sector and the differences between the two sets of statistics are in general small. The main conceptual differences between the two curves can be attributed to the treatment of monetary gold and SDR. In Statistics Denmark's financial accounts monetary gold and SDR are treated as financial assets without a corresponding liability while the historical financial-balance-sheet data follow the treatment in the statistics on Denmark's International Investment Position and assign "non residents" as the counterparty sector. Furthermore, institutional units at the Faroe Islands and Greenland are treated as non-residents in Statistics Denmark's financial accounts during the whole period since 1994. In the historical financial-balance-sheet data institutional units at the Faroe Islands and Greenland are treated as Danish residents prior to 2000 (following the pre-2000 statistics on Denmark's International Investment Position).

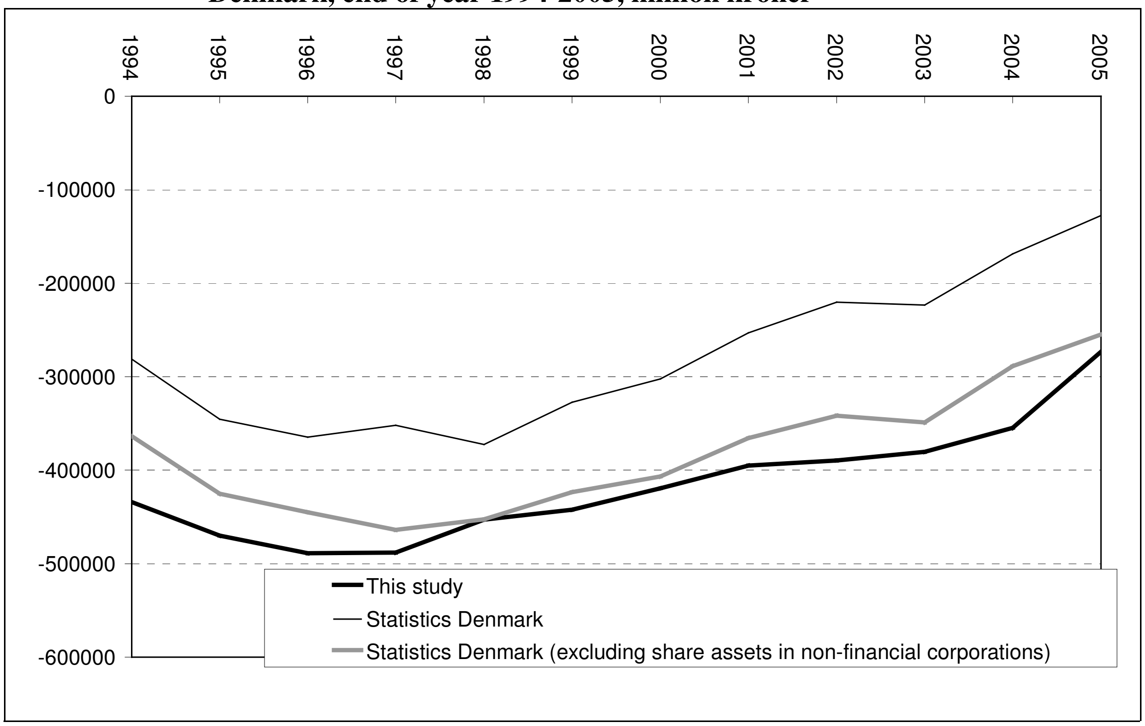
Figure 1.B.1: The net financial asset position of the non-resident sector in Denmark, end of year 1994-2005, million kroner



Source: Figure 1 in Abildgren (2008b).

Figure 1.B.2 shows the net financial asset position of the central-government sector. The main differences between the two curves can be attributed Statistics Denmark's inclusion of the central government's ownership shares of non-financial corporations located in the private non-financial sector. These shares are not included among the central government's financial assets in the historical data set presented in this essay. A minor difference can be attributed to Statistics Denmark's inclusion of the National Church in the central-government sector. In the historical financial-balance-sheet data the National Church is included among "other residents". The development trends in the series from the two sets of statistics are quite close.

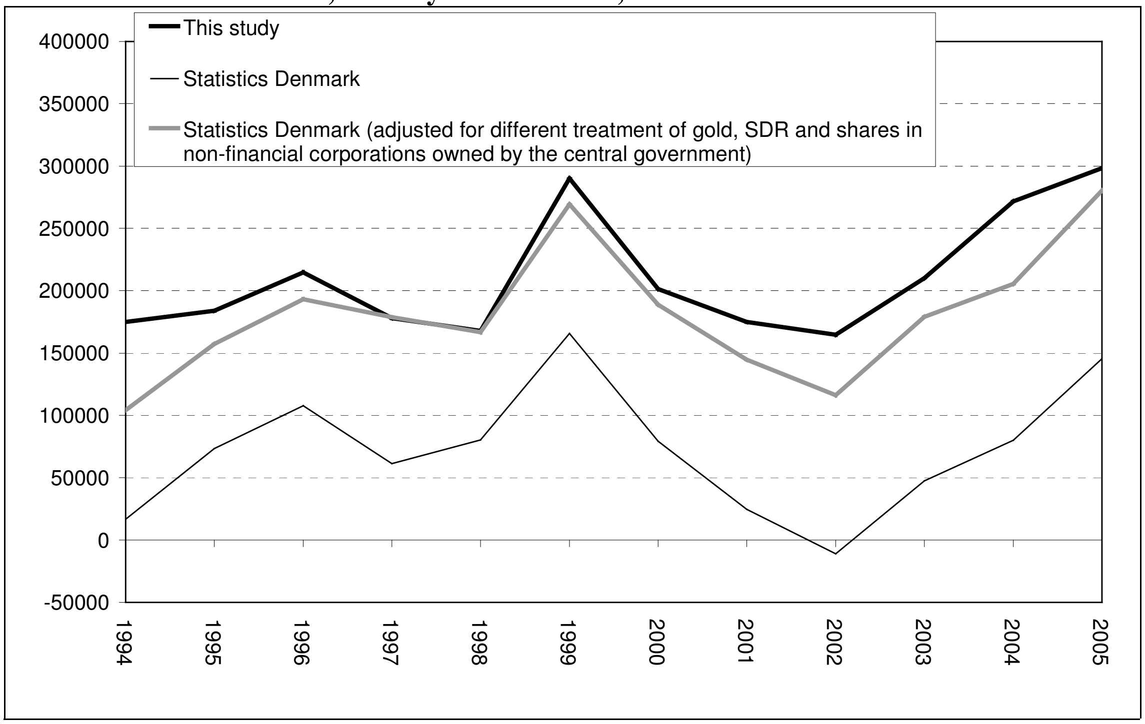
Figure 1.B.2: The net financial asset position of the central-government sector in Denmark, end of year 1994-2005, million kroner



Source: Figure 1 in Abildgren (2008b).

Finally, Figure 1.B.3 shows the net financial asset position of "other residents". The sector "other residents" covers all residents excluding the central government and the differences between the series from the two sets of statistics naturally mainly mirrors the differences regarding the central-government sector.

Figure 1.B.3: The net financial asset position of the "other residents" sector in Denmark, end of year 1994-2005, million kroner



Notes: The sector "other residents" covers all residents excluding the central government.
Source: Figure 1 in Abildgren (2008b).

Annex 1.C: The Baxter-King approximate band-pass filter[86]

Filtering is a commonly used method to isolate cyclical components from macroeconomic time series. The Baxter-King band-pass filter allows one to extract both business cycles and longer-term cycles from the data.

The Baxter-King filter converts an input series y_t into another (filtered) output series y_t^F via a finite centred linear moving average of the following form:

$$[1.C.1] \quad y_t^F = \sum_{i=-K}^{K} w_i \cdot y_{t+i}$$

The filter is based on results from the spectral analysis where a time series is regarded as the composed of a number of components with different frequencies. If one wishes to extract the cyclical component with a duration from a to b years, the filter coefficient used in the Baxter-King filter are found as:

$$[1.C.2] \quad w_i = w_i^* - (2 \cdot K + 1)^{-1} \cdot \sum_{j=-K}^{K} w_j^*$$

where:

$$[1.C.3] \quad w_i^* = \begin{cases} \pi^{-1} \cdot \left[\dfrac{2 \cdot \pi}{a} - \dfrac{2 \cdot \pi}{b} \right] & \text{for } i = 0 \\ (i \cdot \pi)^{-1} \cdot \left[\sin\left(\dfrac{2 \cdot \pi}{a} \cdot i \right) - \sin\left(\dfrac{2 \cdot \pi}{b} \cdot i \right) \right] & \text{for } i = \pm 1, \pm 2, \ldots, \pm K \end{cases}$$

The filtered series are de-trended. The adjustment of the filter coefficients in [1.C.2] ensures that the filtered time series becomes stationary in order to avoid spurious cycles. Furthermore, the filter coefficients (w_i) are symmetric which ensure that the filtered series has no phase shifts compared to the input series.

The number of filter coefficients (determined by K) influences the degree to which the filter approximates an ideal band-pass filter. The Baxter-King filter is thus identified by a, b and K. The higher K the better approximation, but a high K also means loss of observations.

In the essay at hand business cycles are delimited to 2-8 years[87] and long-term cycles to 8-40 years. Recently Dewald & Haug (2004) has analysed the short-term and long-term effects of money growth on nominal and real output growth and inflation on an annual frequency for

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[86] Cf. Baxter & King (1999). A more concise treatment directly oriented towards practical implementation is fond on page 49-51 in DeJong & Dave (2007).

[87] According to the NBER US business cycles has on average been around 5 years for the post-1854 period and a little more than 6 years in the post-1970 period. Hansen & Knudsen (2004) and Hansen (2005) indicate – using both the Baxter-King filter and the Hodrick-Prescott filter – that the post-1974 business cycles in Denmark have been somewhat longer. An upper limit of 8 years therefore seems suitable. The reason for 2 years as the lower limit (and not zero) is the wish to exclude very short-term random fluctuations from the business cycle component.

the period 1880-2001 in 11 countries (including Denmark) using band-pass filters. Their results illustrate that with a choice of K=8 the gain function from the Baxter-King filter gives a good approximation to that of an ideal band pass filter when the sample size is around 120 years of annual observations and the cyclical period is 8-40 years. For K less than 8 the approximation is poor and for K larger than 8 only little improvement is obtained. In the essay at hand K=8 is therefore applied.

By transforming a trended input series by natural logarithms before filtering, the cyclical component extracted from the data can[88] be interpreted as the deviation from the trend measured in per cent. This facilitates the economic interpretation of the filtered time series data. In the essay at hand all the time series have therefore been transformed by natural logarithms before filtering.

Like most – if not all filters – the Baxter & King filter has its strengths and weaknesses, and different filters with different choices of parameters can produce very different results.[89] However, the Baxter & King filter still belongs to the group of popular filtering methods in applied economics.

[88] When multiplied by 100.

[89] Cf. e.g. Gencay, Selcuk & Whitcher (2002) and Mills (2003) for an overview of a broad range of filtering methods applied in economics and finance.

Essay 2:
Development in Interest Rates and Inflation Expectations in Denmark 1875-2008[90]

Abstract

Essay 2 presents a new data set on annual interest rates in Denmark 1875-2008 and paints a broad picture of the development in nominal and real interest rates and inflation expectations in Denmark since 1875.

In the period 1875-1945 the average short-term and long-term nominal interest-rate level was around 4 to 5 per cent per annum. An upward trend in nominal interest rates during the 1960s and 1970s was followed by a downward trend during the 1980s and 1990s. In 2004-2005 the Danish money market rate as well as the long-term government bond yield reached a post-1875 all time low. In this connection it is also worth to notice that the last three decades have not witnessed even a single year with negative CPI inflation whereas deflation or price decreases frequently occurred during the classical gold standard. All else being equal, the inflation-risk premium embedded in the long-term government bond yield is therefore probably higher today than in the gold standard period.

Traditional measures of the *ex ante* real interest rate (nominal interest rate less contemporaneous rate of inflation) show average short-term and long-term real interest rates in Denmark around 3 per cent per annum for the period since 1875. Furthermore, such calculations indicate a rather high long-term real-interest-rate level during the late 1980s and the first half of the 1990s. However, the latter result may reflect a high degree of persistence in inflation expectations. Calculations of financial market inflation expectations derived from nominal bond yields and the growth rate in real GDP suggest relatively stable inflation expectations during World War I and the interwar period despite the large swing in the actual inflation level. Since then, the process of inflation expectations seems to have changed. The financial markets continuously underestimated the actual inflation level during the 1960s and the first half of the 1970s and persistently overestimated the inflation level since the middle of the 1970s.

Annex 2.A presents the main sources and methods used for the compilation of the new set of historical interest-rate data for Denmark 1875-2008. The data set consists of three different short-term interest-rate series (the official discount rate, the private banks' average deposit

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[90] This essay is based on Abildgren (2005a, 2005b).

rate, and the market rate of discount/money market rate) and two different long-term interest-rate series (the government bond yield and the yield on mortgage-credit bonds).

Key words: History of interest rates; Danish interest rates; Inflation expectations.
JEL Classification: E43, N23, N24.

2.1. Introduction

The existence of financial markets and financial instruments facilitates an efficient allocation of savings from economic agents with a savings surplus to economic agents with savings deficits. Although legal regulations and other institutional factors to a certain and time varying degree have influenced the allocation process, nominal and real interest rates have always played a crucial role for both real investments and financial portfolio decisions.

Based on a new set of historical interest-rate data, this essay paints a broad picture of the interest-rate development in Denmark since the introduction of the krone as the Danish currency unit in 1875. Furthermore, some "stylised facts" on the development in real interest rates and inflation expectations in Denmark are presented and discussed.[91]

2.2. Development of nominal interest rates and inflation since 1875 – An overview

Figure 2.1 and 2.2 show the development in a range of short-term and long-term nominal interest rates in Denmark since the introduction of the krone as the Danish currency unit in 1875. In the period 1875-1945 the average short-term and long-term nominal interest-rate level was around 4 to 5 per cent per annum. An upward trend in nominal interest rates during the 1960s and 1970s was followed by a downward trend during the 1980s and 1990s.

Table 2.1 presents a range of summary descriptive statistics on nominal interest rates and inflation broken down by sub-periods determined by in the Danish exchange-rate policy and the degree of restrictions on cross-border capital mobility.[92]

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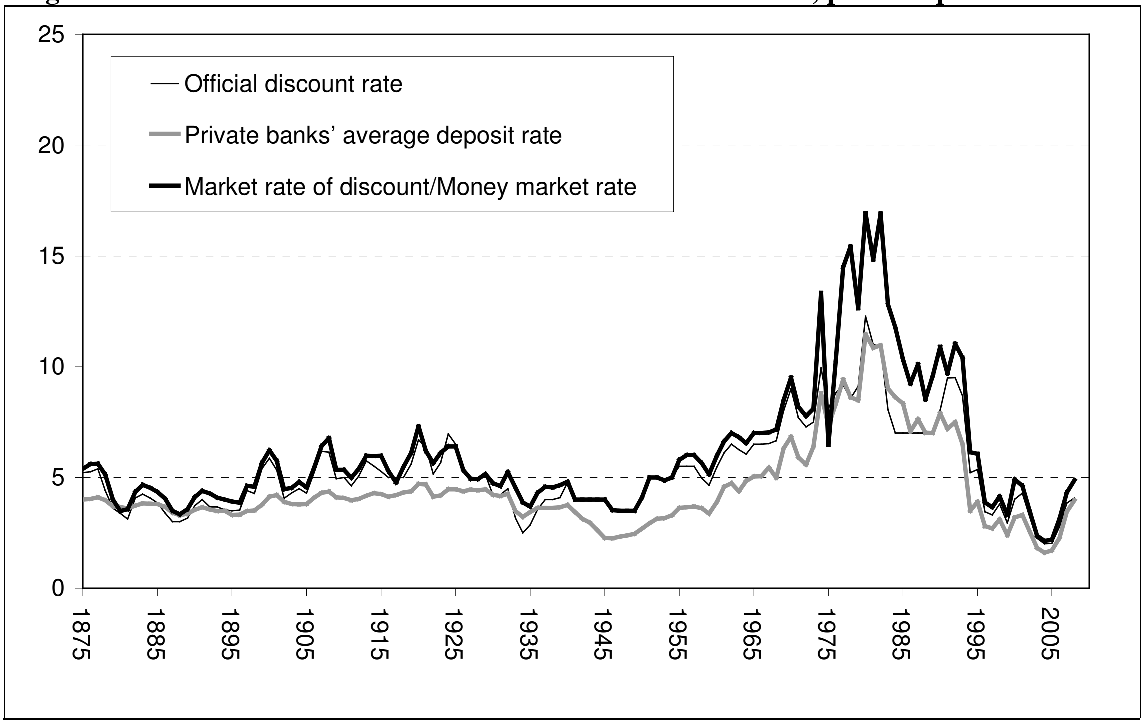
[91] For other long-span studies on the interest-rate development in Denmark, one may refer to Andersen (ed.) (1947), Christiansen & Lystbæk (1994), Møller & Topp (2003), Nielsen & Risager (2001), Oldam (1963), Parum (1999a, 1999b), Pedersen (1930), Statistics Denmark (1969) and Sørensen (1995).

For broad studies on the international development in interest rates covering the period since 1875, one may refer to e.g. Bordo & Jonung (1996, 1997) and Homer & Sylla (1996).

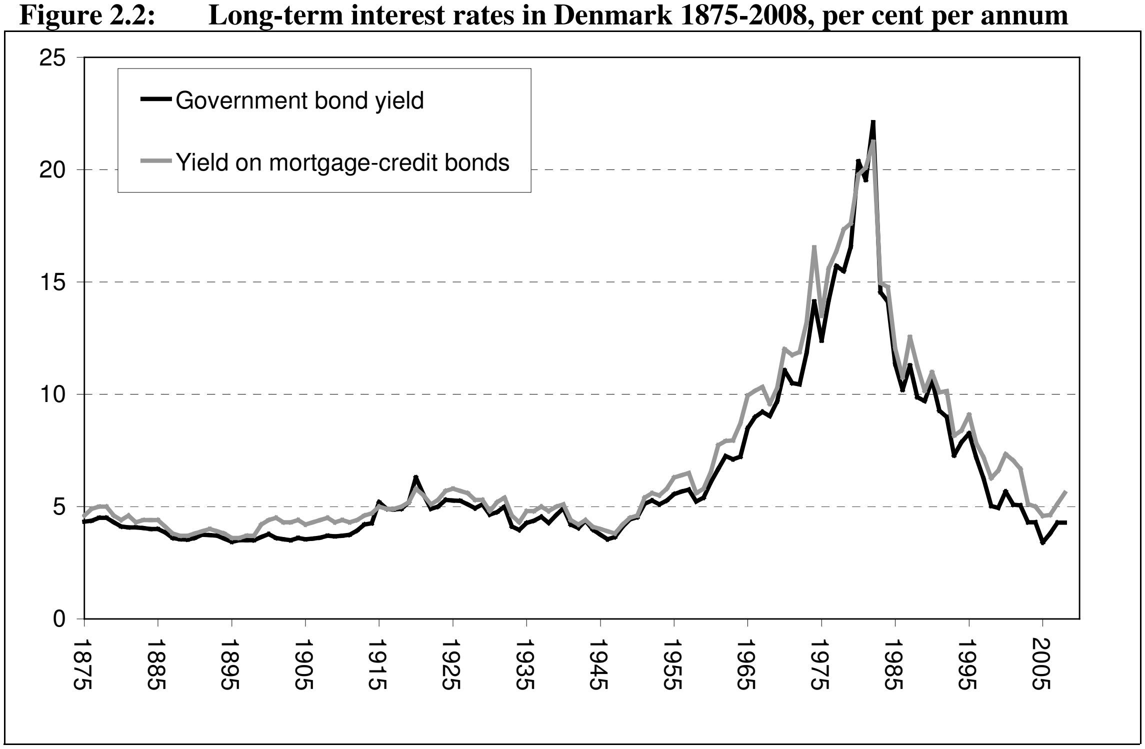
[92] The subdivision by degree of cross-border capital mobility is very rough ("free" or "restrictions"). However, in Denmark – like many other countries – the reintroduction of free cross-border capital movement in the post-World War II period has been a gradual process. For a fact-oriented chronology of the Danish exchange-rate policy and the development in restrictions on cross-border capital movements since 1875, see Abildgren (2004a).

Figure 2.1: Short-term interest rates in Denmark 1875-2008, per cent per annum



Source: Figure 1 in Abildgren (2005b) updated with more recent data from the sources stated in Abildgren, *op.cit*.

Figure 2.2: Long-term interest rates in Denmark 1875-2008, per cent per annum



Source: Figure 2 in Abildgren (2005b) updated with more recent data from the sources stated in Abildgren, *op.cit*.

Table 2.1: Interest rates and inflation in Denmark 1875-2008 – Summary statistics

		Market rate of discount/ money market rate			Government bond yield			CPI inflation		
		Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
		per cent per annum								
Sub-periods determined by exchange-rate regime:										
1875-1913	The Classical Gold Standard	4.73	6.78	3.34	3.81	4.50	3.43	0.0	8.5	-10.6
1914-1945	World Wars and interwar period	5.05	7.31	3.68	4.75	6.30	3.75	3.8	24.4	-15.0
1946-1971	Bretton Woods	5.92	9.50	3.50	6.54	11.07	3.55	4.4	11.7	-0.7
1972-2008	European exchange-rate co-operation	8.40	16.93	2.14	9.99	22.11	3.40	5.1	15.2	1.2
	1972-1978 The Currency Snake	10.84	15.42	6.47	13.45	15.71	10.44	10.1	15.2	6.6
	1979-1998 ERM I	9.98	16.93	3.66	11.52	22.11	5.03	4.9	12.3	1.3
	1999-2008 ERM II	3.53	4.91	2.14	4.51	5.66	3.40	2.2	3.4	1.2
	1972-1986 The devaluation/"soft peg" period	12.09	16.93	6.47	14.87	22.11	10.20	9.1	15.2	3.6
	1987-2008 The unchanged parity/"hard peg" period	5.89	11.04	2.14	6.67	11.29	3.40	2.5	4.8	1.2
Sub-periods determined by degree of restrictions on cross-border capital mobility:										
1875-1913	Free cross-border capital movements	4.73	6.78	3.34	3.81	4.50	3.43	0.0	8.5	-10.6
1914-1926	Restrictions on cross-border capital movements	5.92	7.31	4.77	5.14	6.30	4.25	5.5	19.3	-15.0
1927-1931	Free cross-border capital movements	4.87	5.15	4.60	4.91	5.10	4.65	-3.0	-0.6	-5.7
1932-1988	Restrictions on cross-border capital movements	7.26	16.93	3.50	8.33	22.11	3.55	5.7	24.4	-0.7
1989-2008	Free cross-border capital movements	5.54	11.04	2.14	6.28	10.63	3.40	2.5	4.8	1.2
1875-2008	Total	6.05	16.93	2.14	6.27	22.11	3.40	3.2	24.4	-15.0

Source: Table 1 in Abildgren (2005b) updated with more recent data from the sources stated in Abildgren, *op.cit*.

During the Classical Gold Standard period 1875-1913 Denmark participated in the Scandinavian Currency Union based on gold together with Sweden and (from 1877) Norway. During this period Denmark's other main trading partners participated in the international fixed-exchange-rate Gold Standard system as well. The system was characterised by free movements of capital (including free private import and export of gold in coins and bars). The price level in Denmark was roughly unchanged in the period 1875-1913 seen as one, and the long-term interest-rate spreads between Denmark and other countries were fairly stable.[93]

The period 1914-1945 saw rather frequent changes in the monetary regime. World War I *de facto* terminated the Scandinavian Currency Union and the international Classical Gold Standard, and ended the free cross-border capital movements. After the War Denmark and its main trading partners gradually returned to the Gold Standard and restored the free cross-border movements of capital[94], but the system collapsed again after a few years when the UK went off gold in September 1931. Denmark left the Gold Standard later within the same month, and in 1932 a comprehensive exchange-control system was introduced. Apart from a major Danish devaluation in 1933, the Danish krone was pegged rather closely to the British pound most of the remaining period until the outbreak of World War II. The average Danish inflation rate in the period 1914-1945 was 3.8 per cent, and inflation rates were highly volatile with 10 years of price decreases during the period 1921-1933 and a post-1875 all time high rate of inflation at 24.4 per cent per annum in 1940. However, compared with the Classical Gold Standard period the nominal interest-rate level was only slightly higher and fairly stable - even when the years around World War I and II[95] are included.

In the period 1946-1971 Denmark participated in the Bretton Woods fixed-exchange-rate system established under the auspices of the International Monetary Fund. The US dollar was the anchor currency of the system. In the late 1940s the UK was still Denmark's largest trading partner and the devaluation of the British pound by 30.5 per cent in September 1949 was followed fully by Denmark. During the 1950s and 1960s Denmark's trade pattern gradually changed towards higher export shares to continental Europe, and the devaluation of the British pound in November 1967 by 14.3 per cent vis-à-vis the US dollar was only followed partly by Denmark (7.9 per cent).

During the Bretton Woods period some capital-account transactions (mainly in relation to short-term commercial credits, financial loans and non-financial direct investments) were liberalised but most portfolio investments to and from Denmark still required permission from the Danish monetary authorities. In the Bretton Woods period seen as one the average Danish

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[93] Charts with the short-term and long-term Danish interest-rate spread vis-à-vis Germany, UK, USA, Norway and Sweden since 1875 are found in Abildgren (2005a).

[94] In January 1927 the Danish krone returned to the Gold Standard at the pre-war parity and the Danish ban on exports of gold in coins and bars was removed vis-à-vis countries with gold-encashment of their currencies.

[95] Frey & Waldenström (2008) analyses the changes in the perceived threat of war reflected in the yields from the Nordic government bond markets (including Danish government bonds) during the period 1938-1940. Their analysis finds only a few significant structural breaks in the daily yields on Danish government bonds traded in Copenhagen: In December 1939 after the German-Sovjet anti-aggression pact (+51 basis points); In September 1939 after the outbreak of World War II (+71 basis points); and in February 1940 after the Altmark incident (+54 basis points). The average yield on Danish government bonds during World War II stayed just above 4 per cent per annum due to abundant liquidity, and the central bank of Denmark (Nationalbanken) was more concerned with how to prevent interest rates from falling too much than with high interest rates.

inflation level was only slightly higher than in the period 1914-1945, but during the 1960s there was a sustained upward trend in inflation rates as well as in nominal interest rates.

After the breakdown of the Bretton Woods system in the beginning of the 1970s, the Danish exchange-rate policy became part of the European exchange-rate co-operation, first within the "Currency Snake" founded in 1972 and subsequently from 1979 within the European Exchange Rate Mechanism (ERM).

The post-1971 period also saw a gradual process with deregulation of the remaining Danish restrictions on capital-account transactions. From December 1974 non-residents were given free access to buy Danish krone-denominated exchange-listed bonds (with an original maturity of more than 2 years). However, in February 1979 the free access was abolished again, but it was reintroduced in May 1983. The last restrictions on capital account transactions in Denmark[96] were removed in October 1988.

The oil price shocks of the 1970s and frequent devaluations of the krone during the late 1970s and the beginning of the 1980s caused a continuation of the upward trend in inflation and a widening of the long-term interest spread between Denmark and its main trading partners. Danish government bond yields reached a post-1875 all time high of 22.11 per cent in 1982. The government debt increased rapidly, and a fear that Denmark was on the verge of "state bankruptcy" began to rise. In the beginning of the 1980s the yield on long-term Danish government bonds exceeded the yield on long-term Danish mortgage-credit bonds for the first time since the period around World War I, cf. Figure 2.2. Even though a careful interpretation has to be applied[97] this highlights the extent of the crisis in the Danish economy at the beginning of the 1980s.

In September 1982 the incoming Danish government announced the abolishment of devaluation as an economic-policy instrument. The Deutsche Mark was revalued several times within the ERM in the period 1982-1987, including vis-à-vis the krone, but not on the initiative of Denmark. The last realignments of the central parity for Danish kroner vis-à-vis Deutsche Mark within ERM occurred in the beginning of 1987. Since then Denmark pursued a "hard" peg against the D-mark and later the euro, despite the widening of the fluctuation bands in the ERM in 1993 and major devaluations by some of Denmark's main trading partners. The increased credibility of the Danish fixed-exchange-rate policy and the international decline of inflation rates during the 1980s and the beginning of the 1990s caused a marked downward trend in both inflation and nominal interest rates in Denmark. The long-

[96] Mainly concerning money market papers, Danish banks' foreign-exchange loans to residents, loans in kroner to residents from Danish banks' foreign units, private individuals' loans abroad and private individuals' access to open accounts in foreign banks. For a review of the liberalisation of cross-border capital movements in Denmark in the period 1950-1985, cf. Hald & Jensen (1986) and Chapter II in Det Økonomiske Råd. Formandskabet (1985).

[97] Due to the different characteristics of the government bonds and the mortgage-credit bonds from which the yields in Figure 2.2 have been derived.

term interest spread between Denmark and Germany decreased rapidly from more than 13 per cent in 1982 to less than 1 per cent in 1991 and 0.31 per cent in 2008. The period since 1987 has seen an average inflation level in Denmark of 2.5 per cent, and inflation volatility has been low. In 2004-2005 the Danish money market rate as well as the long-term government bond yield reached a post-1875 all time low. In this connection it is also worth to notice that last three decades have not witnessed even a single year with negative CPI inflation whereas price decreases frequently occurred during the classical gold standard.[98] All else being equal, the inflation-risk premium embedded in the long-term government bond yield is therefore probably higher today than in the gold standard period.

2.3. Real interest rates and inflation expectations

A "classical" proposition in the theory of finance – the Fisher equation – states that the nominal interest rate approximately equals the sum of the expected inflation and the *ex ante* real interest rate.[99] Other factors such as premiums for interest-rate risk (inflation risk), credit risk, illiquidity, tax treatment[100] *etc.* might also influence the nominal interest rate. However, it may still be useful to review the information regarding the expected inflation and the *ex ante* real interest rate that can be derived from the nominal interest rates using the simple Fisher equation.

Neither the expected inflation nor the *ex ante* real interest rate is directly observable – at least not for a time span covering the whole period sine 1875. For shorter historical time-periods one may try to measure inflation expectations more directly from the yield on inflation-index-linked bonds.[101] However, in the case of Denmark such an approach is complicated by a rather illiquid market for index-linked bonds. Furthermore, special tax provisions may distort the results, cf. e.g. Topp (1996) and Hansen (2004).

Another approach could be to try to utilise information regarding price expectations from consumer surveys, cf. e.g. Christensen (1996) and Knudsen (2002). However, in Denmark such surveys cover only the period since the middle of the 1970s.

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[98] Alternating periods of inflation and price decreases was a common characteristic in most countries during the gold standard era, cf. e.g. the survey of 30-40 countries in Bordo & Filardo (2005a, 2005b) and Borio & Filardo (2004). The period 1866-1897 was even characterised by a steadily declining price level in the United States, cf. Beckworth (2007).

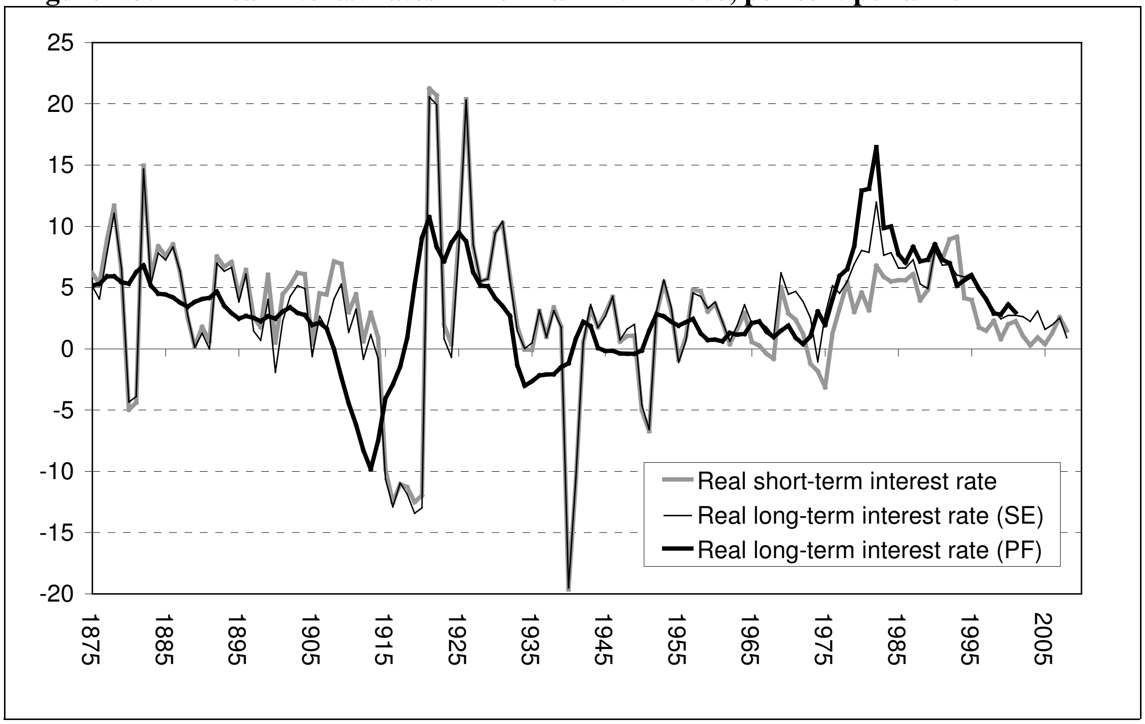
[99] The idea behind this relationship – a distinction between a nominal and a real interest rate – can at least be traced back to the works of William Douglas around 1740, cf. Humphrey (1983). In its "modern" form the proposition is mainly associated with Fisher (1896).

[100] The essay at hand does not cover the importance of non-neutrality of tax deductibility in the nominal-income-based Danish tax system in relation to measurement of the real interest rate development. An analysis of the development in Danish real interest rates before and after tax during the period 1953-1984 is found in Chapter V in Det Økonomiske Råd. Formandskabet (1985). The period 1960-2000 is covered by Pedersen (2001).

[101] A commonly used measure for inflation expectations derived from inflation-index-linked bond is the so-called "break-even inflation", i.e. the rate of expected inflation at which the return on an inflation-index-linked bond is equal to the return on an equivalent nominal bond.

A third approach could be to use "independent" (i.e. non-governmental) inflation forecasts from macroeconomic projections as a measure of the expected inflation. In Denmark such forecasts are only available from Danish Economic Council since the beginning of the 1960s, cf. Det Økonomiske Råd. Formandskabet (1987).[102]

Figure 2.3: Real interest rates in Denmark 1875-2008, per cent per annum



Notes: The "real short-term interest rate (SE)" is measured as the difference between the contemporaneous nominal market rate of discount/money market rate and the contemporaneous rate of consumer price inflation.
The "real long-term interest rate (SE)" is measured as the difference between the contemporaneous nominal government bond yield and the contemporaneous rate of consumer price inflation.
The "real long-term interest rate (PF)" is measured as the difference between the contemporaneous nominal Government bond yield and the annual average consumer price inflation 7 years ahead. Therefore, the last observation is 2001.

Source: Figure 3 in Abildgren (2005b) updated with more recent data from the sources stated in Abildgren, *op.cit*.

In order to derive *ex ante* real interest rates for the entire period since 1875 from the nominal interest rates one therefore needs to make some more crude assumptions regarding inflation expectations. Figure 2.3 shows three different indicators for the real-interest-rate development in Denmark in the period since 1875:

- The "real short-term interest rate" is measured as the difference between the contemporaneous short-term nominal interest rate and the contemporaneous rate of consumer price inflation.
- The "real long-term interest rate (SE)" is measured as the difference between the contemporaneous nominal long-term interest rate and the contemporaneous rate of consumer price inflation. This corresponds to an *ex ante* long-term real interest rate under

[102] In a study of the Fisher effect during the classical gold standard period Mitchener & Weidenmier (2010) use a fourth approach. They derive a measure of inflation expectations using the interest-rate differential between Austrian silver and gold perpetuity bonds.

the assumption of "static expectations" regarding the future long-term inflation development.
- The "real long-term interest rate (PF)" is measured as the difference between the contemporaneous long-term nominal interest rate and the annual average consumer price inflation 7 years ahead.[103] This corresponds to an *ex ante* long-term real interest rate under the assumption of "perfect foresight" (PF) (or "rational expectations") regarding the future long-term inflation development.

All the three measures for the real interest rate in Denmark show an average around 3 per cent per annum[104] for the period since 1875 seen as a whole. Taken at face value the "real long-term interest rate (PF)" indicates a rather high level of long-term real interest rates during the late 1980s and the first half of the 1990.

As an alternative to derive indicators for the *ex ante* real interest rate from the nominal interest rate one can try to derive proxies for the expected inflation from the nominal long-term interest rate by deducting a measure for the expected real long-term interest rate. Dewald (2003) study financial market inflation expectations in thirteen countries (including Denmark) in the period 1880-2001. One of the measures of the expected real long-term interest rate in each country presented in Dewald, *op.cit.*, is the country's own 10-year-ahead real GDP growth trend (the "country growth approach"). The underlying argument is the "Golden Rule" within Neo-classical Growth Theory – according to which the steady state real interest rate approximately equals the annual growth rate of real output[105] – combined with an assumption of "perfect foresight" (or "rational expectations") regarding future economic growth. Such an approach may be reasonable in periods with restrictions on cross-border capital movements, but less obvious in periods with free cross-border capital movements. In the latter case one would expect real interest rates to be equalised across countries.[106] Dewald, *op.cit.* therefore also presents alternative calculations where the expected real long-term interest rate in each

[103] The horizon of 7 years has been chosen because it roughly corresponds to the Macaulay Duration of a 10-year par bullet bond at an interest rate level (6.27 per cent per annum) equal to the average annual yield on Danish government bonds for the period 1875-2008, cf. Table 2.1.

[104] The real short-term interest rate 2.9 per cent per annum, the real long-term interest rate (SE) 3.1 per cent per annum, and the real long-term interest rate (PF) 3.1 per cent per annum.

[105] Cf. e.g. Blanchard & Fischer (1989) or Barro & Sala-i-Martin (2004) for a textbook presentation of the Golden Rule. The so-called Modified Golden Rule within a Ramsey neoclassical growth model states that the real interest rate equals the annual growth rate of real output plus the rate of time preferences. For the period 1875-2008 seen as a whole the average real short-term interest rate in Denmark was 2.9 per cent per annum while the average Danish growth rate of real output was 2.8 per cent per annum. Based on these statistics the rate of time preferences in Denmark seems to have been rather modest (0.1 per cent per annum).

[106] Using a monthly data set on long-term government bond yields for US, UK, France and Japan 1923-2000 Sekioua (2008) finds support for long-run real interest-rate parity. Similar evidence has been found using quarterly data on money market rates for Canada, France, Germany, Japan, UK and the US in the period 1957-2000 by Goldberg *et al.* (2003) and in a monthly data set covering the US, UK, France and Germany 1890-2000 by Obstfeld & Taylor (2002). Furthermore, Sekioua, *op.cit.*, finds no clear-cut differences in the adjustment of shocks to real interest-rate parity across fixed and floating exchange-rate regimes.

country is equal to a cross-country average 10-year-ahead real GDP growth trend (the "world growth approach"). However, in practice the two sets of calculations show similar results.[107]

Following the lines of the "country growth approach" Figure 2.4 show the results regarding financial market inflation expectations in Denmark during the period 1875-2001 using the real growth in GDP 7 years ahead as a measure for the expected real long-term interest rate. According to such calculations financial market inflation expectations in Denmark have roughly been correct for the period 1875-2001 as a whole. On average the actual inflation was 3.3 per cent per annum while the average expected inflation rate was 3.5 per cent per annum. However, given the chosen proxy for the expected inflation the large fluctuations in inflation during World War I and the interwar period were not expected – in fact, inflation expectations remained relatively stable in the period 1910-1930 despite large swing in the actual inflation rate. During this period spikes in inflation were apparently viewed as temporary and the price level (or trend) was more or less expected to return back towards the "normal" level (trend). In the 1960s and the first half of the 1970s inflation expectations underestimated the actual inflation 7 years ahead, and since the mid-1970s inflation expectations have persistently overestimated the actual inflation 7 years ahead. This rather high degree of persistence in the expected inflation rate (including inflation-risk premiums) compared to the development in the actual inflation rate could indicate the presence of a very long learning process in the formation of inflation expectations.[108] The relatively high long-term real-interest-rate level during the late 1980s and the first half of the 1990s – implied by the "traditional" measures in Figure 2.3 – might therefore reflect a high degree of persistence in inflation expectations.[109] If inflation expectations are higher than realised inflation, a real interest rate constructed by subtracting the current or future rate of inflation from the current nominal interest rate can thus be a very imperfect measure in the short term.[110]

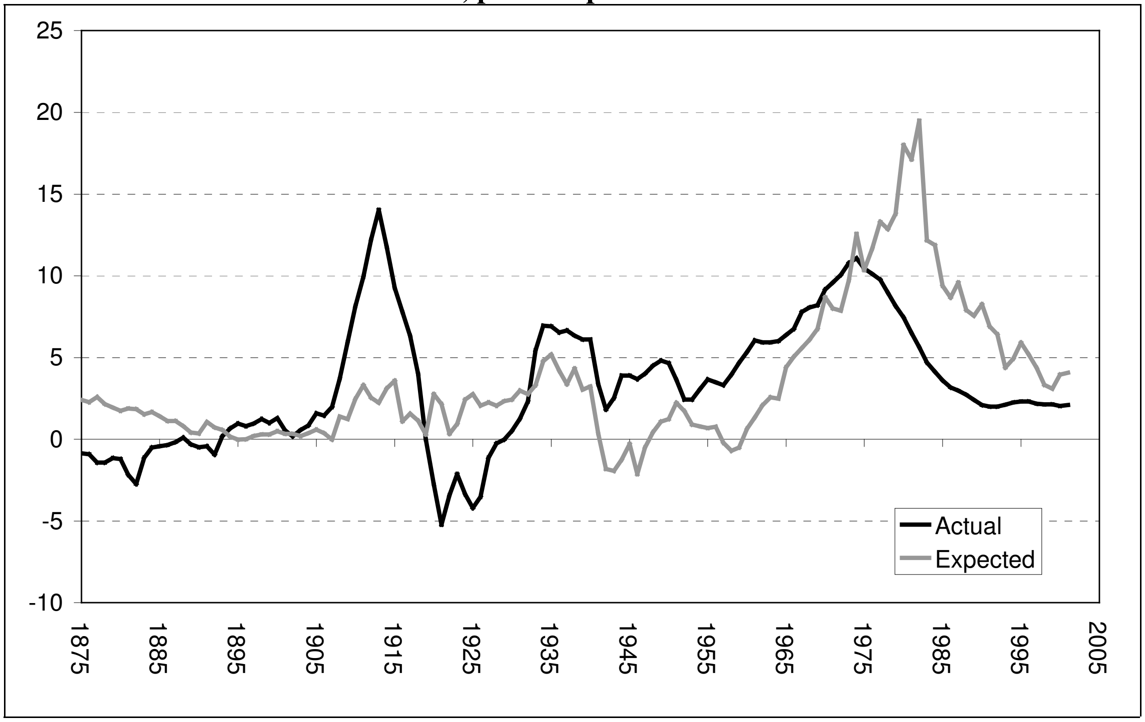
[107] Cf. also Bordo & Dewald (2001).

[108] Similar results are for more recent periods found in the case of Denmark, cf. e.g. Christensen (1996) and Knudsen (2002) and the references therein.

[109] Cf. also the discussion of the so-called "Gibson paradox" in the literature, cf. e.g. Catão & Mackenzie (2006).

[110] Cf. the discussion regarding the US experiences in Delong (2000), Bernanke (2000) and English (2000). However, as noted by e.g. English, *op. cit*., real interest rates may actually have been relatively high during the late 1980s due to financial deregulation, which might have increased demand for funds from previously credit-rationed economic agents.

Figure 2.4: The actual and expected consumer price inflation 7 years ahead in Denmark 1875-2001, per cent per annum

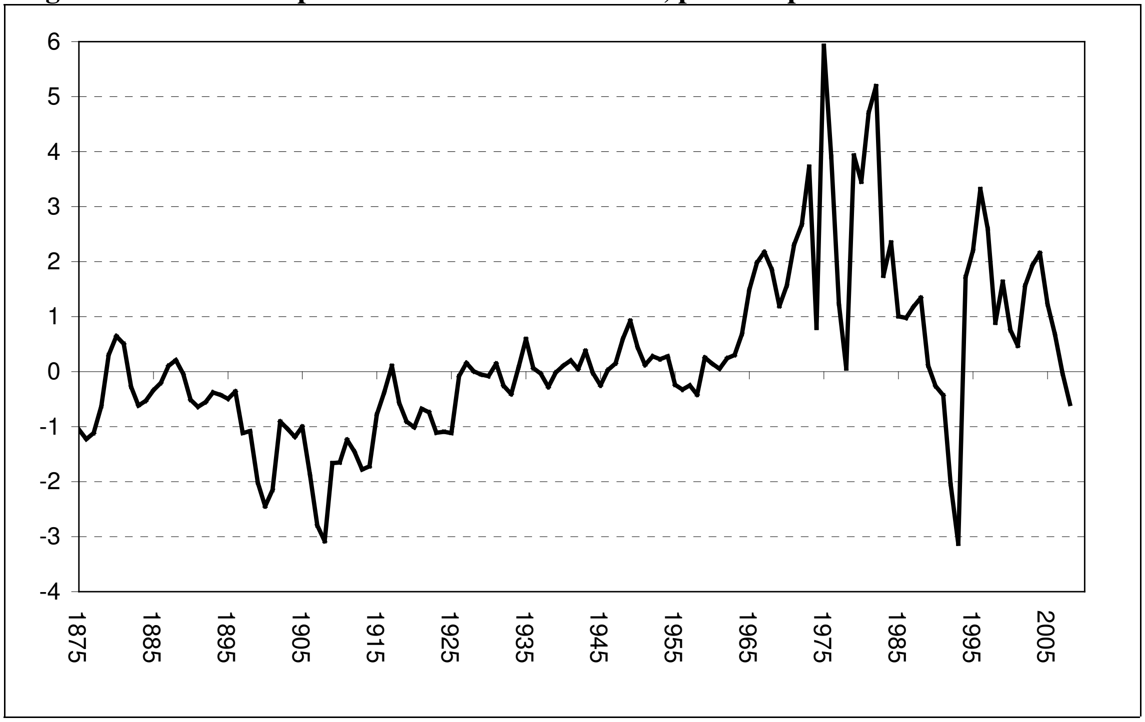


Notes: The expected consumer price inflation 7 years ahead is measured as the difference between the contemporaneous nominal Danish government bond yield and the annual average growth rate in real GDP in Denmark 7 years ahead.

Sources: Chart 9a in Abildgren (2005a) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

Another way to visualise the time-dependence of the inflation-risk premium is to look at the spread between the long-term interest rate and the short-term interest rate (the "term spread") over time, cf. Figure 2.5. Most of the time prior to 1960 the term spread was much more stable than in period from 1960 to the early 1990s. This "stylise fact" could indicate that inflation expectations were much more firmly anchored prior to 1960 than during the period 1960-1990. Atkeson & Kehoe (2008) finds similar evidence for a number other countries (United States, United Kingdom, France, Germany and the Netherlands).

Figure 2.5: Term spread in Denmark 1875-2008, per cent per annum



Note: The term spread is measured as the difference between the government bond yield and the market rate of discount/money market rate.

Source: Chart 4a in Abildgren (2005a) updated with more recent data from the sources stated in Abildgren, *op.cit*.

2.4. Demography and interest rates

Pedersen (2006) applies the data set presented in Abildgren (2005a) in a study on the long-term relationship between interest-rate levels and the demographic developments in Denmark. Pedersen compiles a dependency ratio defined as the population aged 20-34 (borrowers) and over 60 (spenders of savings) as a ratio of the population aged 25-59 (savers) and finds a strong correlation with the nominal interest rate 1900-2005. A possible explanation could be that a high dependency ratio and thereby a relatively low level of savings exerts an upward pressure on interest rates – and vice versa in periods with a low dependency ratio.

However, the correlation is less apparent when real interest rates[111] are studied, and Pedersen notes that other factors such as the monetary and fiscal policy might be more important in explaining the high interest rates during the 1970s.

2.5. Scope for further research

The data set on interest rates presented in the essay at hand has only been on an annual frequency. Recently Norges Bank published a comprehensive collection of historical monetary statistics, which included monthly yield data on bonds issued by the Norwegian government *etc*. for the period 1820–2003 based on contemporary newspaper sources and official lists published by the Oslo Stock Exchange.[112]

As demonstrated by e.g. Gerlach *et al*. (2006) long-span interest-rate data on a monthly frequency can offer an interesting perspective on financial market volatility during episodes of economic and political turbulence. It would therefore be useful if future projects on long-span interest-rate data construction in Denmark would make an attempt to compile time series on the yield on government bonds and mortgage-credit bonds at a monthly frequency or preferable event weekly or daily frequency, if possible.

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[111] Pedersen (2006) does not use the real interest rates presented in Abildgren (2005a) directly, but a smoothed version hereof.

[112] Cf. Klovland (2004).

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Annex 2.A: Compilation of a New Set of Historical Interest-Rate Data for Denmark 1875-2008

This annex presents the main sources and methods used for the compilation of a new set of historical interest-rate data for Denmark 1875-2008. The time series are listed in annex 2.B.

2.A.1. Some methodological notes and issues related to interpretation

In general interest rates depend on the characteristics of the underlying financial assets to which the interest rates relate. The level of interest rates thus depends on the maturity of the underlying asset and its cash-flow profile, the level of credit risks associated with the debtor, the degree of tradability and liquidity of the asset, and the tax treatment of the cash flows from the asset. Furthermore, more specific details in the contract related to the underlying asset (e.g. call provisions or provisions on collateral) might influence the interest rate. Finally, recorded interest rates depend on which side of the market they are quoted (bid, offer or mid prices) and the day-count convention used for the quotation.

Even for shorter time-span – like three or four decades – it is not an easy task to find data on representative interest rates that are fully comparable across time. For a data-construction exercise covering a time span of more than 130 years the choice of data sources is to an even higher degree determined by data availability, leaving consistency to be an important but secondary concern. This introduces certain degrees of measurement errors, and the data set presented in this essay can only be expected to provide a crude review on the broad trends in short-term and long-term interest rates in Denmark since 1875.[113]

The first year in the period covered – 1875 – was the year when the krone was introduced as the Danish currency unit and Denmark changed her monetary standard from silver to gold. Furthermore, the last part of the 19th century was the period in which national financial markets in Denmark were being developed.[114] Before this period segmentation of the regional financial markets prevented differences in interest rates from being (actually or potentially) arbitraged away.

Another aspect in relation to the interpretation of historical interest rate data concerns the extent to which the interest rates are market based. Regarding interest rate conditions in Denmark since 1875 the following should be noted:

- Until 1942 there were some legal provisions regarding maximum interest rates on loans secured by real property. However, loans raised through mortgage-credit institutes were exempted from these provisions.[115]
- In 1933 an act introduced maximum interest rates on deposits with banks and savings banks. These provisions were removed again in 1935. During the period 1935-1973

[113] For a thorough description of many of the general problems related to compilation of historical interest-rate series one may refer to Officer (2003) and Eitrheim & Klovland (2007).

[114] Cf. e.g. Hansen & Johansen (1994) and page 41 in Hansen & Mørch (1997).

[115] Cf. Hansen & Svendsen (1968) and Hoffmeyer & Olsen (1968).

savings banks and the commercial banks had an internal agreement regarding maximum interest rates on deposits.[116]

- In 1975 an Act on Interest Margins was implemented as a part of a wider set of incomes-policy measures with the aim of limiting the interest-rate margin charged by the banking system. The Act was in force until 1979.
- In the years 1978-1979 the banks had an internal agreement on maximum interest rates on special-term deposits in order to limit the tendency to higher interest rates caused by the design of the Act on Interest Margins, cf. above.
- In the years 1979-1981 the Nationalbank had an agreement[117] with the banking sector on an individual bank level according to which the bank's lending rates should followed the development in the Nationalbank's discount rate.

In addition one also has to take into consideration the presence of restrictions on capital-account transactions, cf. the main text of the essay. Finally it should be mentioned that the Danish monetary authorities in some historical periods, e.g. in the 1960s, made use of interventions in the bond market in order to influence the bond yields.[118]

2.A.2. The current availability of historical interest-rate data

There exist a number of earlier studies focusing on the construction of long-span comparable interest-rate data for Denmark.

The official discount rate of the Nationalbank (the central bank of Denmark) for the period 1818-1967 is listed in Mordhorst (1968).

Statistics Denmark (1969) presents detailed quarterly interest-rate data on individual Danish central government bonds, local government bonds, mortgage-credit bonds and bonds issued by Danish banks in the period 1810-1965, although not without gabs. However, the choice of selecting the best representative interest rate over time is left to the user. Based on mainly this study, Johansen (1985) presents end-of-year data for the yield on Danish central government bonds, Danish local government bonds and Danish mortgage-credit bonds in the period 1814-1980, although with some missing observations.

Alternative long-span data series are found in Pedersen (1930) who presents yields on Danish mortgage bonds and Danish government bonds for the period 1855-1930 on an annual frequency. Furthermore, Hoffmeyer (1960) presents annual data for the average deposit interest rates in Danish savings banks in the period 1857-1959 and yield on Danish mortgage-credit bonds covering 1852-1959. For various parts of the period 1874-1945 some annual time series on interest rates on loans and deposits with selected individual banks and savings banks as well as some aggregated figures can be found in Andersen (ed.) (1947).

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[116] Cf. Hoffmeyer (1960) and Mikkelsen (1993).

[117] Reprinted in the Annual Report and Account 1979 from Danmarks Nationalbank.

[118] Cf. e.g. Mikkelsen (1993).

Nielsen & Risager (2001) present end-of-year data for the yield to maturity of Danish government bonds in the 2-, 5- and 10-year maturity segment covering the period 1922/24-1999.

Finally, Parum (1999b) constructs annual data on the realised total return on long Danish mortgage bonds in the period 1925-1998.

2.A.3. The new data set on Danish interest rates 1875-2008

Three different short-term interest-rate series (the official discount rate, the private banks' average deposit rate, and the market rate of discount/money market rate) and two different long-term interest-rate series (the government bond yield and the yield on mortgage-credit bonds) have been constructed for this essay covering the whole period 1875-2008, cf. Figure 2.1 and 2.2. The time series are listed in annex 2.B.

Table 2.A.1: Main characteristics of the new data set on historical Danish interest rates 1875-2008

Data series	Concept
Official discount rate	The discount rate of the Nationalbank (the central bank of Denmark). For the period 1875-1910 the Nationalbank quoted two discount rates.[119] For this period the lower of the two rates has been selected.
Private banks' average deposit rate	Weighted average deposit interest rates in savings banks and commercial banks.
Market rate of discount/money market rate	1875-1940 and 1950-1972: Commercial banks' rate of discount for commercial bills of exchange. 1941-1949: Danmarks Nationalbank's lending rate. Since 1973: 3-month uncollateralised inter-bank interest rate.[120]
Government bond yield	1875-1985: Yield to maturity on long central government bonds. Since 1986: Yield to maturity on 10-year central government bonds.
Yield on mortgage-credit bonds	1875-1959: Average yield to maturity on long callable mortgage-credit bonds. 1960-1972: Yield to maturity on 30-year callable mortgage-credit bonds. Since 1973: Yield to maturity on 20-year callable mortgage-credit bonds.

Sources: Table A.1 in Abildgren (2005b) and Appendix 2 in Abildgren (2005a).

Table 2.A.1 gives an overview of the main characteristics of the series. All the interest-rate data presented are annual averages. The main data source is various publications and databases from Danmarks Nationalbank (the central bank of Denmark) and Statistics

[119] The lower rate was applied vis-à-vis banks while the higher rate was applies vis-à-vis non-bank commercial firms.

[120] A modern-style interbank money market were first established in Denmark in the beginning of the 1970s, cf. page 50 in Hoffmeyer (1993).

Denmark (1969). However, in order to get complete time-series data without gaps for the whole period 1875-2008 a much wider range of sources has been drawn upon, cf. section 2.A.2. In some cases, interpolations have been necessary in order to splice old and new data series into comparable time series. The sources and compilation methods are outlined in detail in Abildgren (2005a).

Annex 2.B: Danish interest rates 1875-2008 – Data

Table 2.B.1: Danish interest rates 1875-2008, annual averages, per cent per annum

Year	Official discount rate	Private banks' average deposit rate	Market rate of discount/ Money market rate	Government bond yield	Yield on mortgage-credit bonds
1875	5.22	4.00	5.38	4.33	4.60
1876	5.26	4.02	5.60	4.38	4.90
1877	5.38	4.09	5.62	4.50	5.00
1878	4.41	3.98	5.13	4.50	5.00
1879	3.62	3.71	4.00	4.30	4.60
1880	3.39	3.67	3.48	4.13	4.40
1881	3.12	3.59	3.57	4.08	4.60
1882	4.08	3.72	4.35	4.08	4.30
1883	4.25	3.83	4.67	4.05	4.40
1884	4.07	3.82	4.53	4.00	4.40
1885	3.85	3.80	4.34	4.00	4.40
1886	3.39	3.67	4.05	3.85	4.10
1887	3.00	3.41	3.50	3.60	3.80
1888	3.00	3.29	3.34	3.55	3.70
1889	3.16	3.36	3.57	3.53	3.70
1890	3.73	3.53	4.11	3.60	3.80
1891	4.00	3.65	4.39	3.75	3.90
1892	3.68	3.55	4.28	3.73	4.00
1893	3.68	3.47	4.08	3.70	3.90
1894	3.53	3.50	4.00	3.58	3.80
1895	3.50	3.31	3.92	3.43	3.60
1896	3.52	3.33	3.86	3.50	3.60
1897	4.41	3.49	4.62	3.50	3.70
1898	4.28	3.52	4.58	3.50	3.70
1899	5.40	3.77	5.67	3.65	4.20
1900	5.87	4.14	6.22	3.78	4.40
1901	5.33	4.21	5.75	3.60	4.50
1902	4.05	3.90	4.46	3.55	4.30
1903	4.31	3.80	4.54	3.50	4.30
1904	4.50	3.79	4.79	3.60	4.40
1905	4.29	3.81	4.55	3.55	4.20
1906	5.22	4.08	5.45	3.58	4.30
1907	6.18	4.30	6.42	3.63	4.40
1908	6.14	4.36	6.78	3.70	4.50
1909	4.94	4.11	5.34	3.68	4.30
1910	5.00	4.07	5.35	3.70	4.40
1911	4.62	3.97	4.99	3.75	4.30
1912	5.06	4.03	5.38	3.93	4.40
1913	5.75	4.18	5.98	4.20	4.60
1914	5.52	4.28	5.97	4.25	4.70
1915	5.27	4.25	5.98	5.20	5.00
1916	5.00	4.14	5.28	4.90	4.90
1917	5.00	4.20	4.77	4.88	4.90
1918	5.00	4.32	5.47	4.90	5.00
1919	5.61	4.38	6.11	5.20	5.20
1920	6.71	4.70	7.31	6.30	5.80
1921	6.35	4.68	6.20	5.53	5.50
1922	5.16	4.14	5.64	4.90	5.10
1923	5.67	4.19	6.11	5.00	5.30
1924	6.96	4.47	6.39	5.30	5.70
1925	6.49	4.46	6.39	5.28	5.80
1926	5.24	4.38	5.33	5.25	5.70
1927	5.00	4.45	4.94	5.10	5.60
1928	5.00	4.42	4.92	4.93	5.30
1929	5.13	4.46	5.15	5.10	5.30
1930	4.19	4.22	4.73	4.65	4.80
1931	4.22	4.16	4.60	4.75	5.20
1932	4.50	4.26	5.25	5.00	5.40
1933	3.17	3.49	4.53	4.13	4.60
1934	2.50	3.22	3.87	3.95	4.30
1935	2.86	3.43	3.68	4.28	4.80
1936	3.56	3.62	4.31	4.38	4.80
1937	4.00	3.62	4.58	4.55	5.00
1938	4.00	3.62	4.55	4.28	4.80
1939	4.08	3.65	4.64	4.63	5.00
1940	4.79	3.76	4.81	4.93	5.10
1941	4.00	3.44	4.00	4.20	4.40
1942	4.00	3.13	4.00	4.05	4.20
1943	4.00	2.96	4.00	4.38	4.40
1944	4.00	2.61	4.00	3.98	4.10

Table 2.B.1 (continued):

Year	Official discount rate	Private banks' average deposit rate	Market rate of discount/ Money market rate	Government bond yield	Yield on mortgage-credit bonds
1945	4.00	2.27	4.00	3.75	4.00
1946	3.52	2.26	3.52	3.55	3.90
1947	3.50	2.32	3.50	3.65	3.80
1948	3.50	2.39	3.50	4.10	4.20
1949	3.50	2.46	3.50	4.43	4.50
1950	4.07	2.68	4.08	4.53	4.60
1951	5.00	2.94	5.00	5.13	5.40
1952	5.00	3.14	5.00	5.28	5.60
1953	4.86	3.17	4.88	5.10	5.50
1954	5.02	3.29	5.00	5.28	5.80
1955	5.50	3.63	5.79	5.55	6.30
1956	5.50	3.66	6.00	5.68	6.40
1957	5.50	3.69	6.00	5.75	6.50
1958	4.96	3.61	5.65	5.23	5.60
1959	4.64	3.36	5.15	5.40	5.80
1960	5.47	3.89	5.96	6.10	6.56
1961	6.11	4.58	6.63	6.68	7.74
1962	6.50	4.74	7.00	7.24	7.91
1963	6.25	4.38	6.81	7.11	7.95
1964	6.06	4.83	6.54	7.23	8.70
1965	6.50	5.04	7.00	8.49	9.94
1966	6.50	5.06	7.00	8.98	10.17
1967	6.53	5.45	7.04	9.21	10.32
1968	6.66	4.98	7.17	9.03	9.57
1969	8.03	6.31	8.50	9.69	10.29
1970	9.00	6.83	9.50	11.07	12.02
1971	7.70	5.91	8.19	10.50	11.75
1972	7.28	5.57	7.77	10.44	11.88
1973	7.50	6.39	8.10	11.83	13.21
1974	9.94	8.79	13.34	14.13	16.54
1975	8.12	7.32	6.47	12.39	13.49
1976	8.82	8.32	10.28	14.19	15.60
1977	9.17	9.42	14.48	15.71	16.38
1978	8.57	8.62	15.42	15.48	17.33
1979	9.12	8.47	12.63	16.57	17.61
1980	12.28	11.45	16.93	20.38	19.78
1981	11.00	10.85	14.84	19.55	20.11
1982	10.91	10.97	16.92	22.11	21.24
1983	8.06	9.02	12.81	14.55	14.97
1984	7.00	8.62	11.77	14.12	14.78
1985	7.00	8.34	10.33	11.33	12.03
1986	7.00	7.08	9.23	10.20	10.77
1987	7.00	7.62	10.11	11.29	12.55
1988	7.00	7.02	8.53	9.87	11.26
1989	7.00	7.00	9.59	9.70	10.16
1990	8.03	7.90	10.89	10.63	10.98
1991	9.50	7.20	9.70	9.27	10.09
1992	9.50	7.50	11.04	8.99	10.14
1993	8.69	6.50	10.41	7.28	8.16
1994	5.21	3.50	6.13	7.85	8.39
1995	5.36	3.90	6.07	8.27	9.09
1996	3.46	2.80	3.87	7.19	7.84
1997	3.31	2.70	3.66	6.26	7.20
1998	3.80	3.10	4.15	5.03	6.27
1999	2.95	2.40	3.31	4.94	6.60
2000	4.02	3.20	4.91	5.66	7.33
2001	4.29	3.30	4.62	5.09	7.05
2002	3.22	2.55	3.48	5.05	6.69
2003	2.26	1.83	2.38	4.31	5.11
2004	2,00	1,60	2,14	4,30	5,00
2005	2,02	1,70	2,17	3,40	4,58
2006	2,77	2,28	3,13	3,81	4,62
2007	3,84	3,45	4,32	4,29	5,13
2008	4,07	3,98	4,88	4,29	5,61

Source: Annex B in Abildgren (2005b) updated with more recent data from the sources stated in Abildgren, *op.cit.*

Essay 3:
Real Effective Exchange-Rate Indices and Relative Purchasing-Power-Parity Convergence for Denmark 1875-2003[121]

Abstract

Essay 3 constructs annual trade-weighted nominal and real effective exchange-rate indices for Denmark 1875-2003 and explore the empirical evidence regarding long-run relative purchasing-power-parity (PPP) convergence based on the new data set.

The results based on univariate unit-root testing of the real effective krone-rate index with wholesale prices as the deflator support a hypothesis of long-run relative PPP convergence. Half-lives of real exchange rate shocks are estimated to around 4 years in the post-1923 period and 2 years in the pre-1914 Classical Gold Standard period. Furthermore, the results indicate that the speed of mean reversion depends on the exchange-rate regime. The fastest mean reversions towards relative PPP seem to have occurred in those periods where Denmark has pursued a fixed-exchange-rate policy vis-à-vis the majority of its trading partners and thus in those periods with the lowest volatility in the nominal effective krone rate.

The essay does not find support for long-run relative PPP convergence when consumer prices are used as deflators in the real effective krone-rate index. This finding is consistent with a priori expectations based on theoretical considerations and highlights the importance of choice of deflators in studies of the relative PPP hypothesis.

Annex 3.A presents the main sources and methods used for the compilation of the new set of annual trade-weighted nominal and real effective exchange rate indices for Denmark 1875-2003. Two real effective krone-rate indices with respectively wholesale prices and consumer prices used as deflators are calculated. All indices are constructed as geometrically weighted chain indices with current (i.e. annually updated) trade weights based on Denmark's foreign trade in goods with 15 of its largest trading partners. During each year in the period since 1875 these 15 countries accounted for at least 77 per cent of Denmark's total foreign trade in goods.

Key words: Exchange-rate policy; Danish krone exchange rates; Effective exchange rates; Purchasing-power parity; History of exchange rates.

JEL Classification: E42; F31; N23; N24.

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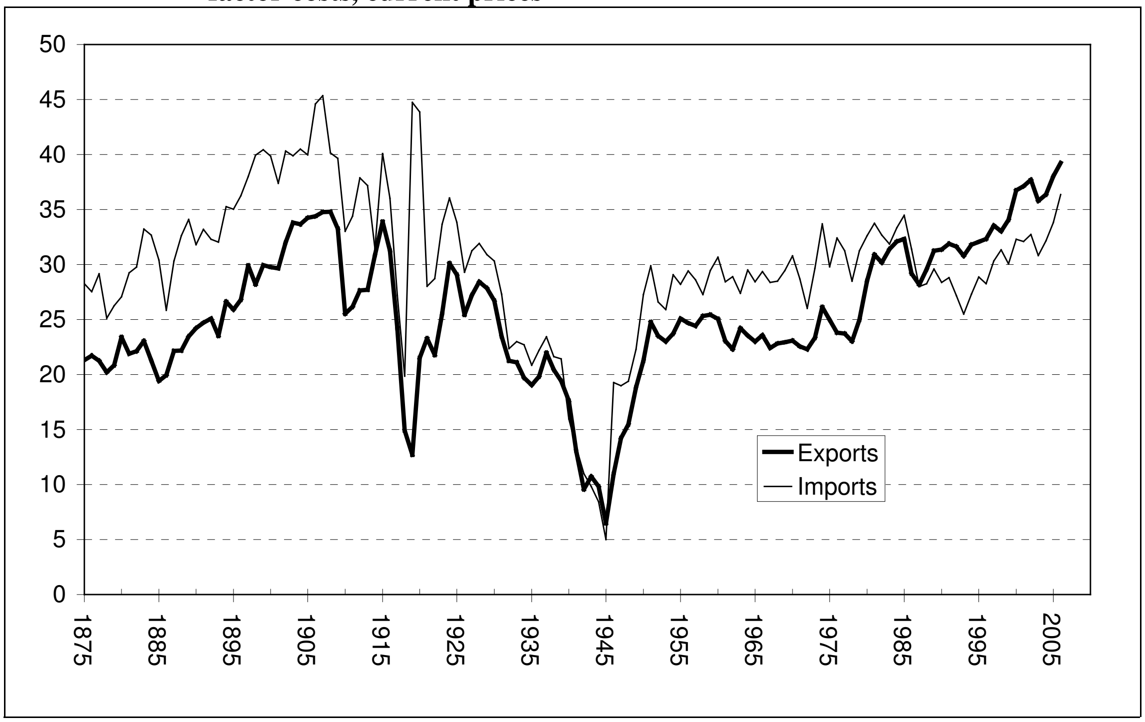
[121] This essay is based on Abildgren (2004a, 2004b, 2004c, 2005c).

3.1. Introduction

A tendency towards relative purchasing-power parity (PPP) – at least in the long run – is a crucial mechanism in many theoretical models on real-exchange-rate determination in open economies.

During most of the post-1875 period, the Danish economy can be characterised as a small, open economy. On average, both exports and imports of goods have amounted to 25-30 per cent of GDP, cf. Figure 3.1.

Figure 3.1: Danish exports and imports of goods 1875-2006, per cent of GDP at factor costs, current prices



Source: Chart 1 in Abildgren (2004c) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

Taylor (2002) tests for long-run relative PPP using data from the period 1870-1996 for 20 countries, including Denmark. Taylor's study is based on bilateral real exchange rates (with consumer prices as deflators) vis-à-vis the U.S. dollar and vis-à-vis a "world" basket constructed as a simple average of the bilateral real exchange rate against the 19 other currencies. For Denmark Taylor is able to reject a null hypothesis of non-stationarity of the real exchange rate relative to the world basket using standard Augmented Dickey-Fuller tests and a Generalized-Least-Squares version of the Dickey-Fuller test. The results in Taylor, *op.cit.*, are thus supportive to a hypothesis of long-run relative PPP convergence in the case of Denmark.

However, in the data set used by Taylor some interpolations have been made around periods with explosive inflation making the results difficult to interpret. Furthermore, Taylor notes that, ideally, one might also prefer to use real effective (i.e. trade-weighted) exchange rates for such an exercise but that the construction of such a data set for all 20 countries would constitute a significant undertaking.

The essay at hand essay try to meet this challenge in the case of Denmark by constructing annual trade-weighted nominal and real effective exchange-rate indices for Denmark 1875-2003 with respectively consumer prices and wholesale prices as deflators. Furthermore, the empirical evidence regarding long-run relative purchasing-power-parity (PPP) convergence is explored on the basis of this new data set.

3.2. The data set

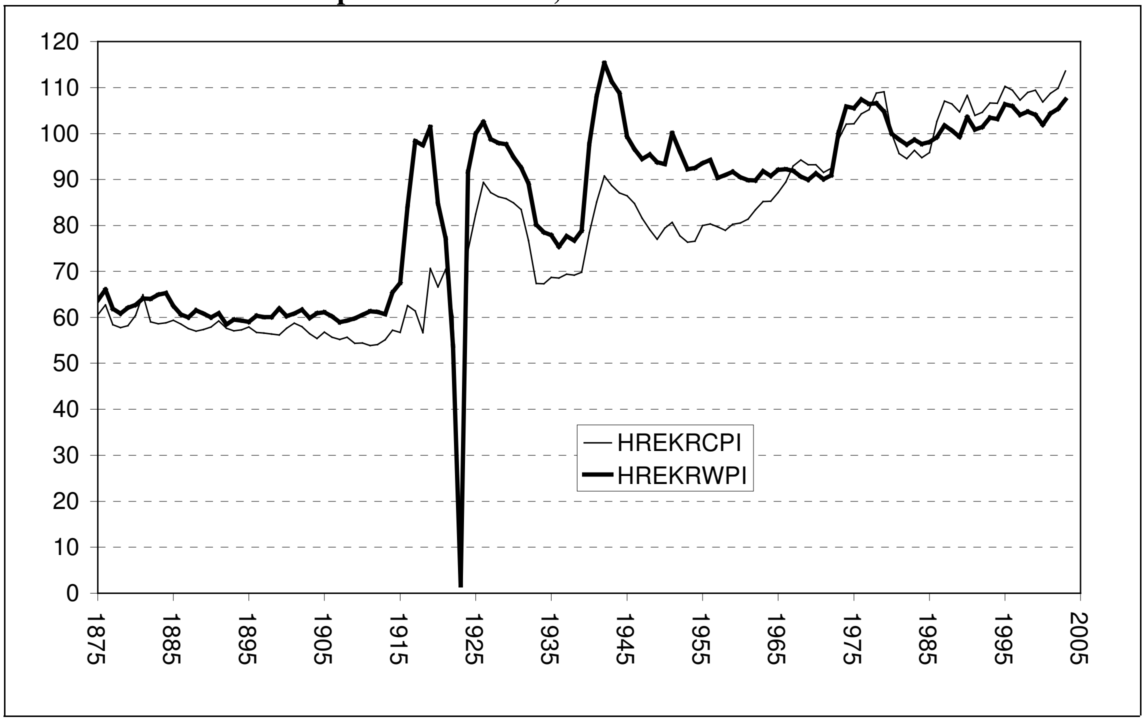
Official real effective krone rate indices compiled by the Danmarks Nationalbank (the central bank of Denmark) are only available for the most recent decades. Annex 3.A makes an attempt to overcome this data shortage by constructing annual-average observations of two real effective krone-rates indices covering the period 1875-2003 with respectively wholesale price indices[122] (WPI) and consumer price indices (CPI) used as deflators. The two real effective krone-rates indices are constructed as geometrically weighted chain indices with current (i.e. annually updated) trade weights based on Denmark's foreign trade in goods with 15 of its largest trading partners.

Although the methodology used to compile historical CPI data (or private consumption deflators) is by no means harmonised across countries, these statistics are probably among the best historical statistics available due to the intensive research in historical cost-of-living conditions and national-income accounting. There are, however, several problems related to the use of consumer price indices as deflators in a real effective exchange rate index if the aim is to assess the validity of the relative purchasing-power-parity hypothesis. Firstly, the CPI includes a substantial amount of goods and services that are not traded internationally, and secondly the development in the CPI is influenced by changes in indirect taxes and subsidies.

The coverage of historical WPI data probably differs even more across countries than that of consumer price indices. However, wholesale price indices are conceptually more interesting in relation to studies of the relative purchasing-power-parity hypothesis since they normally include relatively few non-traded goods. Furthermore, wholesale price data normally also exclude most indirect taxes (apart from custom duties) and subsidies.

[122] I.e. indices for domestic producer prices and import prices excluding indirect taxes and subsidies.

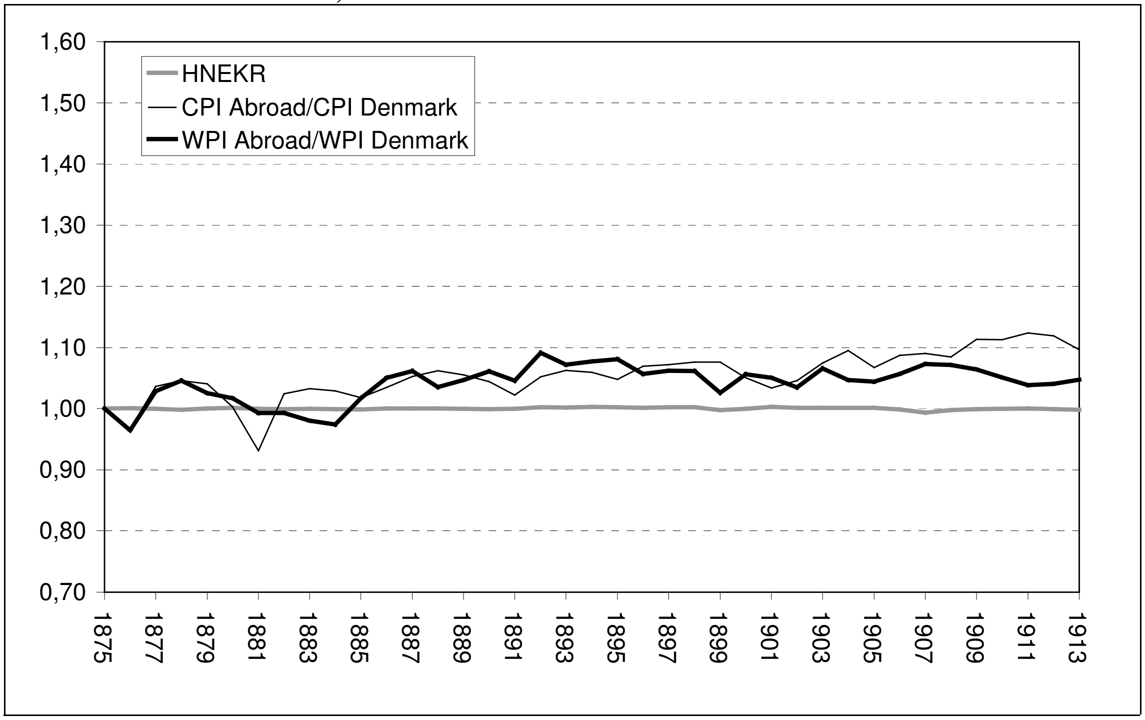
Figure 3.2 Real effective Danish krone-rate indices based on consumer prices and wholesale prices 1875-2003, 1980=100



Sources: Figure 1 in Abildgren (2005c) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

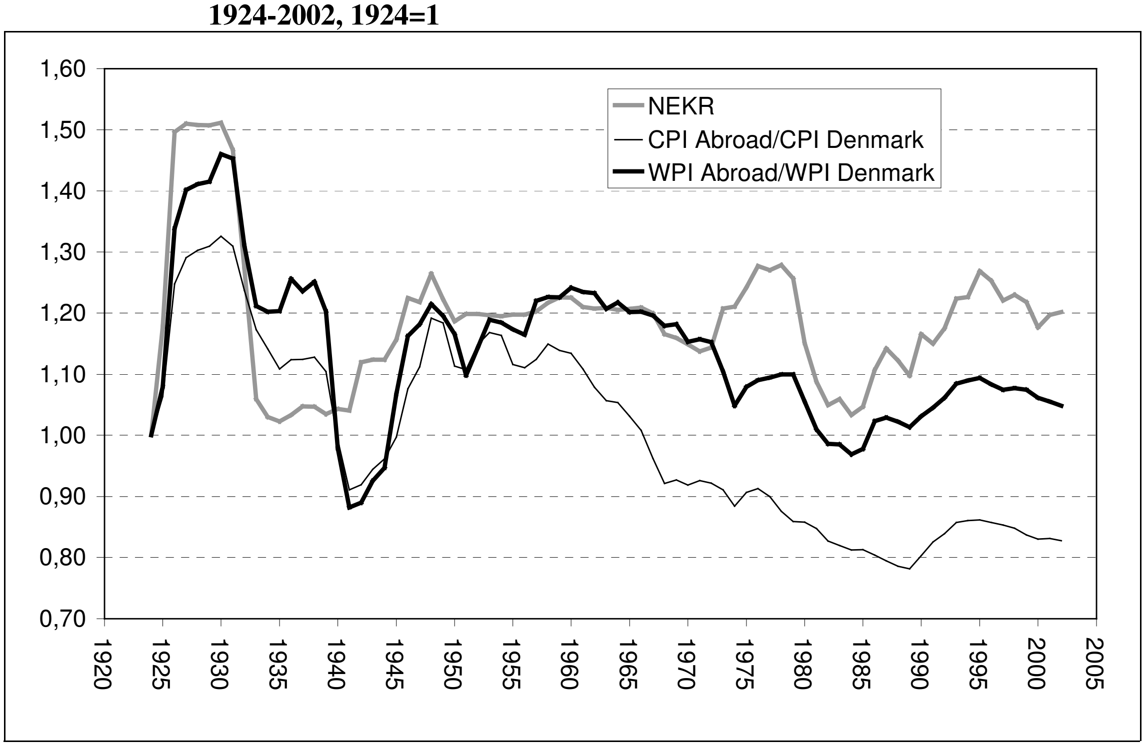
Figure 3.2 shows the development of the indices for the real effective krone rate based on consumer prices (HREKRCPI) and the real effective krone rate based on wholesale prices (HREKRWPI) for the whole period 1875-2003. The two indices show a marked drop followed by a sharp increase around the period of German hyperinflation at the beginning of the 1920s. The reason is that German inflation began to accelerate before the German exchange rate depreciated. The long-term developments in the two real effective krone rate indices are roughly parallel. However, for the post-1950 period the index based on consumer prices shows the largest real appreciation.

Figure 3.3: The historical Danish nominal effective krone rate and relative prices 1875-1913, 1875=1



Source: Chart 3 in Abildgren (2004c).

Figure 3.4: The historical Danish nominal effective krone rate and relative prices 1924-2002, 1924=1



Source: Chart 4 in Abildgren (2004c).

Figure 3.3 shows the development in the historical nominal effective krone-rate index (HNEKR) and indices for the price development abroad relative to Denmark in the pre-1914 period, while Figure 3.4 covers the post-1923 period. In the pre-1914 period, where Denmark and all its main trading partners were on the Gold Standard, the variation in both the nominal effective krone rate and relative prices was very limited, implying only modest fluctuations in the real effective krone rate indices.[123] The post-1923 period has shown much larger fluctuations in both the nominal effective krone rate and the relative prices.

Even though an attempt has been made to transform the data into a set of reasonable consistent long time series, the quality of a data set spanning more than 125 years is always questionable. Furthermore, both retail and wholesale markets have changed a lot during the period regarding e.g. the degree of product differentiation, the ease of transportation, the opportunity costs of price search, the composition of consumption and production *etc*., cf. Kackmeister (2007). The results and conclusions of the essay have therefore to be taken with “a pinch of salt”.

3.3. The Purchasing-Power-Parity (PPP) theory - and a short review of the empirical literature[124]

The idea behind the PPP theory can be traced back several centuries.[125] In “modern times” the origin of studies on PPP is primarily associated with the works of the Swedish economist Gustav Cassel around World War I.[126]

The basic version of the PPP theory assumes a two-country world with homogeneous tradable products, competitive market structures, full information, flexible prices, no transportation costs, no taxes and free trade. Furthermore, it is assumed that the exchange rate

[123] Some gold-standard countries experienced significant larger variations in their nominal effective exchange rates than Denmark during the pre-World War I period because of much higher shares of foreign trade vis-à-vis countries following a silver standard or a paper standard, cf. the nominal effective exchange rates for France, Germany, United Kingdom and the United States presented in Catão & Solomou (2005). France, Germany, United Kingdom and the United States also experienced much larger variations in their real effective exchange rates than Denmark during the Classical Gold Standard period. Catão & Solomou, *op.cit*., also present nominal and real effective exchange rate calculations for Norway and Sweden. In the period since the mid-1870s and until World War I Norway and Sweden followed the gold standard through their participation in the Scandinavian Currency Union together with Denmark. The findings for Norway and Sweden in Catão & Solomou, *op.cit*., are also quite similar to the findings for Denmark presented in the essay at hand. Both Norway and Sweden experienced relatively small variations in their nominal and the real effective exchange rate during the Classical Gold Standard period reflecting that both these two countries like Denmark conducted nearly all their foreign trade with countries on the Gold Standard.

[124] There is a large literature on purchasing-power parity. For surveys of the theoretical and empirical literature on PPP, cf. e.g. Froot & Rogoff (1994), Rogoff (1996), Sarno & Taylor (2002) and Taylor & Taylor (2004).

[125] Cf. e.g. Dornbusch (1987).

[126] Cf. Cassel (1918). In this article Cassel wrote: ”According to the theory of international exchanges which I have tried to develop during the course of the war, the rate of exchange between two countries is primarily determined by the quotient between the internal purchasing power against goods of the money in each country... At every moment the real parity between two countries is represented by this quotient between the purchasing power of the money in the one country and the other. I propose to call this parity ‘the purchasing power parity’. As

is basically determined by demand for cross-border current-account transactions. Within this setting the nominal bilateral exchange rate (defined as the amount of foreign currency per unit of domestic currency) must be equal to the ratio between the aggregated absolute price levels in the two countries (the foreign price level relative to the domestic price level). The argument is the "law of one price": Two identical goods in two different countries should have the same price measured in a common currency. If not, goods-market arbitrage will occur, leading to adjustments in prices and/or the nominal exchange rate. If the law of one price holds true for every commodity, then the relationship must hold for aggregated absolute price levels as well – provided that the same weights are used in the construction of the aggregated absolute price level data. This is termed the "absolute" version (or strong form) of the PPP. The absolute PPP implies that the real exchange rate (defined as the nominal exchange rate multiplied by the ratio between the price level for domestic goods and the price level for foreign goods) will be equal to one on a continuous basis.

If one uses price indices instead of aggregated absolute price levels, the weights and base year in the price indices of the two countries must be identical in order to study the absolute version of PPP. This will normally not be the case. Focus in empirical studies is therefore often on the relative version (or weak form) of the PPP theory. The relative PPP hypothesis states that the rate of depreciation of the nominal bilateral exchange rate between two countries will match the inflation differential between the two countries. This implies that the real exchange rate will be equal to a constant. Furthermore, when studying the relative PPP in a multi-country environment one can expand the relative PPP hypothesis to cover some kind of real effective exchange rate index, cf. section 3.2.

A broad range of empirical studies seems to indicate that the PPP hypothesis does not hold in the short run and definitely not continuously. There can be many explanations for deviations from PPP: Non-traded goods, price and wage rigidities, product differentiation, transportation and insurance costs related to international trade of goods, transportation time, transaction costs in international currency arbitrage, tariffs and non-price trade barriers, index number problems, speculative bubbles, "pricing to market", *etc*. Furthermore, at least in the short run, exchange rates may be significantly affected by demand for currency as an asset (capital flows as a result of interest-rate differentials between countries) rather than demand for currency for current-account transactions. It has also been argued that for some countries a deterministic trend in the real exchange rate could be expected for longer periods, if one studies price data that includes non-traded goods and services for a country that goes through

long as anything like free movement of merchandise and a somewhat comprehensive trade between the two countries takes place, the actual rate of exchange cannot deviate very much from this purchasing power parity".

a catching-up process relative to it's trading partners.[127] Another reason for a temporary deterministic trend in a real effective exchange rate – estimated on the basis of price indices that includes non-traded goods and services – could be a faster and larger build-up of the public sector in a country relative to its trading partners (fiscal shocks). This could increase the prices and wages in the non-tradable goods and service sector at home relative to abroad, if one assumes that government spending contains a larger element of non-tradable goods and services relative to private consumption.

Despite the mixed empirical findings, many still consider the PPP hypothesis relevant as a long-run fundamental tendency, and especially and in the last two decades or so there has been a revival in applied econometric research on the validity of PPP as a long-run parity condition, cf. the selective literature review in Table 3.1. Furthermore, empirical studies on deviations from long-run PPP and the speed of mean reversion in different periods with different exchange-rate regimes, different degrees of cross-border mobility in goods and financial assets, variations in the rate of real or monetary shocks to the economy, *etc*. can in themselves be of interest from a pure historical perspective.

[127] I.e. the so-called (Harrod)-Balassa-Samuelson effect. The argument is the following: Assume that the nominal exchange rate is determined by PPP for tradable goods, and that productivity in the tradable goods sector initially is lower in the home country than abroad whereas productivity in the non-tradable goods sectors are the same at home and abroad. Under the assumption of full mobility of labour between sectors within a country, but not between countries, the wage level is initially highest abroad due to the higher productivity level in the tradable goods sector. This also means that the level of consumer prices (which includes both tradable and non-tradable goods) initially is highest abroad due to the higher price level for non-tradable goods abroad. When the home country catches up through productivity increases in its tradable goods sector, the domestic wage level will increase relative to abroad leading to a relative increase in the prices of non-tradable goods at home relative to foreign goods. If one measures the real effective exchange rate via consumer prices (including both tradable and non-tradable goods), a trend increase in the home country real effective exchange rate should be expected.

Table 3.1 Long-span empirical studies of the PPP hypothesis – a selective literature review

Study	Scope
Adler & Lehmann (1983)	Data from the period 1900-1972 for 9 countries. Study based on bilateral real exchange rates (with wholesale prices as deflators). Evidence **against** long-run PPP.
Edison (1987)	Data on the real USD/GBP exchange rate 1890-1978 based on GDP deflators. Evidence in **favour** of long-run PPP (after taking into account the effects of changes in structural factors)
Lothian (1990)	Data from the period 1874-1987 for 4 countries. Study based on JPY, USD, GBP and FRF bilateral real exchange cross-rates (with wholesale prices as deflators). Evidence in **favour** of long-run PPP.
Abuaf & Jorion (1990)	Data from the period 1901-1987 for 10 countries. Study based on bilateral real exchange rates (with wholesale prices as deflators). Evidence in **favour** of long-run PPP.
Diebold *et. al.* (1991)	Data from the period 1791-1913 for 6 countries. Study based on bilateral real exchange rates (with wholesale prices and consumer prices as deflators). Evidence in **favour** of long-run PPP (fractional integration - long-memory processes).
Lothian & Taylor (1996)	Data from the period 1791-1990 for 3 countries. Study based on USD/GBP and FRF/GBP bilateral real exchange rates (with wholesale prices as deflators). Evidence in **favour** of long-run PPP.
Engel & Kim (1999)	Data on the real USD/GBP exchange rate 1885-1995 based on producer prices as deflators. **Mixed** findings.
Cuddington & Liang (2000)	Data from the period 1791-1990 for 3 countries. Study based on USD/GBP and FRF/GBP bilateral real exchange rates (with wholesale prices as deflators). **Mixed** findings.
Lothian & Taylor (2000)	Data from the period 1791-1990. Study based on USD/GBP bilateral real exchange rates (with wholesale prices as deflators). Evidence in **favour** of long-run PPP.
Ejrnæs & Persson (2000)	Data from the period 1825-1903 on wheat prices from local markets in France. Evidence in **favour** of long-run PPP (implied transport costs derived from wheat prices close to observed transport costs).
Froot *et al*. (2001)	Data from the period 1273-1991 covering 7 agricultural commodities in England and Holland. **Mixed** findings.
Hegwood & Papell (2002)	Data from the period 1792-1913 for 6 countries. Study based on 16 bilateral real exchange rates (with wholesale prices and consumer prices as deflators). Evidence **against** long-run PPP but in **favour** of long-run quasi PPP (mean reversion to a changing mean).
Taylor (2002)	Data from the period 1870-1996 for 20 countries. Study based on bilateral real exchange rates (with consumer prices as deflators) vis-à-vis the U.S. dollar and vis-à-vis a “world” basket constructed as a simple average of the bilateral real exchange rate against 19 other currencies. Evidence in **favour** of long-run PPP.
Cecchetti *et al*. (2002)	Data on consumer price indices from the period 1918-1995 from 19 U.S. cities. Evidence in **favour** of long-run PPP, although with a slow speed of convergence after shocks due to transportation costs and the inclusion of non-traded goods prices. Convergence is faster between cities that are closer.
Peel & Venetis (2003)	Data from the period 1791-1992 for 3 countries. Study based on USD/GBP and FRF/GBP bilateral real exchange rates (with wholesale prices as deflators). Evidence in **favour** of long-run PPP (when non-linear deterministic trends are taken into consideration).
Calderón & Ducan (2003)	Data from the period 1810-2002 for Chile. Study based on real exchange rates (with wholesale prices as deflators and with GDP deflators) of the MEX vis-à-vis the USD and vis-à-vis a weighted average of the USD and GBP. Evidence in **favour** of long-run PPP.
Gadea *et al*. (2003)	Data from the period 1870-1935. Study based on ESP/GBP bilateral real exchange rates (with traded goods prices as deflators). Evidence in **favour** of long-run PPP (when structural breaks are taken into account).
Chen & Devereux (2003)	Data on consumer prices in levels from 19 US cities 1918-2000. Evidence in **favour** of PPP (when taken into account that real exchange rates are non-stationary due to price level convergence).
Lima & Xiao (2004)	Data from the period 1892-1996 for 20 countries. Study based on bilateral real exchange rates (with consumer prices as deflators) vis-à-vis the U.S. dollar. **Mixed** findings.
Lopez *et al.* (2005)	Data from the period 1870-1998 for 16 countries. Study based on bilateral real exchange rates (with consumer prices as deflators) vis-à-vis the U.S. dollar. **Mixed** findings.
Murray & Papell (2005)	Data from the period 1791-1990. Study based on USD/GBP bilateral real exchange rates (with wholesale prices as deflators). Evidence **against** long-run PPP.
Papel & Prodan (2006)	Data from the period 1870-1998 for 7 countries. Study based on bilateral real exchange rates (with consumer prices as deflators) vis-à-vis the U.S. dollar. Evidence in **favour** of long-run PPP (when restricted structural changes are taken into account).
Kanas (2006)	Data from the period 1870-1998 for 16 countries. Study based on bilateral real exchange rates (with consumer prices as deflators) vis-à-vis the U.S. dollar. **Mixed** findings (regime-dependent stationarity).
Christou *et al.* (2009)	Data from the period 1791-1999. Study based on USD/GBP bilateral real exchange rates (with wholesale prices as deflators). Evidence in **favour** of long-run PPP.

3.4. Empirical findings regarding long-run relative PPP convergence for Denmark 1875-2002 within an univariate time-series framework

A first exploratory assessment of the tendency to long-run relative PPP convergence in the case of Denmark can be made by a range of univariate unit-root tests (Augmented Dickey Fuller tests, ADF tests) using the two new historical real effective krone-rate indices with respectively consumer prices and wholesale prices as deflators. The basic idea is to test whether the behaviour of a real effective krone-rate index (REKR) is indistinguishable from a random walk[128] (or more generally an autoregressive process with a unit root, i.e. a non-stationary process), or whether there is a tendency for mean reversion towards a constant long-run level (i.e. a stationary process). In the latter case the level of price increases in Denmark and its trading partners expressed in a common currency are equalised in the long run as predicted by the relative PPP hypothesis, and the so-called "half-life" can be used as a measure of the speed of mean reversion towards the long-run level. The half-life measures the number of years before one half of a shock to the real effective exchange rate is extinguished.

The alternative hypothesis of the ADF(p) test can be formulated as equation [3.1], where $\Sigma b_j<1$ and the error term (e) is assumed to be independently normally distributed with a zero mean and a constant variance:

$$[3.1]\ \mathrm{REKR}_t = b_0 + \sum_{j=1}^{p+1} b_j \cdot \mathrm{REKR}_{t-j} + e_t$$

With p significant lags in the ADF(p) test, the REKR follows a (p+1)-order autoregressive process under the alternative hypothesis, i.e. the REKR is a stationary process which is consistent with long-run relative PPP convergence.

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[128] A simple argument for random walk behaviour in the real exchange rate has e.g. been put forward by the efficient market (or *ex ante*) view of PPP. The starting point of this asset price approach to exchange rate determination is the Uncovered Interest-rate Parity (UIP). The UIP states that the expected depreciation of a currency is equal to the spread between the domestic and foreign interest rate. If one assumes that real interest rates are equalised between countries – due to international arbitrage in capital goods – then the expected rate of depreciation of a currency is equal to the difference between the expected inflation home and abroad. Furthermore, if one assume rational expectations the actual nominal exchange rate, the domestic inflation and the foreign inflation will all be equal to their expected values apart from white noise. This implies that the real exchange rate will follow a random walk, cf. e.g. page 125-126 in Hallwood & MacDonald (2000).

The alternative hypothesis implies that the REKR evolves around a constant long-run level given by $b_0/(1-\Sigma b_j)$. A commonly used approximate formula for the number of years before one half of a shock to the real effective exchange rate is extinguished (the half-life) is given by [3.2]:

$$[3.2]\ \text{Half}-\text{life} = \frac{\ln(0.5)}{\ln\left(\sum_{j=1}^{p+1} b_j\right)}$$

where ln denotes the natural logarithmic function.

The null hypothesis of non-stationarity of the ADF(p) test is that $g = \Sigma b_j - 1 = 0$, and the test-statistic is the usual t value for g. However, under the null hypothesis the distribution of this statistic does not follow the usual Student’s t distribution, but a special non-symmetric distribution with a heavier tail implying larger (absolute) critical values. Under the null hypothesis, the REKR is a (p+1)-order autoregressive process with a unit root (i.e. a non-stationary process), which is inconsistent with the existence of long-run relative PPP convergence.

The Augmented Dickey Fuller test (ADF test) usually serves as the starting point or “benchmark” in the empirical literature on PPP convergence. However, it should be noted that the power of ADF tests against the null hypothesis of a unit root is not very strong. It can therefore be difficult to reject the null hypothesis of non-stationarity even when it is false, especially in cases where convergence towards relative PPP is slow.[129]

It should also be mentioned that the failure to reject a null hypothesis of non-stationarity could be the result of structural breaks caused by e.g. large shocks to the real economy rather than the lack of relative PPP convergence *per se*. Finally, it must be mentioned that the results of ADF tests can be quite sensitive to the presence of serial correlation in the error terms. In the analysis below, the lag length in the ADF tests has been chosen with the aim of ensuring no signs of autocorrelation in the residuals.

[129] Cf. e.g. Haldrup & Jannson (2007). In the ADF test, non-stationarity is the null hypothesis. A null hypothesis is always accepted unless there is strong evidence against it. One the other hand, if the null hypothesis of non-stationarity in an ADF test is rejected, there is a strong case for stationarity. Alternative tests with stationarity as the null hypothesis have been developed, cf. e.g. chapter 7 in Patterson (2000).

Table 3.2 Univariate unit-root tests on the two real effective Danish krone-rate indices

	Sample period 1875-1913		Sample period 1924-2002	
Real effective krone-rate index based on wholesale prices (HREKRWPI)				
Number of lags in ADF test	0		1	
ADF test statistics (a)	-2.67	*	-3.15	**
OLS estimates of half-life (years)	1.9		4.2	
Real effective krone rate based on consumer prices (HREKRCPI)				
Number of lags in ADF test	0		1	
ADF test statistics (a)	-2.57		-1.33	

Notes: * (**) denotes rejection of the null hypothesis at a 10-per-cent (5-per-cent) significance level.

(a) The ADF test applied includes a constant but no trend. Null hypothesis is non-stationarity.

Sources: Table 1 in Abildgren (2005c).

Table 3.2 shows the results of a range of ADF-tests on HREKRWPI and HREKRCPI. One should probably not put too much weight on the information content in price indices in extreme situations such as the German hyperinflation in the early 1920s. To avoid the possibility of bias in the test results due to outliers, the data sets are therefore analysed for two separate sample periods (1875-1913 and 1924-2002).[130]

The results are supportive to a hypothesis of long-run relative PPP convergence in the case of the real effective krone-rate index based on wholesale prices. Non-stationarity is rejected by the ADF test at a 5-per-cent significance level for the post-1923 period. For the pre-1914 period non-stationarity cannot be rejected at a 5-per-cent level, which should be viewed in the light of the relatively short sample period. At a 10 per cent significance level non-stationarity is rejected.[131]

The diagnostics show no trace of autocorrelation in the residuals, but there is some evidence of heteroskedasticity and non-normality.[132] However, taking the results from the estimations at face value they show an average half-life of real exchange rate shocks of 4.2 years in the post-1923 period. In the pre-1914 period, where Denmark and most of its trading partners

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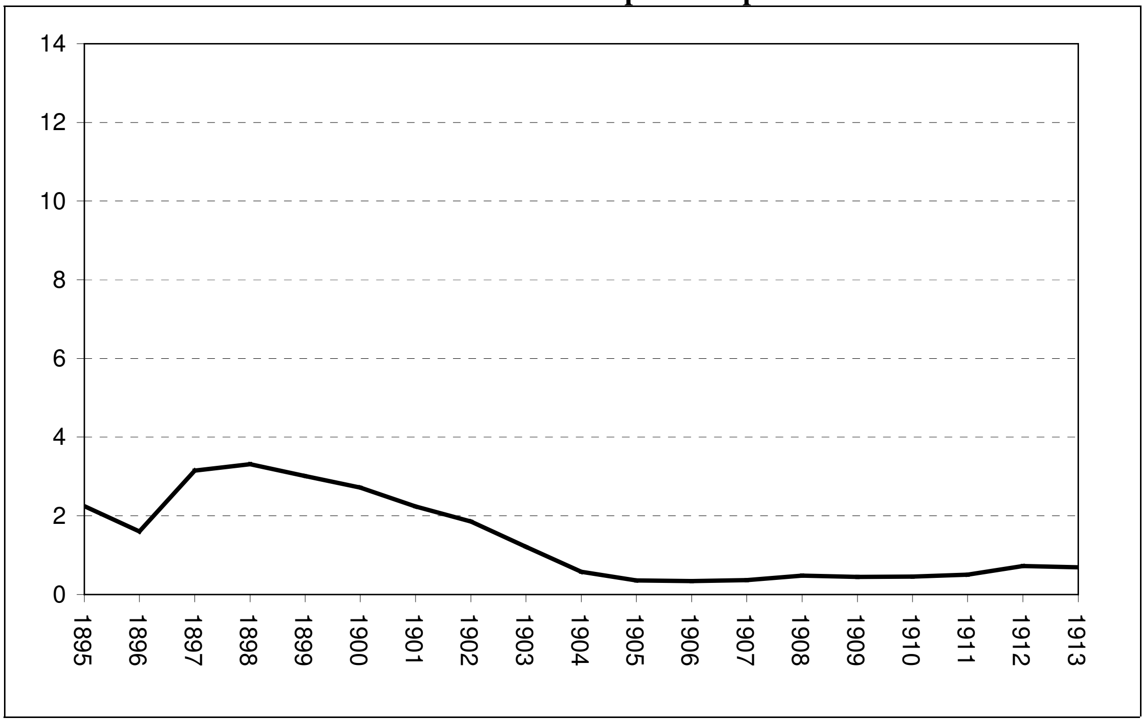
[130] All test results presented in this essay have been obtained by the use of PcGive except for the 10-per-cent critical values for the ADF tests. The critical values for the latter statistics are calculated from the MacKinnon response surface table reproduced on page 372 in Patterson (2000).

[131] In the case of the real effective krone-rate index based on consumer prices, non-stationarity cannot be rejected, cf. Table 3.2. The lack of support for relative PPP convergence when consumer prices rather than wholesale prices are used as deflators seems consistent with *a priori* expectations based on theoretical considerations due to the fact that consumer prices include non-traded goods and indirect taxes. The results of ADF tests with a trend included suggest that the HREKRCPI may be trend stationary, cf. Abildgren (2004c). A positive trend in the post-1923 period could partly be the result of a faster and larger increase in indirect taxes in Denmark than abroad during this period. A "catching up" hypothesis (Balassa-Samuelson effect) hardly seems relevant for Denmark for this period, but the average annual growth in real GDP per capita has been slightly higher in Denmark than abroad in the post-1913 period. For the period 1875-1913 the autoregressive parameter is not significant and the trend is estimated to be negative – despite faster economic growth in Denmark than abroad – so further analysis seems required if the presence of such a trend should have a plausible explanation.

[132] All diagnostics related to Table 3.2 are reported in Abildgren (2004c). The assumption of normality of the residuals is often too strong an assumption in autoregressions. The assumption of stationarity combined with independently and identically distributed residuals with zero means and a finite variance are sufficient to justify the use of Ordinary Least Squares asymptotically, cf. chapter 8 in Hamilton (1994).

followed the Gold Standard[133], the average speed of adjustment towards the long-run equilibrium was about twice as fast.[134]

Figure 3.5 Half-lives measured in years from 20-year rolling-window regressions based on the HREKRWPI in the pre-1914 period



Sources: Figure 2 in Abildgren (2005c).

In Figure 3.5 and 3.6 the half-lives for the HREKRWPI are explored further via 20-year rolling-window regressions. During the last 10 years of the Gold Standard period, half-lives reached an average level of only around 0.5 years, compared to an average of 2.4 years in the period 1895-1903. Immediately after World War II, half-lives are estimated at around 3 years. Towards the end of the Bretton Woods period in the late 1960s, half-lives had once again reached a low level of around 1 year. The breakdown of the Bretton Woods system caused a marked slowdown of the speed of relative PPP convergence measured by half-lives which

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[133] For a recent survey of the Danish exchange-rate policy since 1875 in an international perspective, see Abildgren (2004a).

[134] The half-lives are estimated using Ordinary Least Squares (OLS). All other things being equal point estimates for half-lives tend to be too low when calculated from the OLS estimates on finite samples due to the lagged dependent variables in [3.1], cf. e.g. Cashin & McDermott (2003).

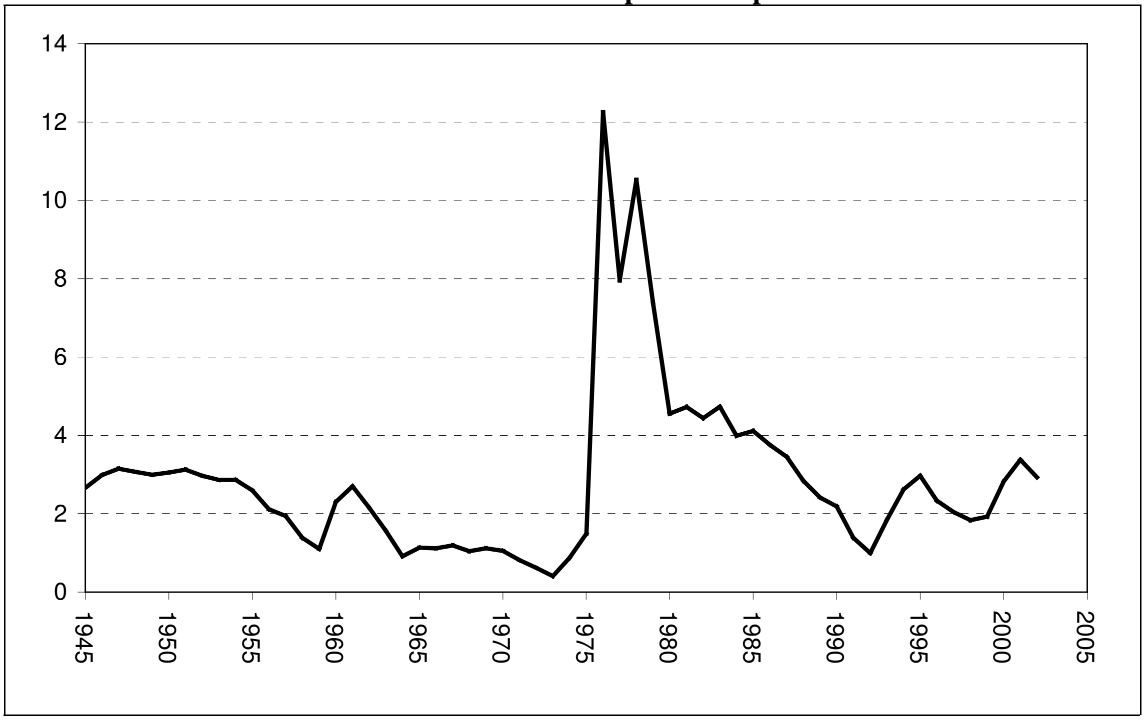
Abildgren (2004c) presents small-sample bias adjusted OLS estimates of the half-life corresponding to Table 3.2, but the differences between the bias-adjusted and the unadjusted half-lives are not very large.

However, other factors (e.g. application of low-frequency data, linear model specification and the use of aggregated price indices) may imply that conventionally estimated half-lives tend to be too high, cf. e.g. Taylor (2001) and Imbs *et al.* (2005).

Half-lives can only be considered as a simple "summary measure" characterising the process of mean reversion. A more complete picture of the adjustment dynamics of the real effective exchange rate may be achieved by the use of impulse response analysis. For a discussion of half-life measures, impulse responses and the construction of confidence intervals related to half-lives and impulse responses, cf. e.g. Cheung & Lai (2000) and Rossi (2005).

reached a level of more than 10 years (still estimated from 20-year rolling-window regressions). However, it may be more reasonable to view this as a result of a structural mean shift in the real exchange rate. In 2002, half-lives had decreased to a level of around 3 years.

Figure 3.6 Half-lives measured in years from 20-year rolling-window regressions based on the HREKRWPI in the post-1923 period



Sources: Figure 3 in Abildgren (2005c).

The euro area – towards which the current Danish fixed-exchange-rate policy is oriented – accounted for 56 per cent of the weighting basis of the HREKRWPI in 2002. Even though this is a substantial share of Danish foreign trade, it is smaller than that of the corresponding groups in previous periods (the share of Denmark's trading partners following the Gold Standard in the pre-1914 period, or the share of Denmark's trading partners participating in the Bretton Woods system at the end of the 1960s). The above results thus seem to indicate that the fastest mean reversion towards relative PPP has occurred in those periods where Denmark pursued a fixed-exchange-rate policy vis-à-vis the majority of its trading partners and thereby had the lowest volatility in the nominal effective krone rate. This finding might reflect that a low level of nominal exchange-rate volatility facilitates cross-border goods-market arbitrage and thereby supports relative PPP convergence.[135]

[135] In an empirical study of commodity price volatility across difference exchange-rate regimes 1880-1996 Cuddington & Liang (1997) find that the volatility of real primary commodity prices is higher under flexible exchange-rate regimes than under fixed exchange-rate regimes. A number of other studies also suggest that the volatility of real exchange rates are higher during floating exchange-rate regimes than during fixed-exchange-rate regimes, cf. e.g. the survey in Lothian & Taylor (2008).

Univariate unit-root tests on the natural logarithms of the nominal effective krone-rate index and the natural logarithms of the ratio between the wholesale price index abroad and in Denmark suggest that both the nominal effective krone-rate index and the index for the relative wholesale-price ratio may be stationary in the two periods 1875-1913 and 1924-2002.[136] This may partly be a result of Denmark's long tradition of pursuing a fixed-exchange-rate policy within the different monetary regimes that have existed since 1875. When a small open economy like Denmark pursue a fixed-exchange-rate policy within a system covering all or most of its trading partners, the nominal effective krone-rate index may becomes a stationary variable even though the exchange-rate policy is not aimed at managing the index. A stationary nominal effective krone-rate index and a stationary index for the relative wholesale-price ratio could be seen as an indication of a tendency towards long-run relative PPP convergence. However, at least for some periods it may also reflect that in order to maintain a credible fixed-exchange-rate regime the domestic price and wage development has in general to be in line with that of the currency anchor. A stationary index for the relative wholesale-price ratio could therefore in certain periods also be the result of domestic economic policies (i.e. fiscal policy and other economic policies) and/or behaviour among labour market partners supporting the requirements for maintaining a fixed-exchange-rate regime.

3.5. Scope for further research

The analysis of the tendency towards long-run relative PPP convergence in the case of Denmark presented in this essay has been based on univariate unit-root tests where only the behaviour of the two real effective krone-rate indices has been studied. The data analysis can therefore be considered only as a first exploratory examination of the time-series properties of the new historical time-series indices for the real effective krone rate.

A natural next step could be exploration of the PPP hypothesis within a multivariate-system framework consisting of the nominal effective krone-rate index and the price indices for Denmark and abroad to review the robustness of the results in this paper and acquire additional insight into the topic. A multivariate-system framework would allow one to tests whether changes in domestic and foreign prices in the long run have symmetric and proportional effects on the nominal effective krone rate. Further analyses could also include additional variables commonly viewed as important determinants of nominal and real exchange rates (e.g. interest rates in periods with free or partly free cross-border capital movements or perhaps relative income or wealth per capita) in order to check for the possibility of omitted variable biases.

[136] Such test results are reported in Table 3.a in Abildgren (2004c).

As indicated via the half-lives estimated from 20-year rolling-window regressions, it may be most reasonable to view the post-1923 period as a sequence of different exchange-rate regimes with structural mean shifts in the real exchange rate. Another way forward could therefore be to analyse the tendency towards long-run relative PPP and the speed of mean reversion using regime-switching models that allow for multiple structural mean shifts in the real effective krone-rate indices. By means of such a procedure it will be possible to estimate breakpoint years in the series, and it would be interesting to see whether such breakpoints could be given reasonable economic history interpretations.

Recent empirical works on the PPP hypothesis based on bilateral real-exchange-rate data have made use of non-linear modelling of PPP deviations, cf. e.g. Paya & Peel (2006). Transaction costs *etc*. might imply that small deviations from PPP are left uncorrected and subject to “unit-root behaviour” whereas major deviations large enough to cover transaction costs lead to mean reversion towards PPP. However, when effective real-exchange-rate indices are analysed such an approach becomes substantially more complicated. An effective exchange-rate index might be stable in a certain period of time if one currency appreciates while another depreciates. The non-linear modelling would therefore have to take place at the bilateral exchange-rate level if the modelling should have an economic interpretation as transaction costs *etc*.

The nominal and real effective krone-rate indices compiled in the annex to this essay covers the period since the introduction of the krone as the Danish currency unit in 1875. Even though data for Denmark’s foreign trade become more sparse for the period before 1875 it would be interesting to make an attempt to extend the time series somewhat backwards in time in order to explore the behaviour of the effective rigsdaler rate during part of the Silver Standard period. In order to overcome shortages in the statistics on Denmark’s foreign trade broken down by countries in the pre-1875 period one could try to explore the possibility of using a “mirror-statistical approach”, i.e. utilise the information on trade with Denmark contained in the pre-1875 foreign-trade statistics from some of Denmark’s major trading partners.

In a background paper to the essay at hand, Abildgren (2004b) lists annual nominal exchange rates for Danish kroner vis-á-vis 15 foreign currencies. Norges Bank has published monthly nominal exchange rates for the period 1819–2003[137], and recently Sveriges Riksbank has even published daily exchange rates covering part of the nineteenth century[138]. It would be highly appreciated if future projects on historical Danish exchange rates would aim at

[137] Cf. Klovland (2004).

[138] Cf. Lobell (2007).

making long-span exchange rate series on a monthly or daily frequency available for the research community.

3.6. References

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Annex 3.A: Nominal and Real Effective Krone-Rate Indices for Denmark 1875-2003

In the foreign exchange market a wide range of different currencies are traded against each other. Within a certain period of time a currency may be strengthened against some currencies and weakened against other. Since the breakdown of the Bretton Woods fixed-exchange-rate system, effective exchange rates has been a common measure to summarise the movements in the value of a currency vis-à-vis other currencies and to assess the development in the level of competitiveness.

Official nominal and real effective krone-rate indices compiled by the Danmarks Nationalbank (the central bank of Denmark) are available only for the most recent decades. This annex makes an attempt to overcome this data shortage by constructing nominal and real effective krone-rate indices covering the whole period since the introduction of the krone as the Danish currency unit in 1875.

3.A.1. Danmarks Nationalbank's nominal and real effective krone-rate indices

Danmarks Nationalbank first presented nominal effective krone-rate calculations in its annual Report and Account from 1971 in relation to an assessment of the consequences of the Smithsonian Agreement[139]. Today the Nationalbank publishes an index for the nominal effective krone rate (NEKR) each banking day. Currently the Nationalbank's NEKR index is compiled by weighting (geometrically) the development in indices for the bilateral value of one krone vis-à-vis the currencies of 27 different countries using a set of fixed weights based on trade in manufactured goods in 2009. From time to time the weights are recalculated and new currencies included reflecting changes in trade patterns.[140] Currently the official series for NEKR covers the period since 1970, but the Nationalbank has released time series for the NEKR covering the period since 1955 in connection with research-oriented work.[141]

[139] With the Agreement the fluctuation bands of the Bretton Woods system were widened from +/-1 per cent to +/-2.25 per cent around parity, and the official gold price was raised from 35 to 38 U.S. dollar per ounce. Furthermore there was agreement of a range of exchange-rate adjustments, cf. Abildgren, K. (2004a) for details.

[140] The weights used in the Nationalbank's NEKR index are based on so-called double-weighted export weights and bilateral import weights, cf. Pedersen (2010). The double-weighted export weights take into consideration that Danish firms compete with a country not only in that country's domestic market but also in other markets. When weights are revised, the new index is chained to the previously published NEKR index at the time or close to the time for the change of weights. Usually, this implies that no revisions are made to previously published figures or, alternatively, that only a few of the previously published figures are revised.

[141] For the period since 8 April 2010 the official nominal effective krone-rate index is based on weights calculated from trade statistics for 2009 (covering trade with 27 countries). For the period 1 October 2004 to 7 April 2010 the index is based on weights calculated from trade statistics for 2002 (covering trade with 27 countries). The period from 30 May 1997 to 30 September 2004 is based on weights calculated from trade statistics for 1995 (25 countries). For the period from 1 January 1992 to 29 May 1997 the weights are based on 1989 trade statistics (21 countries). For 1970-1991 the weights are based on 1983 trade statistics (17 countries). For 1955-1969 the Nationalbank's nominal effective krone-rate index is listed in Blomgren-Hansen & Petersen (1977). For this period the index is based on trade with 13 countries, but the weight-year is not mentioned in the cited reference. However, the figures are identical to the data listed in Blomgren-Hansen (1974), where it is stated that the weights are based on 1964 trade statistics.

The Nationalbank first presented real effective krone-rate calculations based on hourly earnings in its Report and Account from 1977. Currently the Nationalbank regularly calculates real effective krone-rates indices based on consumer price indices (REKRCPI), hourly earnings, unit labour costs, and total hourly wage costs.[142] Figures for REKRCPI compiled by the Nationalbank are available for the period since 1970.

For the period before 1955 and 1970, no official figures for respectively the NEKR and REKRCPI are available, and Danmarks Nationalbank does not compile any official real effective krone-rate index based on wholesale prices.

3.A.2. Historical nominal and real effective krone-rate indices 1875-2003 – Main principles of calculation

In order to allow studies of the development of the effective krone rate for a longer period than that covered by the official figures, historical indices for the nominal effective krone rate (HNEKR), the real effective krone rate based on consumer prices (HREKRCPI) and the real effective krone rate based on wholesale prices (HREKRWPI) covering the whole period 1875-2003 have been calculated for this essay.

The HNEKR index is calculated as a geometrically weighted chain index with current weights based on annual trade statistics. Currencies from 15 countries (Germany, U.K., Ireland, Sweden, Norway, U.S.A., France, Spain, Italy, Portugal, Belgium-Luxembourg, the Netherlands, Japan, Finland and Switzerland) are included in the index. For selected years, the relative weights of these 15 countries in the foreign trade of Denmark is shown in Table 3.A.1 and 3.A.2.

As mention the weights in the Nationalbank's effective krone-rate index are based on trade in manufacturing goods only. Pedersen (2007) has analysed the effect on the effective krone-rate index if trade in services is included. The effect is limited, although the index will be slightly more exposed to fluctuations in the US dollar.

[142] Cf. Pedersen (1996). For discussions on the benefit and drawbacks relating to the choice of price or wage indices as deflators in real effective exchange rate indices, cf. e.g. Turner & Van't Dack (1993).

Table 3.A.1: Danish exports of goods by country 1875-2001

	1875	1913	1927	1949	1967	1979	2001
	per cent						
Germany	29	25	22	7	13	18	20
U.K., Ireland	42	62	60	44	24	15	11
Sweden	13	2	4	5	14	13	11
Norway	10	2	2	5	7	6	6
U.S.A.	0	1	1	3	7	5	7
France	0	1	1	5	3	5	5
Spain	0	0	0	1	1	1	2
Italy	0	0	0	2	4	5	3
Portugal	0	0	0	0	0	0	0
Belgium, Luxembourg	1	0	0	5	2	2	2
Netherlands	1	1	1	2	2	4	5
Japan	...	0	0	0	1	2	3
Finland	...	1	1	3	2	2	3
Switzerland	...	0	1	3	2	2	1
Other countries	4	5	6	15	18	19	20
Total	100	100	100	100	100	100	100

Source: Table 1 in Abildgren, K. (2004a).

Table 3.A.2: Danish imports of goods by country 1875-2001

	1875	1913	1927	1949	1967	1979	2001
	per cent						
Germany	37	38	31	3	20	20	22
U.K., Ireland	28	16	13	32	14	12	9
Sweden	11	8	6	7	14	13	12
Norway	3	1	1	4	4	4	5
U.S.A.	1	10	15	16	9	5	4
France	2	2	4	5	4	5	6
Spain	0	0	0	1	0	1	2
Italy	0	0	1	2	4	3	4
Portugal	0	0	0	1	1	0	1
Belgium, Luxembourg	2	1	2	5	3	4	4
Netherlands	3	2	4	2	4	6	7
Japan	...	0	0	0	2	2	1
Finland	...	1	1	4	3	4	3
Switzerland	...	0	1	2	2	2	1
Other countries	12	18	21	16	17	19	20
Total	100	100	100	100	100	100	100

Source: Table 1 in Abildgren, K. (2004a).

The relative change in the HNEKR index from year t-1 to year t is given by:

$$[3.A.1]\ \frac{HNEKR_t}{HNEKR_{t-1}} = \prod_{i=1}^{n}\left(\frac{BE_t^i}{BE_{t-1}^i}\right)^{w_{t-1}^i} \quad \text{where} \sum_{i=1}^{n} w_{t-1}^i = 1$$

where BE^i_t is the Bilateral nominal Exchange rate between Danish kroner and currency i in year t (amount of foreign currency i per Danish krone) and w^i_{t-1} is the weight used for the change in currency i from year t-1 to year t based on the sum of the Danish bilateral imports and exports of goods vis-à-vis country i in year t-1 relative to the total Danish imports and exports of goods in year t-1 vis-à-vis the 15 countries mentioned above. The methodology implies that the trade weights are updated annually during the whole period. Changes in the currencies from 1875 to 1876 are thus weighted with trade weights reflecting the trade pattern in the year 1875, changes in the currencies from 1876 to 1877 are weighted with trade weights reflecting the trade pattern in 1876, and so on. An increase in the HNEKR index describes an overall nominal appreciation of the krone vis-à-vis the currencies of Denmark's main trading partners.

Methodologically the main differences between the official NEKR and the HNEKR are as follows:

- In order to reflect the change in trade patterns on a current basis, the HNEKR is calculated with annually updated weights (i.e. "current weights") during the whole period (and not occasionally changed fixed weights, as is the case with the NEKR).
- The HNEKR is based on Denmark's total foreign trade in goods (and not only trade in manufactured goods as with the NEKR) in order to cover trade in agricultural products etc. as well.
- The weights used for the HNEKR are based on trade with 15 of Denmark's largest trading partners in the period 1875-2002 (compared to 27 countries in the NEKR). In every year in the period 1875-2002 these 15 countries accounted for at least 77 per cent of Denmark's total foreign trade in goods.[143]
- The weights in the HNEKR are based on the sum of total bilateral imports and exports of goods vis-à-vis the above mentioned countries (i.e. export is not double-weighted as is the case with the NEKR). Naturally double weighting would be preferable, but currently the trade statistics in standard international historical statistical abstracts[144] do not include the necessary common country breakdowns that are required for such double weighting.

The HREKRCPI is calculated as follows:

$$[3.\mathrm{A}.2]\ \mathrm{HREKRCPI}_t = \frac{\mathrm{HNEKR}_t \cdot \mathrm{CPI}_t^{\mathrm{Denmark}}}{\mathrm{CPI}_t^{\mathrm{Abroad}}}$$

where HNEKR_t is the Historical Nominal Effective Krone Rate index in year t, $\mathrm{CPI}_t^{\mathrm{Denmark}}$ is the Consumer Price Index for Denmark in year t and $\mathrm{CPI}_t^{\mathrm{Abroad}}$ is the Consumer Price Index for Denmark's main trading partners in year t calculated as a geometrically weighted chain index with current weights based on annual trade statistics. An increase in the HREKRCPI index describes an overall real appreciation of the krone vis-à-vis the currencies of Denmark's main trading partners.

The HREKRWPI has been compiled following the same methodology as used for the HREKRCPI.

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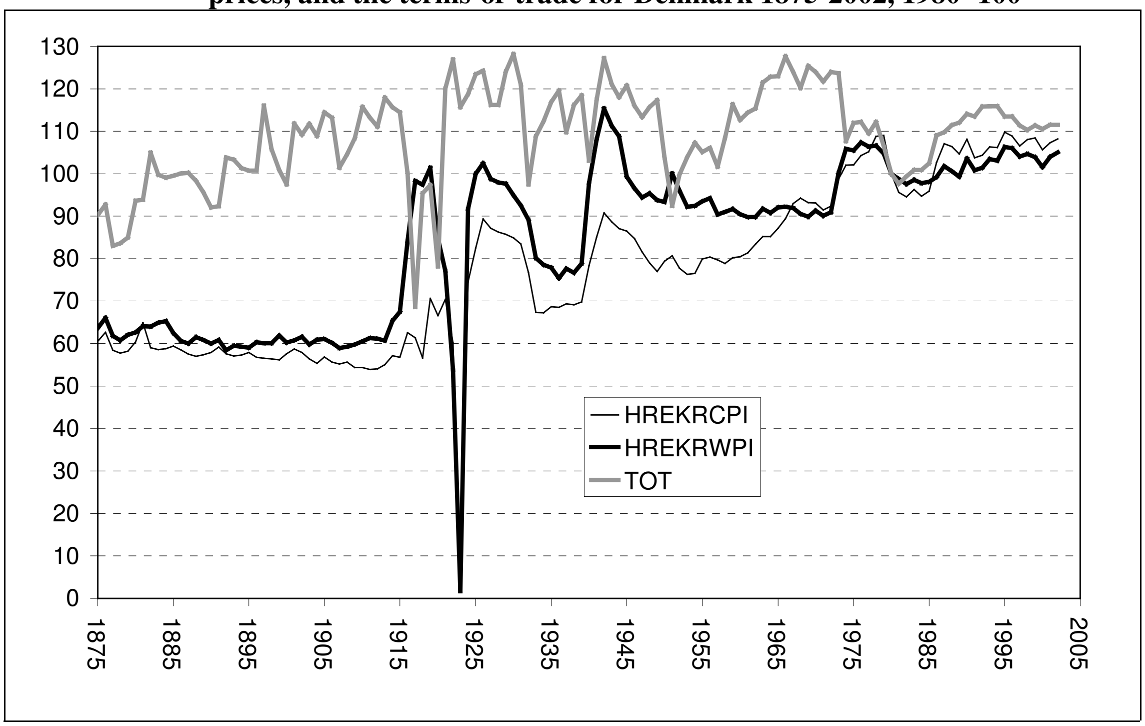
143 The 15 countries in the HNEKR cover 97.8 per cent of the 1983-weighting basis in the NEKR. For the 1989-, 1995-, 2002- and 2009-weighting basis in the NEKR the corresponding figures are 96.4, 93.3, 86.8 and 80.3 per cent respectively.

144 Such as Mitchell (2003).

3.A.3. The historical data set

The time series calculated in this essay are listed in annex 3.B. All indices are based on annual average observations[145] with 1980=100. The main sources for the bilateral nominal exchange rates are data from Danmarks Nationalbank, Statistics Denmark, Norges Bank and a Danish historical statistical abstract[146]. The main data sources for consumer and wholesale price indices are Statistics Denmark, IMF, OECD and standard international historical statistical abstracts. Statistics Denmark is also the source for the annual Danish trade statistics used for the calculations of weights in the indices. However, in order to get complete time-series data without gaps for the whole period 1875-2003 a much wider range of sources has been drawn upon. In some cases interpolations have also been necessary in order to splice old and new data series into comparable time series.[147]

Figure 3.A.1: Real effective krone-rate indices based on consumer prices and wholesale prices, and the terms-of-trade for Denmark 1875-2002, 1980=100



Source: Chart 4 in Abildgren (2004b).

[145] Regarding nominal exchange rates this normally means annual average of observations each trading day, whereas the annual averages for CPI and WPI usually are based on monthly observations.

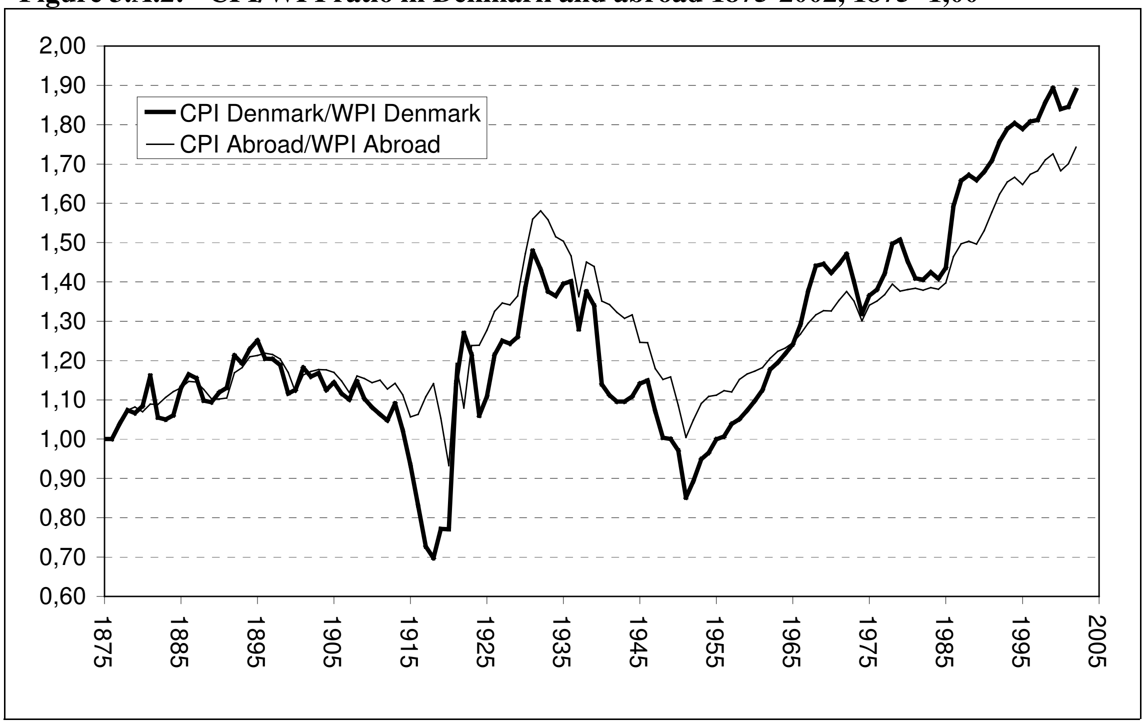
Although period averages of financial time series in some applications might lead to “spurious correlations”, cf. e.g. Mills (1999), annual averages of nominal exchanges is the proper comcept to use in relation to real effective echange rates if those are studies in relation to foreign trade and purchasing power parity. Foreign trade data are period totals and the classical argument for purchasing power parity is cross-border goods-market arbitrage.

[146] Johansen (1985).

[147] A detailed description of the methods used to construct the historical time series, as well as a full listing of all sources and background data, is found in Abildgren (2004b).

Figure 3.A.1 shows the development of the historical real effective krone-rate index based on consumer prices (HREKRCPI) as well as on wholesale prices (HREKRWPI) for the whole period 1875-2002. Furthermore, Figure 3.A.1 contains an index for the terms of trade (TOT)[148]. The two historical real effective krone rate indices show a marked drop followed by a sharp increase around the period of German hyperinflation at the beginning of the 1920s. The reason is that German inflation began to accelerate before the German exchange rate depreciated. However, one should probably not put too much weight on the information content in price indices in extreme situations such as the German hyperinflation in the early 1920s.[149]

Figure 3.A.2: CPI/WPI ratio in Denmark and abroad 1875-2002, 1875=1,00



Source: Chart 5 in Abildgren (2004b).

The long-term developments in the two historical real effective krone-rate indices are roughly parallel. However, for the post-1950 period the index based on consumer prices shows the largest appreciation. The reason is that the ratio between consumer prices and wholesale prices for this period has increased more in Denmark than abroad, cf. Figure 3.A.2.

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148 The terms-of-trade index is compiled as an index for export unit values divided by an index for import unit values. The terms-of-trade index can be considered as a real effective krone rate index based on the actual prices in the foreign trade that takes into account not only the actual geographical distribution but also the actual goods composition of the foreign trade activities.

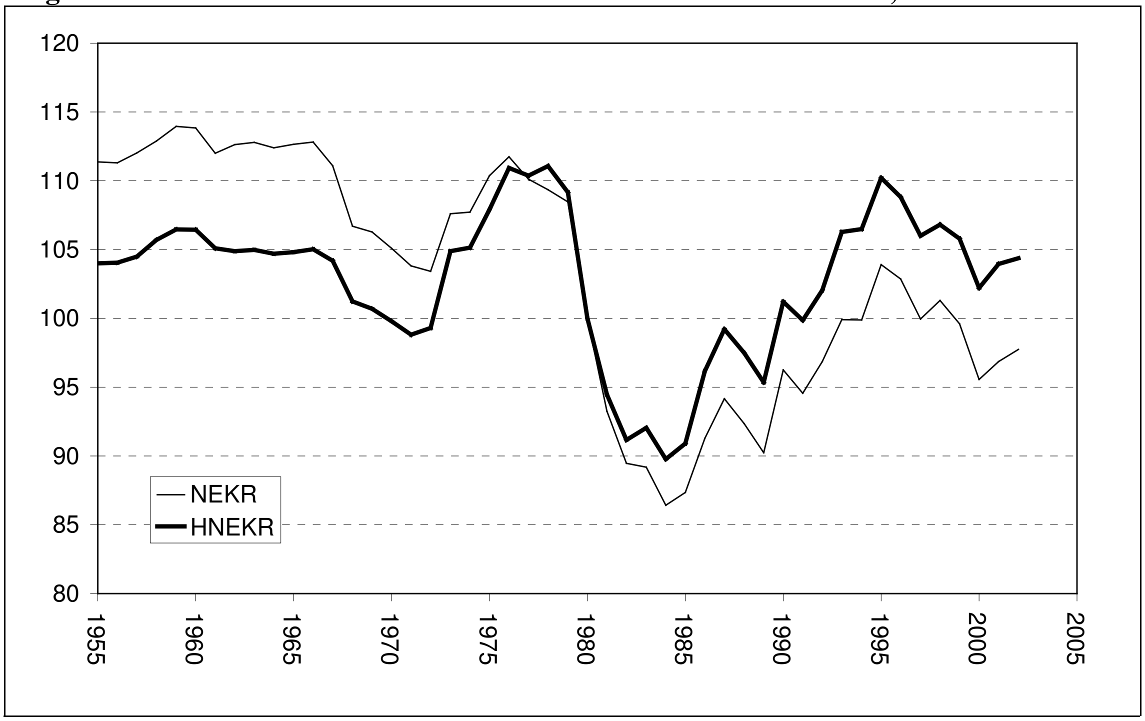
149 Klovland (1998) presents nominal and real effective exchange-rate calculations for Denmark, Norway and Sweden on a monthly frequency for the period January 1919 to July 1939 based on fixed weights (trade in

3.A.4. A comparison with the Nationalbank's effective krone-rate indices

Figure 3.A.3 shows the development in the "official" nominal effective krone rate index (NEKR) and the historical nominal effective krone rate index (HNEKR) for the period since 1955. The short-term development in the two series seems to be roughly parallel. The differences in the long-term development are larger due to the different methods of calculation mentioned above.

manufactures among 16 countries in 1929). These calculations excludes Germany prior to November 1924 in order to avoid large fluctuations in the exchange-rate indices.

Figure 3.A.3: Nominal effective Danish krone rate indices 1955-2002, 1980=100

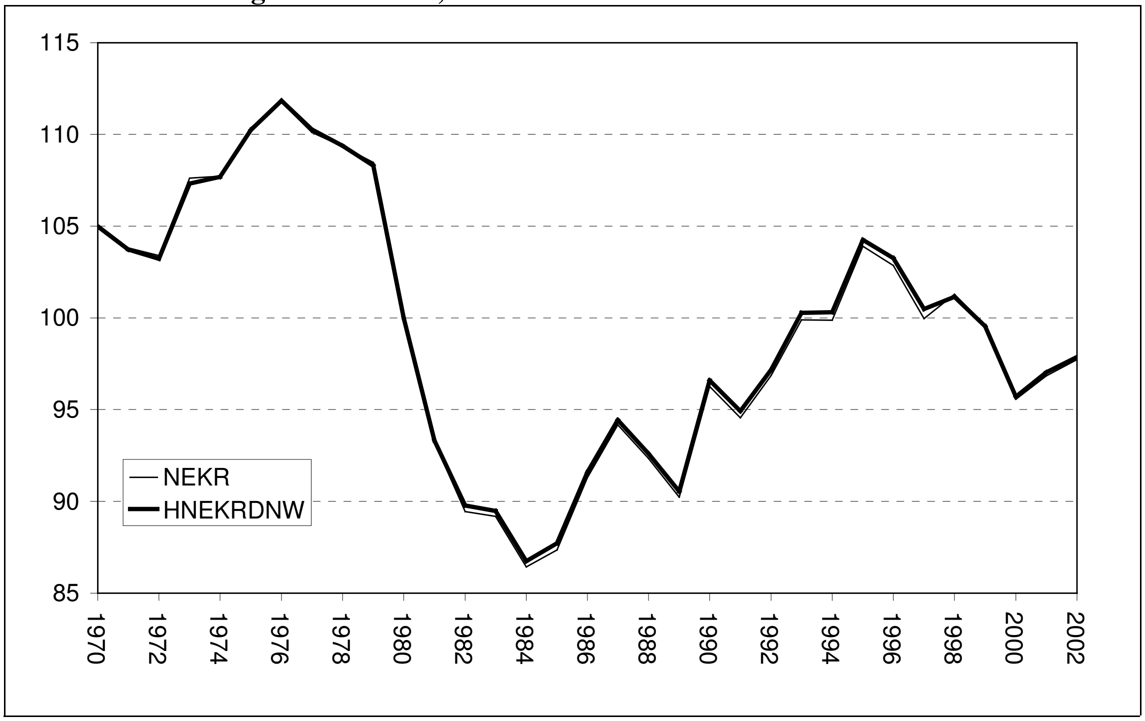


Source: Chart 1 in Abildgren (2004b).

The main part of the differences between the two nominal effective krone rates in Figure 3.A.3 can be attributed to the use of current weights in HNEKR. Figure 3.A.4 shows the official nominal effective krone-rate index (NEKR) together with an index (HNEKRDNW) calculated on basis of the 15 countries in the HNEKR and the weighs from NEKR. There are practically no differences between the development in the two series in Figure 3.A.4.

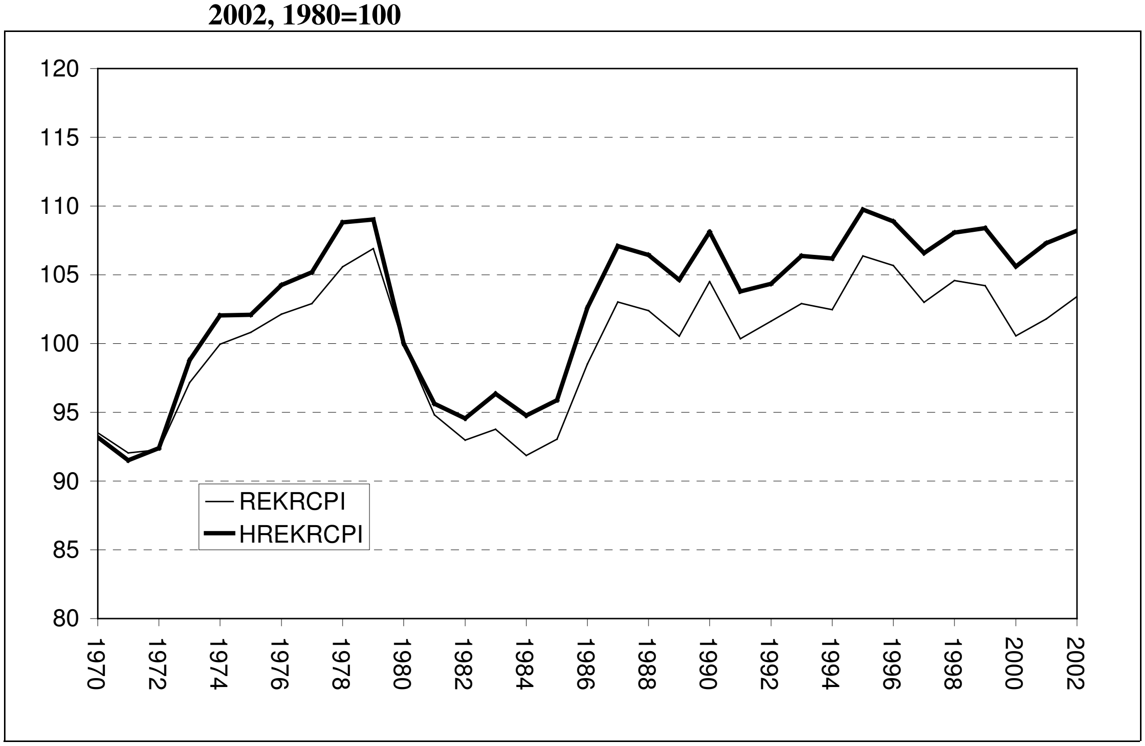
Figure 3.A.5 shows the development in the official real effective krone-rate index based on consumer prices (REKRCPI) and the corresponding historical series (HREKRCPI) for the period since 1970. As was the case with the nominal indices the short-term development in the two real indices seems to be roughly parallel, whereas the differences in the long-term development are larger due to the different methods of calculation.

Figure 3.A.4: Nominal effective Danish krone-rate indices compiled using different weights 1970-2002, 1980=100



Source: Chart 2 in Abildgren (2004b).

Figure 3.A.5: Real effective Danish krone rate indices based on consumer prices 1970-2002, 1980=100



Source: Chart 3 in Abildgren (2004b).

Annex 3.B: Nominal and real effective krone-rate indices for Denmark 1875-2003 – Data

Table 3.B.1: Nominal and real effective krone-rate indices for Denmark 1875-2003

Year	HNEKR	CPI Denmark	CPI Abroad	HREKRCPI	WPI Denmark	WPI Abroad	HREKRWPI
	1980=100						
1875	0.1502	4.915	0.01219	60.54	7.137	0.01683	63.67
1876	0.1503	4.931	0.01182	62.70	7.160	0.01629	66.05
1877	0.1501	4.766	0.01225	58.40	6.666	0.01617	61.88
1878	0.1499	4.453	0.01155	57.79	6.024	0.01485	60.80
1879	0.1502	4.352	0.01123	58.19	5.925	0.01433	62.09
1880	0.1503	4.719	0.01174	60.42	6.320	0.01516	62.69
1881	0.1501	5.095	0.01177	64.96	6.370	0.01492	64.08
1882	0.1500	4.555	0.01157	59.04	6.271	0.01469	64.06
1883	0.1501	4.500	0.01153	58.60	6.221	0.01438	64.92
1884	0.1500	4.328	0.01105	58.78	5.925	0.01361	65.32
1885	0.1500	4.187	0.01057	59.40	5.382	0.01291	62.51
1886	0.1502	3.999	0.01026	58.53	4.987	0.01235	60.64
1887	0.1502	3.890	0.01016	57.53	4.888	0.01224	59.99
1888	0.1502	3.921	0.01033	57.03	5.185	0.01266	61.53
1889	0.1501	4.054	0.01061	57.37	5.382	0.01328	60.83
1890	0.1500	4.148	0.01074	57.93	5.382	0.01346	59.97
1891	0.1501	4.305	0.01091	59.23	5.530	0.01364	60.89
1892	0.1505	4.164	0.01087	57.65	4.987	0.01284	58.46
1893	0.1504	4.054	0.01068	57.09	4.938	0.01248	59.51
1894	0.1506	3.929	0.01033	57.29	4.641	0.01179	59.26
1895	0.1505	3.913	0.01017	57.90	4.543	0.01158	59.05
1896	0.1504	3.812	0.01011	56.72	4.592	0.01145	60.34
1897	0.1505	3.890	0.01034	56.59	4.691	0.01175	60.08
1898	0.1505	3.999	0.01068	56.39	4.888	0.01224	60.12
1899	0.1498	3.984	0.01063	56.15	5.185	0.01255	61.92
1900	0.1501	4.211	0.01097	57.61	5.431	0.01353	60.25
1901	0.1506	4.266	0.01094	58.74	5.240	0.01298	60.80
1902	0.1504	4.234	0.01098	57.96	5.304	0.01294	61.62
1903	0.1503	4.164	0.01109	56.42	5.176	0.01301	59.80
1904	0.1504	4.109	0.01116	55.38	5.304	0.01309	60.90
1905	0.1504	4.281	0.01133	56.84	5.431	0.01337	61.08
1906	0.1500	4.320	0.01165	55.63	5.623	0.01401	60.19
1907	0.1492	4.406	0.01192	55.15	5.815	0.01471	58.95
1908	0.1498	4.391	0.01181	55.67	5.559	0.01405	59.27
1909	0.1500	4.320	0.01193	54.34	5.687	0.01427	59.79
1910	0.1501	4.422	0.01220	54.41	5.943	0.01473	60.57
1911	0.1501	4.446	0.01239	53.88	6.070	0.01487	61.31
1912	0.1500	4.657	0.01292	54.06	6.454	0.01583	61.15
1913	0.1499	4.798	0.01305	55.10	6.390	0.01578	60.69
1914	0.1492	5.040	0.01316	57.17	7.157	0.01633	65.41
1915	0.1553	5.839	0.01598	56.75	9.074	0.02088	67.50
1916	0.1770	6.878	0.01945	62.58	12.013	0.02527	84.15
1917	0.1968	7.966	0.02555	61.37	15.911	0.03184	98.34
1918	0.1894	9.302	0.03111	56.61	19.361	0.03764	97.41
1919	0.2406	11.034	0.03757	70.68	20.767	0.04925	101.46
1920	0.2400	13.162	0.04743	66.59	24.793	0.07016	84.79
1921	0.2883	11.183	0.04579	70.42	14.186	0.05301	77.15
1922	0.4526	9.500	0.07144	60.19	10.863	0.09135	53.82
1923	1.171	9.896	7.318	1.58	11.821	8.163	1.70
1924	86.86	10.49	12.23	74.52	14.38	13.62	91.67
1925	102.30	10.19	12.64	82.50	13.35	13.67	99.98
1926	129.96	8.66	12.60	89.34	10.35	13.13	102.49
1927	131.17	8.36	12.58	87.19	9.71	12.90	98.78
1928	130.98	8.31	12.62	86.28	9.71	12.99	97.96
1929	130.95	8.26	12.61	85.78	9.52	12.77	97.65
1930	131.27	7.87	12.16	84.94	8.24	11.40	94.89
1931	127.43	7.42	11.33	83.48	7.28	10.03	92.58
1932	110.64	7.37	10.63	76.71	7.48	9.29	89.09
1933	92.04	7.57	10.35	67.33	7.99	9.17	80.15
1934	89.50	7.87	10.47	67.27	8.37	9.54	78.55
1935	88.81	8.16	10.55	68.71	8.50	9.69	77.89
1936	89.75	8.26	10.82	68.53	8.56	10.19	75.39
1937	90.95	8.56	11.22	69.39	9.71	11.37	77.68
1938	90.93	8.66	11.38	69.16	9.14	10.83	76.69
1939	89.89	8.91	11.47	69.82	9.65	11.00	78.86
1940	90.62	11.08	12.82	78.34	14.12	13.10	97.71
1941	90.35	12.72	13.50	85.12	16.61	13.88	108.12
1942	97.27	13.16	14.10	90.80	17.44	14.71	115.34
1943	97.61	13.26	14.59	88.70	17.57	15.41	111.30
1944	97.61	13.56	15.19	87.10	17.76	15.93	108.82

Table 3.B.1 (continued):

Year	HNEKR	CPI Denmark	CPI Abroad	HREKRCPI	WPI Denmark	WPI Abroad	HREKRWPI
	1980=100						
1945	100.48	13.71	15.93	86.47	17.44	17.65	99.31
1946	106.37	13.61	17.07	84.78	17.19	18.93	96.57
1947	105.78	14.00	18.16	81.58	18.98	21.25	94.45
1948	109.84	14.35	19.94	79.04	20.77	23.91	95.42
1949	106.21	14.70	20.28	76.97	21.34	24.17	93.79
1950	103.08	16.03	20.80	79.44	23.96	26.46	93.35
1951	104.13	17.91	23.12	80.68	30.54	31.78	100.06
1952	104.13	18.31	24.52	77.75	29.78	32.29	96.03
1953	103.94	18.21	24.80	76.32	27.86	31.40	92.23
1954	103.79	18.56	25.16	76.54	27.92	31.34	92.49
1955	104.00	19.79	25.74	79.96	28.75	31.97	93.54
1956	104.04	20.78	26.90	80.37	29.97	33.07	94.27
1957	104.48	21.03	27.56	79.71	29.39	33.98	90.38
1958	105.71	21.23	28.44	78.90	29.33	34.08	90.97
1959	106.46	21.67	28.76	80.22	29.33	34.07	91.66
1960	106.43	22.17	29.31	80.50	29.33	34.50	90.48
1961	105.10	23.16	29.93	81.32	29.89	34.96	89.84
1962	104.89	24.69	31.05	83.41	30.45	35.56	89.80
1963	104.96	25.98	31.99	85.22	31.56	36.10	91.77
1964	104.69	26.92	33.06	85.23	32.12	37.06	90.75
1965	104.81	28.65	34.44	87.19	33.52	38.17	92.04
1966	105.04	30.58	35.93	89.40	34.36	39.14	92.21
1967	104.19	32.86	36.83	92.93	34.64	39.26	91.92
1968	101.24	35.48	38.10	94.28	35.75	39.95	90.60
1969	100.69	36.71	39.67	93.19	36.87	41.29	89.92
1970	99.79	39.14	41.91	93.18	39.94	43.65	91.31
1971	98.80	41.42	44.71	91.52	41.62	45.64	90.10
1972	99.31	44.14	47.43	92.41	43.58	47.60	90.92
1973	104.88	48.24	51.21	98.80	50.00	52.31	100.24
1974	105.14	55.57	57.24	102.06	61.17	60.77	105.83
1975	107.89	60.91	64.37	102.10	64.80	66.27	105.51
1976	110.92	66.40	70.63	104.28	69.83	72.14	107.38
1977	110.36	73.82	77.45	105.20	75.42	78.20	106.44
1978	111.07	81.20	82.87	108.82	78.77	82.07	106.60
1979	109.17	89.02	89.12	109.05	85.75	89.37	104.75
1980	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1981	94.46	111.67	110.32	95.61	115.08	110.10	98.74
1982	91.16	123.00	118.59	94.55	127.09	118.76	97.56
1983	92.04	131.51	125.64	96.33	134.08	125.16	98.59
1984	89.75	139.77	132.39	94.75	144.13	132.34	97.75
1985	90.90	146.40	138.77	95.89	148.04	137.14	98.12
1986	96.16	151.69	142.17	102.60	138.27	134.04	99.20
1987	99.21	157.78	146.18	107.08	138.27	134.80	101.76
1988	97.48	165.00	151.10	106.45	143.30	138.79	100.65
1989	95.35	172.90	157.46	104.70	151.40	145.40	99.29
1990	101.21	177.40	165.75	108.33	153.35	149.85	103.58
1991	99.86	181.70	174.58	103.94	154.47	152.97	100.84
1992	102.04	185.50	180.98	104.59	153.35	154.29	101.42
1993	106.28	187.83	187.17	106.66	152.49	156.70	103.43
1994	106.50	191.58	191.48	106.55	154.22	159.25	103.13
1995	110.20	195.57	195.54	110.21	158.72	164.51	106.32
1996	108.78	199.73	198.61	109.40	160.45	164.71	105.97
1997	105.99	204.08	201.69	107.24	163.56	166.54	104.09
1998	106.81	207.85	203.70	108.98	162.53	165.75	104.73
1999	105.78	213.04	206.00	109.40	163.39	166.10	104.05
2000	102.21	219.25	209.73	106.85	173.08	173.66	101.88
2001	103.97	224.40	214.56	108.74	176.55	175.98	104.31
2002	104.39	229.90	218.45	109.86	176.72	175.01	105.40
2003	107.54	234.70	222.20	113.59	177.06	177.22	107.44

Notes: The nominal effective krone-rate index (HNEKR), the real effective krone-rate index based on consumer prices (HREKRCPI) and the real effective krone-rate based on wholesale prices (HREKRWPI) are calculated as geometrically weighted chain indices with current (i.e. annually updated) weights based on Denmark's trade with 15 countries. An increase in the HNEKR index describes an overall nominal appreciation of the krone vis-à-vis the currencies of Denmark's main trading partners. An increase in the HREKRCPI or HREKRWPI index describes an overall real appreciation of the krone vis-à-vis the currencies of Denmark's main trading partners.

Source: The annex in Abildgren (2005c) updated with more recent and revised data from the sources stated in Abildgren, op.cit.

Essay 4: The Scope for Reduced Unemployment in the 1930s Through the Danish Exchange Control System[150]

Abstract

Essay 4 presents an analysis of the employment effects of the Danish exchange control in the 1930s. The aim is to shed light on the amount of extra employment that could have been created in 1934 by a purely reallocation of the import compared to the actual import allocation in 1934. The analysis is based on an input-output linear programming model where a new detailed Historical Input-Output Table for the Danish economy in 1934 forms the core. The model is used to calculate the level of employment for all possible allocations of imports and to find the allocation that – subject to certain assumptions and constrains – would have maximised the level of employment in 1934.

The calculations suggest that it would have been possible to increase employment by between 34,000 and 82,000 persons (equivalent to between 1.7 and 4.2 per cent of the labour force) in 1934 by implementation of such alternative employment maximising import allocations.

Annex 4.A presents the main sources and methods used for the compilation of the new Historical Input-Output Table for Denmark 1934, which is considerably more detailed than the official input-output table for 1934 compiled by Statistics Denmark in the late 1930s and the early 1940s. The annex illustrates the power of the commodity-flow method to compilation of input-output tables even (or especially) when data are sparse, which is often the case in relation to production of historical national-account statistics. As a supplement to the new input-output table, a corresponding set of employment figures following the same industry classification is also presented. Furthermore, a set of input-output multipliers measuring direct and indirect import and employment requirements by industry and final demand categories is calculated from the new input-output table based on the open static Leontief-model.

Key words: Historical national accounts, input-output tables, input-output models; exchange control, linear programming models.

JEL Classification: C61, C67, C82, D57, N14, N24, N74.

[150] This essay is based on joint work with Anders Nørskov presented in Abildgren & Nørskov (1991, 1992) and Abildgren (1992a, 1992b). The contributions to this work by Mr. Anders Nørskov and Mr. Kim Abildgren has equal weight, cf. the co-author declaration on page iv in Abildgren & Nørskov (1991). Abildgren & Nørskov (1991) received the Zeuthen Award of the Copenhagen University in 1992.

4.1. Introduction

After the break down of the international gold standard in the beginning of the 1930s, Denmark – in line with many other European countries[151] – introduced a comprehensive system of foreign-exchange restrictions with the establishment of the Exchange Control Office (Valutacentralen) in January 1932.[152]

The main objective of the new Exchange Control Office was to maintain the krone's value vis-à-vis the British pound, and at the same time support domestic production and employment. The Nationalbank (the central bank of Denmark) was provided with the means to control the total supply and demand of foreign currency. All foreign exchange earnings were to be taken home and sold at the official exchange rate fixing to the Nationalbank or banks authorised by the Nationalbank to deal in foreign exchange. Furthermore, all payments to foreign countries now required licence from the Exchange Control Office, and priorities were given to imports of raw materials for agriculture and manufacturing industry. The trade organisations were consulted in the practical administration of the import regulation, but the final decisions rested with the Minister of Commerce.

The exchange-control system was administratively very demanding. Approximately 60.000 licenses were allocated every four month among the about 18.000 Danish importers[153], and in 1933 the Exchange Control Office acquired an IBM punched card system to process the huge number of import licenses.[154] Out of a total of 18.000 importers, wholesale trading firms and agents accounted for around 8.000. The other 10.000 importers consisted of firms within manufacturing with own raw material importing activities as well as big retailers importing directly. During the first couple of years of its existence the Exchange Control Office used the trade patterns from 1931 as the basis for the allocation of import licenses. In 1935 the basis was changed to the 1934 foreign-trade statistics.[155]

Most studies of the employment effect of the Danish exchange control in the 1930s has focused the amount of employment that was created through the protection of domestic

[151] Germany (July 1931), Italy (May 1934), Belgium (March 1935) and Poland (April 1936) were among the group of European countries that introduced exchange controls during the 1930s, cf. Eichengreen & Sachs (1985).

[152] Originally the Exchange Control Office was administered by Nationalbank, but from 1935 the Office reported directly to the Ministry of Trade even though it was physically located within the Nationalbank, cf. e.g. pp. 373-378 in Knudsen (ed.) (2000). Abildgren (2004a) offers a fact oriented chronology of the Danish foreign exchange rate policy since 1875. Gøtrik (1939) covers the period 1931-1938 in details.

[153] Cf. page 66 in Andersen (1942).

[154] Cf. page 73-75 in Heide (1996). Møller (1978) offers a personal description of the work at the Exchange Control office in the middle of the 1930s.

[155] It has been noted that this allocation framework – based on trade statistics from previous years – implied a tendency to preserve the existing industrial structure and hampered innovation in the Danish business sector. Furthermore, the administrative burdens related to import license application were heavy to bear for small firms and therefore *de facto* gave larger firms a preferential treatment, cf. page 284-285 in Hastrup (1979).

production against imports[156] or the amount of employment that could have been created through further substitution of imports by domestic production[157].

This essay aims to assess the amount of extra employment that could have been created in 1934 by a purely reallocation of imports compared to the actual import allocation in 1934. In the analysis a new detailed Historical Input-Output Table for the Danish economy in 1934 forms the core in a linear programming model. The model is used to calculate the level of employment for all possible allocations of imports and to find the allocation that – subject to certain assumptions and constrains – would have maximised the level of employment in 1934.

A crucial assumption behind the analysis is that import in 1934 was a factor limiting the level of production and thereby the level of employment. It is thus ruled out by assumption that production in any industry could have been increased without additional use of imports. For the Danish economy in the mid-1930s this is not a totally unreasonable assumption. A large part of the import in 1934 consisted of raw materials and other production inputs, which were not produced domestically and which it would have been difficult to substitute with domestic production in the short run.

The analysis furthermore makes an assumption on constant shares of import in all categories of final demand. This assumption seems reasonable for some categories of final demand, e.g. in relation to gross fixed capital formation. For other categories of final demand this assumption can partly be justified by the fact that Denmark's bilateral trade agreements required import of specific foreign products in return for export of Danish production.[158] However, this assumption is less obvious for at least a certain proportion of the final demand.

Thirdly, it is assumed that the production function in each industry is characterised by constant return to scale and the use of inputs in fixed proportions (a so-called "Leontief production function"). An assumption of fixed proportions is also applied to all categories of final demand. Although these assumptions are "standard" in most static input-output analyses they are of course debatable.[159]

Finally, the model assumes certain limits on the extent to which the production in each industry could have been increased or decreased compared to the actual level in 1934. It also sets some limits for the amount of increase or decrease of each the final demand categories compared to the actual 1934-level. These assumptions aim to capture short run rigidities in production

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[156] Cf. p. 48 in Boserup (1947), p. 69 in Cohn (1935), pp. 166-167 in Dich (1942), pp. 68-69 in Hansen (1983), pp. 228-231 in Philip (1939), "Beretning om Revision af Valutaloven" in *Rigsdagstidenden* 1934-35 supplement A.I, column 2323-2326, 2403-2408 and 2427-2430, "Betænkning over Forslag til Lov om Indløseligheden af Nationalbankens Sedler og om Foranstaltninger til Værn for den danske Valuta" in *Rigsdagstidenden* 1934-35 supplement B, column 269-272 and "Beretning fra Udvalget angaaende Valutalovens Revision" in *Rigsdagstidenden* 1937-38 supplement A.I, column 2571-2574.

[157] Cf. Philip (1939) p. 231 ff.

[158] Cf. pp. 80-81 and pp. 111-119 in Christiansen (1938).

[159] A discussion of these assumptions can be found in e.g. Blair & Miller (1985) and Chenery & Clark (1959).

processes[160], labour mobility among sectors, consumption patterns *etc*. and furthermore to ensure that no "corner solutions" with e.g. an unrealistic consumption pattern are included in the set of feasible import allocations.

Any model has to be a simplified description of reality and thus subject to limitations. As indicated above also the following analysis is based on assumptions that are open for discussion.[161] Furthermore it should be noted that the analysis is a pure "planning exercise" which does not deal with all the practical aspects that would had occurred if the Exchange Control Office (the "benevolent social planner" in this exercise) had chosen to implement the employment maximising import allocation in practice.[162] However the analysis can still give some valuable information about the unutilised potential for further increases in employment in the 1930s via the exchange-control system through an alternative distribution of the import licenses in 1934 compared to the actual chosen distribution.

4.2. Data description and model formulation

The linear programming model used for the analysis is estimated on basis of a new detailed Historical Input-Output Table for the Danish economy in 1934 (HIOT 1934) supplemented with corresponding data for employment by industry in 1934. The sources and methods used to construct the HIOT 1934 and the employment figures are described in annex 4.A.

Figure 4.1: The Historical Input-Output Table for Denmark 1934 (HIOT 1934), algebraic form

	Industries (94)	Final Demand (15)	Sum (1)
Industries (94)	**DZU**	**DZF**	**g**
Imports (1)	**mu'**	**mf'**	μ_{1934}
Primary inputs (3)	**S**	$\mathbf{S_f}$	**s**
Sum (1)	**g'**	**f'**	

Source: Box 1 in Abildgren & Nørskov (1992).

The HIOT is shown in algebraic form in Figure 4.1.[163] The numbers shown in brackets denotes the dimensions of the matrices and vectors.[164] The employment figures in 1934 by industry are

160 The available statistics does not allow for a detailed assessment of the degree of capital utilisation in the different sectors of the Danish economy in 1934. However, viewed against the background of the economic recession in the 1930s it is reasonable to assume a certain unutilised level of capacity in most sectors. Warming (1935) has assessed that the level of unutilised capital stock within manufacturing in 1935 would have allowed for 40,000 jobs without encountering capacity restrictions.

161 A more thorough discussion of the assumptions and limitations of the model and the analysis is found in Abildgren & Nørskov (1992).

162 Naturally one of these "practical problems" would be the conflict of interest between those industries who would have gained from such a reallocation of import licenses and those who would have been losers.

163 All data in the input-output table are expressed in current prices (1,000 kroner). However, each row can also be interpreted as representing physical quantities if one unit is defined as the amount of output from a given sector that can be purchased for 1 krone, cf. p. 22 in Leontief (1986). Such an interpretation is normally termed "Leontief-units".

symbolised by a (94x1) column vector $\mathbf{l}$. The total employment in 1934, λ_{1934}, is thus given by $\lambda_{1934} \equiv \mathbf{i'l} = 1{,}660{,}200$ persons.

The static input-output linear programming model can then be formulated as follows:

Maximise:

Total employment: [4.1] $\lambda = \mathbf{k'g}$

subject to:

The open static Leontief-model: [4.2] $\mathbf{g} = \mathbf{DZBg} + \mathbf{DZEf}$

with imports equal to the 1934-level: [4.3] $\mu_{1934} = \mathbf{mb'g} + \mathbf{me'f}$

and total employment below or equal to the total labour force: [4.4] $\lambda \leq \lambda_{max}$

Upper-bound constraint on production: [4.5] $\mathbf{g} \leq \mathbf{g}_{max}$

Lower-bound constraint on production: [4.6] $\mathbf{g}_{min} \leq \mathbf{g}$

Upper-bound constraint on final demand: [4.7] $\mathbf{f} \leq \mathbf{f}_{max}$

Lower-bound constraint on final demand: [4.8] $\mathbf{f}_{min} \leq \mathbf{f}$

Non-negativity conditions: [4.9] $\mathbf{o} \leq \mathbf{g}$

[4.10] $\mathbf{o} \leq \mathbf{f}$

The matrices of coefficients used for the input-output model above can be estimated on basis of the data in Figure 4.1 by non-stochastic single-point estimation (calibration)[165] as follows:

$$\mathbf{DZB} = \mathbf{DZU}\langle\mathbf{g}\rangle^{-1} \qquad \mathbf{DZE} = \mathbf{DZF}\langle\mathbf{f}\rangle^{-1}$$

$$\mathbf{mb'} = \mathbf{mu'}\langle\mathbf{g}\rangle^{-1} \qquad \mathbf{me'} = \mathbf{mf'}\langle\mathbf{f}\rangle^{-1}$$

The employment coefficients can be estimated as:

$$\mathbf{k'} = \mathbf{l'}\langle\mathbf{g}\rangle^{-1}$$

The linear programming model maximises the total employment [4.1] subject to the equilibrium condition for domestic production [4.2] and the requirement that the total level of imports shall be equal to the actual level in 1934 [4.3]. The constraint in [4.4] states that the total level of employment is not allowed to exceed the total labour force in 1934 (denoted λ_{max}).[166]

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[164] In this essay matrices are indicated with bold capital letters, whereas bold small letters symbolise column vectors. Small Greek letters symbolise real numbers. ' means transponation. $\mathbf{i}$ symbolises a column vector, where each element is 1, whereas $\mathbf{o}$ symbolises a column vector, where each element is 0. $\langle\mathbf{a}\rangle$ symbolises a diagonal matrix with the elements from $\mathbf{a}$ in the diagonal and zeros elsewhere. $\mathbf{A}^{-1}$ is the inverse to $\mathbf{A}$, thus $\mathbf{AA}^{-1} = \mathbf{A}^{-1}\mathbf{A} = \mathbf{I}$ where $\mathbf{I}$ is the identity matrix.

[165] For early critics of this estimation method, cf. Briggs (1957), p. 205 in Klein (1953) and page 46 in Rasmussen (1956).

[166] The figure chosen for the total labour force in 1934 is 1,914,000 persons based on p. 231 in Hansen (1983). Together with the employment figures used this implies an unemployment rate in 1934 at 13.3 per cent. If one alternatively uses the labour-force figure on p. 54 in Pedersen (1977) (1,802,000 persons) the unemployment rate in 1934 would be 7.9 per cent. However, the labour force restriction is not binding in any of the employment-

Finally, [4.5-4.8] sets some limits for the changes allowed in the level of production in each industry and in each category of final demand compared to the actual level in 1934 whereas [4.9-4.10] are non-negativity requirements for domestic production and final demand. Regarding exports both the lower and upper bound in [4.7-4.8] are fixed at the 1934-level which also (due to the fixed coefficients in **DZE**) implies an assumption on fixed export composition by delivering industries. This shall be viewed against the fact that Denmark's bilateral trade agreements in the 1934 required import of foreign products in return for specific exports of Danish production.[167] Given the assumption on a fixed level of import, cf. μ_{1934} in [4.3], model solutions operating with increased level of exports or a markedly changing of the export composition are not considered to be realistic counterfactual alternatives.

4.3. Empirical findings

The linear programming model in section 4.2 can be solved via the Simplex-method.[168] This section presents calculations with the upper- and lover-bounds on production fixed at 5 or 10 per cent over and below the actual 1934 level. The upper- and lover-bounds on final demand (except exports) are fixed at respectively 5, 10, 15, 20, 25 or 30 per cent over and below the actual 1934 level[169].

Table 4.1: Total increase in employment in Denmark 1934 achieved by implementing the employment maximising import allocation

	Bounds on final demand (per cent)					
	+/- 5	+/- 10	+/- 15	+/- 20	+/- 25	+/- 30
+/- 5 per cent bounds on production	34,300	39,233	40,798	42,074	43,054	43,741
+/- 10 per cent bounds on production	34,300	68,601	76,133	78,466	80,120	81,598

Source: Table 5.1 in Abildgren & Nørskov (1992).

Table 4.1 shows the increase in employment compared to the actual 1934 level that could have been achieved if the employment-maximising allocation of imports derived by the model [4.1]-[4.10] had been chosen instead of the actual allocation implemented by the Exchange Control Office. The results indicates that it would have been possible to increase employment by between 34,000 and 82,000 persons (equivalent to between 1.8 and 4.3 per cent of the labour force) in 1934 by alternative allocations of imports.

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maximising solutions presented in the analysis regardless of the figure chosen for the total labour force, cf. p. 596 in Abildgren & Nørskov (1992).

167 Around 70 per cent of the foreign trade in Denmark 1934 was on a bilateral basis, cf. p. 246 in Philip (1939).

168 The calculations presented in this section were performed by use of the computer-program SAS/OR, cf. SAS-Institute (1983) for a description of the program. Extensive general descriptions on linear programming and the Simplex-method are found in e.g. Dorfman, Samuelson & Solow (1958), Danø (1974) and Sydsæter & Øksendal (1988). All solutions presented in this essay are unique.

169 In order to minimise aggregation errors all calculations have been conducted at the detailed 94-sector level. However the results in this section are presented in an aggregated version.

Table 4.2: Increase in employment by industry in Denmark 1934 achieved by implementing the employment maximising import allocation
(+/- 5 per cent bound constraint on production)

	Bounds on final demand (per cent)					
	+/- 5	+/- 10	+/- 15	+/- 20	+/- 25	+/- 30
1.A Agriculture, horticulture, etc.	9,700	9,932	9,960	10,070	10,147	10,192
1.B Forestry and logging	14	29	30	30	30	31
1.C Fishing	175	176	176	178	180	181
2 Mining and quarrying	-65	-51	-51	-51	-51	-51
3.A Manuf. of food, beverages, tobacco	1,278	1,126	1,281	1,952	2,422	2,692
3.B Textile, clothing, leather industries	-3,665	-3,743	-3,732	-3,738	-3,740	-3,739
3.C Manuf. of wood products	621	818	839	818	809	814
3.D Manuf. of paper, printing, publishing	985	1,027	1,040	1,053	1,063	1,069
3.E Chemical and petroleum industries	312	365	376	376	376	377
3.F Non-metallic mineral products	585	850	851	856	860	862
3.G Metal industries	-988	-1,343	-1,369	-1,662	-1,808	-1,804
3.H Other manufacturing industries	122	113	112	107	104	104
4 Electricity, gas and water	-163	-148	-142	-140	-138	-136
5 Construction	2,819	4,396(+)	4,396(+)	4,396(+)	4,396(+)	4,396(+)
6.A Wholesale and retail trade	2,581	2,494	2,748	3,508	4,053	4,383
6.B Restaurants and hotels	1,776	1,800	1,800	1,798	1,797	1,797
7.A Transport	-703	813	1,720	1,743	1,760	1,773
7.B Communication	46	334	502	514	523	530
8.A Financing and insurance	713	748	765	769	772	774
8.B Dwellings	-46(-)	-46(-)	-46(-)	-46(-)	-46(-)	-46(-)
9.A Household service	1,289	1,307(+)	1,307(+)	1,307(+)	1,307(+)	1,307(+)
9.B Recreational and cultural services and 9.C Producers of government services	16,915	18,236(+)	18,236(+)	18,236(+)	18,236(+)	18,236(+)
Sum	34,300	39,233	40,798	42,074	43,054	43,741

Notes:
(+) indicates that an upper-bound constraint on production in a given industry has been reached.
(-) indicates that a lower-bound constraint on production in a given industry has been reached.
Source: Table 5.3 in Abildgren & Nørskov (1992).

Table 4.2 shows how the increase in employment is distributed by industry when a +/- 5 per cent bound constraint on production in each industry is applied. Around 75 per cent of the increases in employment occur in agriculture, construction and public services. The largest decreases in employment take place within manufacturing of textiles and in metal industries.

Table 4.3 shows the effect on the final demand categories with the actual level in 1934 equal to 100. The employment maximising solution implies higher levels of consumption of food and services as well as a higher level of gross fixed capital formation in buildings whereas most other demand categories show a decrease. The model basically redistributes employment from sectors with low direct and indirect employment/import ratios to sectors with high direct and indirect employment/import ratios until upper or lower bound constraints on production or final demand are reached.

Table 4.3: Level of final demand in Denmark 1934 achieved by implementing the employment maximising import allocation

(+/- 5 per cent bound constraint on production)

	Bounds on final demand (per cent)					
	+/- 5	+/- 10	+/- 15	+/- 20	+/- 25	+/- 30
	Actual 1934-level = 100					
Imputed bank service	105(+)	105	105	105	105	105
Private consumption, sum	101	101	101	101	102	102
Food	105(+)	105	105	105	105	105
Beverages and tobacco	95(-)	94	95	99	102	104
Clothing and footwear	95(-)	95	95	95	95	95
Rents, fuel, power	95(-)	95	95	95	95	95
Transport and communication	96	102	105	105	105	105
Miscellaneous goods and services, purchase in Denmark by non-resident households	105(+)	105	105	105	105	105
Purchase abroad by resident households	95(-)	90(-)	85(-)	80(-)	75(-)	70(-)
Government consumption	105(+)	106	106	106	106	106
Gross fixed capital formation, sum	101	101	100	100	100	100
Machinery etc., agricultural breeding stock	95(-)	92	92	92	92	92
Transport-equipment	95(-)	90(-)	85(-)	80(-)	77	77
Construction	105(+)	108	107	107	107	107
Exports	100	100	100	100	100	100

Notes:
(+) indicates that an upper-bound constraint on a given category of demand has been reached.
(-) indicates that a lower-bound constraint on a given category of demand has been reached.
Source: Table 5.4 in Abildgren & Nørskov (1992).

4.4. Scope for further research

The analysis in this essay indicates an unutilised potential for further increases in employment in the 1930s via the exchange-control system. This could have been obtained through alternative distributions of imports with relatively larger shares of import licenses allocated to industries characterised by higher direct and indirect employment content per krone direct and indirect imports. However, a closer inspection of each of the 94 industries in the model solutions one may find cases where the upper and lower bound constraints on production at 5 per cent or 10 per cent of the 1934-level are not reasonable assumptions. For instance, it is unrealistic to obtain a 10 per cent reduction for dwellings since the main part of the production value of this sector is rents (including rents in owner-occupier dwellings). In order to take into account such special factors, one could have chosen an even more detailed approach with more differentiated constraints on the different industries and demand components.

One could also make an attempt to broaden the modelling of the bilateral trade agreements of the 1930s. For example, one could estimate a matrix of import market shares based on a country breakdown of the 1934 imports or set some limits on the import of specific commodities.

Calculations with such extensions and refinements have not been carried out. However, if such further restrictions were implemented in the model they would have limited the number of feasible import allocations and thereby most likely reduced the amount of extra employment in the employment maximising solutions.

Finally, some further limitations due to the nature of the analysis in this essay have to be mentioned. Focusing on only a single year, 1934, does not give a full picture of the consequences of different allocations of imports for the development in production and employment in the following years. Also by design the simple Leontief model does not includes "second round" effect (income effect) known from traditional Keynesian macroeconomic models. A broader picture could be gained from analyses covering several years, e.g. the 1930s as a whole, taken into account both income effect as well as the consequences for gross fixed capital formation and employment over time in a dynamic modelling framework.

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Annex 4.A: Compilation of an Input-Output Table for Denmark 1934 by the Commodity-Flow Method

At the end of the 1930s and in the beginning of the 1940s the Danish Central Bureau of Statistics (Statistics Denmark) compiled an input-output table for Denmark 1934 as an integrated part of the 1934 national account statistic.[170] This annex presents the main sources and methods used to construct a new and substantially more detailed Historical Input-Output Table for Denmark 1934 (HIOT 1934).[171]

The number of industries in the official input-output table for 1934 was 10, of which the manufacturing industries consisted of two sectors only: "Handicrafts" and "Manufacturing". At the most detailed level the HIOT 1934 presented in this essay contains 95 industries (of which 67 are manufacturing industries).

The more general aim with this annex is to illustrate the power of the commodity flow method to compile input-output tables even (and especially) when data are sparse, which is often the situation in relation to production of historical national-account statistics. Due to the commodity flow method it was possible to take advantage of all relevant primary and secondary statistics covering the year 1934 or the nearest years around. Furthermore, the detailed commodity classification made it possible to use *a priori* information about the use of different commodities based solely on the kind of the commodities themselves.

4.A.1. Input-output tables, their historical origin and their application within economic-historical research

An input-output table gives a statistical description of the flows of goods and services in the economy for a given period (e.g. a given year). The supply side in an input-output table consists of output from all the producing sectors of the domestic economy, from imports of goods and services and from "primary inputs" (i.e. GDP). The use side consists of intermediate consumption in all the domestic producing sectors, final domestic demand and exports of goods and services.

The basic idea behind input-output tables can be traced back to Quesnay's famous Tableau Economique from 1758.[172] In "modern times" the pioneer work on input-output tables has

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[170] Cf. Det Statistiske Departement (1948) and Kampmann (1942). Official input-output tables has been compiled by Statistics Denmark for the years 1930-39 (10 industries), 1946 (16 industries), 1947 (20 industries), 1949 (20 industries), 1953 (19 industries), 1958 (9 industries) and on an annual basis since 1966 (more than 100 industries). Non-official input-output tables for each year in the period 1921-31 (10 industries) have been compiled by Jørgensen (1946). For surveys on the history of Danish national-accounts statistics, cf. Hyldtoft (1993a) and Jensen (2000). For an overview of works on historical national-accounts statistics in Denmark, see Mogensen (1987), Hyldtoft (1993b, 1994), Christensen *et al*. (1995), and Nilsson (1991, 2004).

[171] For a detailed documentation of the HIOT 1934 the reader is referred to Abildgren (1992a). The version of the HIOT presented in Abildgren, *op.cit*., is slightly revised compared to the original version found in Abildgren & Nørskov (1991). The revisions concern imputed bank service and the distribution of output from waterworks, cf. p. 65 and p. 68 in Abildgren (1992a).

[172] Cf. e.g. pp. 25-28 in Blaug (1985).

mainly been associated with Leontief who in 1936 published his first input-output table for the U. S. economy in the year 1919.[173]

Parallel with the broader availability of powerful computers several historical input-output tables have been compiled[174] and found their application in a number of quantitative studies of topics within economic history. Historical input-output tables has e.g. served as part of a broader database in relation to Social Accounting Matrices and Computable General Equilibrium models[175], in analysis of underlying inflation developments[176] and the impact of tariffs on consumer prices[177].

4.A.2. The commodity-flow method[178]

The HIOT 1934 is based on a commodity-flow system consisting of 413 commodity balances for imported goods and services and 413 commodity balances for domestic production. About 300 of the 413 commodities are aggregations of the 449 goods in the 1935 "List of Commodities for International Trade Statistics" by the League of Nations[179]. This commodity nomenclature made the Industrial Production Statistics 1934 and the Foreign Trade Statistics 1934 fit together. The rest of the 413 commodities are services.

The supply side of a commodity balance consists of domestic production and imports, whereas the use side consists of intermediate consumption, household consumption, government consumption, gross fixed capital formation, and exports.[180]

The system is illustrated in Figure 4.A.1.[181] The numbers shown in brackets denotes the dimensions of the matrices and vectors.

In Figure 4.A.1 the supply of domestic commodities is contained in the matrix **V**. A column in **V** shows the domestic output of the commodity from each of the 95 branches. The use side of domestic commodities in Figure 4.A.1 consists of the matrices **ZU** and **ZF**. In **ZU** a row shows

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[173] Cf. Table 6 in Loentief (1936). This input-output table contains 41 industries.

[174] Cf. e.g. Siriwardana (1987), Horrell *et al*. (1994), Kauppila (2005, 2008b) and Fremdling & Stäglin (2009). In the essay at hand an input-output table is considered to be "historical" if it has been compiled at a time distant from the reference period as part of a historical analysis and not as part of contemporary national-account statistics.

[175] Cf. e.g. James (1984), Thomas (1987), Siriwardana (1991, 1995, 1998), den Bakker *et al*. (1994) and Vikström (2004).

[176] Cf. Abildgren (2007b).

[177] Cf. Kauppila (2008a).

[178] For a more detailed description of the commodity flow method in relation to construction of input-output tables, cf. Thage (1982, 1986a, 1986b).

[179] Cf. League of Nations (1938, 1939) and Société des Nations (1935).

[180] Due to lack of information, stock changes are neglected in the HIOT 1934.

[181] Figure 4.A.1 is a modified version of Table 3.13 in United Nations (1968). In general, the compilation methods used for the HIOT 1934 follows the principles laid out in the 1968-revision of the System of National Accounts (SNA68). In this annex matrices are indicated with bold capital letters, whereas bold small letters symbolise column vectors. ' means transponation. **i** symbolises a column vector, where each element is 1, whereas **o** symbolises a column vector, where each element is 0. **<a>** symbolises a diagonal matrix with the elements from **a** in the diagonal and zeros elsewhere. $\mathbf{A}^{-1}$ is the inverse to **A**, thus $\mathbf{AA}^{-1} = \mathbf{A}^{-1}\mathbf{A} = \mathbf{I}$ where **I** is the identity matrix.

the intermediate consumption of the domestic output of the commodity by each of the 95 branches whereas a row in **ZF** shows the deliveries of the domestic production of the commodity to the various categories of final demand.

Similarly, the vector **b'** contains the supply of the 413 imported goods and services, whereas the matrices **MU** and **MF** represent the use side.

Figure 4.A.1: The commodity flow system in the HIOT 1934, algebraic form

	Commodities (413)	Industries (95)	Final demands (15)	Sum (1)
Domestic commodities (413)		**ZU**	**ZF**	**q**
Imported commodities (413)		**MU**	**MF**	**b**
Industries (95)	**V**			**g**
Imports (1)	**b'**			**b'i**
Special categories of import (3)		**IVU**	**IVF**	**v**
Primary inputs (3)		**S**	$\mathbf{S_f}$	**s**
Sum (1)	**q' + b'**	**g'**	**f'**	

Source: Figure 1 in Abildgren (1992b).

The Special categories of imports are in Figure 4.A.1 illustrated by the matrices **IVU** and **IVF**. They contain tourist transactions, expenditures in Denmark by foreign ships, and expenditures by Danish ships abroad.

The Primary inputs – the matrices **S** and $\mathbf{S_f}$ – contain commodity taxes, net, other taxes linked to production and GDP at factor prices. In the HIOT 1934 the GDP is the residual.

The matrices **V**, **ZU**, **ZF**, **MU**, and **MF** and the vectors **q**, **g** and **b** are measured in basic values, which for domestic production consist of *ex* works prices and for import is c.i.f. plus customs duties. The vector **f** of final demands is measured in purchaser prices.

4.A.3. Initial estimates of the matrices in the commodity-flow system

Altogether, Figure 4.A.1 contains all the matrices, which were necessary for the compilation of the HIOT 1934 and had to be filled out with data.

The imports of goods c.i.f. and custom duties came from the Foreign Trade Statistics 1934 and the Government Finance Statistics 1934. Imports of services could be found in the Balance of Payment Statistics 1934. This resulted in the data for the vector **b'**.

The estimates of the supply of domestic production, **V**, were based on several sources:

- The Industrial Production Statistics contains the value of output by commodity in 1934 for those establishments in manufacturing, which employed more than 5 persons. The Census of Manufacturing, Distribution and Other Industries contains the total value of output (but not distributed by commodity) in the year 1934 for all establishments in manufacturing. Therefore, the output by commodity from the Industrial Production Statistics were scaled up with the ratio between the value of output from the Census of Manufacturing, Distribution and Other Industries and the value of output from the Industrial Production Statistics.

- For Agriculture, Forestry, Transport, Communications, Financial institutions, Insurance, Recreational and cultural service *etc*. the calculations were based on other separate statistics.
- The production in Fishing, Construction, Dwellings, Producers of government service etc. could be adapted directly from the official National Account Statistic 1934.

All in all, the initial estimates on the supply side of the HIOT 1934 were firmly based on (mainly) primary statistics and were only in a few cases changed in the balancing process.

On the use side the amount of statistical information was sparser except for the export of goods and services which was known from the Foreign Trade Statistics 1934 and Balance of payment statistics 1934.

For manufacturing industries the intermediate consumption of some of the raw materials (in physical quantities) were taken from the Industrial Production Statistics 1934. There figures were scaled up with the ratio between the value of output from the Census of Manufacturing, Distribution and Other Industries and the value of output from the Industrial Production Statistics. Due to lack of price information the value figures for intermediate consumption had in many cases to be compiled by the use of unit values for domestic production by commodity from the Industrial Production Statistics 1934 and export unit values f.o.b.[182] by commodity from the Foreign Trade Statistics 1934.

For the majority of industries outside manufacturing initial estimates of intermediate consumption were only made for energy. Similarly only few initial estimates were made concerning domestic final demand, namely for gross fixed capital formation of construction (which was known from the calculations of output in Construction) and breeding stocks (which were known from the calculations of agricultural output).

In some cases the initial estimations of intermediate consumption could be based on structural information from other years than 1934. In particular, the Industrial Production Statistics 1939 was used since this statistics is more detailed than the Industrial Production Statistics 1934.

4.A.4. The balancing process

For each of the 413 commodity balances for import and the 413 commodity balances for domestic production the supply must equal the use. Due to the lack of initial estimates concerning the intermediate consumption of some industries and some categories of domestic final demand this would of course not be true using only the initial estimates. Thus each commodity balance had to go through a manual balancing process.

Due to the detailed commodity flow system it was possible to use many different kind of information in the balancing process. Most important was a priori information about the use of

[182] Reduced by wholesale trade margins and commodity taxes.

the different commodities based solely on the kind of the commodities. To give a few examples fertiliser, feeding stuffs and seed corn, which are not exported, are almost exclusively used in Agriculture while bricks, paving stones, cement and asphalt, which are not exported, must be used in Construction. In a similar way many consumption and investment goods are easily identified when using a detailed commodity flow system.

Furthermore, a number of distributions keys, say production values by branch, employment by branch, horsepower by branch and motor vehicles by branch and household, could be used to distribute paper and pencils, bulbs, repair of motor vehicles, auto insurance, spare parts etc.

4.A.5. Derivation of the input-output table

After the matrices in Figure 4.A.1 had been filled out with data and balanced, an industry x industry input-output table could be compiled directly from the supply and use matrices.

A matrix of market shares, **D**, could be estimated as the observed market shares 1934 by $\mathbf{D} = \mathbf{V}\langle\mathbf{q}\rangle^{-1}$. Based on an assumption, that each commodity was delivered to industries and final demands according to these market shares, the industry x industry matrix of intermediate consumption and the deliveries from industries to final demands could then be found by the matrix-products **DZU** and **DZF**, respectively.[183]

The HIOT 1934 can be illustrated by Figure 4.A.2 where the matrices **MU**, **MF**, **IVU**, **IVF**, **S** and $\mathbf{S_f}$ and the vectors **g**, **b**, **v**, **s** and **f'** are taken directly from Figure 4.A.1.

Figure 4.A.2: The Historical Input-Output Table for Denmark 1934 (HIOT 1934), algebraic form

	Industries (95)	Final Demand (15)	Sum (1)
Industries (95)	**DZU**	**DZF**	**g**
Imported commodities (413)	**MU**	**MF**	**b**
Special categories of import (3)	**IVU**	**IVF**	**v**
Primary inputs (3)	**S**	$\mathbf{S_f}$	**s**
Sum (1)	**g'**	**f'**	

Source: Figure 2 in Abildgren (1992b).

The matrices in Figure 4.A.1 and 4.A.2 give many degrees of freedom in the treatment of the import. The whole import or some selected commodities can thus be made endogenous or exogenous.[184] In Table 4.A.1 the HIOT 1934 is shown in an aggregated version with 23 industries and the import aggregated to one endogenous row.

[183] The assumption on fixed market shares is critical if huge amounts of secondary production occur. However, the amount of secondary production in the HIOT 1934 is only 3.6 per cent of the total value of production.

[184] Cf. the methods described by Thage (1982, 1986b).

Table 4.A.1: Input-output table for Denmark 1934, Endogenous import, DKK 1,000

INTERMEDIATE CONSUMPTION:

		1.A	1.B	1.C	2	3.A	3.B	3.C	3.D	3.E	3.F
1	1.A AGRICULTURE, HORTICULTURE, ETC.	52879	-	-	-	1058499	2595	-	-	381	-
2	1.B FORESTRY AND LOGGING	0	-	-	-	-	-	14766	-	960	-
3	1.C FISHING	-	-	-	-	2695	-	-	-	-	-
4	2 MINING AND QUARRYING	3	-	-	-	-	-	-	-	44	83
5	3.A MANUF. OF FOOD, BEVERAGES, TOB.	183329	7	2193	2	207044	8444	2188	401	19867	35
6	3.B TEXTILE, CLOTHING, LEATHER IND.	9872	2	10	10	3880	107513	8480	1467	2757	1044
7	3.C MANUF. OF WOOD PRODUCTS	723	1	305	4	7388	166	11963	1571	1225	57
8	3.D MANUF. OF PAPER,PRINTING,PUBLIS.	2440	28	49	8	13383	4144	215	77146	2394	1170
9	3.E CHEMICAL AND PETROLEUM INDUST.	24339	30	53	108	6025	4058	252	3254	2927	170
10	3.F NON-METALLIC MINERAL PRODUCTS	618	-	-	-	4168	43	-	100	1354	11132
11	3.G METAL INDUSTRIES	24983	115	1837	44	6595	930	1473	1304	2039	735
12	3.H OTHER MANUFACTURING INDUSTRIES	-	-	-	-	-	11	-	109	-	-
13	4 ELECTRICITY, GAS AND WATER	11058	52	92	84	15104	5010	1923	2110	3975	2651
14	5 CONSTRUCTION	28920	211	369	40	7810	3667	1097	1574	1177	751
15	6.A WHOLESALE AND RETAIL TRADE	34715	62	142	29	49199	46788	6905	6853	9567	2894
16	6.B RESTAURANTS AND HOTELS	-	-	-	-	-	-	-	-	-	-
17	7.A TRANSPORT	15644	244	1786	68	23359	6217	1859	2669	1994	1273
18	7.B COMMUNICATION	10413	162	285	45	15549	4138	1237	7159	1328	847
19	8.A FINANCING AND INSURANCE	10762	139	242	41	13758	3625	1189	1566	1186	852
20	8.B DWELLINGS	-	-	-	-	-	-	-	-	-	-
21	9.A HOUSEHOLD SERVICE	-	-	-	-	-	-	-	-	-	-
22	9.B RECREATIONAL AND CULTURAL SERV.	-	-	-	-	-	-	-	-	-	-
23	9.C PRODUCERS OF GOVERNMENT SERV.	10566	168	294	47	16051	4273	1278	1834	1371	875
24	IMPORTS AT BASIC VALUES	154418	232	1791	472	252138	180950	35710	28496	54117	14732
25	TOURIST TRANSACTIONS	-	-	-	-	-	-	-	-	-	-
26	EXPEND. IN DENMARK BY FOREIGN SHIPS	-	-	-	-	-	-	-	-	-	-
27	EXPENDITURES BY DANISH SHIPS ABROAD	-	-	-	-	-	-	-	-	-	-
28	COMMODITY TAXES, NET	8722	9	260	18	29684	481	475	143	695	317
29	OTHER TAXES LINKED TO PRODUCTION	1549	865	123	28	7550	1943	764	813	653	518
30	GDP AT FACTOR PRICES	865080	20716	30569	5372	464348	201845	83694	113326	78254	79990
31	SUM	1451032	23042	40400	6421	2204227	586843	175467	251895	188264	120125

FINAL DEMANDS:

PRIVATE CONSUMPTION

		FOOD	BEVERAGES AND TOBACCO	CLOTHING AND FOOTWEAR	RENTS, FUEL, POWER	TRANSP. AND COMMUN.	MISCELLANEOUS GOODS AND SERVICES
1	1.A AGRICULTURE, HORTICULTURE, ETC.	182411	-	-	-	-	26889
2	1.B FORESTRY AND LOGGING	-	-	-	6684	-	5
3	1.C FISHING	7149	-	-	-	-	-
4	2 MINING AND QUARRYING	-	-	-	2136	-	-
5	3.A MANUF. OF FOOD, BEVERAGES, TOB.	686290	164946	-	-	-	823
6	3.B TEXTILE, CLOTHING, LEATHER IND.	-	-	382768	-	148	20798
7	3.C MANUF. OF WOOD PRODUCTS	-	-	3882	1350	3392	55020
8	3.D MANUF. OF PAPER,PRINTING,PUBLIS.	-	-	-	-	-	92727
9	3.E CHEMICAL AND PETROLEUM INDUST.	552	-	-	-	3660	64025
10	3.F NON-METALLIC MINERAL PRODUCTS	-	-	-	-	-	9450
11	3.G METAL INDUSTRIES	-	-	-	-	35840	30927
12	3.H OTHER MANUFACTURING INDUSTRIES	-	-	-	-	-	17102
13	4 ELECTRICITY, GAS AND WATER	-	-	-	93102	-	-
14	5 CONSTRUCTION	-	-	-	-	-	-
15	6.A WHOLESALE AND RETAIL TRADE	314913	78067	209884	11959	15665	245877
16	6.B RESTAURANTS AND HOTELS	-	-	-	-	-	248212
17	7.A TRANSPORT	-	-	-	-	158107	-
18	7.B COMMUNICATION	-	-	-	-	28500	-
19	8.A FINANCING AND INSURANCE	-	-	-	-	2040	48127
20	8.B DWELLINGS	-	-	-	549800	-	-
21	9.A HOUSEHOLD SERVICE	-	-	-	-	-	58965
22	9.B RECREATIONAL AND CULTURAL SERV.	-	-	-	-	-	306640
23	9.C PRODUCERS OF GOVERNMENT SERV.	-	-	-	-	-	-
24	IMPORTS AT BASIC VALUES	56701	14051	82283	33520	10049	59744
25	TOURIST TRANSACTIONS	-	-	-	-	-	-
26	EXPEND. IN DENMARK BY FOREIGN SHIPS	-	-	-	-	-	-
27	EXPENDITURES BY DANISH SHIPS ABROAD	-	-	-	-	-	-
28	COMMODITY TAXES, NET	37838	92550	-	-	17098	13918
29	OTHER TAXES LINKED TO PRODUCTION	-	-	-	-	-	-
30	GDP AT FACTOR PRICES	-	-	-	-	-	-
31	SUM	1285854	349614	678817	698551	274500	1299248

Table 4.A.1 (continued)

3.G	3.H	4	5	6.A	6.B	7.A	7.B	8.A	8.B	9.A	9.B	9.C	IMP.BANK SERVICE	SUM	
-	-	-	2343	-	18011	-	-	-	-	-	-	2363	-	1137071	1
127	-	-	48	-	-	-	-	-	-	-	-	-	-	15901	2
-	-	-	-	-	706	-	-	-	-	-	-	93	-	3494	3
7	-	-	4112	-	-	-	-	-	-	-	-	-	-	4247	4
326	309	53	2031	358	84123	173	33	77	-	74	91	11164	-	522322	5
342	380	1297	102	1212	1	5903	591	0	2	15	0	7252	-	152131	6
10204	596	6	62855	1986	24	412	15	21	1	13	26	113	-	99678	7
1579	166	227	2673	18383	304	701	5304	4165	267	78	375	21561	-	156762	8
9441	49	243	30728	1626	379	893	152	349	70	2543	495	7043	-	95227	9
1155	-	-	77933	-	-	-	-	-	-	-	-	-	-	96503	10
61851	144	3767	86907	6104	262	53636	163	240	94	177	294	10759	-	264452	11
8431	305	-	1331	-	-	-	-	-	-	-	57	-	-	10243	12
8975	416	4862	4248	13449	1270	8724	264	1291	782	898	698	3748	-	91683	13
3793	191	6700	-	17531	3500	20900	10700	3769	70200	-	-	76525	-	259425	14
44478	2088	2027	43034	3616	10975	5015	430	348	146	1168	284	4172	-	274933	15
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	16
6430	324	1965	7220	17042	2630	46097	9176	3664	3406	674	3248	6507	-	163496	17
4280	216	1308	4806	12233	1750	4038	818	5334	3877	449	2162	5066	-	87500	18
4003	199	1115	4325	9256	1532	15084	2918	1641	3368	405	1877	2937	141771	223792	19
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	20
-	-	-	-	821	-	-	-	176	-	3523	-	-	-	4520	21
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	22
4420	223	1351	4963	9160	1807	3903	845	1946	4004	463	2233	-	-	72075	23
181254	8982	27201	94511	20022	7816	21979	532	1487	1195	3851	1098	4070	-	1097057	24
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	25
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	26
-	-	-	-	-	-	75000	-	-	-	-	-	-	-	75000	27
1445	66	74	1674	7249	12871	6775	187	263	9	167	327	2430	-	74342	28
2539	124	583	2877	7494	882	-15280	438	922	55744	274	1071	1518	-	73993	29
251897	15835	132721	242805	1110373	99370	282027	83433	248266	406634	48850	292303	305280	-141771	5321214	30
606979	30614	185500	681525	1257915	248212	535980	116000	273959	549800	63622	306640	472600	0	10377061	31

PURCH. IN DK BY NON-RES. HOUSEHO.	PURCH. ABROAD BY RES. HOUSEHO.	SUM	GOVERN-MENT CON-SUMP-TION	GROSS FIXED CAPITAL FORMATION: MACHI-NERY ETC.	TRANS-PORT-EQUIP.	CON-STRUC-TION	AGRIC. BREEDING STOCK	SUM	EXPORTS	SUM	SUM	
-	-	209300	-	-	-	-	-13001	-13001	117662	313961	1451032	1
-	-	6689	-	-	-	-	-	0	453	7141	23042	2
-	-	7149	-	-	-	-	-	0	29757	36906	40400	3
-	-	2136	-	-	-	-	-	0	37	2174	6421	4
-	-	852059	-	-	-	-	-	0	829845	1681905	2204227	5
-	-	403714	-	11957	629	-	-	12586	18412	434712	586843	6
-	-	63644	-	8173	374	-	-	8547	3598	75789	175467	7
-	-	92727	-	-	-	-	-	0	2406	95133	251895	8
-	-	68237	-	559	-	-	-	559	24241	93037	188264	9
-	-	9450	-	4625	-	-	-	4625	9547	23622	120125	10
-	-	66767	-	141712	46063	-	-	187775	87985	342527	606979	11
-	-	17102	-	1972	-	-	-	1972	1296	20371	30614	12
-	-	93102	-	-	-	-	-	0	715	93817	185500	13
-	-	0	-	-	-	422100	-	422100	-	422100	681525	14
-	-	876365	-	37487	8446	-	-	45933	60684	982981	1257915	15
-	-	248212	-	-	-	-	-	0	-	248212	248212	16
-	-	158107	-	-	-	-	-	0	214377	372484	535980	17
-	-	28500	-	-	-	-	-	0	-	28500	116000	18
-	-	50167	-	-	-	-	-	0	-	50167	273959	19
-	-	549800	-	-	-	-	-	0	-	549800	549800	20
-	-	58965	-	-	-	-	-	0	137	59102	63622	21
-	-	306640	-	-	-	-	-	0	-	306640	306640	22
-	-	0	400525	-	-	-	-	0	-	400525	472600	23
-	-	256349	-	45868	8412	-	2083	56362	47591	360302	1457359	24
-20000	20000	0	-	-	-	-	-	0	20000	20000	20000	25
-36623	-	-36623	-	-	-	-	-	0	36623	0	-	26
-	-	0	-	-	-	-	-	0	-	0	75000	27
-	-	161403	-	-	-	-	-	0	-	161403	235745	28
-	-	0	-	-	-	-	-	0	-	0	73993	29
-	-	0	-	-	-	-	-	0	-	0	5321214	30
-56623	20000	4549961	400525	252353	63922	422100	-10919	727457	1505368	7183311	17560373	31

Source: Abildgren (1992b).

4.A.6. Employment figures

As a supplement to the HIOT 1934, a corresponding set of employment figures following the same industry classification has been calculated. However, the employment figures are only available at a 94-industry level (and not a 95-industry level) since it was not possible to separate the employment figures for sector 9.B Recreational and cultural services and sector 9.C Producers of government services.

The main sources behind the employment figures are the Census of Manufacturing, Distribution and Other Industries and other separate statistics for selected sectors.[185] In Table 4.A.2 the employment figures are shown in an aggregated version with 22 industries.

Table 4.A.2: Employment by industry in Denmark 1934, persons

1.A Agriculture, horticulture, etc.	454,252
1.B Forestry and logging	4,270
1.C Fishing	14,235
2 Mining and quarrying	2,551
3.A Manuf. of food, beverages, tobacco	74,955
3.B Textile, clothing, leather industries	89,807
3.C Manuf. of wood products	29,260
3.D Manuf. of paper, printing, publishing	25,513
3.E Chemical and petroleum industries	11,455
3.F Non-metallic mineral products	21,679
3.G Metal industries	83,017
3.H Other manufacturing industries	4,999
4 Electricity, gas and water	7,166
5 Construction	87,925
6.A Wholesale and retail trade	212,250
6.B Restaurants and hotels	38,628
7.A Transport	69,455
7.B Communication	18,471
8.A Financing and insurance	18,536
8.B Dwellings	911
9.A Household service	26,145
9.B Recreational and cultural services and 9.C Producers of government services	364,720
Sum	1,660,200

Source: Table 3.21 in Abildgren (1992a).

4.A.7. Input-output multipliers

Measures such as direct and indirect import or employment requirements are examples of the so-called input-output multipliers that can be calculated from an input-output table on basis of the static open Leontief-model.[186]

In Figure 4.A.3 the HIOT 1934 from Table 4.A.3 is illustrated in algebraic form in an aggregated version with 22 industries (thereby matching the employment figures from Table 4.A.2).

[185] This implies that a large part of the employment figures refer to the level of employment on 28 May 1935 and not the year 1934 *per se*. The sources and methods used for construction of the employment figures for 1934 are described in detail on page 73-76 in Abildgren (1992a).

Figure 4.A.3: The Historical Input-Output Table for Denmark 1934 (HIOT 1934), aggregated version in algebraic form

	Industries (22)	Final Demand (15)	Sum (1)
Industries (22)	**DZU**	**DZF**	**g**
Imports (1)	**mu'**	**mf'**	μ_{1934}
Primary inputs (3)	**S**	$\mathbf{S_f}$	**s**
Sum (1)	**g'**	**f'**	

The matrices of coefficients required for the static open Leontief-model can then be estimated on basis of the data in Figure 4.A.3 as follows:

$$\mathbf{DZB} = \mathbf{DZU}\langle\mathbf{g}\rangle^{-1} \qquad \mathbf{DZE} = \mathbf{DZF}\langle\mathbf{f}\rangle^{-1}$$

$$\mathbf{mb'} = \mathbf{mu'}\langle\mathbf{g}\rangle^{-1} \qquad \mathbf{me'} = \mathbf{mf'}\langle\mathbf{f}\rangle^{-1}$$

The employment coefficients can be estimated as:

$$\mathbf{k'} = \mathbf{l'}\langle\mathbf{g}\rangle^{-1}$$

where the employment figures in 1934 by industry is symbolised by a (22x1) column vector **l**.

Using this notation the input-output import and employment multipliers 1934 can be derived as follows:

- The percentage direct import requirement in the output from industry j is given by element no. j in the 1x22 row vector 100**mb'**.
- The percentage direct and indirect import requirement in the output from industry j is given by element no. j in the 1x22 row vector $100\mathbf{mb'}(\mathbf{I} - \mathbf{DZB})^{-1}$.
- The percentage direct import requirement in the demand category j is given by element no. j in the 1x15 row vector 100**me'**.
- The percentage direct and indirect import requirement in the demand category j is given by element no. j in the 1x15 row vector $100[\mathbf{mb'}(\mathbf{I} - \mathbf{DZB})^{-1}\mathbf{DZE} + \mathbf{me'}]$
- The direct employment requirement in the output from industry j (measured in persons per 1000 kroner) is given by element no. j in the 1x22 row vector **k'**.
- The direct and indirect employment requirement in the output from industry j (measured in persons per 1000 kroner) is given by element no. j in the 1x22 row vector $\mathbf{k'}(\mathbf{I} - \mathbf{DZB})^{-1}$.
- The direct and indirect employment requirement in the demand category j (measured in persons per 1000 kroner) is given by element no. j in the 1x15 row vector $\mathbf{k'}(\mathbf{I} - \mathbf{DZB})^{-1}\mathbf{DZE}$.

[186] General introductions to static input-output models (Leontief-models) are found in e.g. Leontief (1986), Rasmussen (1956), United Nations (1973), Blair & Miller (1985) and Eurostat (2008). The open static open Leontief-model was originally developed by Leontief (1944).

Table 4.A.3 and 4.A.4 show the results of the calculations.[187]

Table 4.A.3: Input-output multipliers by industry for Denmark 1934

	Direct import requirement	Direct and indirect import requirement	Direct employment requirement	Direct and indirect employment requirement
	per cent		persons per 1000 kroner	
1.A Agriculture, horticulture, etc.	10.64	16.74	0.313	0.385
1.B Forestry and logging	1.01	1.92	0.185	0.197
1.C Fishing	4.43	9.11	0.352	0.394
2 Mining and quarrying	7.35	9.06	0.397	0.413
3.A Manuf. of food, beverages, tobacco	11.44	22.79	0.034	0.261
3.B Textile, clothing, leather industries	30.83	39.92	0.153	0.227
3.C Manuf. of wood products	20.35	25.70	0.167	0.233
3.D Manuf. of paper, printing, publishing	11.31	19.15	0.101	0.183
3.E Chemical and petroleum industries	28.75	34.29	0.061	0.123
3.F Non-metallic mineral products	12.26	15.53	0.180	0.222
3.G Metal industries	29.86	36.09	0.137	0.190
3.H Other manufacturing industries	29.34	32.20	0.163	0.200
4 Electricity, gas and water	14.66	17.53	0.039	0.064
5 Construction	13.87	25.17	0.129	0.231
6.A Wholesale and retail trade	1.59	3.20	0.169	0.187
6.B Restaurants and hotels	3.15	13.19	0.156	0.293
7.A Transport	18.09	25.92	0.130	0.188
7.B Communication	0.46	6.20	0.159	0.214
8.A Financing and insurance	0.54	1.88	0.068	0.086
8.B Dwellings	0.22	3.73	0.002	0.038
9.A Household service	6.05	8.75	0.411	0.454
9.B Recreational and cultural services and 9.C Producers of government services	0.66	5.81	0.468	0.515

Source: See text.

Table 4.A.4: Input-output multipliers by final demand categories for Denmark 1934

	Direct import requirement	Direct and indirect import requirement	Direct and indirect employment requirement
	per cent		persons per 1000 kroner
Imputed bank service	0.00	1.88	0.086
Private consumption, total	6.07	20.07	0.204
Food	4.41	19.80	0.242
Beverages and tobacco	4.02	15.48	0.165
Clothing and footwear	12.12	35.77	0.187
Rents, fuel, power	4.80	10.22	0.046
Transport and communication	3.66	24.94	0.171
Miscellaneous goods and services	4.60	16.10	0.286
Purchase in Denmark by non-resident households	0.00	13.19	0.293
Purchase abroad by resident households	100.00	100.00	0.000
Government consumption	0.00	5.81	0.515
Gross fixed capital formation, total	7.75	32.77	0.197
Machinery etc.	18.18	42.25	0.159
Transport-equipment	13.16	40.13	0.165
Construction	0.00	25.17	0.231
Agricultural breeding stock	-19.08	0.86	0.458
Exports	3.16	24.91	0.245

Note: The input-output multipliers for the total private consumption and the total gross fixed capital formation has been calculated from the detailed input-output multiplies using the value of each of the detailed demand categories in purchaser prices as weights.

Source: See text.

[187] The calculations behind Table 4.A.3 and 4.A.4 have been made by the use of GAUSS. In the calculations it has been assumed that purchases in Denmark by non-resident households are delivered by the sector "Restaurants and hotels".

The interpretation of input-output multiplies can be illustrated by looking at manufacturing of food, beverages and tobacco in Table 4.A.3. If this sector had to increase its production in 1934 by 100 kroner it would have had to import raw materials for 11.44 kroner (denoted the direct import requirement). However, the sector would also have had to use inputs from other sectors, which would then have needed to import raw materials in order to produce the extra output. And the sub-suppliers to these other sectors would also have had to import raw materials, and so would the sub-suppliers to the sub-suppliers, etc. In total an import amounting to 22.79 kroner in total (denoted the direct and indirect import requirement) would have had to be imported to Denmark if the final demand if the final demand for output from manufacturing of food, beverages and tobacco should have been increased by 100 kroner in 1934.

4.A.8. Applications of the new detailed Historical Input-Output Table for Denmark 1934 in other economic-historical research

Comparative historical input-output studies

Kauppila (2005) uses the input-output table in Abildgren & Nørskov (1991) in a comparison with a Finnish input-output table from 1928 as part of a larger study of the structure and dynamics of the Finnish economy at the dawn of the Great Depression in the 1930s.

Kauppila's analysis includes among other things the compilation of backward linkages[188] and forward linkages[189] for the Danish economy 1934. Kauppila finds a high degree of direct and indirect backward linkages in the Danish manufacture of food products due to its link with the Danish agricultural sector. A high degree of direct and indirect backward linkages is also found in construction and paper production as well as in hotels and restaurants. High degrees of direct and indirect forward linkages are found in Danish agriculture, forestry, mining, manufacturing of wood, paper and mineral products as well as in communication services.

Next generation historical national-account statistics

Several authors have indicated that the new detailed input-output table for Denmark 1934 might be useful in relation to the compilation of a "new generation" of historical national-account figures for Denmark.

[188] I.e. inter-industrial linkages to other industries as buyer of inputs.

[189] I.e. inter-industrial linkages to other industries as provider of inputs.

The input-output table in Abildgren (1992a) is referred to by Christensen *et al*. (1995) as a possible source in relation to a project on compilation of a input-output table for Denmark 1905 and new Danish national account series covering the period 1914-1947.

Abildgren & Nørskov (1991) is also mentioned by Hyldtoft (1994) as a possible source to bridge Danish national account series covering the periods before and after World War II.

In 1996 the project "Nordic Historical National Accounts" were initiated with financial support from the Nordic Economic Research Council. The project aims at improving the content, coverage and comparability of the Nordic national-accounts statistics and establishing a Historical National Accounts Database on the Internet, cf. Nilsson (2004). Abildgren (1992a) is included among the references on Danish historical national-accounts statistics relevant for the project (cf. the website of the project http://nhh.no/forskning/nnb/).

Essay 5:
The Cyclical Impact on the Danish General Government Budget Balance 1875-2005[190]

Abstract

Essay 5 presents new time series data for the Danish general-government net lending in the period 1875-2005 and analyses the long-term fiscal development in Denmark.

Even though Denmark today has one of the largest public sectors in Europe, relatively speaking, the Danish general government's deficit has only significantly exceeded 3 per cent of GDP during World War II and in the early 1980s.

The cyclical impact on the general government budget balance seems most often to have been relatively modest. However, calculations on the cyclical budget volatility also seem to suggest that the cyclically adjusted budget balance has to be in surplus in periods with strong economic growth if the automatic stabilisers should be allowed to work freely during a cyclical downturn without violating a 3-per-cent budget criteria (the reference value in the Maastricht Treaty).

So far projects on compilation of historical national-account statistics for Denmark has not included a split of the total economy into institutional sectors. This essay presents a first crude attempt to overcome the lack of time series for general government net lending in the existing version of Danish historical national accounts. However, it would be useful if future projects on historical national-accounts statistics in Denmark would make an attempt to include a full split of the total economy into the general government and the private sector.

Key words: Historical statistics; Cyclical adjustment; Government budget; Business cycles; Fiscal policy; Maastricht Treaty.

JEL Classification: E32; E62; N13; N14; N43, N44.

[190] This essay is based on Abildgren (2005d, 2006c).

5.1 Introduction

The general government budget balance do not only reflect the impact from discretionary fiscal policy changes but also a more or less automatic impact from the cyclical development of the economy as well as influence from other structural or extraordinary factors. The general government budget balance can therefore not stand alone in an assessment of the stance of the fiscal policy.

However, an assessment of the long-term term fiscal development in Denmark faces even larger challenges due to the lack of basic historical statistics on the development of general government finances. This essay makes a first crude attempt to overcome this data shortage by constructing time series for the general government budget balance in the period 1875-2005. Furthermore, the essay studies the long-term fiscal development in Denmark based on the new set of data. The aim is to shed some light on to what extent the annual changes in the general government budget balance can be attributed to cyclical factors.

5.2. Data sources and data constructions

In order to allow a study of the long-term developments of general government finances during the whole period 1875-2005 a number of time series covering general government net lending, employment and unemployment, unemployment benefits, total taxes and nominal GDP had to be established for the analysis in this essay. Even though an attempt has been made to transform the figures into a set of reasonable consistent long time series, the quality of a data set spanning more than 130 years is to a high degree determined by data availability. This section describes briefly the main sources and methods used to construct the data set and discusses some of the more conceptual problems related to the data sources and compilation methods applied.[191]

General government net lending

The current version of the official national-account statistics offers figures for the total general government savings surplus (net lending) for the period since 1971. In the national-accounts statistics the general government sector comprises the central government, the local governments and some social security funds (mainly unemployment benefit societies and the Employees' Wage Guarantee Fund).

None of the existing versions of Danish historical national-account statistics covering the pre-1971 period include a full split of the total economy into a general government sector and

[191] A full listing of all sources (including publications and databases from Statistics Denmark) used for the construction of the data set as well as a listing of most background data with more detailed comments is found in Abildgren (2005d). However, the data set applied in this essay has been slightly revised and updated compared to the one in Abildgren, *op.cit.*

a private sector with corresponding net lending figures.[192] For the pre-1971 period figures for the general government net lending has therefore been estimated based on accounting statistics from the central government, the local governments and (since 1907[193]) unemployment benefit societies. Ideally one would also prefer to include sick benefit associations within the general government sector for the period since 1892 where public subsidies to sick benefit associations were introduced.[194] The calculations presented in this paper do not include sick benefit associations within the general government sector, but the bias from this omission is believed to be negligible since the net lending of sick benefit associations usually were close to zero.[195]

For the period 1915-1970 the figures for central and local government net lending are based on the central and local government accounting statistics presented in Johansen (1985) supplemented with data from the publications of Statistics Denmark. The detailed and carefully documented tables in Johansen *op.cit.* make it possible to e.g. exclude debt transactions (i.e. borrowing and redemption on loans) and lending operations from central government's expenditures and revenue. Furthermore, the Johansen data allows for the inclusion of non-financial capital accumulation, capital taxes and other capital transfers into the net lending figures. The pre-1915 data are based on the figures for the balance on the central and local governments current and investment account in Hansen (1983). For all relevant years the data have been converted from a fiscal year basis to a calendar year basis.

The accounting principles applied in central and local government accounting statistics have changed over time and the principles are not fully in accordance with the concepts and definitions applied in modern national accounts statistics.[196] In particular, accrual basis of accounting was not the dominating principle in central and local government accounts in the pre-1971 period. For instance, prior to the transition to the withholding taxing principle in 1970 there was a time lag between receipt of income and payment of income taxes. No attempt has been made to adjust the figures presented in this essay for differences between cash basis accounting and accrual basis accounting. There is therefore a certain amount of uncertainty attached to the exact timing on the general government's expenditures and revenue in the figures presented for the pre-1971 period.

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[192] For an overview of the available historical national-account figures in Denmark, cf. pp. 164-179 in Mogensen (1987), Hyldtoft (1993, 1994), Christensen *et al.* (1995), and Nilsson (1991, 2004).

[193] Public subsidies to unemployment benefit associations were introduced in 1907.

[194] The activities of the sick benefit associations were transferred to the local governments in 1973. Hansen (1974) and chapter 2 in Bundesen *et al.* (2001) cover the history of the Danish sick benefit associations.

[195] The net lending of the sick benefit associations in the years 1893, 1900, 1910, 1920, 1930, 1940, 1950, 1960 and 1971 can be compiled on the basis of Hansen (1974). For all these years the net lending figure of the sick benefit associations was in the range of 0.0-0.1 per cent of GDP at market prices.

[196] For a summery of the main accounting principle in central and local government accounts in the period since 1875, cf. pp. 304-309 in Johansen (1985).

A few comments should be given to the treatment of certain large "special" transactions in the pre-1971 figures for the general government net lending applied in this essay:

- The proceed received by the central government from the sale of the Danish West Indies (87 million kroner) in 1917 is included as revenue in the central government net lending.
- The amount paid to Germany (101.4 million kroner) in 1920 as compensation for assets in Sønderjylland (the northern part of the old Duchy of Schleswig) is included as an expenditure item in the central-government net lending.
- In 1928 an amount of 136 million kroner is included as an expenditure item in the government net lending representing the central governments expenditures in the reconstruction of Den Danske Landmandsbank.
- The German occupation forces expenditures in Denmark during the years 1940-1945[197] – compulsorily financed via German accounts at Danmarks Nationalbank against a guarantee from the Danish central government – were newer paid by Germany. The amounts are included as expenditures (debt write-off) in the central-government net lending as they occurred in the period 1940-1945. In the central government accounts most of these expenditures were recorded in the revaluation account during the years from 1946 and forward while the rest was included among the current and capital expenditures. The appropriate adjustments for the years 1946 and forward have been made to avoid double recording of the expenditures.

For the period 1907-1970 the figures for net lending of the unemployment benefit associations are based on Vater (ed.) (1932) and Arbejdsdirektoratet (1957) supplemented with data from Statistics Denmark. For the period before 1931 the figures have been compiled as movement in the net wealth position of the associations, and for all years of relevance the figures have been converted from fiscal year basis to calendar year basis.

Annex 5.A presents the resulting estimates of the Danish general government net lending for the whole period 1875-2005. The figures should however only be considered as a first crude attempt to overcome the lack of time series for general government net lending in the existing version of Danish historical national accounts. It would be highly desirable if future projects on historical national-accounts statistics in Denmark would make an attempt to include a full split of the total economy into the general government and the private sector based on a more thorough collation of general government accounting data.

Unemployment

The applied figures for the number of unemployed persons cover the average annual number of insured and non-insured unemployed persons based on Pedersen (1977) (for the years 1911-1948)[198] and data from Statistics Denmark (for the period since 1949). In the period

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[197] The amounts in million kroner were the following: 1940: 804.6; 1941: 852.6; 1942: 701.7; 1943: 1902.5; 1944: 2728.0; and 1945: 574.1

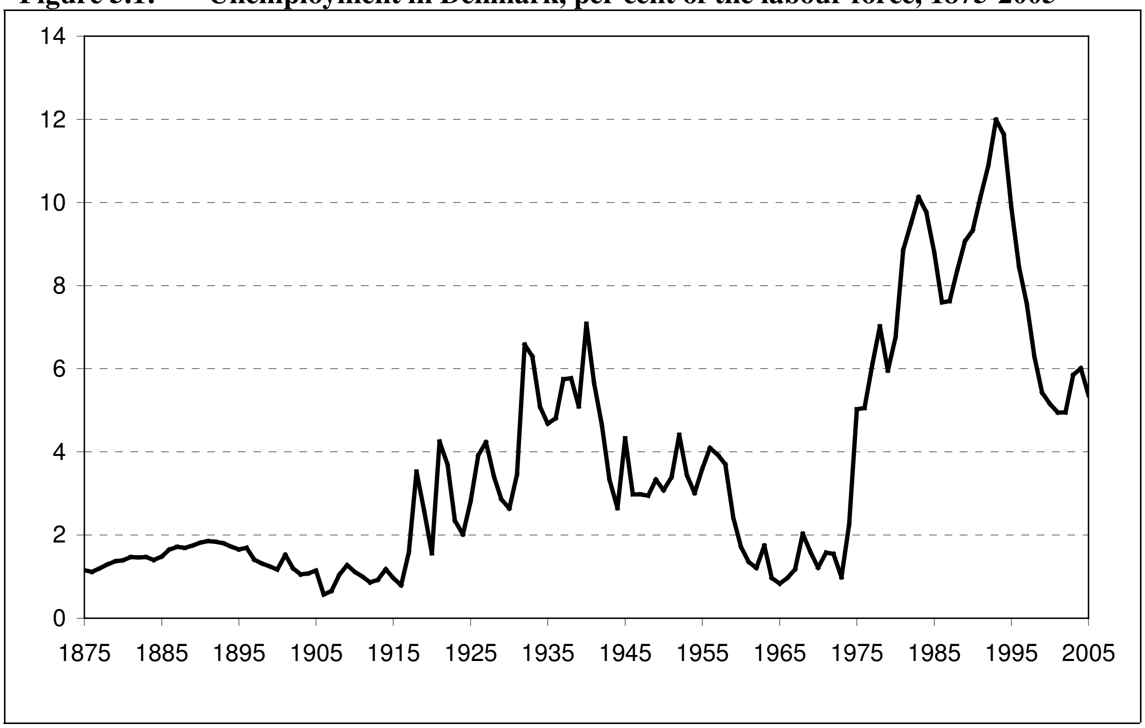
[198] For the years 1931-1939 the unemployment figures in Pedersen (1977) are quite close to the more recent calculations performed by Topp (1997) and on page 229 in Christensen (2002), also covering the number of insured and non-insured unemployed persons. The implied figures for the unemployment rate in the years 1937-1940 – that can be calculated on the basis of the unemployment figures applied in the essay at hand – are also quite close to the figures published in Danmarks Statistik (1996), also covering the number of insured and non-insured

1900-1910 the figures have been interpolated from the development in the average number of insured unemployed persons listed in Cohn (1958) (for the period 1903-1910) and unemployment among labour union members in November stated in Pedersen (1930) (for the years 1900-1902).

For the pre-1900 period only more sporadic information on the level of unemployment in Denmark are available, cf. Hvidt (1977), Jansen & Johansen (1975) and Jensen (2008a, 2008b). For the period 1875-1899 the figures have therefore been interpolated from the development in the number of persons receiving social security benefits from the local authorities in Copenhagen listed in Christensen (1975). Naturally, the latter can only be perceived as a rough proxy. For the period 1901-1904 the correlation coefficient between the percentage changes in the figures for the number of unemployed persons and the number of persons receiving social security benefits from the local authorities in Copenhagen is 0.6.

The implied unemployment rate in Denmark since 1875 resulting from the data described is shown in Figure 5.1.[199]

Figure 5.1: Unemployment in Denmark, per cent of the labour force, 1875-2005



Source: Chart 3 in Abildgren (2005d) updated with revised and more recent data from the sources stated in Abildgren, *op.cit*.

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unemployed in per cent of the total labour force. Topp (2008) and Johansen (2009) contain detailed analysis and discussions of the measurement problems related to Danish unemployment figures from the 1930s.

[199] Calculated as unemployment in per cent of the total labour force, cf. below. The share of self-employed persons in per cent of the total labour force has shown a declining trend during the last century or so. If the unemployment rate in stead is calculated as unemployment in per cent of the total amount of wage earners, the unemployment rate in the 1930s would be around the same level as the unemployment rate in the 1980s and early 1990, cf. Hansen & Kærgaard (1994).

Employment

The employment figures are based on Hansen (1983) (1903-1947) and data from Statistics Denmark (since 1948). Adjustments have been made for break in series in 1948 and 1966. In the period 1875-1902 the employment figures are calculated as the total labour force less the number of unemployed persons. The pre-1903 figures for the total labour force have been interpolated from Hansen (1983) so that the level of the labour force in 1903 matches the sum of the figures for employment and unemployment in 1903 applied in the essay at hand.

Unemployment benefits

For the period since 1963 the general government expenditures on unemployment benefits are based on data from Statistics Denmark. For the period 1903-1962 the figures have been calculated as the number of unemployed persons multiplied by the daily unemployment benefit level per unemployed person stated in Kærgård (1991) and the number of working days per year based on Schmidt-Sørensen (1985). For the period 1875-1902 the calculation method is similar, but here the daily unemployment related government expenditures per unemployed person has been interpolated from the level of unemployment benefits in 1903 and the development in nominal GDP at factor costs per employed person.

Total taxes

The figures for the total direct and indirect taxes to the general government (including social security membership contributions) are based on Kærgård (1991) and data from Statistics Denmark. For years of relevance the figures have been converted from fiscal year basis to calendar year basis.

Nominal GDP

Finally, the figures for total nominal GDP at factor costs in current prices are based on Hansen (1983) and data from Statistics Denmark.

5.3. Trends in general government net lending in Denmark 1875-2005[200]

Figure 5.2 shows the calculated figures for the general government net lending in per cent of GDP since 1875. It is worth to notice that the general government's deficit in per cent of GDP has only significantly exceeded 3 per cent during World War II and in the beginning of the

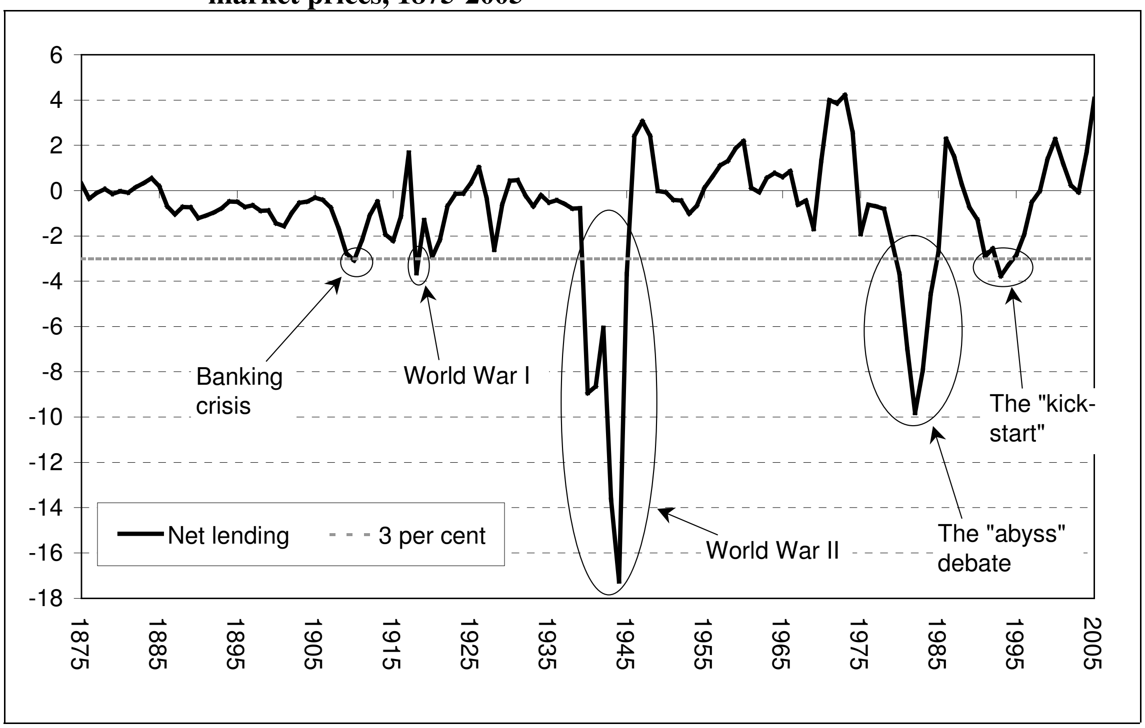
[200] Other long-span studies on the development of the public sector in Denmark are found in e.g. Rasmussen (1972), Norstrand (1977) and Hansen (1980).

1980s (the “abyss” debate[201]). Only in three other periods the budget deficit exceeded 3 per cent slightly. In two of these cases special factors played a role:

- In 1910 the budget deficit reached 3.1 per cent of GDP. This year an amount of 6 million kroner (equivalent to 0.3 per cent of GDP) is included as expenditures in the central government net lending representing the central governments pay-in to the liquidation fund of 1910 which were to guarantee deposits in a number of failed banks.
- In 1918 – at the end of World War I – the budget deficit reached 3.6 per cent of GDP

The last case with a budget deficit exceeding 3 per cent of GDP occurred in the years 1993-1994 after 7 years of slow economic growth and a fiscal stimulus to “kick-start”[202] the economy.

Figure 5.2: Danish general government net lending, per cent of GDP at current market prices, 1875-2005



Source: Figure 1 in Abildgren (2006c).

Today Denmark has one of the largest public sectors in Europe measured by the total general government expenditures in per cent of GDP. This was not the case around 1870 where the level of government expenditures in e.g. France, Germany, Italy, UK and Austria exceeded that of Denmark, cf. Table 5.1.

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201 Cf. e.g. the description of the budget crisis in Christensen & Topp (1997).

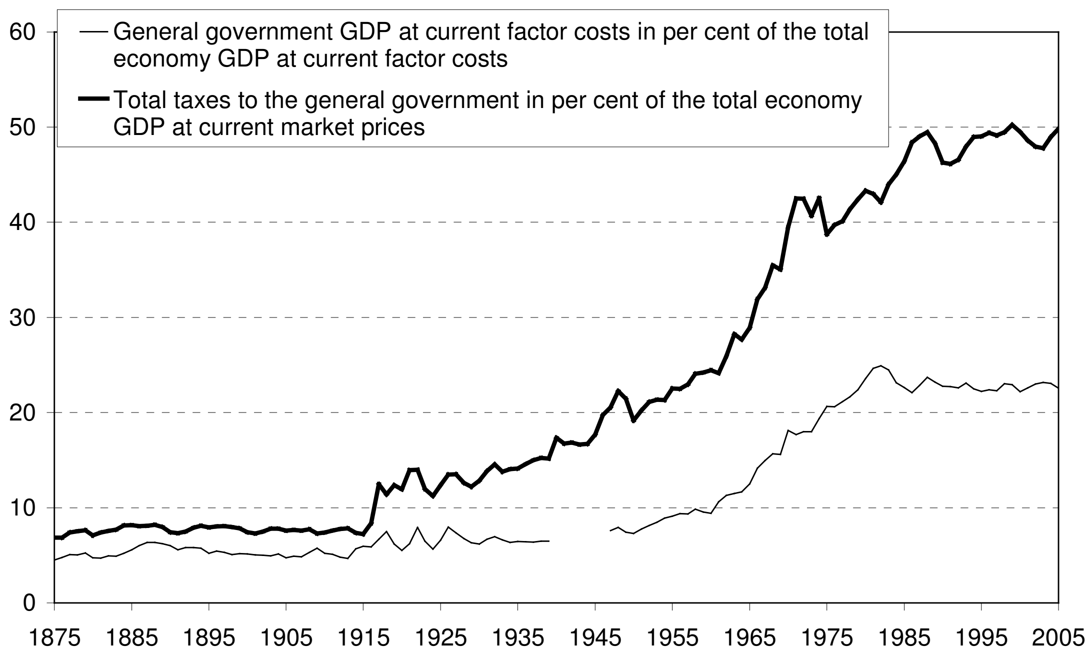
202 Also described in e.g. Christensen & Topp (1997).

Table 5.1: Total general government expenditures in selected European countries circa 1870 and 2003, per cent of GDP at current prices

	circa 1870	2003
France	12.6	54.5
Germany	10.0	48.8
Italy	13.7	48.9
UK	9.4	43.7
Austria	10.5	50.8
Denmark	8.9	56.1

Source: Table 1 in Abildgren (2006c).

Figure 5.3: Danish general government's share of the total economy and the total level of taxation in Denmark, 1875-2005



Source: Chart 2 in Abildgren (2005d) updated with revised and more recent data from the sources stated in Abildgren, *op.cit*.

Figure 5.3 shows the general government's share of the total economy GDP and the level of taxation since 1875. Government spending and taxes grew markedly relative to GDP in the decades following World War II, but the level has stabilised or decreased slightly during the most recent decades. Even though the Danish general government budget deficit has not exceeded 3 per cent of GDP in most of the period since 1875 it has not prevented the build up of a large tax-financed welfare state where the general government accounts for a substantial share of the economy.[203]

[203] Recent reviews of the history of the Danish welfare state include Søndergaard (2000), Jonasen (2004) and Henriksen *et al.* (eds.) (2004). A Nordic perspective is provided by Christiansen *et al.* (2006) and a European one in Baldwin (1990).

5.4. Cyclically impact on the general government budget balance

The government budget balance is influenced by the business cycle due to the so-called "automatic stabilisers". In periods with strong economic growth and a decline in unemployment the government's expenditures on unemployment benefits will (at unchanged level of unemployment benefits) decline and the government's direct and indirect tax revenue will (at unchanged tax level) increase, thereby dampening the economic activity. In periods with slow economic growth and increasing unemployment the government budget balance tend to deteriorate, thereby stimulating the economic activity. At unchanged discretionary fiscal policy the automatic stabilisers thus contributes to an improved budgetary position in periods with high economic growth and a worse budgetary position in periods with slow economic growth.

Several different methods can be used to evaluate the cyclical impact on the annual changes in the general government budget balance. Since all such methods are surrounded by an element of uncertainty they may to a certain extent paint different pictures. Furthermore, all estimation methods rely on different assumptions that are open for criticism.

A commonly used aggregated method for estimating the cyclical component of the budget builds on compilation of an output gap (actual GDP less potential GDP) for the economy as a whole and an estimated elasticity of the budget with respect to the output gap. Since potential GDP can not be observed it has to be estimated. This is usually done using either filtering methods or a production-function approach.

The filtering approach estimates potential GDP as a trend based on the actual GDP by smoothing the series. This method is therefore not very data demanding but the smoothing is based on a number of more or less arbitrary assumptions that are outside economic-theoretical interpretation and that may have a strong influence on the results. Furthermore, special attention has to be made regarding the treatment of observations in the beginning and the end of the time series being filtered.

The production-function approach demands data for the physical capital stock, the structural work force, the non-accelerating inflation level of unemployment and potential total factor

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Garrett & Rhine (2006) offer a brief review of the theories on the size and growth of the government sector within the public choice and political science literature in relation to an empirical analysis of the development of the U.S. government sector in the 20th century.

In a panel regression study Aidt *et al.* (2006) explore the relation between public spending and the level of democracy in 12 European countries (including Denmark) during the period 1830-1938. Their results indicate that the gradual lifting of property and income qualifications in relation to voting rights has contributed to increased public spending on infrastructure, internal security and administration. Furthermore they find weak support to the theory that the extension of voting rights to women has resulted in increased public spending on health, education, housing, social insurance and redistribution.

productivity, and requires therefore a more comprehensive set of data. Furthermore, some of the data estimations required for the production-function methods also rely on filtering.

A more disaggregated method taking into account the different cyclical variations of the various revenue and expenditure items in the budget can also be applied, but naturally such a method requires an even larger database and still makes use of filtering in order to separate out the cyclical elements.

In both the aggregated and disaggregated approaches described above problems may also arise in the econometric estimation of the elasticities of the budget items with respect to the output gap. It can be difficult to find stable relationships even though one control for discretionary fiscal-policy measures, and problems of endogeneity may occur since fiscal policy affects the level of economic activity.

A third and even more comprehensive approach to evaluate the cyclical impact on government finances could be to estimate the influence on the budget from discretionary fiscal-policy changes with the aid of a complete macroeconometric model and subsequently calculate the cyclical budget impact on a residual basis.[204]

Christensen (1984, 1993) uses a much simpler and less data-demanding methodological approach where the focus is on the changes in the cyclically adjusted budget balance – not the absolute level of the cyclically adjusted budget balance. No estimation of the level of potential GDP is necessary for the application of this method. The estimations of the cyclical impact on the Danish general-government budget 1875-2005 below follows therefore an approach heavily inspired by Christensen *op.cit*.[205]

Using the following mnemonics:

T_t	Total taxes (million kroner, current prices) received by the general government in year t.
Y_t	Total GDP (million kroner, current prices) at factor costs in year t.
L_t	Total employment (1000 persons) in year t.
UB_t	Total amount of unemployment benefits (million kroner, current prices) paid out by the general government in year t.
U_t	Unemployment (1000 persons) in year t.
a	Parameter ($a<0$) representing the change in the number of employed persons (1000 persons) when the number of unemployed persons increase by 1000 persons.
CA_t	Cyclical impact (million kroner, current prices) on the change in the general government net lending from year t-1 to year t.

[204] For a more detailed technical outline and discussion of different methods to compile cyclically budget impacts and cyclically adjusted budget balances in a Danish perspective, cf. e.g. Andersen (2002), Hansen & Knudsen (1999) and Skaarup (2005).

[205] Topp (1995) has also applied an approach close to Christensen (1993) in a study of the cyclical impact on the Danish general-government budget balance 1929-1939.

According to Christensen his method of calculation for the period 1960-1990 delivers results regarding discretionary fiscal-policy changes that are quite close to calculations made by the Danish Ministry of Finance based on a macroeconometric model when one takes differences in the treatment of interest payments into account, cf. page 123 in Christensen (1993).

the cyclical impact on the change in the general government net lending from year t-1 to year t can been estimated as:

$$[5.1]\ CA_t = \frac{T_t}{Y_t} \cdot \frac{Y_t}{L_t} \cdot a \cdot (U_t - U_{t-1}) + \frac{T_t}{Y_t} \cdot \frac{UB_t}{U_t} \cdot (U_t - U_{t-1}) - \frac{UB_t}{U_t} \cdot (U_t - U_{t-1})$$

When e.g. the number of unemployed increases ($U_t – U_{t-1} > 0$) the calculation procedure in equation [5.1] assumes that the government budget is affected by the following three channels:

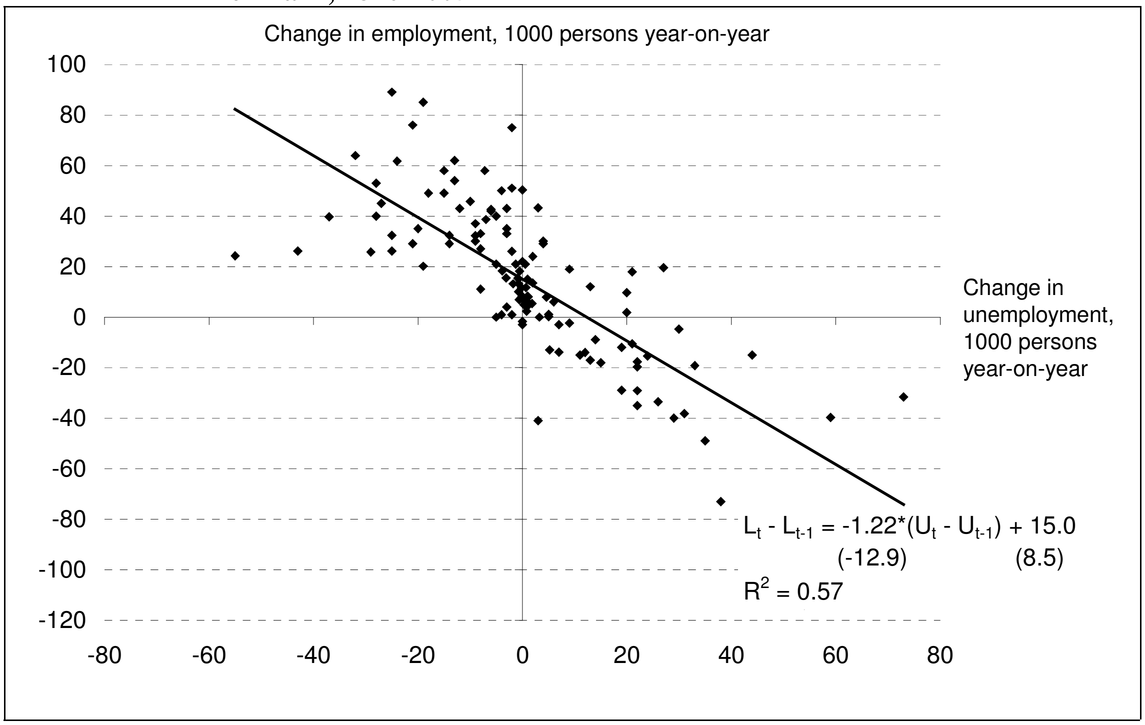
- The total number of employed persons declines thereby reducing the government's tax revenue by an amount corresponding to the implicit tax rate (T_t/Y_t) multiplied by the decrease in employment ($a*(U_t – U_{t-1})$) and the level of GDP per employed person (Y_t/L_t).
- However, the government's tax revenue increases by an amount corresponding to the implicit tax rate (T_t/Y_t) multiplied by the increase in the number of unemployed persons ($U_t – U_{t-1}$) and the level of unemployment benefits (UB_t/U_t).
- Finally, the government's expenditures increases by the increase in the number of unemployed persons ($U_t – U_{t-1}$) multiplied by the level of unemployment benefits per unemployed person (UB_t/U_t).

The estimates of the cyclical impact on the general government budget balance compiled in this essay is based on figures for the total amount of direct and indirect taxes, the total economy GDP, the total number of employed and unemployed persons for the whole economy and the total amount of unemployment benefits, cf. T_t, Y_t, L_t, U_t and UB_t in equation [5.1]. The calculations are therefore performed on a rather aggregated level due to data availability and should only be considered as rough approximations. The calculations in Christensen (1993) and Topp (1995) cover shorter historical time span, which makes its more tractable to apply a somewhat more detailed approach. The calculations in Christensen *op.cit.* involve the total economy unemployment, the unemployment benefit compensation rate, the private sector wage sum, the personal tax rate, indirect taxes and private demand. Topp *op.cit.* uses the total economy unemployment, the unemployment benefit compensation rate, the total economy wage sum, indirect taxes, private consumption, the direct tax ratio and the total economy GDP.

As mentioned in section 5.2 unemployment benefit societies are first included within the general government sector with effect from 1907. However, the calculations made on the basis of equation [5.1] assumes that the development in unemployment also in the pre-1907 period can be used as a proxy for the cyclical variation of the economy that impacts the government budget balance.

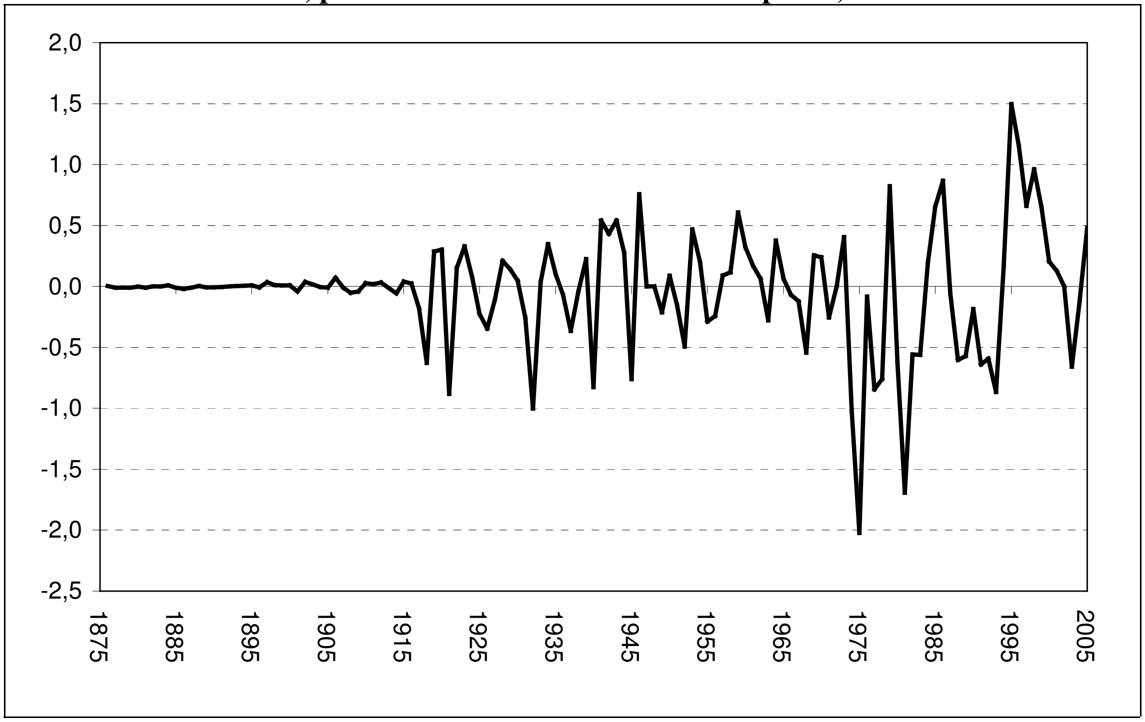
The parameter a in equation [5.1] has been estimated at –1.22 on the basis of a simple linear regression of the annual changes in employment and unemployment in the period 1876-2005, cf. Figure 5.4. Employment thus has to be increased by 1,220 persons in order to reduce the unemployment by 1,000 persons, reflecting a pro-cyclical labour market participation rate (i.e. better employment opportunities causes more people to enter into the labour force, and vice versa).

Figure 5.4: Relation between changes in employment and unemployment in Denmark, 1876-2005



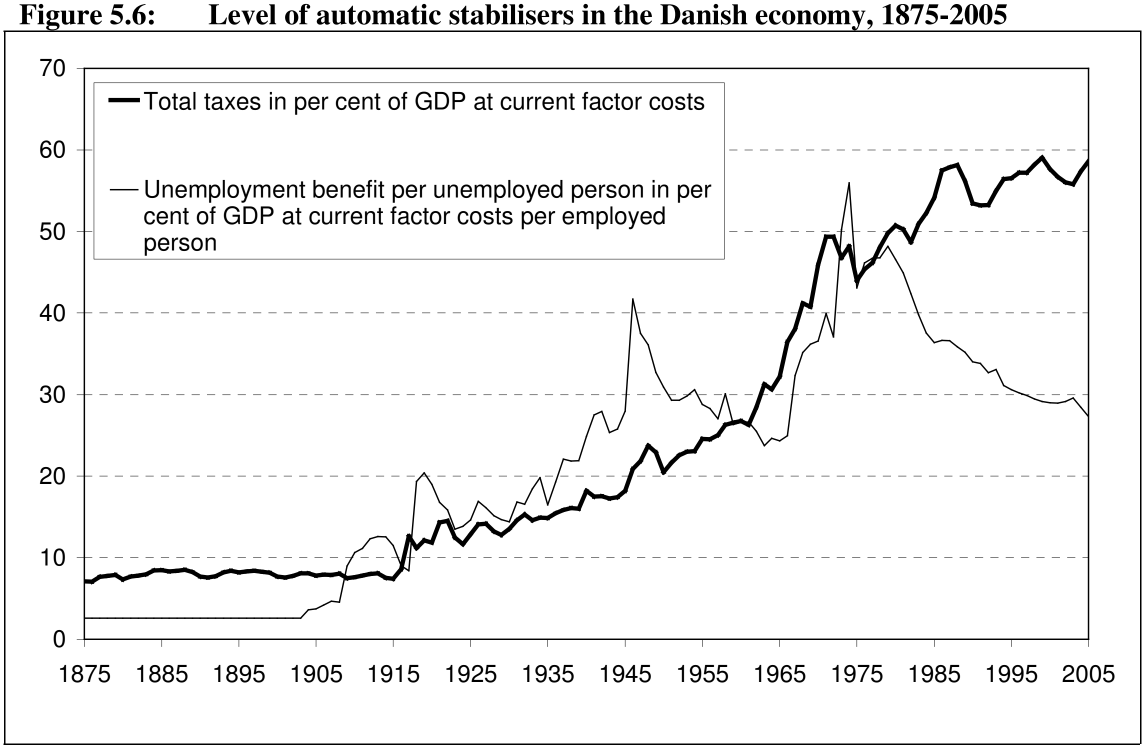
Note: t-values in brackets below the estimated parameters in the regression equation.
Source: Chart 4 in Abildgren (2005d) updated with revised and more recent data from the sources stated in Abildgren, *op.cit*.

Figure 5.5: Cyclical impact on the change in the Danish general government budget balance, per cent of GDP at current market prices, 1876-2005



Source: Figure 2 in Abildgren (2006c).

Figure 5.6: Level of automatic stabilisers in the Danish economy, 1875-2005



Source: Chart 6 in Abildgren (2005d) updated with revised and more recent data from the sources stated in Abildgren, *op.cit*.

The estimated cyclical impact on the general government budget balance in the period since 1875 measured in per cent of GDP is shown in Figure 5.5. The cyclical impact has increased over time in step with the increased level of the automatic stabilisers (i.e. the increased tax rate and unemployment benefit compensation rate), cf. Figure 5.6.

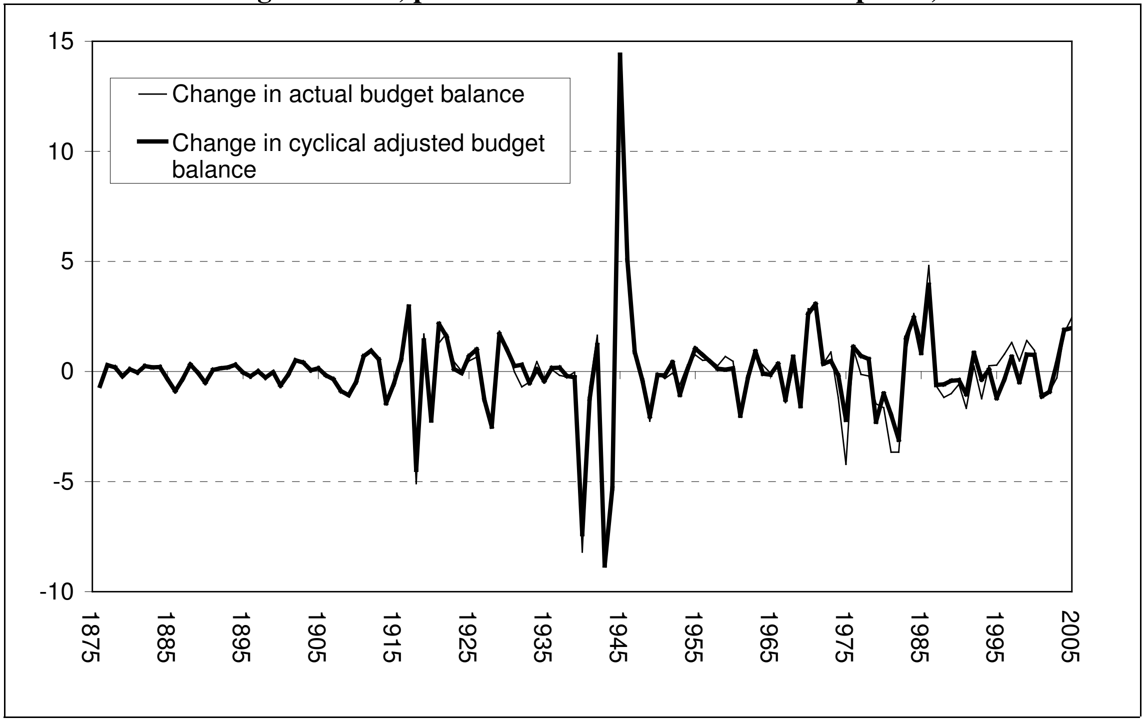
When interpreting the figures for the cyclical impact on the general government budget in Figure 5.5, one should take a number of factors into consideration:

- Any change in the number of unemployed persons gives rise to a cyclical impact on the budget – irrespective of the "nature" of the change in unemployment (i.e. whether it relates to a change in the level of "structural" unemployment or not). This reflects that any changes in the level of unemployment will automatic have a budget impact due to the government's unemployment-related expenditures.
- It may be argued that the budget impact of some of the labour-force-reducing measures that have been applied in certain periods ought to be considered as "cyclical". Examples from the last couple of decades include the early retirement schemes introduced in 1979 and the temporary leave schemes introduced in 1994.
- All changes in government net interest payments are treated as non-cyclical. An increase in e.g. the interest payments on the government debt due to a higher level of interest rates will therefore be considered as an expansive discretionary fiscal policy if the increase in interest expenditures is not covered by increased revenue.
- The calculations behind Figure 5.5 make use of a rather narrow definition of the cyclical factors influencing the government budget since they solely reflect the budgetary effects resulting from changes in the level of unemployment. The cyclical influence on e.g. corporate gross profits and thereby corporate taxes is not taken into account in the calculations.
- Finally, one could argue that also discretionary fiscal-policy changes depend on the business cycle in some sort of fiscal-policy reaction function. Such endogenous fiscal-policy effects are not included in the more "automatic" cyclical budget impact shown in Figure 5.5.

Figure 5.7 shows the annual changes in the actual and cyclically adjusted general government budget balance in per cent of GDP in the period 1876-2005. It seems that the cyclical impact on the government budget balance is most often relatively modest compared to the budgetary impact of discretionary fiscal policy changes or other (structural or extraordinary) factors influencing the budget.

Figure 5.8 shows the frequency distribution of the 130 cyclical driven annual changes in Danish general government budget balance in the period since 1876. The largest cyclical deterioration of the general government budget in a single year (in 1975) amounted to around 2 per cent of GDP. If one looks at the accumulated cyclical impact on the budget over 2, 3 or 4 consecutive years, the number of cases where the accumulated negative impact on the budget exceeded more than that 3 per cent of GDP is respectively 1, 1 and 3 during the whole period since 1875, cf. Figure 5.9.

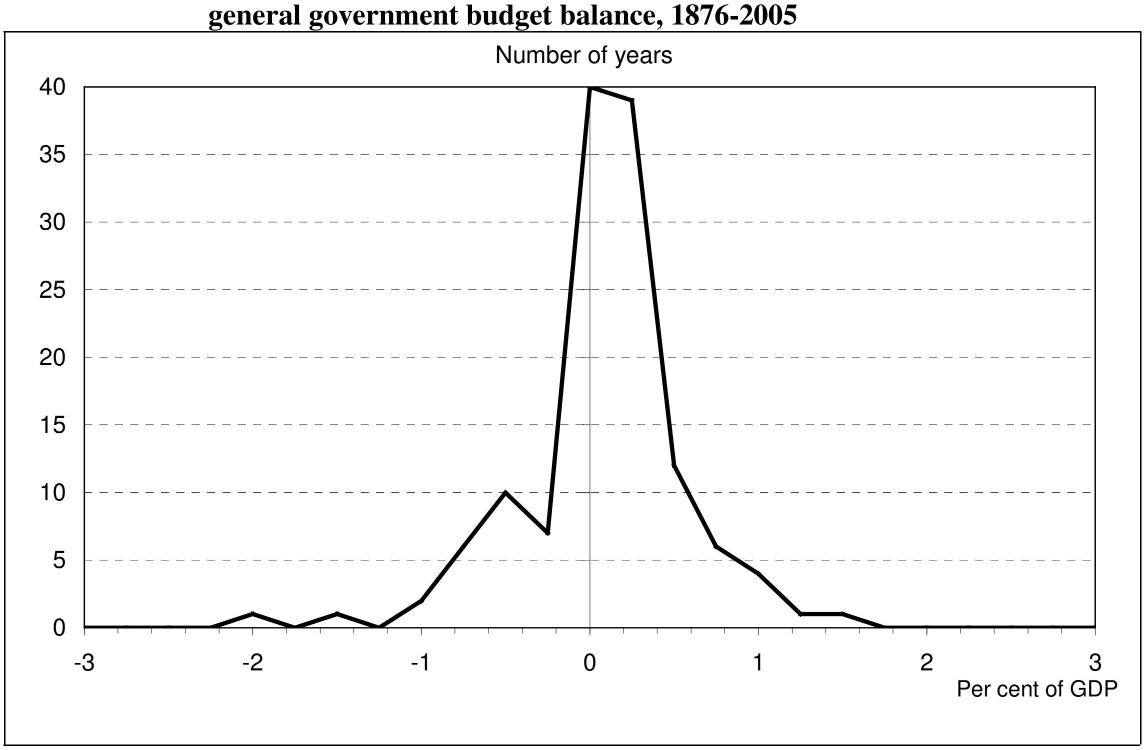
Figure 5.7: Actual and cyclical adjusted changes in the Danish general government budget balance, per cent of GDP at current market prices, 1876-2005



Note: The change in the cyclical adjusted budget balance is equal to the change in the actual budget balance less the cyclical impact on the budget.

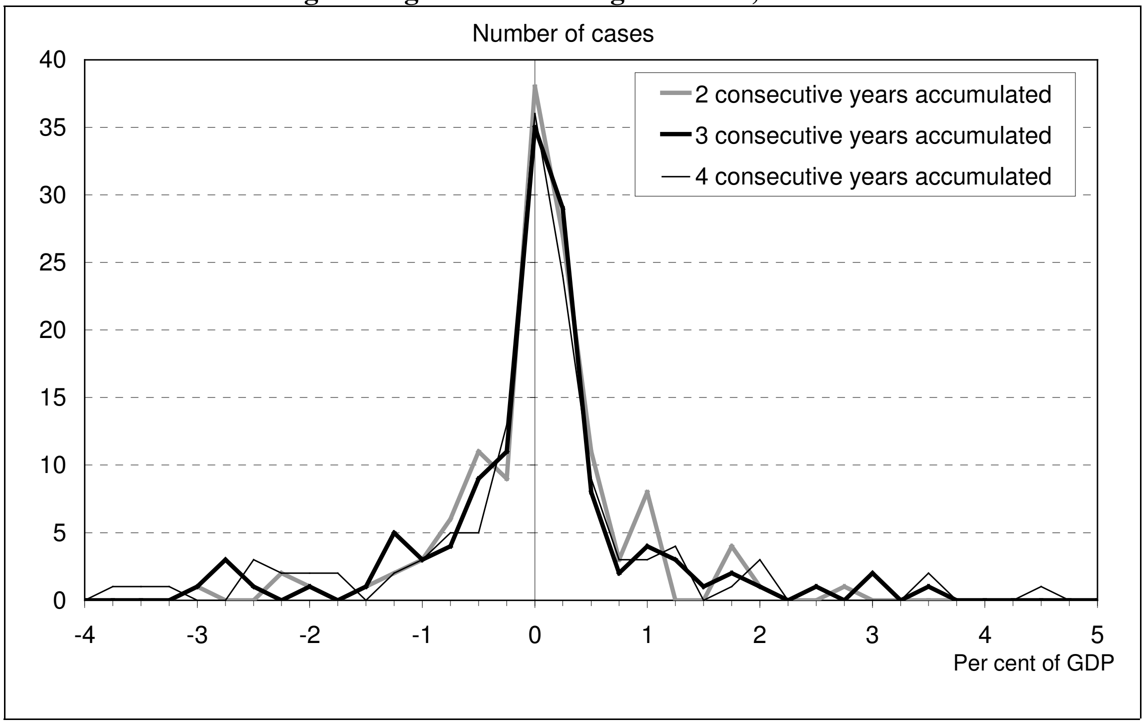
Source: Figure 3 in Abildgren (2006c).

Figure 5.8: Frequency distribution of the cyclical driven annual changes in Danish general government budget balance, 1876-2005



Source: Figure 4 in Abildgren (2006c).

Figure 5.9: Frequency distribution of the accumulated cyclical driven changes in Danish general government budget balance, 1876-2005



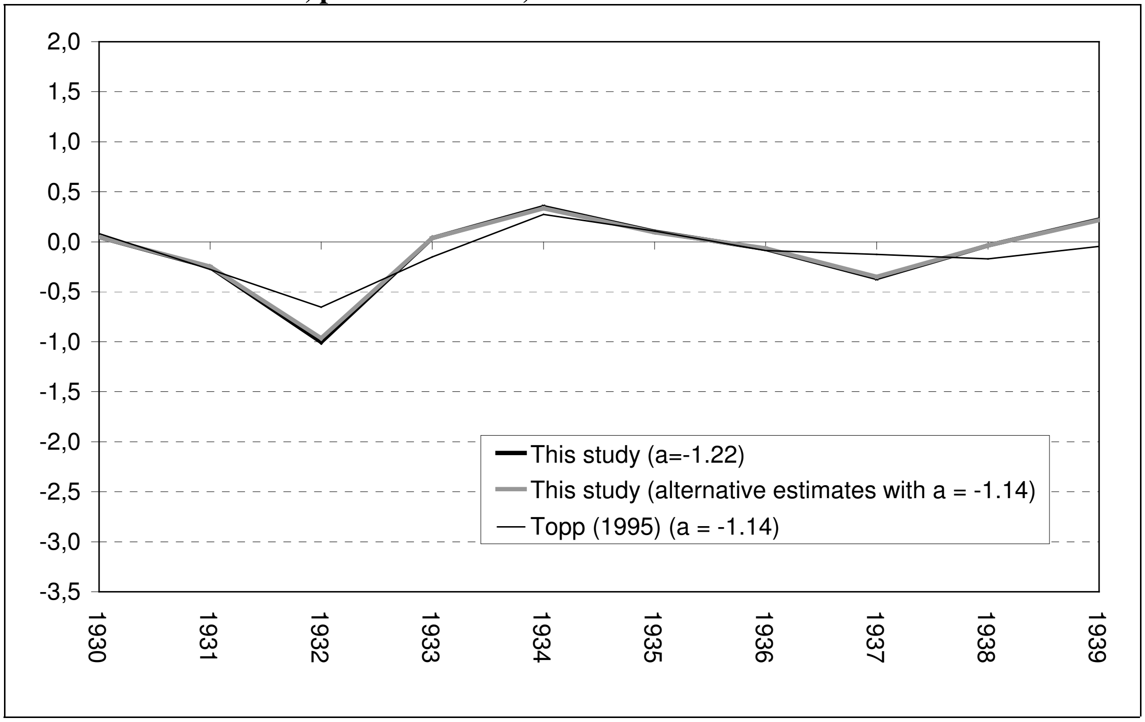
Source: Figure 5 in Abildgren (2006c).

5.5. Robustness check

As a robustness check the estimates of the cyclical impact on the general government budget balance presented in this essay can be compared with the results found in Topp (1995) for the period 1930-1939 and in Christensen (1993) for the period 1960-1990. When studying the results of the comparison one needs to take into consideration that the different author's uses somewhat different compilation methodology and data sets. Some of the major differences are the following:

- The parameter (a) represents the change in the number of employed persons (1000 persons) when the number of unemployed persons increases by 1000 persons. In Christensen (1993) a = –1.67 whereas the study in the essay at hand uses a= –1.22. Topp (1995) uses a= –1.14.
- The data set in Christensen (1993) includes the Labour market Supplementary Pension Fund (ATP) and the Employees' Wage Indexation Fund (LD) within the general government sector, whereas ATP and LD in the figures presented in the essay at hand are included in the private sector in line with the current definitions in the official national accounts statistics.

Figure 5.10: Cyclical impact on the change in the Danish general government budget balance, per cent of GDP, 1930-1939



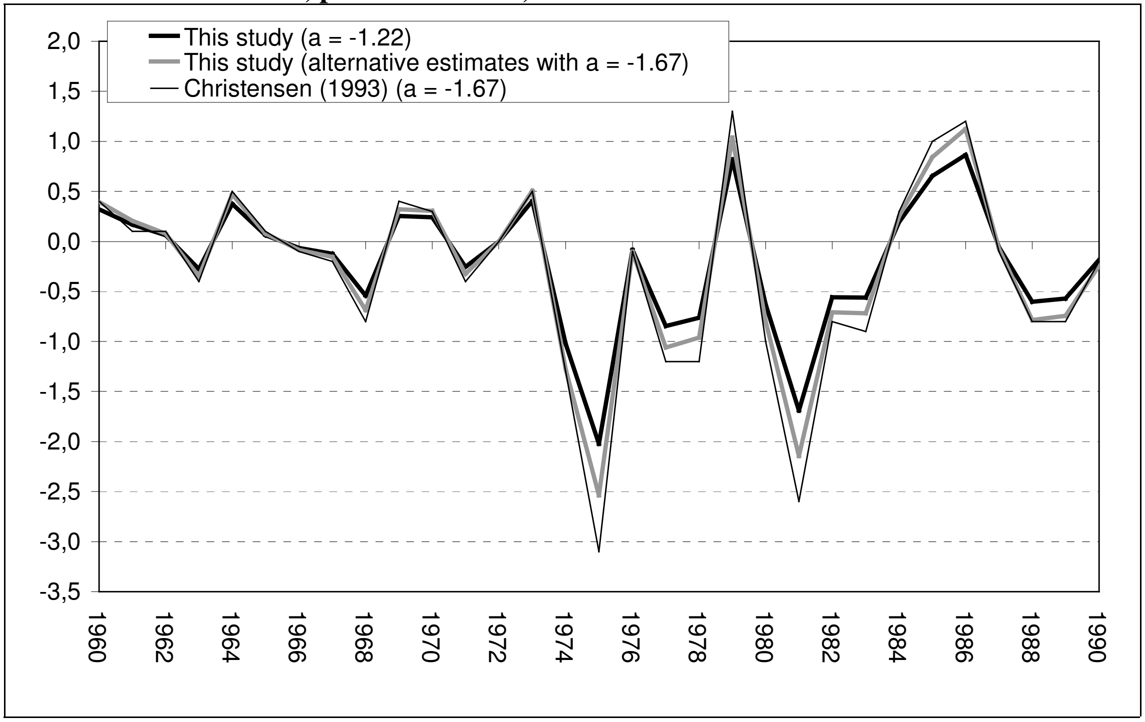
Note: In order to improve comparability the data from Topp (1995) has been transformed from fiscal-year basis to calendar-year basis.

Source: A slightly revised version of Chart 10 in Abildgren (2005d).

Figure 5.10 compares the cyclical impact on the general government budget balance for the period 1930-1939 in the essay at hand with that of Topp (1995). The results are quite similar, although the cyclical budgetary impact calculated in the essay at hand for some years are slightly larger than those calculated by Topp.

Figure 5.11 compares the cyclical impact on the general government budget balance in the period 1960-1990 presented in this essay with that of compiled by Christensen (1993). Christensen (1993) finds in general somewhat larger cyclical impact on the general government budget balance than the study at hand, but a large part of this difference can be attributed to the use of different estimates of the parameter a.

Figure 5.11: Cyclical impact on the change in the Danish general government budget balance, per cent of GDP, 1960-1990



Source: A slightly revised version of Chart 11 in Abildgren (2005d).

The comparisons with the results in Topp (1995) and Christensen (1993) do not alter the overall impression that the cyclical impact on the government budget balance most often seems to be relatively modest. However, the comparisons underline the importance regarding the choice of the parameter a in equation [5.1] representing the change in the number of employed persons (1000 persons) when the number of unemployed persons increase by 1000 persons. The results presented in the essay at hand based on a value of a equal to a = –1.22 (estimated on the basis of the whole period 1875-2005) may tend to underestimate the cyclical impact on the general government budget balance in the post-1960 period. One could of course try to redo the calculations with a time-varying estimate of the parameter a, but the value-added to the analysis above will probably be limited. A better way forward would be to try to establish a more detailed set of data for general government finances since 1875 that will allow a more comprehensive estimation of the cyclical impact on the general government budget.

5.6. Summary and scope for further research

The economic literature does not provide any unique and clear-cut operational definition of fiscal sustainability.[206] A 3-per-cent reference value for the general government deficit relative to GDP has served as a key benchmark in the monitoring of public finances within EU member states since the start of the second stage of the Economic and Monetary Union (EMU) in 1994. Taking into account that the cyclical budget volatility presented in this essay may be too low in the post-1960 period the results seems to indicate a need for the cyclically adjusted budget balance to be in surplus in periods with strong economic growth if the automatic stabilisers should be allowed to work freely during a cyclical downturn without violating a 3-per-cent budget criteria.

So far projects on compilation of historical national-account statistics for Denmark has not included a split of the total economy into institutional sectors. This essay has attempted to overcome part of this data shortage by the constructing of time series for public net lending in the period 1875-2005. However, the accounting principles applied in central and local government accounting statistics has changed over time and the principles are not fully in accordance with the concepts and definitions applied in modern national accounts statistics. This introduces undoubtedly measurement errors, and the figures presented in this essay can only be considered as a first crude attempt to overcome the lack of time series for general government net lending in the existing version of Danish historical national accounts. It would be useful if future projects on historical national-accounts statistics in Denmark would make an attempt to include a full split of the total economy into the general government and the private sector.

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[206] Cf. e.g. the survey and discussion in Marinheiro (2005).

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Annex 5.A: Danish general government net lending 1875-2005

Table 5.A.1: Danish general government net lending, current prices, 1875-2005

Year	million kroner	per cent of GDP at market prices	Year	million kroner	per cent of GDP at market prices
1875	2.6	0.3	1945	-530.3	-3.7
1876	-3.1	-0.4	1946	376.3	2.4
1877	-0.8	-0.1	1947	529.6	3.1
1878	0.6	0.1	1948	454.1	2.4
1879	-1.2	-0.1	1949	-1.8	0.0
1880	-0.3	0.0	1950	-18.3	-0.1
1881	-0.8	-0.1	1951	-100.2	-0.4
1882	1.4	0.2	1952	-118.7	-0.4
1883	3.1	0.3	1953	-289.3	-1.0
1884	4.9	0.6	1954	-199.1	-0.7
1885	1.8	0.2	1955	37.9	0.1
1886	-5.9	-0.7	1956	208.6	0.6
1887	-9.0	-1.1	1957	396.1	1.1
1888	-6.2	-0.7	1958	488.8	1.3
1889	-6.8	-0.7	1959	769.5	1.9
1890	-12.1	-1.2	1960	974.7	2.2
1891	-11.5	-1.1	1961	64.5	0.1
1892	-10.0	-1.0	1962	-41.7	-0.1
1893	-8.0	-0.8	1963	335.8	0.6
1894	-4.9	-0.5	1964	522.9	0.8
1895	-5.4	-0.5	1965	465.9	0.6
1896	-7.9	-0.7	1966	695.2	0.9
1897	-7.5	-0.7	1967	-554.7	-0.6
1898	-10.8	-0.9	1968	-434.6	-0.4
1899	-11.1	-0.9	1969	-1907.8	-1.7
1900	-19.6	-1.4	1970	1648.0	1.3
1901	-22.3	-1.6	1971	5502.0	4.0
1902	-14.4	-1.0	1972	6054.0	3.9
1903	-8.0	-0.5	1973	7658.0	4.2
1904	-7.3	-0.5	1974	5231.0	2.6
1905	-5.1	-0.3	1975	-4365.0	-1.9
1906	-6.9	-0.4	1976	-1629.0	-0.6
1907	-13.5	-0.8	1977	-2021.0	-0.7
1908	-30.9	-1.7	1978	-2660.0	-0.8
1909	-52.0	-2.8	1979	-8013.0	-2.2
1910	-61.0	-3.1	1980	-14446.0	-3.7
1911	-45.9	-2.2	1981	-30200.0	-7.0
1912	-24.2	-1.1	1982	-48209.0	-9.8
1913	-11.3	-0.5	1983	-42971.0	-7.9
1914	-50.2	-1.9	1984	-27268.0	-4.6
1915	-65.8	-2.2	1985	-17584.0	-2.7
1916	-44.1	-1.1	1986	15985.0	2.3
1917	68.1	1.7	1987	11120.0	1.5
1918	-170.3	-3.6	1988	2141.0	0.3
1919	-73.9	-1.3	1989	-5863.0	-0.7
1920	-215.4	-2.9	1990	-10762.0	-1.3
1921	-135.2	-2.2	1991	-25417.0	-2.9
1922	-37.8	-0.7	1992	-23184.0	-2.6
1923	-9.4	-0.2	1993	-34453.0	-3.8
1924	-8.8	-0.1	1994	-32006.0	-3.3
1925	21.6	0.3	1995	-29081.0	-2.9
1926	59.2	1.0	1996	-20610.0	-1.9
1927	-18.5	-0.3	1997	-5680.0	-0.5
1928	-148.7	-2.6	1998	-146.0	0.0
1929	-37.0	-0.6	1999	16979.0	1.4
1930	26.8	0.4	2000	29358.0	2.3
1931	26.0	0.5	2001	15876.0	1.2
1932	-11.8	-0.2	2002	3226.0	0.2
1933	-40.4	-0.7	2003	-998.0	-0.1
1934	-12.5	-0.2	2004	24800.0	1.7
1935	-35.4	-0.5	2005	62862.0	4.1
1936	-29.6	-0.4			
1937	-43.6	-0.6			
1938	-63.2	-0.8			
1939	-66.1	-0.8			
1940	-808.9	-8.9			
1941	-882.0	-8.6			
1942	-694.5	-6.1			
1943	-1764.9	-13.6			
1944	-2491.4	-17.3			

Source: Annex A in Abildgren (2006c).

Essay 6:
An Input-Output Based Measure of Underlying Domestic Inflation in Denmark 1903-2002[207]

Abstract

Essay 6 presents input-output based time-series data for the underlying domestic inflation in Denmark 1903-2002 and analyses the inflationary development during the last century. More conceptual issues in relation to the interpretation and use of input-output based domestic inflation measures are also discussed. The purpose of such inflation measures is to track the development in the domestic market-determined inflation, which is closely related to the price of gross value added in the domestic market-based private business sector. A price index for value added has a clear conceptual interpretation and displays often a different short-term development than the headline CPI. Such differences can be useful in an assessment of the current inflationary environment and in relation to an interpretation of the historical inflation development.

The new annual input-output based time-series data for the underlying domestic inflation in Denmark 1903-2002 presented in the essay are constructed by stripping the development in the private consumption deflator of price increases caused by the direct and indirect content of imports, indirect taxes and gross rents.

The analysis seems to suggest that an input-output based underlying inflation measure paints a fundamentally different picture of the inflationary development than the private consumption deflator in periods with large structural movements in the relative prices or periods with high inflation volatility. The most marked example is the period 1973-1986 characterised by large increases in indirect taxes and gross rents as well as a high and volatile element of imported inflation due to large oil price movements and frequent devaluations of the Danish krone.

A low level of input-output based underlying inflation does not necessary imply a low future level of inflation. The input-output based measure of underlying domestic inflation reflects the development in wages and gross profit per produced unit in domestic goods and services delivered for private consumption. A temporary drop in the level of underlying inflation, e.g. around the second oil-price shock, may therefore partly reflect a temporary squeeze of profit margins that later gets restored. An input-output based underlying inflation measure may however provide insights into the inflation process that can not be easily uncovered from other economic indicators. It can be a useful supplement to other types of information (e.g. the development in wages, output gap etc.) in relation to both an

[207] This essay is based on Abildgren (2006a, 2007b).

interpretation of the historical inflation development and as an input into a broad assessment of the current inflationary environment. Despite the relatively comprehensive calculation procedure input-output based measures of underlying inflation may therefore add value to the arsenal of other core-inflation indicators used within the central-banking community.

Input-output based measures of underlying domestic inflation are on the other hand hardly suitable to be used as the targeted measure of inflation by inflation-targeting central banks. Not only because of the high volatility but also due to their relatively complicated calculation procedure which makes such inflation measures less transparent and therefore more difficult to communicate to the general public than “headline” inflation figures.

Key words: Underlying inflation, core inflation, history of inflation, input-output price models.

Key words: Underlying inflation, core inflation, inflation history, input-output price models.
JEL Classification: C67, C82, D57, E31, E52, N13, N14.

6.1. Introduction

During the last decade or so there has been a renewed interest in concepts like "underlying inflation" or "core inflation" due to the increased use of inflation targeting as a monetary-policy strategy around the world. There do not seem to be any consensus in the academic literature on how to measure underlying inflation in the most appropriate way. Different measures of underlying inflation may paint different pictures of the inflationary trend[208] and the ideal properties of an underlying inflation measure can not be seen independently of its analytical purposes.

Inflation-targeting central banks focuses mainly on underlying inflation measures constructed from the headline consumer price index (CPI) either by simply excluding certain volatile commodity groups (e.g. food and energy) or as so-called trimmed measures where the components with the highest and lowest inflation rates or inflation volatility are trimmed away.[209] The main purpose of such "traditional" core measures of inflation is to capture the current inflationary trend and thereby facilitate the decision-making of the central bank in its attempt to achieve the targeted medium-term inflation level. Low volatility is therefore a crucial design criterion in this regard, and if the core inflation measure even serves as the targeted rate of inflation ease of communication becomes vital as well.

Input-output based inflation measures have only received modest attention in the past decades' international debate and research on underlying inflation measures. In Denmark, however, input-output based price measures have a long-standing tradition. Such price measures were introduced already in 1974 in a report on cost-of-living clauses in wage agreements in order to determine the impact of import prices on the domestic price development.[210] In 1984 Danmarks Nationalbank (the central bank of Denmark) introduced an input-output based measure of domestic inflation to the public.[211] The Nationalbank's index for domestic market-determined inflation is based on consumer prices excluding indirect taxes and subsidies and the index is adjusted for a number of special factors (energy, imports, foodstuffs, gross rents and public services) using input-output multipliers. The index is calculated on a monthly frequency and is published on a quarterly frequency in the Nationalbank's Monetary Review. Data going back to 1975 have been released in relation to various analytical works[212].

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[208] Cf. e.g. BIS (1999) and Roberts (2005).

[209] The interest in underlying inflation measures in relation to monetary-policy implementation has deep roots in the past. In the period 1931–1937 the Swedish Riksbank followed a monetary-policy strategy based on price-level targeting, and the bank stressed the need to exclude temporary factors such as indirect taxes, custom duties and seasonal effects in its monitoring of the inflationary development, cf. Berg & Jonung (1999).

[210] Cf. Arbejdsministeriet (1974) and Holdt & Thage (1976).

[211] Cf. Lauritzen (1987), Christensen (1994) and Hansen & Knudsen (2005).

[212] Cf. e.g. Danmarks Nationalbank (2004).

This essay presents input-output based annual time-series data for the underlying domestic inflation 1903-2002 and analyses the inflationary development in Denmark during the last century. Furthermore, a number of more general conceptual issues in relation to the interpretation and use of input-output based domestic inflation measures are discussed.

6.2. The purpose and design of underlying inflation measures

Traditional core inflation measures are usually constructed in order to be used for policy assessment and short-term inflation forecasting.[213] Timeliness, outside replicability, low volatility, unbiasness and ease of communication are probably the most important design criteria of relevance in this connection. The inflation-targeting-related literature on core inflation have therefore mainly focused on inflation measures constructed from the headline CPI either by excluding certain volatile product groups (e.g. food and energy) or as trimmed measures where the components with the highest and lowest inflation rates or inflation volatility are excluded.

The purpose of input-output based underlying domestic inflation measures is to track the development in the domestic market-determined inflation, that is the rate of inflation determined by the development in wages and gross profit per produced unit in market-based domestic goods and services delivered for private consumption. Based on classical input-output multipliers it is possible to decompose the development in the consumer-price inflation into price increases caused (directly or indirectly) by imports, net indirect taxes, non-market determined domestic products, and market-determined domestic gross value added (i.e. gross profit and wages). The latter constitutes the input-output based underlying domestic inflation measure.

The aim with such an input-output based inflation measure is not to construct an inflation measure with low short-term volatility. Gross profit per produced unit may e.g. fluctuate substantially over the business cycle, and such fluctuations are a very characteristic element of a market-determined price-formation process.[214] A price index for value added will therefore often displays a different short-term development than the headline CPI or traditional core-inflation measures, and such differences can be of interest in an assessment of the current inflationary environment. A recent study[215] covering the period 1987-2002 shows

[213] Cf. Silver (2007).

[214] In a recent paper Siviero & Veronese (2007) criticises the standard approach to building core inflation measures where the focus is on removing erratic components from the headline CPI without a firm theoretical justification. Instead the authors propose an underlying inflation measure derived within the context of a well-defined monetary-policy optimisation problem. Their empirical investigation suggests that traditional core-inflation measures might be too smoothed compared to the "optimal" underlying inflation index because information relevant for the optimal monetary-policy decisions has been removed. Low volatility is therefore not necessary a good design criteria for an underlying inflation index.

[215] Hansen & Knudsen (2006).

that the cyclical component of the Nationalbank's measure of domestic market-determined inflation – calculated using a HP filter – displays a positive correlation with the cyclical component of the real GDP several quarters in advance of the headline CPI. An input-output based price measure might therefore also be suitable as an early indicator of demand-pressure in the economy.

6.3. An input-output based measure of underlying domestic Danish inflation 1903-2002 – Methodological approach and data sources

The basic idea behind the input-output based measure of underlying domestic inflation compiled in this essay is to strip the actual development in the Danish private consumption deflator for price increases caused by imports, indirect taxes and gross rents using multipliers from input-output price models estimated for each year in the period 1903-2002.

Using the following mnemonics:

PCP_t	Change in the implicit deflator for private consumption from year t-1 to year t, per cent.
PIT_t	Change in the implicit deflator for indirect consumption taxes (excluding custom duties) net of subsidies from year t-1 to year t, per cent.
PM_t	Change in the implicit deflator for imports of goods and services (including custom duties) from year t-1 to year t, per cent.
PH_t	Change in the implicit deflator for private consumption of gross rents from year t-1 to year t, per cent.
a^{IT}_t	Direct and indirect content of indirect taxes (excluding custom duties) net of subsidies in the private consumption at current prices in year t, per cent.
a^{M}_t	Direct and indirect content of imports of goods and services (including custom duties) in the private consumption at current prices in year t, per cent.
a^{H}_t	Content of gross rents in the private consumption at current prices in year t, per cent.
$UNDPCP_t$	Underlying domestic inflation, change in per cent from year t-1 to year t.

the annual changes in the implicit deflator for private consumption expenditures can be decomposed as follows:

$$[6.1]\ PCP_t = \frac{a_t^{IT} \cdot PIT_t + a_t^{M} \cdot PM_t + a_t^{H} \cdot PH_t + \left(100 - a_t^{IT} - a_t^{M} - a_t^{H}\right) \cdot UNDPCP_t}{100}$$

The underlying domestic rate of inflation ($UNDPCP_t$) is not directly observable, but it can be calculated from equation [6.1] on a residual basis as:

$$[6.2]\ UNDPCP_t = \frac{100 \cdot PCP_t - a_t^{IT} \cdot PIT_t - a_t^{M} \cdot PM_t - a_t^{H} \cdot PH_t}{100 - a_t^{IT} - a_t^{M} - a_t^{H}}$$

A static open input-output price model[216] has been used for the decomposition of the private consumption into its direct and indirect content of imports, indirect taxes net of subsidies, gross rents and other items, cf. the model exposition in annex 6.A.

The input-output based measure of underlying domestic inflation presented in this essay have been compiled by the use of annually updated input-output weights (i.e. “current weights”) during the whole period 1903-2002. The choice of current weights has been made in order to reflect changes in consumption patterns and production structures on a current basis, which is necessary when a century of data is analysed. As is the case with other price indices based on current weights this implies that both prices and quantities can cause movements in the index.

The choice of data and the specific model formulation for an exercise covering a time span of a whole century is always to a high degree determined by data availability. It has therefore only been possible to strip the UNDPCP for indirect net taxes, imports and gross rents. Ideally, one should also exclude the price development of other goods and services not determined on domestic market terms. The Nationalbank’s input-output based measure for domestic market-determined inflation published in the bank’s quarterly Monetary Review is e.g. also stripped for public services (public transport, education and child care services) as well as domestically produced energy and food products. The world market largely determines energy prices and the prices on agricultural products. The latter have also been heavily influenced by the Common Agricultural Policy since the Danish membership of EEC in 1973. However, the Nationalbank’s input-output based inflation measure covers only the most recent decades where the statistical sources are richer compared to the long-span period covered in the essay at hand.

Since the input-output based inflation measure is calculated on a residual basis the index may be influenced by statistical uncertainty. The significance of this potential uncertainty depends on the quality of both the price indices and the input-output multipliers applied in the calculations.

For the period since 1966 the calculations are based on the input-output multipliers published by Statistics Denmark as part of the current and earlier versions of the official national accounts statistics. For the most recent years Statistics Denmark has derived these input-output multipliers from detailed input-output tables with around 130 industries and more than 2,000 import commodity groups. An input-output table for Denmark 1934 with 23 industries based on a detailed commodity-flow system is found in Abildgren (1992a, 1992b), and Kærgård (1991) presents annual input-output tables for Denmark for most of the period 1903-1970 with the economy divided into two main sectors (a “rural” sector and an “urban”

[216] Cf. e.g. Blair & Miller (1985) or Leontief (1986).

sector). Based on these references input-output multipliers for the periods 1903-1914, 1922-1939 and 1948-1965 have been calculated and adjustments have been made to avoid break in the series in 1934 and 1966. Especially for the pre-1966 period the rather high aggregation level of the input-output tables used for the calculations may raise an issue regarding the homogeneity of the industries and thereby the accuracy of the compiled multipliers.

The annual changes in the implicit deflators for total private consumption, net indirect taxes, imports and gross rents are mainly based on the current and earlier versions of the official national-accounts statistics from Statistics Denmark and the historical national accounts in Hansen (1983). The earliest official national account statistics compiled by the Danish central bureau of statistics covers only the period since 1930. The figures for the price deflators (as well as for the input-output tables behind the input-output multipliers) may therefore be surrounded by an extra amount of uncertainty for the first part of the twentieth century. Furthermore, for the pre-1967 period import price movements are based on unit values which of cause can only be seen as a crude indicator for the price development.

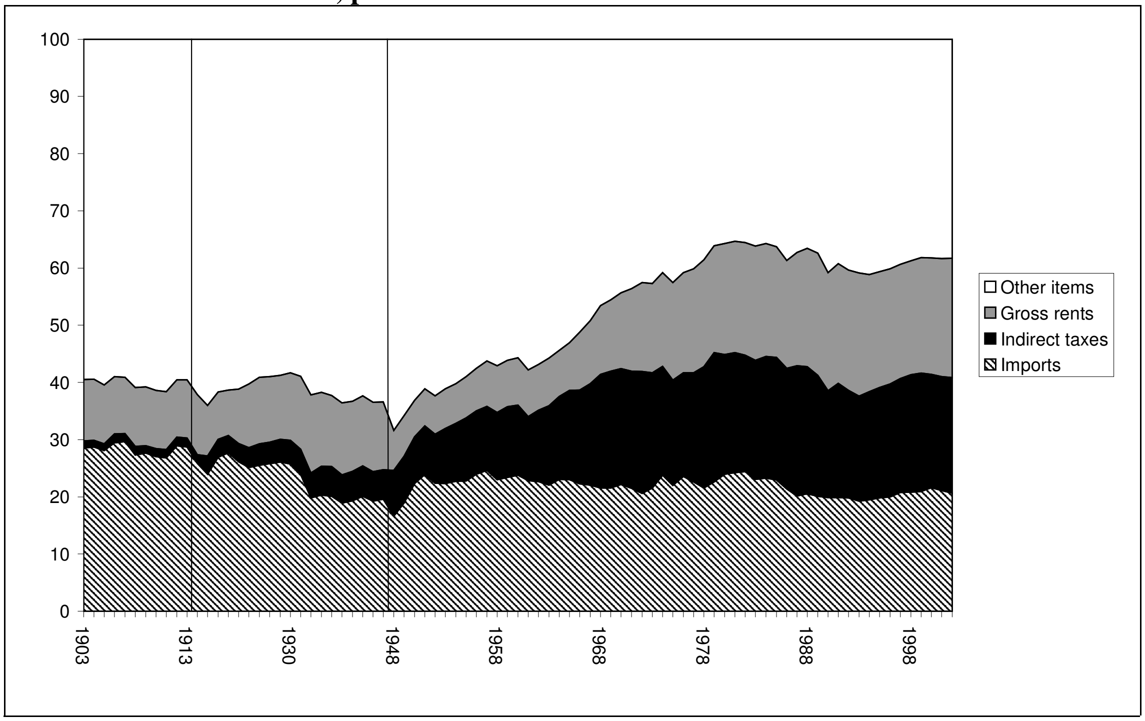
In light of these uncertainty factors the historical input-output based underlying domestic inflation figures presented in this paper can only be expected to give a rough picture of the inflationary trends in Denmark since 1903 and the results and conclusions have to be taken with “a pinch of salt”.

Annex 6.C lists all the time-series data of input-output multipliers and underlying domestic inflation 1903-2002 compiled for the analysis in this essay. A detailed description of data sources and compilation methods is found in Abildgren (2006a).

6.4. Input-output multipliers for Denmark 1903-2002

The calculated direct and indirect content of imports of goods and services, indirect taxes (net of subsidies), gross rents and other items in private consumption at current prices since 1903 is shown in Figure 6.1.

Figure 6.1: Direct and indirect content of imports, indirect taxes, gross rents and other items in the private consumption at current prices in Denmark 1903-2002, per cent



Note: The vertical lines mark missing observations around World War I and II (1915-1921 and 1940-1947).
Source: Figure 1 in Abildgren (2007b).

During most of the period, the Danish economy can be characterised as a small, open economy. On average the direct and indirect content of imports of goods and services in private consumption have been around 20-25 per cent. The lowest content of imports occurred during the 1930s and after the World War II where the international economy was characterised by a high degree of protectionism and a complex net of bilateral trading arrangements.[217]

The direct and indirect content of indirect taxes in private consumption increased gradually from close to 1 per cent in the early 1900s to around 20 per cent in the post-1970 period. Seen as one the period has been characterised by the build up of a large tax-financed welfare state in Denmark where the general government accounts for a substantial share of the economy.

Gross rents accounted for around 6-14 per cent of the private consumption expenditures in the pre-1970 period. The gross rent item covers both rental housing as well as imputed rents

[217] The Danish Exchange Control in the 1930s is covered by e.g. Boserup (1947).

In the pre-World War II period imports of services are only partly covered in the data series in Figure 6.1. In 1934 the import figures cover imports of goods, custom duties, tourist transactions and expenditures by Danish ships abroad. For the years 1903-1914, 1922-1933 and 1935-1939 the data covers only imports of goods and custom duties. A level adjustment for break in series in 1934 has been made, but the development of the direct and indirect content of imports of goods and services in the private consumption in the pre-World War II period may to some extent be influenced by the incomplete coverage of services.

in owner-occupied housing. During the last three decades the share of gross rents in private consumption has increased to around 20 per cent in the early 2000s. In a large part of the post-1903 period gross rents have been subject to administrative regulation by the public authorities. In 1916 the local authorities were authorised to establish rent committees that were to approve all increases in rents in rental housing. This rent regulation ceased in 1926 outside Copenhagen and in 1931 in Copenhagen.[218] The rental housing market was then allowed to work freely until 1939 where a general rent freeze in rental housing was introduced. After World War II the maximum rent was raised gradually (starting in 1951), but during the whole post-World War II period most of the rental housing sector has been subject to public regulation.[219]

The share of other items – reflecting the direct and indirect content of gross value added (wages and gross profit) in domestic market-determined goods and services delivered for private consumption – has declined from 60-70 per cent of the total private consumption in the pre-1950 period to just below 40 per cent in the early 2000s.

6.5. The inflationary development in Denmark 1903-2002

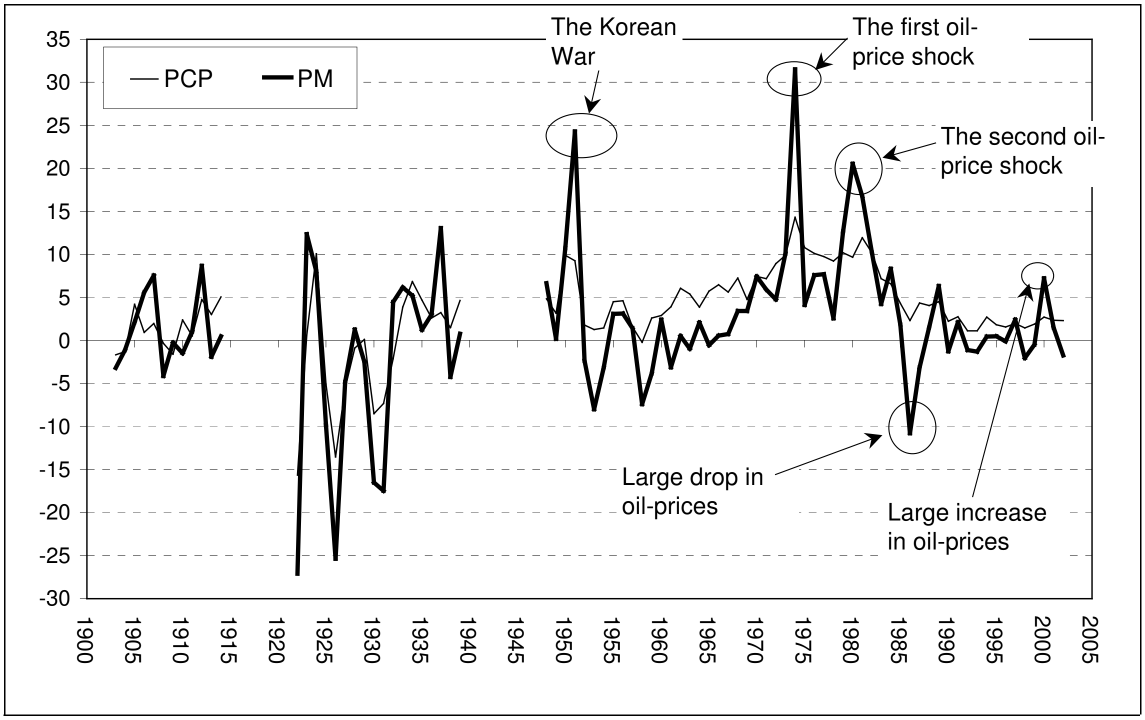
Figure 6.2 shows the annual growth in import prices (PM) together with the annual growth rate of the total private consumption deflator (PCP) in the period since 1903. The volatility in PM has in general been larger than the volatility in the PCP. During the post-World War II period the level of PM has most of the years been lower than the level of PCP. However, significant exceptions occurred in the early 1950s (around the Korean War) and during the 1970s and early 1980s (the oil price shocks). The large movements in oil prices in 1986 and 2000 are also clearly visible in Figure 6.2.

Analytically it may be of interest to split the annual growth rate of import prices into an exchange-rate component and a price component. This has not been done for the analysis in this essay. However, Abildgren (2004b) includes a data set suitable as a starting point for such an exercise via a complete listing of the Danish imports broken down by 15 main trading partners and corresponding bilateral exchange rates for each year in the period 1875-2002.

[218] Cf. e.g. Andersen, Matthiessen & Ølgaard (1989).

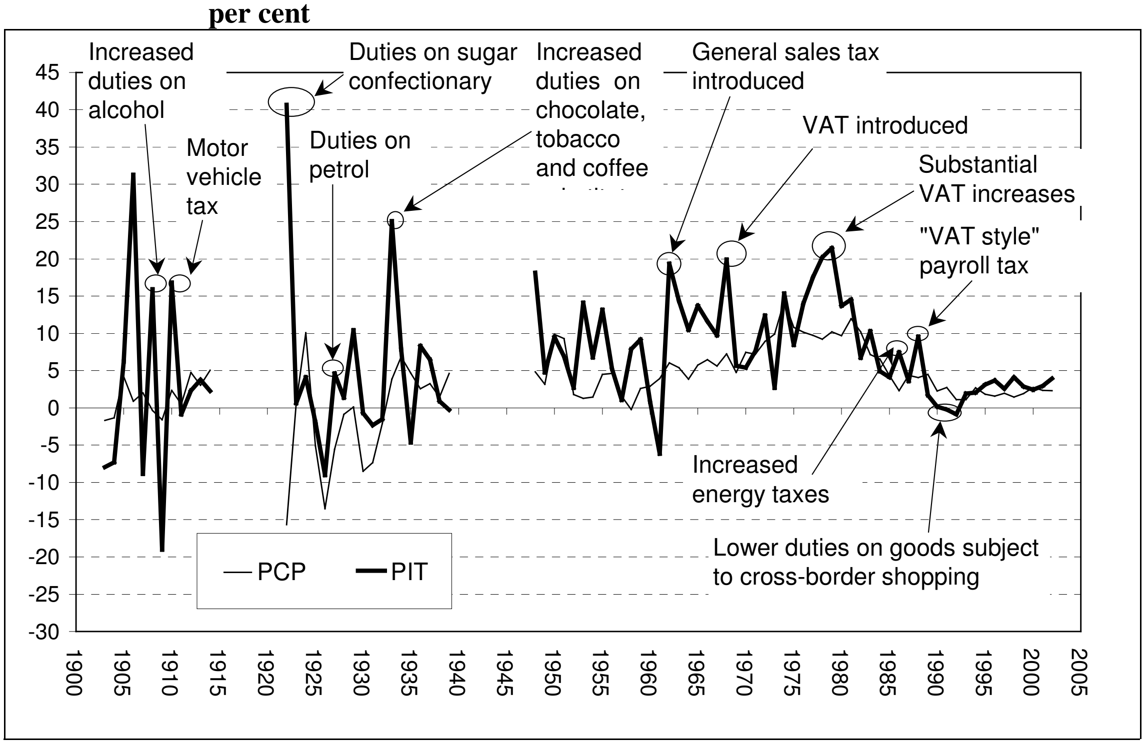
[219] Cf. e.g. pp. 121-122 and pp. 145-147 Johansen (1987).

Figure 6.2: Annual growth in import prices (including custom duties) (PM) and the total private consumption deflator (PCP) in Denmark 1903-2002, per cent



Note: Missing observations around World War I and II (1915-1921 and 1940-1947).
Source: Figure 2 in Abildgren (2007b).

Figure 6.3: Annual growth in the deflator for indirect taxes net of subsidies (PIT) and the total private consumption deflator (PCP) in Denmark 1903-2002, per cent

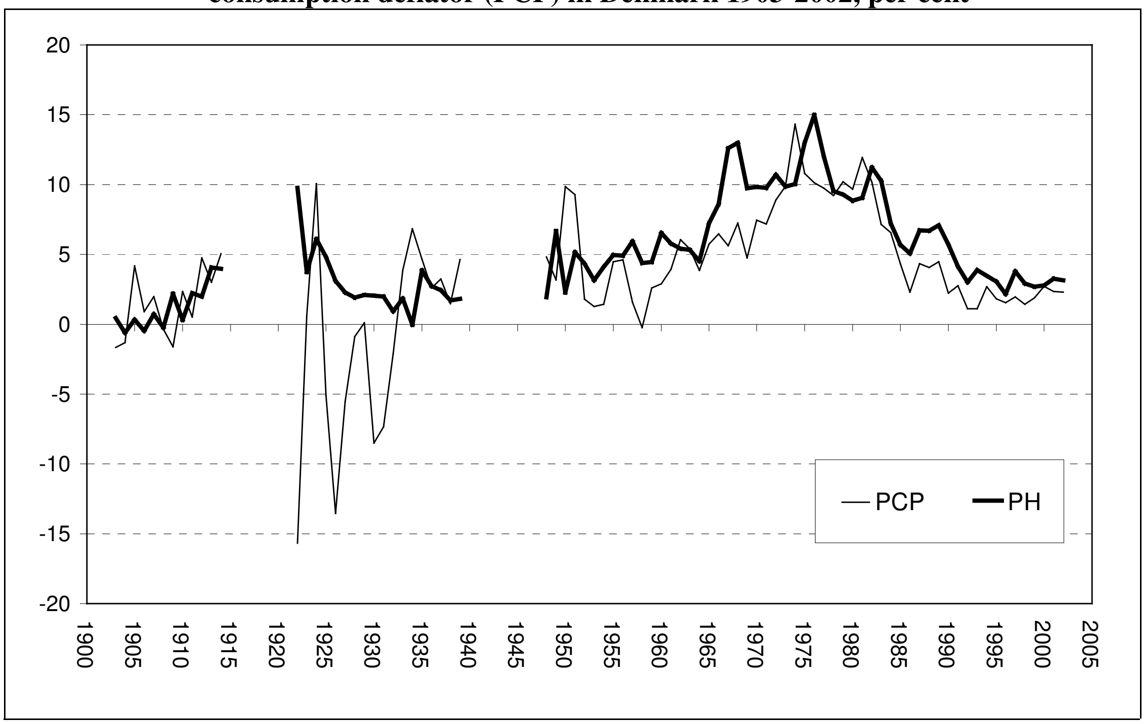


Note: Missing observations around World War I and II (1915-1921 and 1940-1947).
Source: Figure 3 in Abildgren (2007b).

The annual growth in the deflator for indirect taxes (PIT) is illustrated in Figure 6.3 together with the annual growth in the total private consumption deflator (PCP) in the period since 1903. During most of the period the level of PIT have been higher than the level of PCP. The relatively high volatility in PIT in the pre-World War II period should be viewed in light of the relatively low level of indirect taxes.[220] Most of the volatility in PIT on this period is caused by increased excise duties. In the post-World War II period several of the large swings in PIT are related to the introductions and increases of more general sales taxes and VAT.[221]

Figure 6.4 shows the annual growth in the deflator for gross rents (PH) together with the annual growth in the total private consumption deflator (PCP) in the period since 1903. During most of the post-World War II period the level of PH have been somewhat larger the level of PCP.

Figure 6.4: Annual growth in the deflator for gross rents (PH) and the total private consumption deflator (PCP) in Denmark 1903-2002, per cent



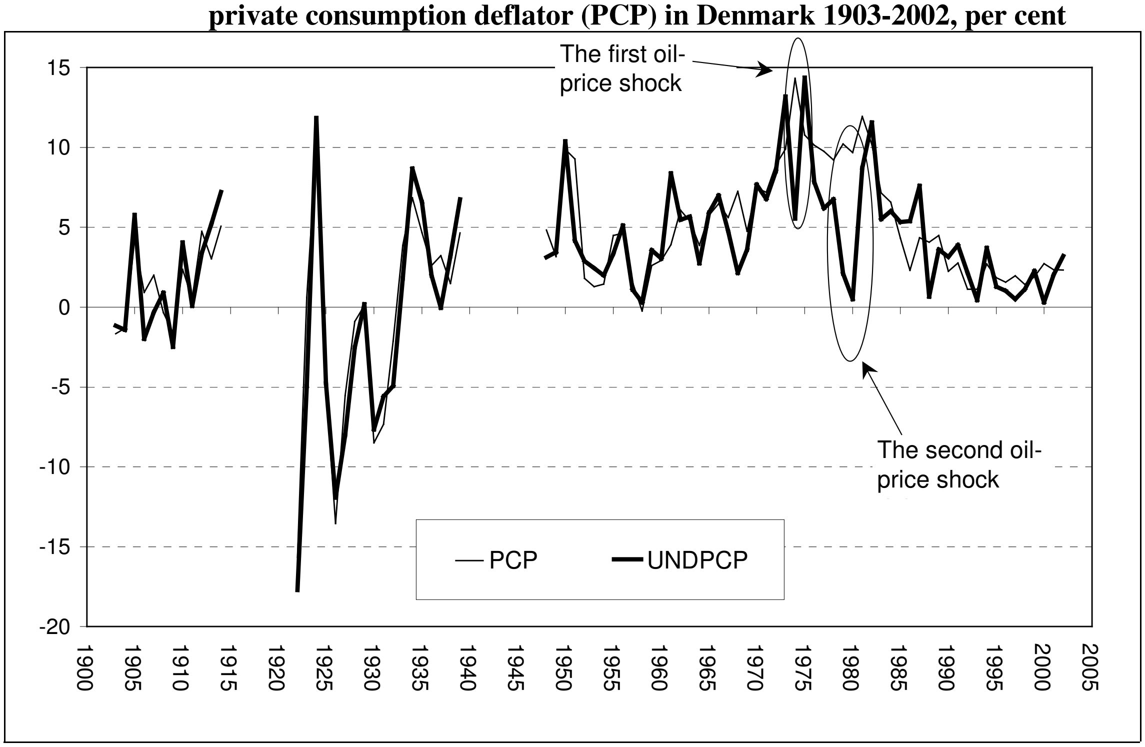
Note: Missing observations around World War I and II (1915-1921 and 1940-1947).
Source: Figure 4 in Abildgren (2007b).

[220] Figure 6.3 indicates only a few selected examples of changes within the areas of excise duties. Johansen (2007) covers the history of the Danish taxation system since 1903.

[221] A general sales tax was introduced in 1962. It amounted to 9 per cent (12.5 per cent from 1965) of the wholesale prices on most commodities except foodstuffs. It was replaced by a general 10 per cent VAT in 1967. The VAT rate was raised to 12.5 per cent in 1968 and 15 per cent in 1970. It was temporary reduced to 9.25 per cent in 1975-1976. The VAT rate was raised again in 1977 from 15 to 18 per cent, in 1978 to 20.25 per cent, in 1980 to 22 per cent and finally in 1992 to the current rate, 25 per cent, cf. Statistics Denmark (1995). The increase in the VAT rate in 1992 replaced a 2.5 per cent "VAT style" payroll tax introduced in 1988.

Finally, the compiled input-output based measure of the underlying rate of domestic inflation (UNDPCP) is shown in Figure 6.5 together with the annual growth in the total private consumption deflator (PCP).[222] In the pre-1960 period the development in the PCP and the UNDPCP seems to be quite similar for most of the years. This reflects a rather high weight to "other items" in the total private consumption (55-70 per cent) during this period, cf. also Figure 6.1. In the post-1960 period the differences between PCP and UNDPCP has in general been somewhat larger and the two oil-price shocks in the 1970s and early 1980s are clearly visible. Figure 6.5 also illustrates that the underlying domestic inflation trend in the late 1990s and early 2000 reached a low level measured by post-World War II standards. However, it is also worth to notice that lower levels of underlying domestic inflation were found during in the pre-World War II period where deflation frequently occurred.

Figure 6.5: Annual growth in underlying domestic inflation (UNDPCP) and the total private consumption deflator (PCP) in Denmark 1903-2002, per cent



Note: Missing observations around World War I and II (1915-1921 and 1940-1947).
Source: Figure 5 in Abildgren (2007b).

Table 6.1 presents a range of summary descriptive statistics on the inflationary development in Denmark 1903-2002 broken down by sub-periods determined by in the Danish exchange-rate policy. In all the sub-periods the growth of import prices has on average been lower but more volatile than the growth in the private consumption deflator. The price development for gross rents has in most periods on average been higher and in general less volatile than the

[222] Annex 6.B contains a post-1975 comparison of the domestic underlying rate of inflation compiled in this essay

total private consumption inflation. The deflator for indirect taxes has tended to show larger increases with higher volatility than that of the total private consumption deflator. Finally, the calculated measure for the underlying domestic inflation has on average been lower than the private consumption inflation, but as expected in general more volatile, cf. the discussion in section 6.2.

Table 6.1: The inflationary development in Denmark 1903-2002 – Summary statistics

	Deflator for indirect taxes (excluding custom duties), net of subsidies (PIT)			Deflator for gross rents (PH)			Deflator for imports (including custom duties) (PM)			Underlying domestic inflation (UNDPCP)			Private consumption deflator (PCP)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
	per cent per annum														
1903-1914: The Classical Gold Standard	2.9	-19.0	31.3	1.2	-0.6	4.1	1.1	-4.1	8.7	1.6	-2.5	7.2	1.5	-1.7	5.1
1922-1939: Interwar period	5.0	-9.0	40.7	3.0	0.0	9.8	-2.9	-27.1	13.0	-1.5	-17.7	11.8	-1.1	-15.7	10.1
1948-1971: Bretton Woods	8.8	-6.1	19.9	6.3	1.9	13.0	1.9	-8.0	24.3	4.4	0.3	10.4	4.6	-0.2	9.9
1972-1986: European exchange-rate co-operation – The devaluation period	11.6	2.7	21.5	9.8	5.1	15.0	8.8	-10.8	31.5	7.2	0.5	14.4	9.0	2.3	14.3
1987-2002: European exchange-rate co-operation – The unchanged parity period	2.7	-0.9	9.6	4.0	2.2	7.1	0.7	-3.1	7.2	2.3	0.3	7.6	2.4	1.1	4.5
1903-2002: Total	6.5	-19.0	40.7	5.1	-0.6	15.0	1.8	-27.1	31.5	2.8	-17.7	14.4	3.3	-15.7	14.3

Source: Table 1 in Abildgren (2007b).

The calculations seem to suggest that the input-output based underlying domestic inflation measure paints a fundamentally different picture of the inflationary development than the private consumption deflator in periods with large structural movements in the relative prices or periods with high inflation volatility. The most marked example is the period 1973-1986 characterised by large increases in indirect taxes and gross rents as well as a high and volatile element of imported inflation. The high volatility in the level of imported inflation in this period should be viewed in light of several large oil price movements as well as large and frequent devaluations of the Danish krone vis-à-vis Deutsche Mark.

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and the Nationalbank's measure for the domestic market-determined inflation.

6.6. The interpretation and use of input-output based domestic inflation measures

Measures of underlying inflation are typically compiled in order to interpret the historical inflationary development, to assess the current inflationary environment or to be used as leading indicators of the future inflationary outlook.

Empirical studies on core-inflation measures as leading indicators generally tend to show that no single measure clearly outperforms others under all circumstances.[223] Hansen & Knudsen (2006) shows that the Nationalbank's input-output-based measure of domestic market-determined inflation clearly outperform a more traditional measure of underlying inflation (year-on-year growth in CPI excluding food and energy) as a predictor of the year-on-year growth in the monthly Danish headline CPI two years ahead in the period 1985-2006. Input-output based domestic price measures might therefore deserve some attention in relation to medium-term inflation forecasting and it would be interesting if similar studies for other countries were carried out in order to assess the robustness of this result.

However, also input-output based measures of underlying domestic inflation do not exempt a forecaster from the work related to a broader assessment of the future inflation prospects. An input-output based measure of underlying domestic inflation reflects the development in wages and gross profit per produced unit in domestic market-based goods and services delivered for private consumption. A drop in the level of underlying inflation, e.g. around the second oil-price shock, may therefore be reflecting that profit margins were temporarily squeezed while import prices accelerated.[224] Another example could be "second round effects" related to a rise in the level of indirect taxation. Since the input-output measure of underlying domestic inflation is stripped for the content of indirect taxes, this measure will tend to show a rate of inflation below the "headline" figure immediately after the tax increase. A tax increase may indeed lead to lower future inflation if the fiscal tightening dampens the total demand in the economy. However, if the tax increase is compensated by higher wage demands it could also raise future inflation though a wage-price spiral.[225] A low (high) current level of input-output based underlying domestic inflation does therefore not necessarily always imply a low (high) future level of headline inflation.

A difference between the current rate of headline inflation and the current rate of input-output based underlying domestic inflation may cause the headline inflation to move closer towards the underlying domestic inflation in the following period. However, as indicated above, a gap between the headline inflation and the underlying domestic inflation could also

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[223] Cf. e.g. Rich & Steindel (2005, 2007) and Silver (2007).

[224] Cf. Lauritzen (1987).

[225] Cf. Christensen (1994).

be closed by a future move of the underlying inflation towards the headline inflation. The number of possible reactions to gaps between headline and underlying domestic inflation does not necessarily make the input-output based underlying domestic inflation measure less helpful. The different patterns in the adjustment of prices may indicate both the nature of a shock (temporary or permanent shock, supply or demand shock, nominal or real shock, etc.) as well as the structure and state of the economy (the level of capacity utilisation, the institutional set-up on the labour market, the degree of competitiveness on the product markets, the process of inflation-expectation formation, etc.).

It is a common finding in the literature that different measures of underlying inflation may capture different aspects of the inflationary development and thereby in combination give a more robust picture of the inflationary development than a single measure.[226] This result highlights the importance of having an open mind for using a multiplicity of underlying inflation measures in both economic-historical analyses as well as in central bankers monitoring of the current inflationary environment.

6.7. Some concluding remarks and scope for further research

An input-output based underlying domestic inflation measure may provide insights into the inflation process that can not be easily uncovered from other economic indicators. It can serve as a useful analytical tool and supplement other types of information (e.g. the development in "traditional" core-inflation measures, wages, output gap etc.) in relation to interpretation of the historical inflation development as well as a broad assessment of the current inflationary development. Despite the relatively comprehensive calculation procedure input-output based measures of underlying domestic inflation may therefore add value to the arsenal of other core-inflation and cost indicators used within the central-banking community in analysis of the inflationary environment.

In the essay at hand the input-output based underlying domestic inflation measure for Denmark 1903-2002 has been compiled on the basis of annual growth rates of the private consumption deflator from the national accounts statistics in order to cover a long historical time span. If such underlying inflation measures should be of any value in an assessment of the current or future inflationary developments they should naturally be based on price indices released with higher frequency and timeliness such as a monthly CPI-index or other monthly price indices. One will then have a good indicator of the development in the deflator for gross value added in the private market-based business sector well in advance of the release date for the corresponding national-account components.

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[226] Cf. e.g. Mankikar & Paisley (2004).

Monthly input-output based price calculations has been carried out internally by Danmark Nationalbank for more than two decades and the calculations have provided a different insight into the inflationary process compared to other more "traditional" core-inflation measures.[227] Since the early 1980s Denmark has pursued a fixed exchange-rate strategy, but also at least one of the inflation-targeting central banks, Bank of England[228], makes use of an input-output based domestic inflation measure in the bank's monitoring of the inflationary development.

Input-output based measures of underlying domestic inflation are on the other hand hardly suitable to be used as the targeted measure of inflation by inflation-targeting central banks. Not only because of the high volatility but also due to their relatively complicated calculation procedure which makes such inflation measures less transparent and therefore more difficult to communicate to the general public than "headline" inflation figures.

Finally, a few remarks should be given on the scope for improving on the quality of the underlying inflation data for Denmark presented in the essay at hand. For the period since 1966 the calculations are based on detailed input-output tables with more than 100 industries, but for the pre-1966 period (except 1934) the input-output tables used for the calculations have only 2 industries. This may raise an issue regarding the accuracy of the compiled multipliers. However, for selected years more detailed input-output tables are available. Jørgensen (1946) presents non-official input-output tables for each year in the period 1921-31 with 10 industries. Furthermore, official input-output tables has been compiled by Statistics Denmark for the years 1930-39 (10 industries), 1946 (16 industries), 1947 (20 industries), 1949 (20 industries), 1953 (19 industries) and 1958 (9 industries). Utilising these sets of more detailed input-output tables it will be possible to improve on the accuracy of the compiled multipliers for a large part of the pre-1966 period. This work will, however, be left for future research.

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[227] Cf. Hansen & Knudsen (2005).

[228] Cf. Bank of England (1998).

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Annex 6.A: Calculation of underlying inflation measures from input-output price models

In this annex matrices are indicated with bold capital letters, whereas bold small letters symbolise column vectors. Small non-bold letters symbolise real numbers. ' means transponation. **i** symbolises a column vector, where each element is 1, whereas **o** symbolises a column vector, where each element is zero. <**a**> symbolises a diagonal matrix with the elements from **a** in the diagonal and zeros elsewhere. $\mathbf{A}^{-1}$ is the inverse to **A**, thus $\mathbf{A}\mathbf{A}^{-1} = \mathbf{A}^{-1}\mathbf{A} = \mathbf{I}$ where **I** is the identity matrix.

Figure 6.A.1 shows a simplified input-output table in algebraic form. The letters or numbers shown in brackets denotes the dimensions of the matrices and vectors. The use side consists of intermediate consumption in all the n domestic producing sectors and the k categories of final demand (i.e. various categories of private consumption, government consumption, gross capital formation and exports of goods and services). The supply side in the input-output table consists of output from all the n producing sectors of the domestic economy, imports of goods and services, indirect taxes net of subsidies and GDP (Gross Domestic Product) at factor costs (i.e. wages and gross profits). Gross rents is singled out as a separate row due to its special treatment in the calculation of the underlying domestic inflation in this essay.

Figure 6.A.1: A simplified input-output table in algebraic form

	Industries (n)	Final Demand (k)	Sum (1)
Industries (n)	**DZU**	**DZF**	**g**
Imports (1)	**mu'**	**mf'**	m
Gross rents (1)	**o'**	**hf'**	h
Indirect taxes, net (1)	**su'**	**sf'**	s
GDP at factor costs (1)	**yu'**	**o'**	y
Sum (1)	**g'**	**f'**	

The matrices of coefficients required for a standard static input-output price model can be estimated on basis of the data in Figure 6.A.1 as follows, cf. also Figure 6.A.2:

$$
\begin{array}{lcl@{\qquad}lcl}
\mathbf{DZB} & = & \mathbf{DZU}\langle\mathbf{g}\rangle^{-1} & \mathbf{DZE} & = & \mathbf{DZF}\langle\mathbf{f}\rangle^{-1} \\
\mathbf{mb}' & = & \mathbf{mu}'\langle\mathbf{g}\rangle^{-1} & \mathbf{me}' & = & \mathbf{mf}'\langle\mathbf{f}\rangle^{-1} \\
 & & & \mathbf{he}' & = & \mathbf{hf}'\langle\mathbf{f}\rangle^{-1} \\
\mathbf{sb}' & = & \mathbf{su}'\langle\mathbf{g}\rangle^{-1} & \mathbf{se}' & = & \mathbf{sf}'\langle\mathbf{f}\rangle^{-1} \\
\mathbf{yb}' & = & \mathbf{yu}'\langle\mathbf{g}\rangle^{-1} & & &
\end{array}
$$

Figure 6.A.2: Input-output coefficients in algebraic form

	Industries (n)	Final Demand (k)
Industries (n)	**DZB**	**DZE**
Imports (1)	**mb'**	**me'**
Gross rents (1)	**o'**	**he'**
Indirect taxes, net (1)	**sb'**	**se'**
GDP at factor costs (1)	**yb'**	**o'**
Sum (1)	**i'**	**i'**

Using the following notation:

- **pg** Annual changes in the output prices of the n domestic industries
- **pf** Annual changes in the prices of the k final demand categories
- pm Annual change in the import price
- ph Annual change in the price for gross rents
- ps Annual change in the price for indirect taxes net of subsidies
- py Annual change in the price for value added (GDP at factor costs)

and assuming fixed input-output coefficients, the annual changes in the output prices of the n domestic industries can then be modelled from the development of the costs of production (intermediate domestic inputs, imports, net indirect taxes and value added) as follows:

$$\mathbf{pg'} = \mathbf{pg'DZB} + \mathrm{pm}\,\mathbf{mb'} + \mathrm{ps}\,\mathbf{sb'} + \mathrm{py}\,\mathbf{yb'}$$

or:

$$\mathbf{pg'} = \mathrm{pm}\,\mathbf{mb'}(\mathbf{I} - \mathbf{DZB})^{-1} + \mathrm{ps}\,\mathbf{sb'}(\mathbf{I} - \mathbf{DZB})^{-1} + \mathrm{py}\,\mathbf{yb'}(\mathbf{I} - \mathbf{DZB})^{-1}$$

Similarly, the annual changes in the prices of the k final demand categories can be derived from the development of the prices of the goods and services delivered for final demand (domestically produced goods, imports of goods and services for final demand, gross rent and net indirect taxes on final demand) as:

$$\mathbf{pf'} = \mathbf{pg'DZE} + \mathrm{pm}\,\mathbf{me'} + \mathrm{ph}\,\mathbf{he'} + \mathrm{ps}\,\mathbf{se'}$$

equivalent to:

$$[6.A.1]\quad \mathbf{pf'} = \mathrm{pm}[\mathbf{mb'}(\mathbf{I} - \mathbf{DZB})^{-1}\mathbf{DZE} + \mathbf{me'}] + \mathrm{ps}[\mathbf{sb'}(\mathbf{I} - \mathbf{DZB})^{-1}\mathbf{DZE} + \mathbf{se'}] + \mathrm{ph}\,\mathbf{he'} + \mathrm{py}\,\mathbf{yb'}(\mathbf{I} - \mathbf{DZB})^{-1}\mathbf{DZE}$$

Using this notation in equation [6.A.1] the percentage direct and indirect import content in the final demand category j is given by element no. j in the following 1xk row vector:

$$100[\mathbf{mb'}(\mathbf{I} - \mathbf{DZB})^{-1}\mathbf{DZE} + \mathbf{me'}].$$

Likewise, the percentage direct and indirect content of indirect taxes net of subsidies in the final demand category j is given by element no. j in the 1xk row vector:

$$100[\mathbf{sb'}(\mathbf{I} - \mathbf{DZB})^{-1}\mathbf{DZE} + \mathbf{se'}].$$

The percentage (direct) content of gross rent in the final demand category j is given by element no. j in the 1xk row vector:

$$100[\mathbf{he'}].$$

Finally, the percentage (indirect) content of GDP at factor costs in the final demand category j is given by element no. j in the following 1xk row vector:

$$100[\mathbf{yb'}(\mathbf{I} - \mathbf{DZB})^{-1}\mathbf{DZE}].$$

The input-output price model thus describes annual changes in the price indices of the final demand categories as weighted averages of the annual changes in the price indices for imports, net indirect taxes, gross rents and gross value added (GDP at factor costs). The direct and indirect contents of imports, indirect taxes net of subsidies, gross rents and GDP at factor costs in each of the final demand categories enter as weights. This can be illustrated by a simple example. Suppose that the direct and indirect import content in private consumption is 20 per cent in the year of observation. A 10 per cent increase in import prices will then *ceteris paribus* leads to a 2 per cent increase in the private consumption deflator.

Given a set of input-output coefficients corresponding to Figure 6.A.2 and data for the annual changes in the deflator for private consumption (included in **pf**), imports (pm), gross rents (ph) and indirect taxes net of subsidies (ps) for each of the years 1903-2002 the development in the input-output based underlying domestic inflation index (py) can be calculated from equation [6.A.1] on a residual basis.

Annex 6.B: A post-1975 comparison with Danmarks Nationalbank's measure for the domestic market-determined inflation

As mentioned in the introduction the Nationalbank regularly publishes an index on the development in the domestic market-determined inflation.

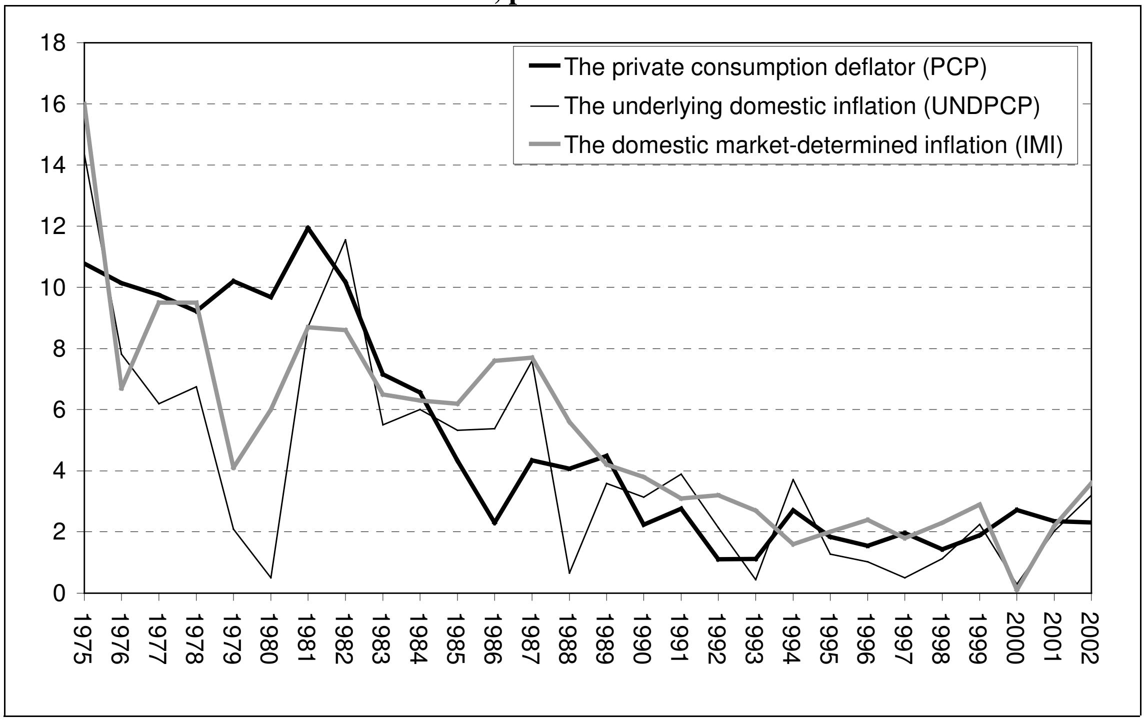
Methodologically the main differences between the domestic underlying rate of inflation (UNDPCP) calculated in the essay at hand and the Nationalbank's measure for the domestic market-determined inflation (IMI) are as follows:

- The IMI-index is based on a decomposition of the net price index[229] whereas the UNDPCP is based on a decomposition of the private consumption deflator in the national accounts statistics.
- IMI is stripped for the development in the prices of energy (both imported and domestically produced), foodstuffs (both imported and domestically produced food products including alcohol and tobacco), other imports, gross rents and public services (public transport, education and child care services). Furthermore IMI does not include indirect taxes. The UNDPCP is only stripped for indirect taxes, imports and gross rents.
- The IMI is calculated on a monthly frequency and is used by the Nationalbank to assess the current inflationary conditions. Since input-output tables in Denmark are only compiled on an annual frequency and furthermore are published with a time-lack of several years, the IMI calculations are carried out with occasionally changed fixed input-output based weights (adjusted by the development in prices). The UNDPCP has been compiled on an annually frequency for the purpose of long-span economic-historical analyses. It can therefore make use of annually updated input-output based weights (i.e. "current weights") in order to reflect the changes in consumption patterns and production structures on a current basis.

Figure 6.B.1 shows the post-1975 development of the domestic underlying rate of inflation (UNDPCP) and the Nationalbank's measure for the domestic market-determined inflation (IMI). The volatility in the UNDPCP is somewhat larger than the volatility in the IMI, but overall the two measures paint the same picture of the underlying inflationary development during the last two decades: a decline from 14-16 per cent in the mid-1970s to 2-3 per cent in the late 1990s and early 2000s. Furthermore, both indices of underlying inflation show a significant different development than the headline inflation around the large movements of oil prices in 1979, 1986 and 2000.

[229] An index on consumer prices excluding indirect taxes and subsidies.

Figure 6.B.1: Annual growth in two different indices of underlying domestic inflation in Denmark 1975-2002, per cent



Source: Figure B.1 in Abildgren (2006a).

Annex 6.C: Input-output multipliers and underlying domestic inflation 1903-2002 – Data

Table 6.C.1: Input-output based decomposition of the private consumption at current prices in Denmark 1903-2002, per cent

Year	Direct and indirect content of taxes (excluding custom duties), net of subsidies (a^{IT})	Gross rents (a^{H})	Direct and indirect import content (including custom duties) (a^{M})	Other items	Total
1903	1.2	10.7	28.6	59.5	100.0
1904	1.2	10.7	28.7	59.4	100.0
1905	1.2	10.3	28.1	60.4	100.0
1906	1.6	10.0	29.5	59.0	100.0
1907	1.4	9.8	29.7	59.1	100.0
1908	1.6	10.3	27.3	60.9	100.0
1909	1.3	10.3	27.7	60.8	100.0
1910	1.4	10.2	27.0	61.4	100.0
1911	1.4	10.1	26.8	61.6	100.0
1912	1.5	10.0	28.9	59.5	100.0
1913	1.6	10.2	28.7	59.6	100.0
1914	1.5	10.5	25.9	62.1	100.0
1915	...	...	...	...	...
1916	...	...	...	...	...
1917	...	...	...	...	...
1918	...	...	...	...	...
1919	...	...	...	...	...
1920	...	...	...	...	...
1921	...	...	...	...	...
1922	3.2	8.9	24.0	64.0	100.0
1923	3.2	8.3	26.9	61.6	100.0
1924	3.1	7.9	27.7	61.3	100.0
1925	3.2	9.5	26.1	61.1	100.0
1926	3.5	11.1	25.2	60.3	100.0
1927	3.8	11.6	25.5	59.1	100.0
1928	3.8	11.4	25.8	59.0	100.0
1929	4.0	11.2	26.1	58.7	100.0
1930	4.2	11.8	25.7	58.3	100.0
1931	4.4	12.7	23.9	58.9	100.0
1932	4.4	13.6	19.8	62.2	100.0
1933	5.0	12.9	20.3	61.8	100.0
1934	5.2	12.4	20.1	62.3	100.0
1935	4.9	12.6	18.9	63.6	100.0
1936	5.2	12.3	19.3	63.3	100.0
1937	5.4	12.3	20.1	62.3	100.0
1938	5.1	12.1	19.3	63.5	100.0
1939	5.2	11.9	19.6	63.4	100.0
1940	...	...	...	...	...
1941	...	...	...	...	...
1942	...	...	...	...	...
1943	...	...	...	...	...
1944	...	...	...	...	...
1945	...	...	...	...	...
1946	...	...	...	...	...
1947	...	...	...	...	...
1948	8.0	7.0	16.6	68.4	100.0
1949	8.1	7.1	18.9	65.8	100.0
1950	8.2	6.3	22.3	63.1	100.0
1951	8.5	6.5	23.9	61.1	100.0
1952	8.5	6.7	22.4	62.3	100.0
1953	9.6	6.9	22.3	61.1	100.0
1954	10.1	7.0	22.7	60.2	100.0
1955	11.0	7.3	22.8	59.0	100.0
1956	11.1	7.4	24.0	57.5	100.0
1957	11.2	7.9	24.6	56.2	100.0
1958	11.8	8.1	23.0	57.1	100.0
1959	12.4	8.1	23.4	56.1	100.0
1960	12.3	8.3	23.8	55.7	100.0
1961	11.2	8.2	22.8	57.8	100.0
1962	12.4	8.0	22.7	56.9	100.0
1963	13.9	8.4	22.1	55.7	100.0
1964	14.5	8.1	23.1	54.4	100.0
1965	15.6	8.3	23.0	53.1	100.0
1966	16.4	10.1	22.3	51.2	100.0
1967	17.7	11.0	22.1	49.2	100.0
1968	19.9	12.0	21.6	46.6	100.0
1969	20.5	12.5	21.5	45.5	100.0
1970	20.2	13.3	22.2	44.3	100.0
1971	20.5	14.4	21.5	43.6	100.0
1972	21.3	15.5	20.6	42.5	100.0

Table 6.C.1 (continued)

Year	Direct and indirect content of taxes (excluding custom duties), net of subsidies (a^{IT})	Gross rents (a^{H})	Direct and indirect import content (including custom duties) (a^{M})	Other items	Total
1973	20.1	15.6	21.6	42.7	100.0
1974	19.0	16.4	23.8	40.8	100.0
1975	18.4	17.1	22.0	42.6	100.0
1976	18.1	17.5	23.6	40.8	100.0
1977	19.1	18.2	22.6	40.1	100.0
1978	21.2	18.7	21.6	38.6	100.0
1979	22.6	18.7	22.6	36.1	100.0
1980	20.9	19.4	24.0	35.7	100.0
1981	20.9	19.5	24.3	35.3	100.0
1982	20.4	19.7	24.4	35.6	100.0
1983	20.8	20.0	23.1	36.1	100.0
1984	21.2	19.8	23.3	35.7	100.0
1985	21.5	19.3	22.9	36.2	100.0
1986	21.1	18.8	21.4	38.7	100.0
1987	22.8	19.8	20.2	37.3	100.0
1988	22.2	20.7	20.6	36.6	100.0
1989	21.2	21.3	20.1	37.4	100.0
1990	18.6	20.7	19.9	40.8	100.0
1991	20.0	20.9	19.9	39.2	100.0
1992	18.9	21.0	19.8	40.3	100.0
1993	18.3	21.5	19.3	40.9	100.0
1994	18.9	20.4	19.5	41.1	100.0
1995	19.3	20.2	19.8	40.7	100.0
1996	19.7	20.1	20.0	40.2	100.0
1997	19.9	20.0	20.8	39.4	100.0
1998	20.6	19.9	20.8	38.7	100.0
1999	20.7	20.2	21.0	38.2	100.0
2000	19.7	20.4	21.6	38.3	100.0
2001	19.9	20.7	21.1	38.3	100.0
2002	20.2	20.9	20.7	38.3	100.0

Source: Table C.1 in Abildgren (2006a).

Table 6.C.2: Input-output based decomposition of the annual growth in the total private consumption deflator in Denmark 1903-2002, per cent

Year	Deflator for indirect taxes (excluding custom duties), net of subsidies (PIT)	Deflator for gross rents (PH)	Deflator for imports (including custom duties) (PM)	Underlying domestic inflation (UNDPCP)	Total private consumption deflator (PCP)
1903	-8.0	0.5	-3.2	-1.2	-1.7
1904	-7.3	-0.6	-1.1	-1.4	-1.3
1905	6.2	0.3	2.1	5.8	4.2
1906	31.3	-0.5	5.6	-2.0	0.9
1907	-8.8	0.7	7.6	-0.3	2.0
1908	15.9	-0.2	-4.1	0.9	-0.4
1909	-19.0	2.2	-0.3	-2.5	-1.6
1910	16.8	0.3	-1.5	4.0	2.4
1911	-0.9	2.2	1.0	0.1	0.5
1912	2.3	2.0	8.7	3.4	4.8
1913	3.8	4.1	-1.9	5.2	3.0
1914	2.3	4.0	0.5	7.2	5.1
1915	...	...	...	...	...
1916	...	...	...	...	...
1917	...	...	...	...	...
1918	...	...	...	...	...
1919	...	...	...	...	...
1920	...	...	...	...	...
1921	...	...	...	...	...
1922	40.7	9.8	-27.1	-17.7	-15.7
1923	0.6	3.7	12.3	-5.0	0.6
1924	4.1	6.1	8.0	11.8	10.1
1925	-1.9	4.8	-9.8	-4.8	-5.1
1926	-9.0	3.1	-25.4	-11.9	-13.5
1927	4.6	2.3	-4.8	-8.0	-5.5
1928	1.4	1.9	1.3	-2.5	-0.9
1929	10.4	2.1	-2.5	0.2	0.1
1930	-0.7	2.1	-16.5	-7.6	-8.5
1931	-2.3	2.0	-17.5	-5.6	-7.3
1932	-1.5	0.9	4.4	-4.9	-2.1
1933	25.0	1.8	6.2	1.8	3.9
1934	7.8	0.0	5.2	8.7	6.8
1935	-4.6	3.9	1.2	6.6	4.7
1936	8.3	2.7	3.0	2.0	2.6
1937	6.5	2.4	13.0	0.0	3.2
1938	0.9	1.7	-4.2	3.2	1.5
1939	-0.3	1.8	0.8	6.7	4.6
1940	...	...	...	...	...
1941	...	...	...	...	...
1942	...	...	...	...	...
1943	...	...	...	...	...
1944	...	...	...	...	...
1945	...	...	...	...	...
1946	...	...	...	...	...
1947	...	...	...	...	...
1948	18.1	1.9	6.6	3.1	4.8
1949	4.8	6.7	0.2	3.4	3.2
1950	9.5	2.3	10.8	10.4	9.9
1951	6.9	5.2	24.3	4.2	9.3
1952	2.7	4.3	-2.4	2.9	1.8
1953	14.1	3.2	-8.0	2.4	1.3
1954	6.8	4.1	-3.2	2.0	1.4
1955	13.2	5.0	3.1	3.3	4.5
1956	5.2	4.9	3.1	5.1	4.6
1957	1.0	5.9	1.4	1.1	1.6
1958	7.9	4.4	-7.4	0.3	-0.2
1959	9.2	4.5	-3.8	3.6	2.6
1960	0.8	6.5	2.4	3.0	2.9
1961	-6.1	5.8	-3.1	8.4	3.9
1962	19.3	5.4	0.5	5.5	6.1
1963	14.4	5.3	-1.0	5.7	5.4
1964	10.4	4.5	2.1	2.7	3.9
1965	13.7	7.2	-0.6	5.9	5.7
1966	11.6	8.6	0.6	7.0	6.5
1967	9.7	12.6	0.7	4.7	5.6
1968	19.9	13.0	3.4	2.1	7.3
1969	5.7	9.7	3.4	3.6	4.7
1970	5.4	9.8	7.4	7.7	7.4
1971	7.6	9.8	5.9	6.8	7.2
1972	12.4	10.7	4.8	8.5	8.9

Table C.2: (continued)

Year	Deflator for indirect taxes (excluding custom duties), net of subsidies (PIT)	Deflator for gross rents (PH)	Deflator for imports (including custom duties) (PM)	Underlying domestic inflation (UNDPCP)	Total private consumption deflator (PCP)
1973	2.7	9.9	10.1	13.2	9.9
1974	15.3	10.0	31.5	5.5	14.3
1975	8.5	13.0	4.1	14.4	10.8
1976	14.0	15.0	7.6	7.8	10.1
1977	17.5	12.0	7.7	6.2	9.8
1978	20.2	9.5	2.6	6.7	9.2
1979	21.5	9.3	12.7	2.1	10.2
1980	13.7	8.8	20.5	0.5	9.7
1981	14.5	9.1	16.7	8.7	11.9
1982	6.7	11.2	10.2	11.6	10.2
1983	10.3	10.3	4.2	5.5	7.2
1984	4.9	7.2	8.3	6.0	6.6
1985	4.1	5.7	1.8	5.3	4.3
1986	7.5	5.1	-10.8	5.4	2.3
1987	3.6	6.7	-3.1	7.6	4.3
1988	9.6	6.7	1.5	0.7	4.1
1989	1.7	7.1	6.3	3.6	4.5
1990	0.1	5.7	-1.3	3.1	2.2
1991	-0.2	4.1	2.1	3.9	2.8
1992	-0.9	3.0	-1.1	2.1	1.1
1993	1.9	3.9	-1.3	0.4	1.1
1994	2.0	3.5	0.4	3.7	2.7
1995	3.1	3.1	0.5	1.3	1.8
1996	3.7	2.2	-0.1	1.0	1.6
1997	2.6	3.8	2.4	0.5	2.0
1998	4.1	2.9	-2.1	1.1	1.4
1999	2.9	2.7	-0.5	2.3	1.9
2000	2.4	2.8	7.2	0.3	2.7
2001	2.9	3.3	1.5	2.0	2.3
2002	3.9	3.2	-1.8	3.2	2.3

Source: Table C.2 in Abildgren (2006a).

Essay 7: Short-Term Impacts on Exchange Rates in Denmark from Cross-Border Portfolio Flows 1984-2004[230]

Abstract

Utilising a unique data set on monthly private cross-border portfolio gross and net flows to and from Denmark 1984-2004 essay 7 analyses the short-term relationship between capital flows related to portfolio investments and changes in the Danish nominal krone rate vis-à-vis the euro (D-mark prior to 1999).

The main finding is that portfolio investments are important to short-term exchange-rate determination and that the sign of the estimated effect is as expected: Net inflows of capital strengthen the exchange rate. This result is robust to a division of the data sample into sub-periods as well as to an inclusion of central-bank intervention in the foreign-exchange market and changes in the short-term interest-rate spread vis-à-vis the currency anchor as endogenous explanatory variables. Portfolio flows in Danish bonds appear to be driving the results prior to the introduction of the euro. Since then the main driver has been portfolio investments in foreign shares.

Over time there appears to have been a declining effect on the krone-rate from portfolio flows which might be seen as the result of increased credibility of the Danish exchange-rate peg.

The relatively low levels of the coefficients of determination in the estimated regression models seem to indicate that the krone rate in the short-term is also influenced by other factors than contemporaneous portfolio flows. However, statistics on the magnitude and composition of cross-border portfolio flows is still crucial information for a central bank when implementing and communicating interest-rate and intervention strategies for stabilising the exchange rate within a regime of pure exchange-rate targeting and no capital-account restrictions.

Key words: Portfolio flows; FX microstructure; Exchange-rate dynamics.
JEL Classification: E52, F31, F32.

[230] This essay is based on Abildgren (2007a, 2008c).

7.1. Introduction

Traditional models of exchange-rate determination focus on macroeconomic fundamentals such as cross-country differentials in interest-rates, inflation, money growth, current account balances, and economic growth. Furthermore, such models are implicitly based on the assumption that all information relevant for exchange-rate determination is publicly available and immediately reflected in the exchange rate. However, empirically the macroeconomic approach has had rather great difficulties at outperforming a random walk benchmark in explaining short-term exchange-rate movements, cf. the survey in Sarno & Taylor (2002).

During the past decade or so the microstructure literature on exchange-rate determination has highlighted the importance of trading institutions, order flows and the spread of information in the foreign exchange (FX) markets to short-term exchange-rate behaviour. [231] The basic line of reasoning is that trading in many FX markets largely takes place between market participants - mainly market makers, brokers, customers and central banks - outside an exchange (so-called Over-The-Counter trading, OTC). Within this setting a market maker may extract information on e.g. trends in supply and demand of foreign exchange from order flows and central-bank interventions. The market maker can utilise this information to adjust his prices for purchase and sale of foreign exchange in order to avoid an undesirably large or small FX inventory. An overweight of purchase orders pushes prices up, while prices are reduced if there is an overweight of sales orders. Furthermore, the market maker may use private information extracted from order flows for trade positions for own account with the aim of making a profit (proprietary trading).

The microstructure approach should not be seen as an alternative theory of foreign-exchange-rate determination compared to the macroeconomic approach, cf. e.g. Gereben *et al.* (2005), Evans (2010) and Rime *et al.* (2010). Ultimately, order flows probably mainly depend on the economic agent's expectations regarding future macroeconomic fundamentals. However, the microstructure approach focuses on the process by which changes in such expectations are transmitted into the actual exchange rates via order flows and basic supply-demand forces.

Microstructure-inspired empirical studies seem to have had some success in explaining short-term exchange-rate fluctuations and basically two fundamentally different data approaches have been used to explore the relationship between FX order flows and exchange-rate movements: A "direct" approach and an "indirect" one.

[231] Cf. e.g. Lyons (2001) for a theoretical exposition of the microstructure theory and Sager & Taylor (2008) for a recent survey on the empirical literature on order flows and exchange rate movements.

One strand of research is based directly on FX-transaction data from an individual bank[232], an electronic foreign-exchange broker[233] or from special statistics covering all or most of the FX transactions in a small currency area[234]. The main advantage of this approach is that the data sets concern actual FX transactions. Furthermore, these kinds of data sets usually contain detailed information on each transaction (e.g. the side of the trade, the initiator of the trade, transaction price and size, the type of customer, etc.). They are also often recorded at a very high frequency, e.g. time-stamped transaction data or at least data on a daily frequency. The main drawback of the direct approach is that the data sets applied most often only cover a minor share of all FX transactions in the currency pair under study. Furthermore, the public access to such data sources may be very restricted due to e.g. confidentiality of customer transactions or simply the proprietary nature of the data.

The indirect approach utilises public information on e.g. portfolio investments or direct investments from the financial accounts of the balance of payments statistics or equivalent sources[235] as proxies for FX order flows. Such data sets give a complete picture of all cross-border financial transactions, although usually at a lower data frequency (monthly or quarterly data) and with limited breakdowns on instruments, counterparty sector and customer's residence. However, certain capital flows may not even give rise to FX transactions at all. Direct investments linked to mergers and acquisitions (M&A) may e.g. partly be settled by equity swaps ("payment" in shares) rather than cash. The exchange-rate impact related to M&A activities may also take place quite some time before the actual transactions due to market participants taking positions based on rumours of – or announcement of – M&A activities.[236] Furthermore, the influence on the exchange rate from e.g. portfolio investments may depend on the degree to which the exchange-rate risks are hedged by other financial instruments.[237] Being one step away from the actual FX transactions the indirect approach thus also has its limitations.

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[232] Evans & Lyons (2006) utilise e.g. Citybank customer transaction-level order flows (aggregated to a daily frequency) in the USD/EUR and USD/DEM spot and forward market 1993-1999. Citybank's market share at that time was estimated to be around 10-15 per cent in the relevant segment.

[233] Killeen *et al.* (2006) use for example daily data on brokered interdealer purchases and sales in the FRF/DEM spot market in 1998 from Electronic Broking Services (EBS). The market share by EBS was estimated to be around 20 per cent in the segment at that time.

[234] Gereben *et al.* (2006) utilise e.g. data from the Daily Foreign Exchange Report 2001-2006 of the central bank in Hungary covering the major foreign-exchange transactions carried out by commercial banks resident in Hungary. Rime (2006) utilises a daily data set from 2005-2006 reported to Norges Bank by participants in the NOK foreign-exchange market. Hansen & Storgaard (2005) uses daily data for the period December 2004 to April 2005 on the foreign-exchange turnover vis-à-vis Danish kroner reported by a group of major Danish banks.

[235] Brooks *et al.* (2004), Hau & Rey (2006) and Siourounis (2008) use e.g. monthly or quarterly US data on net cross-border capital flows since the 1980s.

[236] Cf. Jayaswal *et al.* (2006) for recent event studies in a Danish context.

[237] Assume e.g. that a Danish insurance company makes a spot purchase of foreign bonds denominated in euro from a foreign investor. The Danish insurance company purchases euro vis-à-vis kroner in the FX spot market in order to pay for the transaction. However, the Danish insurance company may chose to hedge the foreign-

Trading in the Danish foreign-exchange market for Danish kroner solely take place OTC and the market structure fits quite well with the main line of thinking in the microstructure literature.[238] A priori one should therefore expect that order flows might have an effect on the short-term behaviour of the krone exchange rate. Hansen & Storgaard (2005) have analysed the short-term relationship between private cross-border capital flows to and from Denmark and the development in the Danish nominal krone rate vis-à-vis the euro in the period 1999-2004 using data on a monthly frequency from Danmarks Nationalbank's payment statistics. They find a significant relationship between the krone rate and portfolio flows but no impacts from direct investments or other capital flows. The exchange-rate impact from portfolio flows is also confirmed by Hansen and Storgaard, *op.cit.* in a data set on a weekly frequency.

Utilising a unique data set on monthly cross-border portfolio gross and net flows 1984-2004 broken down by instruments compiled on the basis of Danmarks Nationalbank's payment statistics the essay at hand complements the study in Hansen and Storgaard, *op.cit.,* by analysing a longer historical time span characterised by (almost) fully liberalised portfolio flows and a strategy of pure exchange-rate targeting in Denmark.

7.2. The Danish road to free cross-border portfolio flows and pure exchange-rate targeting

During the Bretton Woods period portfolio investments to and from Denmark required permission from the Danish monetary authorities. With the Danish membership of EEC in 1973 Denmark became subject to EEC's capital directives. This initiated a gradual process with deregulation of cross-border portfolio flows to and from Denmark. In January 1973 non-residents were given free access to buy Danish exchange-listed portfolio shares and in December 1974 also Danish exchange-listed bonds (with an original maturity of more than 2 years). However, in February 1979 this permission was abolished again regarding krone-denominated Danish central-government bonds issued since 1975. In May 1983 non-residents once again was granted permission to buy krone-denominated Danish central-government bonds (with an original maturity of more than 2 years). Furthermore, in May 1983 non-residents purchase of Danish non-exchange-listed shares was liberalised. In January 1978 residents got permission to purchase exchange-listed bonds issued by international organisations of which Denmark was a member and in May 1983 this permission was

exchange risk by a sale of euro vis-à-vis kroner on a forward basis to a Danish bank. The bank will normally not assume the exchange-rate risk in relation to such forward contracts by holding open net positions. Instead the bank will usually hedge the transactions by an offsetting contract, i.e. sell euro vis-à-vis kroner in the FX spot market. The net demand for euro vis-à-vis kroner in the FX spot market is therefore zero, whereas the cross-border portfolio flow data from the financial accounts of the balance of payments statistics will show a net outflow of capital from Denmark indicating a net demand for euro vis-à-vis kroner.

[238] The microstructure of the Danish krone-denominated foreign-exchange market is covered in detail by Abildgren (2006d).

extended to cover all exchange-listed foreign bonds (with an original maturity of more than 2 years). In January 1984 residents were granted free access to purchase exchange-listed foreign shares. The last restrictions on cross-border portfolio flows – mainly concerning non-residents purchase of Danish Treasury notes and other Danish money market papers and resident's purchase of non-listed foreign shares – were removed in October 1988.[239]

The early 1980s also witnessed a fundamental change in the Danish exchange-rate policy and the fiscal-policy regime. After the breakdown of the Bretton Woods system in the beginning of the 1970s, the Danish exchange-rate policy became part of the European exchange-rate co-operation, first within the "Currency Snake" founded in 1972 and subsequently from 1979 within the European Exchange Rate Mechanisms (ERM I and from 1999 ERM II). The oil price shocks of the 1970s and the frequent devaluations of the krone during the late 1970s and the beginning of the 1980s caused an upward trend in inflation and a widening of the long-term interest spread between Denmark and its main trading partners. Danish government bond yields reached a post-1875 all time high of 22.11 per cent in 1982. The government debt increased rapidly, and a fear that Denmark was on the verge of "state bankruptcy" began to rise. In the beginning of the 1980s the yield on long-term Danish government bonds exceeded the yield on long-term Danish mortgage-credit bonds for the first time since the period around World War I.[240] This highlights the extent of the crisis in the Danish economy at the beginning of the 1980s. In September 1982 the incoming Danish government announced the abolishment of devaluation as an economic-policy instrument. Furthermore, wage indexation was abolished and the fiscal policy was tightened and became oriented towards medium-term stability. The Deutsche Mark was revalued several times within the ERM I in the period 1982-1987, including vis-à-vis the krone, but never on the initiative of Denmark. The last realignments of the central parity for Danish kroner vis-à-vis Deutsche Mark within ERM I occurred in January 1987. Since then Denmark has pursued a "hard" peg against the D-mark and later the euro[241], despite major devaluations during the 1990s by some of Denmark's main trading partners, cf. Figure 7.1.

The stabilisation measures and the international decline of inflation rates during the 1980s and the beginning of the 1990s caused a marked downward trend in both inflation and nominal interest rates in Denmark. The long-term interest spread between Denmark and Germany decreased rapidly from more than 13 per cent in 1982 to less than 1 per cent in 1991

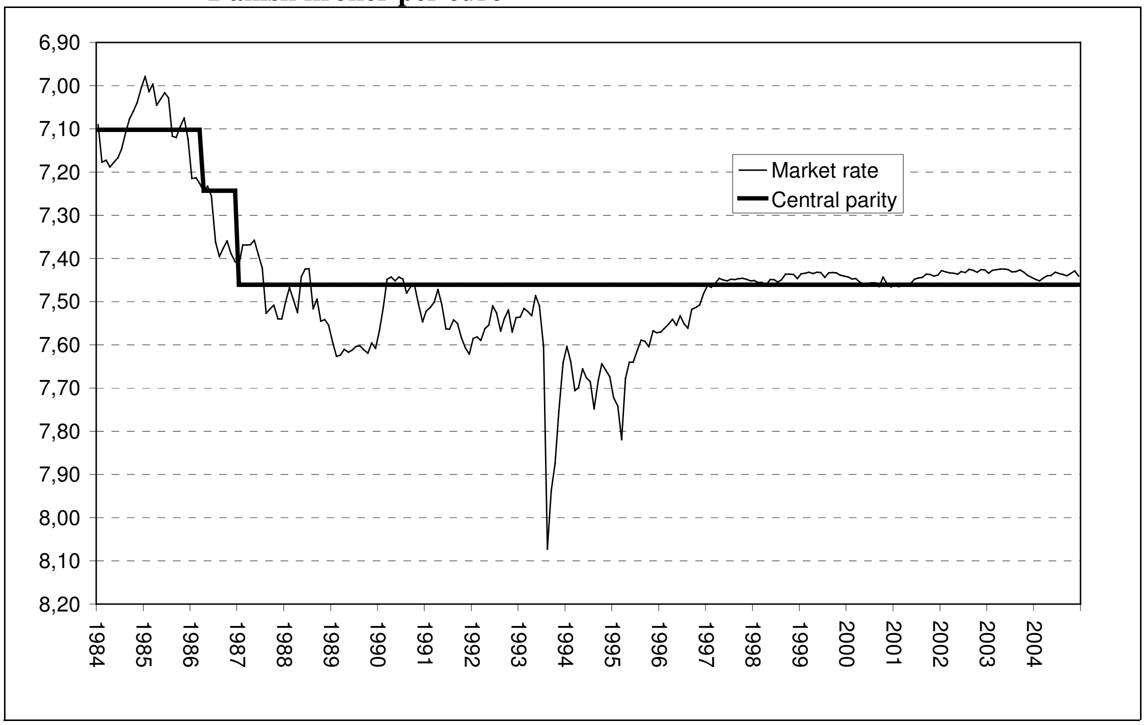
[239] For a review of the liberalisation of cross-border capital movements in Denmark in the period 1950-1988, cf. Hald & Jensen (1986) and Biltoft-Jensen (1991).

[240] Cf. Abildgren (2005b).

[241] The central parity of kroner within ERM II (7.46038 kroner per euro) corresponds exactly to the central parity rate vis-à-vis Deutsche Mark from 1987. Danmarks Nationalbank (2003) offers more details on ERM I and II, including the differences and similarities between the two exchange-rate mechanisms.

and 0.22 per cent in 2004, and since the early 1990s the level of inflation in Denmark has roughly been of the same low level as that of Germany and since 1999 the euro area.

Figure 7.1: Bilateral exchange rate and central parity vis-à-vis the euro 1984-2004, Danish kroner per euro



Note: End of month. Reversed scale. Before 1999 a synthetic krone rate vis-à-vis the euro is applied, calculated on the basis of the krone rate vis-à-vis the D-mark and the D-mark-to-euro conversion rate fixed at 1 January 1999.
Source: Figure 1 in Abildgren (2008c).

For the whole period since 1984 the Danish economy can be characterised as a small open economy with (almost) fully liberalised private cross-border portfolio flows and a monetary-policy regime oriented towards pure exchange-rate targeting vis-à-vis the D-mark and later the euro. This part of Denmark's recent exchange-rate history is therefore particularly suitable for an empirical analysis of the short-term exchange-rate effect from portfolio flows within a fixed exchange-rate regime.

7.3. Data description and trends in the key variables

For the analysis in this essay a data set on monthly gross and net capital flows related to cross-border portfolio investments 1984-2004 broken down by four categories (Danish shares, Danish bonds *etc.*, foreign shares and foreign bonds *etc.*) has been constructed on the basis of Danmarks Nationalbank's payment statistics. During the period 1984-2004 the Nationalbank's payment statistics was mainly compiled on the basis of information on all cross-border portfolio transaction made via a large number of Danish foreign-exchange dealers[242] (a so-called ticket system[243]). This information was supplemented by reports from Danish non-financial firms[244] and private individuals on cross-border portfolio transactions made via accounts held abroad. Prior to 1998 the reporting system was entirely paper based making the system increasingly more costly to administrate – both for the foreign-exchange dealers and the Nationalbank – in step with the strong increase in the level of cross-border capital flows. In 1998 an electronic reporting system was introduced but the main principles (reporting of every transactions) remained unchanged. In the early period of the new electronic system around 4,400 securities transactions was on average reported each day, cf. Tryde (1999).

Fundamentally, the origin of the ticket-based payment-statistics reporting system can be traced back to the period before portfolio flows were liberalised and payments across borders required permission from the Danish monetary authorities. Since then a number of other statistics (e.g. MFI statistics and security statistics based on reporting by custodian institutions) have evolved significantly and can now also be used as sources for the financial accounts in the balance of payment statistics. With effect from 2005 the Nationalbank's ticked-based payment-statistics reporting system was therefore abolished and the statistics on capital flows is now drawn from other sources.[245] As a consequence information on cross-border gross capital flows is no longer available, which is the reason why the data sample behind the analysis in the essay at hand ends in 2004.

Figure 7.2 shows the gross and net capital flows to and from Denmark related to cross-border portfolio investments 1984-2004. Both gross and net flows have increased markedly during the recent decades in step with the liberalisation of the international financial markets. Today – with the free movement of capital and the greater international diversification of Danish and foreign investors' portfolios – the amounts of net portfolio flows measured in billion kroner can even in periods when the foreign currency markets are calm reach a level previously only seen in connection with actual currency crises. Some sort of transformation has thus to be applied in order to ensure stationarity of the time series. One approach would be to measure the net portfolio flows in per cent of GDP. However, in this essay it has been chosen to measure the net portfolio flows in relation to the gross flows, which can be perceived as an indicator for the development in the liquidity of the foreign-exchange markets. Hereby the scaled figures on net portfolio flows can be interpreted as an indicator of

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[242] In 1999 around 70 large and medium-sized banks.

[243] The name of such a system is due to the fact that reporting to Danmarks Nationalbank was made every time a trade ticket was completed.

[244] In 1999 around 640 firms.

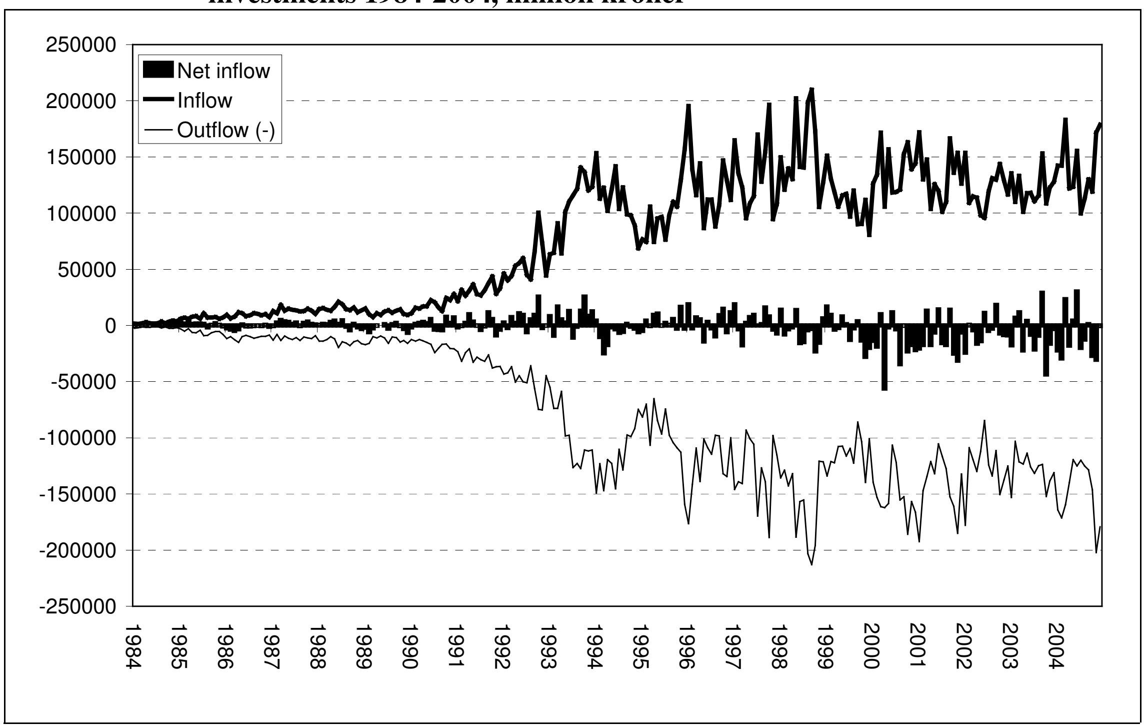
[245] Cf. Hald (2007).

the relative degree of “disequilibrium” in the krone-denominated foreign-exchange market resulting from cross-border portfolio flows.

To ensure stationarity all capital flows studied in this paper has therefore been scaled by the total gross portfolio flow (inflow + outflow) in the segment of relevance. However, the robustness of this transformation method will be examined further in section 7.4.

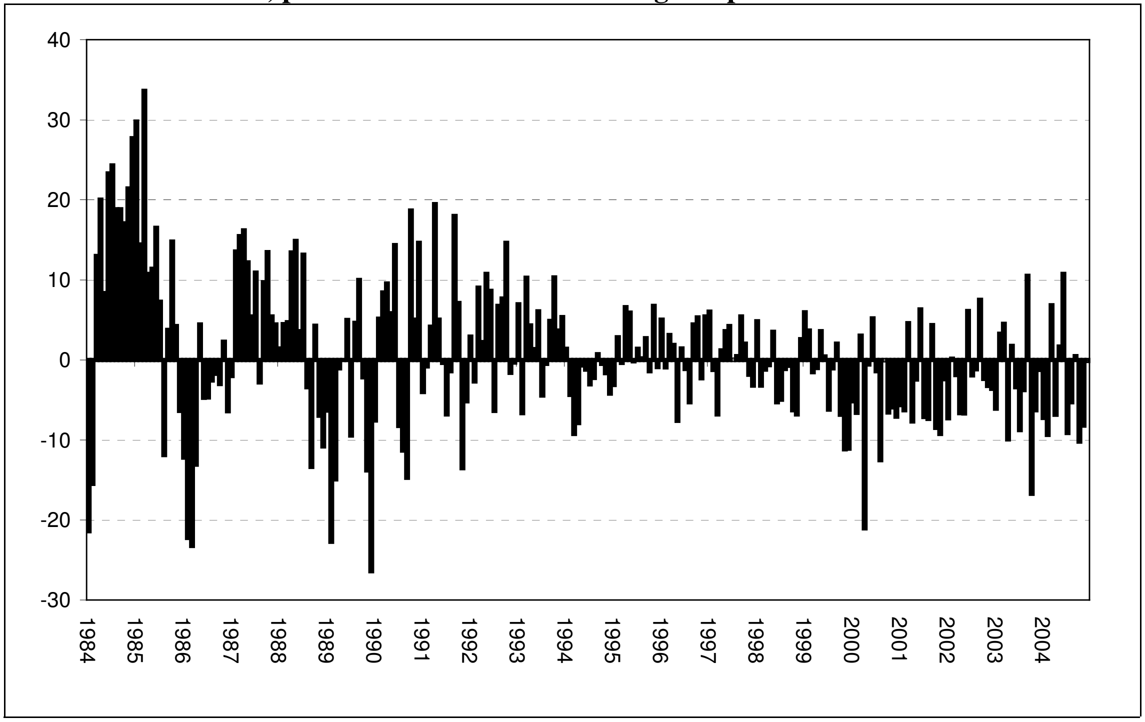
Figure 7.3 shows the results regarding the total net capital flows related to cross-border portfolio investments. *A priori* one should expect that a net inflow of capital lead to a strengthening of the krone. Over the period 1984-2004 the simple contemporaneous correlation coefficient between the total net capital inflow to Denmark from portfolio investments and the monthly change in the exchange rate (DKK per EUR and before 1999: DKK per DEM) is –0.21. A visual impression of this correlation is hinted in Figure 7.4 in which a 12-month moving average is used in order to smooth out short-term fluctuations.

Figure 7.2: Capital flows to and from Denmark related to cross-border portfolio investments 1984-2004, million kroner



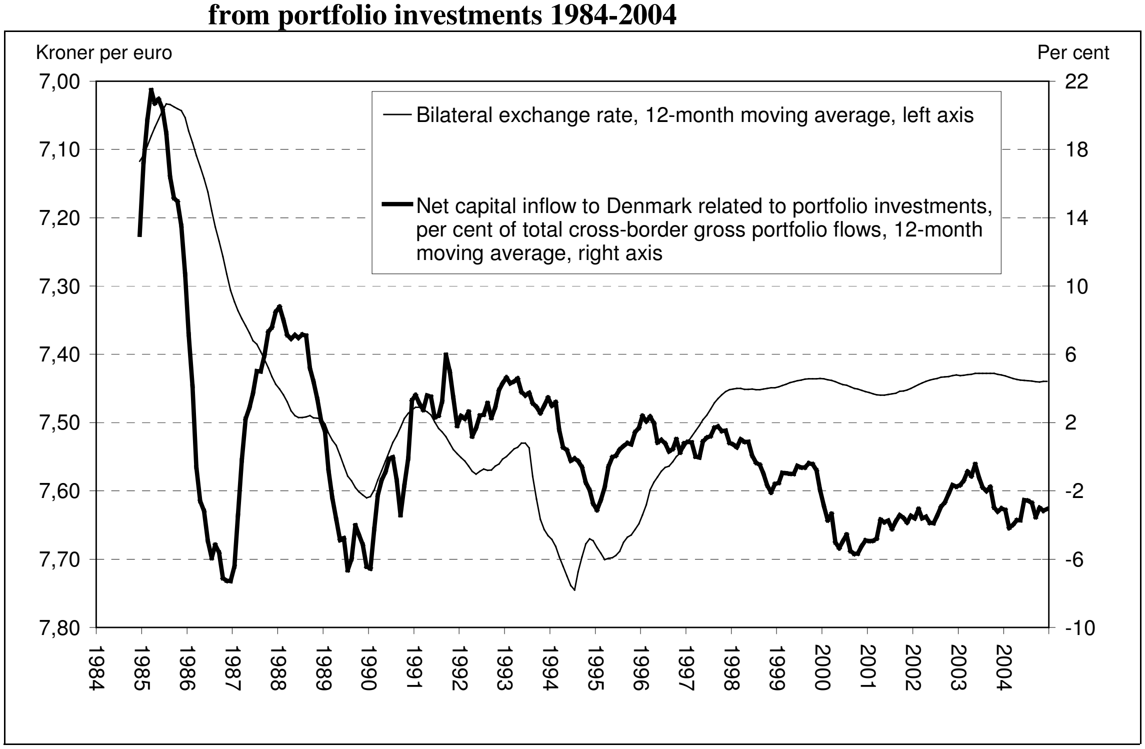
Source: Figure 2 in Abildgren (2008c).

Figure 7.3: Net capital inflow to Denmark related to portfolio investments 1984-2004, per cent of total cross-border gross portfolio flows



Source: Figure 3 in Abildgren (2008c).

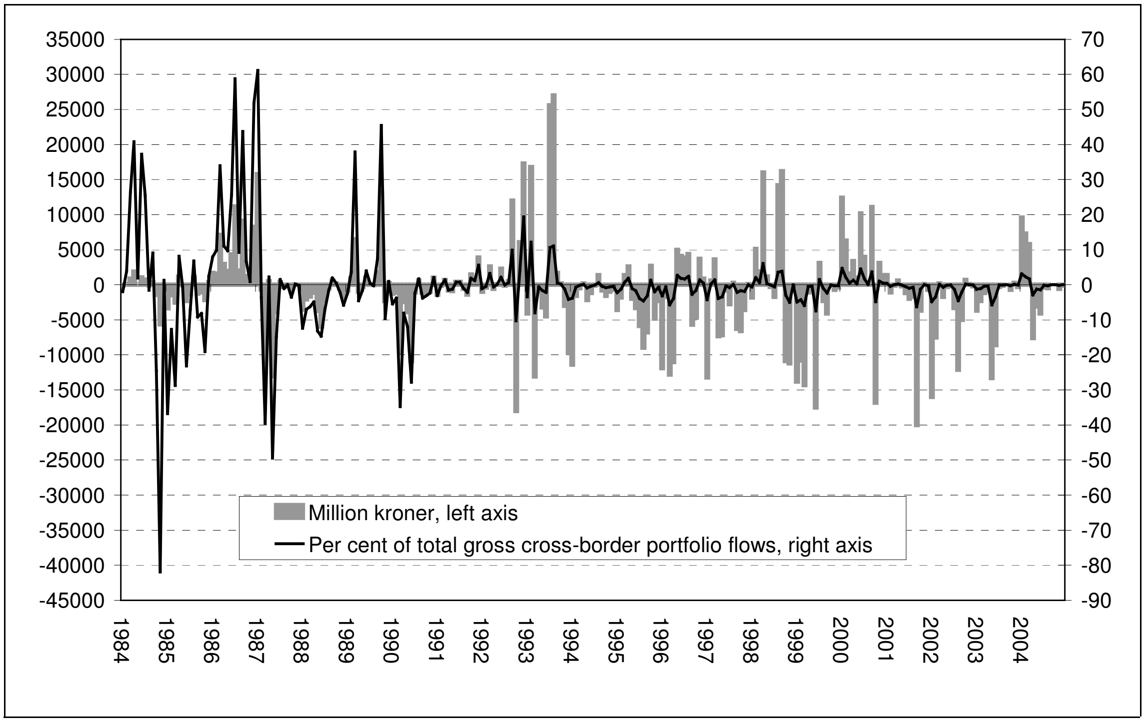
Figure 7.4: Bilateral krone-rate vis-à-vis the euro and net capital inflow to Denmark from portfolio investments 1984-2004



Source: Based on appendix B in Abildgren (2007a).

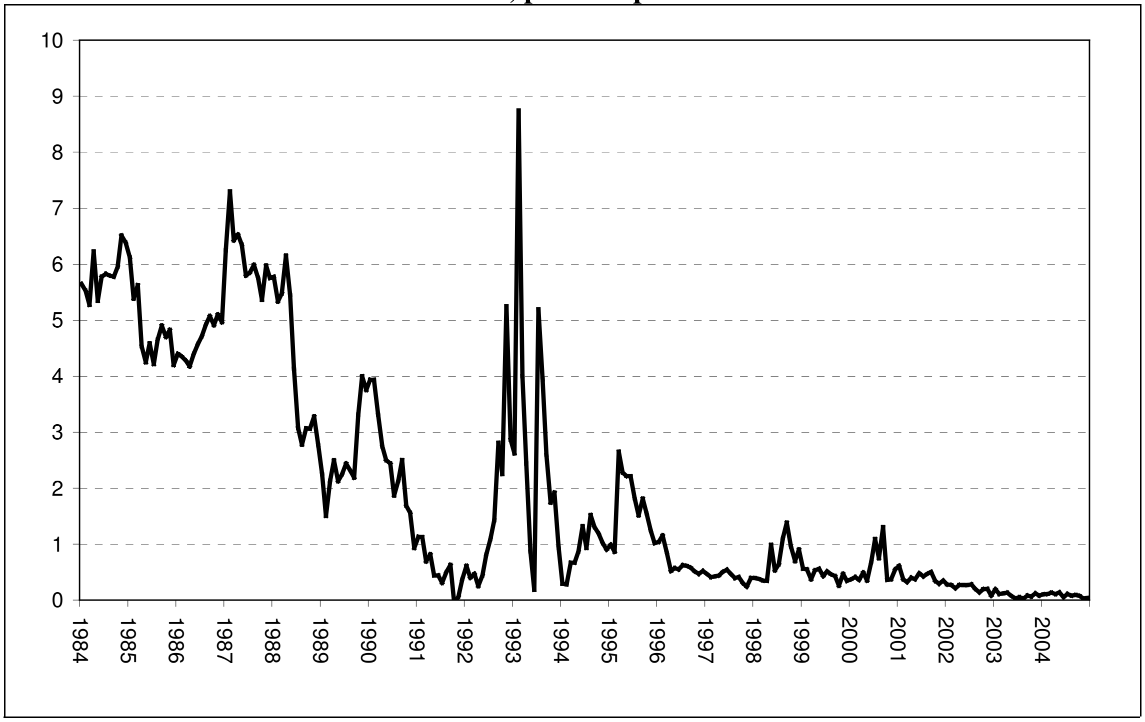
Following the lines within the FX microstructure literature the analysis in this paper is based on the assumption that the causality goes from portfolio flows to changes in the krone-euro exchange rate – and not vice versa – so that simultaneity bias is not an issue. This assumption is reasonable at very high data frequencies (e.g. at intraday or daily frequencies) but is naturally debatable for an analysis based on monthly observations. Due to the increasingly credible Danish fixed-exchange-rate policy in the period 1984-2004 – with a unchanged parity vis-à-vis the currency anchor for almost 18 out of the 21 years – it might also be a reasonable starting point to assume that portfolio decisions within a month does not depend on contemporaneous changes in the krone-euro rate. However, this assumption will be discussed more thoroughly in section 7.6.

Figure 7.5: Danmarks Nationalbank's net sale of foreign exchange vis-à-vis kroner 1984-2004



Source: Figure 4 in Abildgren (2008c).

Figure 7.6: Short-term money market interest-rate spread between Denmark and the euro area 1984-2004, per cent per annum



Note: End of month. Prior to 1999: Short-term interest rate spread vis-à-vis Germany.
Source: Figure 5 in Abildgren (2008c).

Danmarks Nationalbank's intervention in the krone-foreign-exchange market and changes in the short-term interest-rate spread between Denmark and the currency anchor are two other key variables that must be assumed to affect the short-term movements in the krone-euro exchange rate, cf. Figure 7.5 and 7.6. The *a priori* expectation is that a central-bank sale of foreign exchange vis-à-vis Danish kroner or an increase in the short-term interest-rate spread[246] tends to strengthen the krone. However, Danmarks Nationalbank's interventions in the foreign exchange market and changes in the short-term money-market interest rate spread vis-à-vis the currency anchor can not be seen as exogenous to the changes in krone-euro exchange rate. In a system with pure exchange-rate targeting interventions and changes in the interest-rate spread are used as instruments in the monetary and foreign-exchange-rate policy in order to manage the exchange rate. The three variables are therefore part of a simultaneous system, which has to be taken into account in the empirical analysis.

The empirical analysis in the sections below are based on the following variables and mnemonics:

[246] The short-term money market rate is actually not the monetary policy instrument, but during the whole period since 1984 Danmarks Nationalbank has managed the short-term money market rates via its monetary-policy interest rates and money market operations. Furthermore, via the use of market rates instead of policy rates expectations regarding future monetary-policy actions will be reflected in the data.

$dSdkkeur_t$ — Percentage change in the krone-euro spot exchange rate (DKK per EUR) from end-of-month t-1 to end-of-month t. A positive sign denotes a weakening of Danish kroner vis-à-vis the euro.

NPF_t — Total net capital flows related to cross-border portfolio investments in month t measured in per cent of total cross-border gross portfolio flows in month t. A positive sign denotes an inflow of capital to Denmark.

$NPFDS_t$ — Non-residents net cross-border portfolio purchase of Danish shares in month t measured in per cent of total cross-border gross portfolio flows in Danish shares in month t. A positive sign denotes an inflow of capital to Denmark.

$NPFDB_t$ — Non-residents net cross-border portfolio purchase of Danish bonds *etc*. in month t measured in per cent of total cross-border gross portfolio flows in Danish bonds etc. in month t. A positive sign denotes an inflow of capital to Denmark.

$NPFFS_t$ — Residents net cross-border portfolio sale of foreign shares in month t measured in per cent of total cross-border gross portfolio flows in foreign shares in month t. A positive sign denotes an inflow of capital to Denmark.

$NPFFB_t$ — Residents net cross-border portfolio sale of foreign bonds *etc*. in month t measured in per cent of total cross-border gross portfolio flows in foreign bonds etc. in month t. A positive sign denotes an inflow of capital to Denmark.

$CBFX_t$ — Danmarks Nationalbank's net sale of foreign exchange vis-à-vis kroner in month t measured in per cent of total cross-border gross portfolio flows in month t. A positive sign denotes that the Nationalbank sells foreign currency and buys Danish kroner.

$d3MIS_t$ — Change in the 3-month uncollateralised money market interest-rate spread between Denmark and the euro area from end-of-month t-1 to end-of-month t measured in per cent per annum.

For all variables stated above non-stationarity is rejected at a 1 per cent significance level using Augmented Dickey Fuller (ADF) tests.[247] This result is also consistent with *a priori* expectations based on conventional economic reasoning. The variables are therefore treated as stationary.

Abildgren (2007a) details the sources and methods used to construct the data set applied in the essay at hand and includes a listing of all variables.

[247] Cf. Table 1 in Abildgren (2007a). The ADF tests applied include a constant but no trend. ADF tests are known to be sensible to the choice of lag length. The lag length in the ADF tests has been chosen with the aim of ensuring no signs of autocorrelation in the residuals from the auxiliary regressions. Furthermore, since August 1993 proves to be a serious outlier observation all tests has been made both with and without this observation. However, the results from all the tests are the same: non-stationarity is rejected at a 1 per cent significance level. All econometric results presented in this essay have been obtained using PcGive.

7.4. The exchange-rate effects from portfolio flows

The baseline regression model used as a starting point is the following:

$$[7.1]\ \text{Model I}: \text{dSdkkeur}_t = \text{constant} + b_{NPF} \cdot \text{NPF}_t + e_t$$

where the monthly change in the krone rate (dSdkkeur_t) is explained by the total net capital flows from portfolio investments (NPF_t). e is an error term and the model is estimated via Ordinary Least Squares (OLS) based on the assumption that the explanatory variable is exogenous, cf. the discussion in section 7.3.

The estimation results for the full sample period 1984-2004 (model Ia in Table 7.1) indicate that portfolio flows are significantly related to short-term changes in the krone rate and that the sign of the effect is as expected: A net inflow of capital to Denmark leads to a strengthening of the krone.

However, the standardised residuals indicate that August 1993 – the month where the fluctuation bands in ERM were widened to +/- 15 per cent after a period with severe European currency turmoil – is a serious outlier. Excluding the observation from August 1993 from the sample (model Ib in Table 7.1) leaves the estimated exchange-rate effect from the net capital inflow virtually unchanged.

Table 7:1: OLS regression of the monthly change in the krone exchange rate (dSdkkeur_t) explained by total net capital inflow from portfolio investments

	Model Ia	Model Ib
	Full sample 1984-2004	Full sample 1984-2004 (excluding August 1993)
Constant term	0.02967	0.004996
HAC standard error	0.03286	0.02700
Net capital inflow (b_{NPF})	-0.01308***	-0.01274***
HAC standard error	0.002652	0.002535
R^2 adjusted for degrees of freedom	0.04	0.07
Number of observations	252	251

Note: Monthly observations. *, ** and *** denotes rejection of the null hypothesis (coefficient equal to zero) at a respectively 10, 5 and 1-per-cent significance level based on heteroskedasticity and autocorrelation consistent (HAC) standard errors.

Source: Table 1 in Abildgren (2008c).

The adjusted coefficient of determination shows that model Ib explains around 7 per cent of the monthly changes in the krone rate vis-à-vis the currency anchor. This is comparable in magnitude with findings in similar studies for other countries. However, it also underlines that the short-term fluctuations in the krone rate are influenced by other factors than portfolio flows.

The credibility of the Danish fixed-exchange-rate regime increased gradually during the period 1984-2004, which also has witnessed several cases of currency crises or turmoil within the European exchange-rate co-operation. Furthermore, the period includes the launch of the euro in 1999 and the introduction and increased use of electronic trading in the krone-denominated foreign-exchange market. Thus this part of Denmark's recent exchange-rate history includes a number of macroeconomic and microstructure developments with may have influenced the exchange-rate effects from portfolio flows and consequently call for a certain degree of caution when results from econometric estimations are interpreted.

As part of a general robustness check the baseline model from Table 7.1 has therefore been estimated for three separate sub-periods with the following characteristics:

1984-1988: Almost free cross-border portfolio flows and pure exchange-rate targeting vis-à-vis the D-mark. Two cases of adjustment of the central parity vis-à-vis D-mark.

1989-1998: Totally free cross-border portfolio flows and pure exchange-rate targeting with unchanged parity vis-à-vis the D-mark. Several cases of currency turmoil within the European Exchange-rate Co-operation.

1999-2004: Totally free cross-border portfolio flows and pure exchange-rate targeting with unchanged parity vis-à-vis the euro.[248]

Table 7.2: OLS regression of the monthly change in the krone exchange rate ($dSdkkeur_t$) explained by total net capital inflow from portfolio investments, various sub-periods

	Model Ic	Model Id	Model Ie	Memo: Model Ib
	1984-1988	1989-1998	1999-2004	1984-2004
Constant term	0.2111***	-0.05270	-0.01512**	0.004996
HAC standard error	0.06297	0.04096	0.007532	0.02700
Net capital inflow (b_{NPF})	-0.01922***	-0.01560**	-0.004621***	-0.01274***
HAC standard error	0.004395	0.006530	0.001116	0.002535
R^2 adjusted for degrees of freedom	0.20	0.05	0.11	0.07
Number of observations	60	119	72	251

Notes: Monthly observations. Excluding August 1993. *, ** and *** denotes rejection of the null hypothesis (coefficient equal to zero) at a respectively 10, 5 and 1-per-cent significance level based on heteroskedasticity and autocorrelation consistent (HAC) standard errors.

Source: Table 2 in Abildgren (2008c).

[248] The introduction of the euro in January1999 has been chosen as the separation point between the second and third sub-period since this event may have changed the microstructure of the FX markets (elimination of a large number of currencies). However, looking at Figure 7.1 one could also have chosen a split point in the mid-1990s after the end of the currency turmoil and after the Nationalbank began to stabilise the krone rate very close to the central parity vis-à-vis the D-mark, cf. below.

Table 7.3: OLS regression of the monthly change in the krone exchange rate ($dSdkkeur_t$) explained by total net capital inflow from portfolio investments (in levels), various sub-periods

	Model Ic (NPF in levels)	Model Id (NPF in levels)	Model Ie (NPF in levels)
	1984-1988	1989-1998	1999-2004
Constant term	0.1617**	-0.03977	-0.01378*
HAC standard error	0.06676	0.03730	0.007676
Slope coefficient to net capital inflow in levels	-0.09073***	-0.01974***	-0.001558***
HAC standard error	0.03102	0.006428	0.0004978
R^2 adjusted for degrees of freedom	0.11	0.13	0.09
Number of observations	60	119	72

Notes: Monthly observations. Excluding August 1993. *, ** and *** denotes rejection of the null hypothesis (coefficient equal to zero) at a respectively 10, 5 and 1-per-cent significance level based on heteroskedasticity and autocorrelation consistent (HAC) standard errors.

Source: Table 3 in Abildgren (2008c).

The results are shown in Table 7.2. In all sub-periods net capital flows from portfolio investments are clearly significantly related to short-term changes in the krone rate with the expected sign.

Based on the average conditions in the period 1999-2004 the estimated coefficient from model Ie in Table 7.2 translates into the following absolute effect: A net capital inflow of 10 billion kroner strengthens the krone by 13 pips (e.g. from 744.01 to 743.88 kroner per 100 euro). This effect is similar to the findings (12 pips) in Hansen & Storgaard (2005) based on weekly data in a somewhat different model set-up.[249]

As a robustness check of the chosen method of transformation to stationarity model Ic to Ie can be estimated on the basis of net portfolio flows in levels (billion kroner), e.g. without the scaling by the total gross portfolio flows, cf. Table 7.3. The main results remain unchanged: In all sub-periods net capital flows from portfolio investments are clearly significantly related to short-term changes in the krone rate with the expected sign.

The estimated models in Table 7.2 and 7.3 indicate that the exchange-rate effect from portfolio flows has declined over time. The estimated coefficients in Table 7.3 translate into the following effects: A net capital inflow of 10 billion kroner strengthens the krone vis-à-vis euro by 12 pips in the period 1999-2004, 149 pips in the period 1989-1998 and 661 pips in the period 1984-1988. The reduced effect on the exchange rate from net portfolio flows over time might be interpreted as a result of a more liquid krone-denominated foreign-exchange market. However it might also be the result of an increased credibility of the Danish exchange-rate

[249] Hansen & Storgaard, *op.cit.* find that a net capital inflow from portfolio investments of 10 billion kroner strengthens the krone by 12 pips in the period 1999-2004 distributed with an effect of 6 pips in the same week and a further 6 pips in the subsequent week. Their model is estimated on the basis of net capital flows in levels (e.g. the

peg. The market participants have gradually become more convinced that the Danish monetary authorities will ensure a stable krone-euro rate through interventions and interest-rate changes – no matter the size of cross-border capital flows. In recent years the market participants have taken positions in expectation of a stable krone-rate, and thereby contributed to stabilising the krone (self-stabilising speculation).[250]

Table 7.4: OLS regression of the monthly change in the krone exchange rate ($dSdkkeur_t$) explained by net capital inflow from portfolio by instruments

	Model IIa	Model IIb	Model IIc	Model IId
	1984-2004	1984-1988	1989-1998	1999-2004
Constant term	0.01573	0.2838***	-0.004244	-0.02538
HAC standard error	0.03801	0.1012	0.05771	0.01530
Net capital inflow, Danish shares (b_{NPFDS})	-0.002632*	-0.0001462	-0.006346**	0.0001756
HAC standard error	0.001428	0.001359	0.003028	0.0007641
Net capital inflow, Danish bonds (b_{NPFDB})	-0.009479***	-0.01804***	-0.01151**	-0.001623
HAC standard error	0.001962	0.004560	0.004550	0.001224
Net capital inflow, foreign shares (b_{NPFFS})	-0.0009810	-0.0003684	0.0004910	-0.001426**
HAC standard error	0.001610	0.002596	0.002414	0.015
Net capital inflow, foreign bonds (b_{NPFFB})	-0.001275	-0.001428	-0.0008597	-0.0009546
HAC standard error	0.001283	0.002879	0.001660	0.0005732
R^2 adjusted for degrees of freedom	0.07	0.20	0.06	0.06
Number of observations	251	60	119	72

Notes: Monthly observations. Excluding August 1993. *, ** and *** denotes rejection of the null hypothesis (coefficient equal to zero) at a respectively 10, 5 and 1-per-cent significance level based on heteroskedasticity and autocorrelation consistent (HAC) standard errors.

Source: Based in Table 4 in Abildgren (2008c).

A deeper understanding of the exchange-rate effect from different types of portfolio can be obtained by the use of the following regression model:

$$[7.2]\ \text{Model II}: dSdkkeur_t = constant + b_{NPFDS} \cdot NPFDS_t + b_{NPFDB} \cdot NPFDB_t + b_{NPFFS} \cdot NPFFS_t + b_{NPFFB} \cdot NPFFB_t + e_t$$

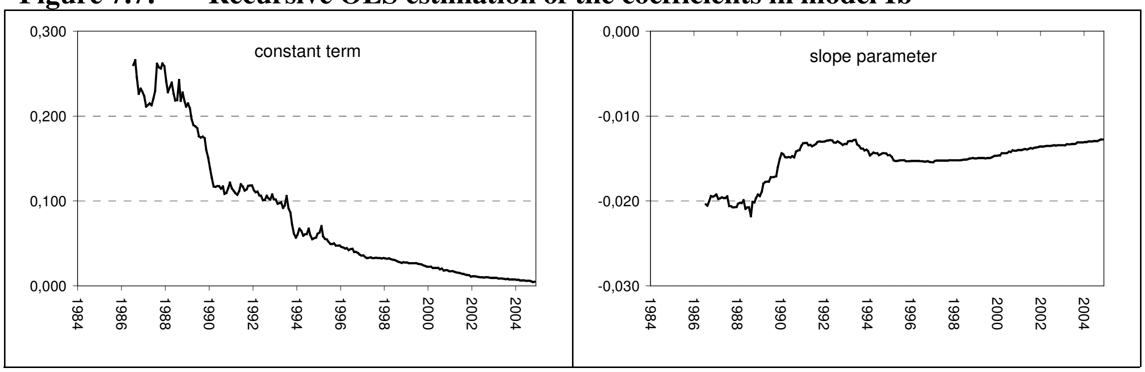
where the monthly change in the krone rate is explained by the net capital flows from portfolio investments broken down by instruments. The results are shown in Table 7.4. Net capital inflows from portfolio investments in Danish bonds have had a clearly significant impact on the krone rate with the expected sign prior to 1999. Since then the main driver has been capital flows from portfolio investments in foreign shares.

net portfolio flows are not scaled by the total gross portfolio flows). Furthermore, Hansen & Storgaard, *op.cit.* use average weekly data for the exchange rate – not end-of-week data.

[250] Cf. page 22 in Danmarks Nationalbank (2003).

The delimitation of the three separate sub-periods studied above is based on institutional characteristics of the Danish foreign-exchange regime. Alternatively one could have chosen to let the subdivision be determined empirically. One way to compare the differences between these two approaches is to examine the parameter stability using recursive estimations and then compare possible breaks with the chosen three-period sub-division. Figure 7.7 shows a recursive estimation of the coefficients in equation [7.1]. The data might suggest a break in the parameters in the late 1980's, which correspond to the split between the first two sub-periods. However, no obvious break is visible around 1999. The data rather indicate that a split in the mid-1990s might be suitable.

Figure 7.7: Recursive OLS estimation of the coefficients in model Ib



Note: Monthly observations. Excluding August 1993. 30 observations have been used to initialise the recursive estimation.
Source: Figure 6 in Abildgren (2008c).

An economic explanation for a possible break in the mid-1990s might be the end of several years with currency turmoil within the ERM. Furthermore, there was a change in the Nationalbank's strategy for interventions in the FX market in the mid-1990s. From 1996 the Nationalbank began to intervene more frequently in the krone-denominated FX market in order to smooth out even miner fluctuations in the krone rate and stabilise it closer around the central parity within ERM[251], cf. also Figure 7.1. The results from estimation of equation [7.1] with an alternative sub-division of the post-1989 period is shown in Table 7.5. The main results remain unchanged: In both sub-periods net capital flows from portfolio investments are clearly significantly related to short-term changes in the krone rate with the expected sign.

[251] Cf. page 37-38 in Danmarks Nationalbank (1997).

Table 7.5: OLS regression of the monthly change in the krone exchange rate ($dSdkkeur_t$) explained by total net capital inflow from portfolio investments – alternative division in sub-periods after 1989

	Model If	Model Ig
	1989-1995 (excluding August 1993)	1996-2004
Constant term	0.04734	-0.03099**
HAC standard error	0.04691	0.01224
Net capital inflow (b_{NPF})	-0.01531***	-0.007379***
HAC standard error	0.003129	0.002047
R^2 adjusted for degrees of freedom	0.08	0.13
Number of observations	143	108

Note: Monthly observations. *, ** and *** denotes rejection of the null hypothesis (coefficient equal to zero) at a respectively 10, 5 and 1-per-cent significance level based on heteroskedasticity and autocorrelation consistent (HAC) standard errors.

Source: Table 5 in Abildgren (2008c).

7.5. Central-bank interventions and changes in the short-term interest-rate spread

Besides portfolio flows changes in the short-term interest rate spread vis-à-vis the currency anchor and interventions in the krone-denominated foreign-exchange market by Danmarks Nationalbank must *a priori* also be assumed to have an effect on the short-term movements in the krone-euro exchange rate. It is therefore interesting to review the robustness of the main results in section 7.4 to the inclusion of these two variables in the regression model. However, as mentioned in section 7.3 changes in the krone rate vis-à-vis the currency anchor, changes in the short-term interest rate spread vis-à-vis the country of the currency anchor and the central bank's interventions are all part of a simultaneous system in a fixed exchange-rate regime which has to be taken into account in the analysis.

The baseline regression model used in this section is the following:

$$[7.3]\ \text{Model III}: \text{dSdkkeur}_t = \text{constant} + b_{NPF} \cdot \text{NPF}_t + b_{CBFX} \cdot \text{CNFX}_t + b_{d3MIS} \cdot \text{d3MIS}_t + e_t$$

where the monthly change in the krone rate ($dSdkkeur_t$) is explained by the total net capital flows from portfolio investments (NPF_t), the Nationalbank's interventions in the FX market ($CBFX_t$) and changes in the short-term interest-rate spread vis-à-vis the currency anchor ($d3MIS_t$). The regression model is estimated using Instrumental Variables (IV) methods. The assumption is that NPF is exogenous whereas CBFX and d3MIS are endogenous.

Good instruments that are both highly correlated with the relevant endogenous variables for which they serve as instrument and at the same time uncorrelated with the error term in the IV regression are always difficult to find. Lagged values of the central bank's interventions have been used as additional instruments for both the central bank's interventions as well as for the changes in the three-month money market interest-rate spread vis-à-vis the currency anchor. The economic intuition behind this choice of additional instruments is the following:

- Interventions often come in clusters. If there has been a net sale of foreign exchange in the previous months ($CBFX_{t-j}>0$, j=1,2,...) the central bank is more likely to make a net sale of foreign exchange vis-à-vis kroner in month t ($CBFX_t>0$).

- Interventions (first line of defence) normally precede changes in monetary-policy interest rates (second line of defence) within a fixed-exchange-rate system. If there has been a net sale of foreign exchange in the previous months ($CBFX_{t-j}>0$, j=1,2,...) the central bank is more likely to (or to be expected to) raise its monetary policy interest rate in month t which will cause an increase the money-market interest-rate spread in month t ($d3MIS_t>0$).

The IV-estimation results are shown in Table 7.6. Model IIIa and IIIb each includes one of the endogenous variables whereas model IIIc includes both CBFX and d3MIS. The signs of the estimated parameters in the stage one regressions[252] confirm the *a priori* arguments for the chosen additional instruments. Furthermore, both the Sargan test for independence of the instruments and the error terms as well as the Chi^2 test for the significance of all variables indicate that the instruments are valid in all three IV-regressions in Table 7.6.

The inclusions of changes in the short-term interest rate spread vis-à-vis the currency anchor and central-bank interventions in the krone-denominated foreign-exchange market in the regressions do not materially change the results from section 7.4. Net capital inflows to Denmark from portfolio investments have a clearly significant impact on the krone rate with the expected sign in all the IV-models in Table 7.6. The sizes of the estimated coefficients are also comparable to the analysis in section 7.4, and the diagnostics indicate no traces of autocorrelation in the residuals up to lag 7.[253]

The sign of the estimated coefficients to interventions and changes in the short-term interest-rate spread in model IIIa and IIIb in Table 7.6 are also as expected: A sale of foreign exchange (corresponding to a purchase of Danish kroner) by the central bank and an increase in the short-term interest-rate spread strengthen the krone. The estimated parameters are significantly different from zero at a 5 or 10 per cent significance level.

When both interventions and changes in the short-term interest-rate spread are included simultaneously (model IIIc in Table 7.6) these variables are not significant at a 10 per cent level. However, all the estimated coefficients have the expected sign and the effect from capital flows from portfolio investments on changes in the exchange rate is still highly significant.

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[252] Reported in Table 6 in Abildgren (2007a).

[253] Cf. also the detailed diagnostics in Abildgren (2007a).

Table 7.6: IV regression of the monthly change in the krone exchange rate ($dSdkkeur_t$) explained by total net capital inflow from portfolio investments, the Nationalbank's interventions and changes in the short-term interest-rate spread 1984-2004

	Model IIIa	Model IIIb	Model IIIc
Constant term	0.02370	0.02311	0.01935
Standard error	0.02784	0.03882	0.03767
Net capital inflow (NPF_t)	-0.01674***	-0.01702***	-0.02100***
Standard error	0.003905	0.005272	0.006511
Interventions ($CBFX_t$)	-0.01392**	...	-0.008332
Standard error	0.005982	...	0.009214
Short-term interest rate spread ($d3MIS_t$)	...	-0.5713*	-0.4875
Standard error	...	0.3152	0.3253
Additional instruments	$CBFX_{t-1}$ $CBFX_{t-2}$ $CBFX_{t-3}$	$CBFX_{t-1}$ $CBFX_{t-2}$ $CBFX_{t-3}$ $CBFX_{t-4}$ $CBFX_{t-5}$	$CBFX_{t-1}$ $CBFX_{t-2}$ $CBFX_{t-3}$ $CBFX_{t-4}$ $CBFX_{t-5}$ $CBFX_{t-6}$
Sargan test on instrument validity[a]	0.464	2.524	2.095
Significance probability	0.793	0.640	0.718
Chi^2 test[b]	18.62	10.44	11.83
Significance probability	0.000	0.005	0.008
LM (lag 1-7)[c]	1.393	1.590	1.573
Significance probability	0.209	0.139	0.144
Number of observations	242	240	239

Notes: Monthly observations. Excluding August 1993-February 1994 due to the six lags of some instruments. *, ** and *** denotes rejection of the null hypothesis (coefficient equal to zero) at a respectively 10, 5 and 1-per-cent significance level.

Source: Table 6 in Abildgren (2008c).

[a] Null hypothesis: Instruments are exogenous. The test statistics is calculated as the number of observations times the R^2 from a regression of the IV residuals on all instruments.

[b] Null hypothesis: All regression coefficients are zero (excluding the intercept).

[c] LM test (F-form) for autocorrelation in residuals. Null hypothesis: No autocorrelation.

It is worth noticing that the estimated magnitude of the krone-rate effect of interventions in Table 7.6 depends on whether changes in the short-term interest rate spread is included in the regression or not. If changes in the short-term interest-rate spread are included – as in model IIIc in Table 7.6 – the effect of interventions drops markedly compared to model IIIa. This is in line with *a priori* expectations: If the Nationalbank has intervened in the same direction for some months, a change in the short-term monetary-policy interest-rate spread vis-à-vis the currency anchor will usually follow and affect the exchange rate in the same direction as the intervention events. The simple correlation coefficient between interventions and changes in the short-term interest-rate spread is 0.19. This positive correlation indicates that a problem of multicollinearity may – at least to some extent – help to explain why these two variables are not significant different from zero in model IIIc in Table 7.6.

Although the estimated coefficient to central bank interventions in model IIIc in Table 7.6 is insignificant, the magnitude of the coefficient is in line with previous findings. In an event study based on daily data covering the period January 1999 to September 2004 Andersen (2005) finds that an intervention sale of foreign exchange (purchase of Danish kroner) of 10 billion kroner strengthens the krone by 14 pips. Based on the average conditions in the period January 1999 - September 2004 the estimated exchange-rate impact from interventions in model IIIc in Table 7.6 implies that an intervention sale of foreign exchange of 10 billion kroner strengthens the krone by 24 pips. In a high-frequency study based on time-stamped intervention data from Danmarks Nationalbank for the period from August 2002 to December 2004 Fatum & Pedersen (2009) find that an intervention sale of foreign exchange (purchase of Danish kroner) of 10 billion kroner strengthens the krone by 43 pips. Based on the average conditions in the period August 2002 - December 2004 the estimated exchange-rate impact from interventions in model IIIc in Table 7.6 implies that an intervention sale of foreign exchange of 10 billion kroner strengthens the krone by 23 pips.

Model IIIc in Table 7.4 indicates that an increase in the short-term interest-rate spread vis-à-vis the currency anchor with 1 per cent pro annum (100 basis points) strengthens the krone by 0.49 per cent. The effect is insignificant at a 5-per-cent significance level but the magnitude of this effect is still roughly in line with previous studies. In a SVAR model estimated for the period January 1996 to November 2005 Beier & Storgaard (2006) find that an increase in the short-term interest-rate spread vis-à-vis the currency anchor by 1 per cent pro annum strengthens the krone by around 0.35 per cent.

7.6. A larger multivariate system?

In the previous two sections the short-term impact on exchange rates from portfolio flows has been studied via the aid of single-equation OLS- and IV-regressions. The most obvious weakness in the analysis is probably the assumption that the causality goes from portfolio flows to changes in the krone-euro exchange rate – and not vice versa – so that simultaneity bias is not an issue.

The “true” economic model is probably a much more comprehensive multivariate system that might be summarised as follows:

$$[7.4.1]\ \mathrm{dSdkkeur}_t = f^1(\mathrm{CBFX}_t, \mathrm{d3MIS}_t, \mathrm{NPF}_t, \ldots \text{other variables} \ldots, e_t^1)$$

$$[7.4.2]\ \mathrm{NPF}_t = f^2(\mathrm{dSdkkeur}_t, \mathrm{d3MIS}_t, \ldots \text{other variables} \ldots, e_t^2)$$

$$[7.4.3]\ \mathrm{CBFX}_t = f^3(\mathrm{dSdkkeur}_t, \ldots \text{other variables} \ldots, e_t^3)$$

$$[7.4.4]\ \mathrm{d3MIS}_t = f^4(\mathrm{dSdkkeur}_t, \ldots \text{other variables} \ldots, e_t^4)$$

where [7.4.1] summarises the krone-denominated foreign-exchange market, [7.4.2] represents cross-border portfolio demand, [7.4.3] is the Nationalbank’s reaction function regarding interventions in the krone-denominated FX market and [7.4.4] is the Nationalbank's interest-rate reaction function.

The "other variables" in [7.4.2] might e.g. be differentials in long-term interest rates between Denmark and abroad as well as share prices and current account balances in Denmark and abroad. Some of these "other variables" might also be dependent on e.g. dSdkkeur and d3MIS within an even larger system. Furthermore one can think of various kinds of lag structures. Finally, the relation in [7.4.2] does not have to be linear and the error term (e^2) might not be "nice" in some ways (for instance in the case of measurement errors). Similar considerations might apply to some of the other equations in the multivariate system.

Even if one assumes a linear system, "nice" error terms and disregard lags and "other variables" in all the equations [7.4.1]-[7.4.4] there is still a need for identifying restrictions. The approach taken in section 7.4 and 7.5 in the paper has been the assumption of exogenous NPF. In section 7.5 equation [7.4.1] could therefore be estimated via a single-equation IV approach using lagged values of interventions as economic plausible instruments for interventions and changes in the short-term interest-rate spread, cf. model IIIc in section 5. One could also have chosen a SVAR approach. However, without the assumption of exogenous NPF other identifying restrictions are necessary, and the plausibility of such restrictions has to be considered. Alternatively one has to expand the system with more equations. This challenge is left for further research.

7.7. Policy implications and scope for further research

The overall findings in the article support the view that portfolio flows are relevant for short-term exchange-rate determination within the Danish fixed-exchange-rate system and that the sign of the effect is as expected: A net inflow of capital to Denmark leads to a strengthening of the krone. This result is robust to divisions of the data sample into sub-periods and to the inclusion of central-bank interventions and changes in the short-term interest-rate spread as endogenous explanatory variables. Portfolio flows in Danish bonds *etc.* – which mainly consist of krone-denominated fixed-income assets – appear to be driving the results prior to the introduction of the euro. Since then the main driver has been portfolio flows in foreign shares.

Today's cross-border capital flows are considerably larger than at the beginning of the 1990s. However, the results in the essay also indicate a tendency towards a declining effect on the krone-euro rate from net portfolio flows over time, which might be seen as the result of increased credibility of the Danish exchange-rate peg. As a result, capital flows of a magnitude previously only observed during foreign-exchange crises might now be seen even when the foreign exchange markets are stable. A recent example occurred in February 2006, where the Nationalbank sold foreign exchange for 34 billion kroner in order to stabilise the krone.[254] In absolute terms, this intervention amount was at the level of the substantial interventions during the currency crisis in 1993. The Nationalbank raised its lending rate by 0.1 percentage point in the middle of February 2006. This unilateral interest-rate increase was modest but nevertheless sufficient to stabilise the krone. Today even very small adjustments of Danmarks Nationalbank's monetary-policy interest rates can thus be sufficient to curtail large capital flows in periods without currency turmoil.

The relatively low levels of the coefficients of determination in the estimated regression models in the essay seem to indicate that the krone rate in the short-term is also influenced by other factors than contemporaneous portfolio flows. However, statistics on the magnitude and composition of cross-border portfolio flows is still crucial information for a central bank when implementing and communicating interest-rate and intervention strategies for stabilising the exchange rate within a regime of pure exchange rate targeting and no capital account restrictions.

The recent international financial crisis, which began in the summer of 2007, escalated during the autumn of 2008. The global money markets more or less froze, and dollars and euro were in short supply in many countries. In order to stabilise the krone, the Nationalbank had to intervene in the foreign-exchange market for considerable amounts and significantly increase the interest-rate spread vis-a-vis the euro. The krone-rate impact from portfolio flows, changes in the interest-rate spread vis-à-vis the euro and the Nationalbank's FX interventions might be sensitive to the situation in the international capital markets. It could therefore be interesting to review the robustness of the findings in the essay at hand on an updated data sample, which includes the recent financial turmoil. However, this exercise will be left for future research.

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[254] Cf. page 33-34 in Danmarks Nationalbank (2007).

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Essay 8:
Credit Dynamics in Denmark since World War II[255]

Abstract

Based on new time series data for credit to Danish residents by sector and industry 1951-2008 constructed by the author essay 8 explores the trends and cycles in credit during the past six decades or so.

The essay finds a structural shift in the relationship between growth in real credit and economic activity around 1980. In the post-1980 period characterised by increased influence from market forces due to financial liberalisation and internationalisation the swings in real credit growth have been substantial relative to the economic growth compared to the pre-1980 period where credit rationing and exchange controls served as important economic-policy instruments. The house price development seems also to have played an important role in the credit dynamics.

There seems also to have been a shift over time in the short-term cyclical behaviour of credit to the various industries. Real commercial credit was contemporaneous with private sector real GDP in the pre-1980 period but has lagged the business cycle with one year in the post-1980 period. This might reflect the more restricted access to credit in the pre-1980 period. Another possible explanation suggested in the essay is the increased significance of commercial and industrial foundations in the Danish economy. Industrial foundations might be seen as "patient owners" without an urgent need for return on equity. In step with the increased capital accumulation in those foundations it might have been possible for Danish firms to finance larger shares of their fixed investments in the initial stages of an upturn with own funds from retained earnings rather than loans from domestic and foreign credit institutes.

Key words: Bank-lending data, credit growth, financial liberalisation, credit dynamics, business cycles, band-pass filter.

JEL Classification: C82; E51; G21; N24.

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[255] This essay is based on Abildgren (2007c, 2009c).

8.1. Introduction

A deeper understanding of the relationship between credit growth, financial stability and the monetary transmission process requires a careful analysis of the country-specific institutional environments and policy regimes that have characterised the different historical time periods and the major macroeconomic shocks that have influenced the economic development. During the last decade or so, there has therefore been a renewed research interest in long-span studies on financial liberalisation, lending booms and financial globalisation. The outbreak of the sub-prime crises in the summer of 2007 and the subsequent turmoil on the international financial markets has also made credit dynamics a very topical issue, cf. e.g. Bech & Berg (2009).

Long-span time series on credit by institutional sectors and industries are not readily available in Denmark and many other countries. Empirical studies on trends and cycles in credit growth have therefore often to rely on either very aggregated time series or more detailed data sets covering only the most recent decades, cf. e.g. the survey in Ibáñez *et al.* (2009). A general concern regarding the robustness of empirical results based on aggregated credit data might occur due to a possible heterogeneity in both the short-term as well as the long-term behaviour of credit to different sectors and industries. With more disaggregated data sets such heterogeneity issues can be considered. However, if only shorter time-span of data are available one will not be able to analyse the cross-sector and cross-industry dimension in credit dynamics under different monetary regimes, financial structures, macroeconomic conditions and regulatory environments that might be of importance to the way monetary transmission or potential financial-system instability works.

In order to allow for a study of credit dynamics in the Danish post-World War II period the author has constructed new annual time series for credit to respectively Danish firms and private individuals in the period 1951-2008. The data set covers credit extended by domestic commercial banks and savings banks, domestic mortgage-credit institutions and foreign banks. Credit from domestic commercial banks and savings banks is furthermore broken down by main industry (agriculture, industry and services). On basis of this new data set the essay explores the trends and cycles in credit by sector and industry during the past six decades. Credit has traditionally been a major component in the capital structure of Danish firms, and the post-World War II period has been a phase in Danish economic history characterised by a transition from a regulated financial sector to a market-based financial system with free cross-border movements of capital.

It is not the ambition of the essay to formally model the credit development but simply to uncover some stylised facts and empirical regularities that have characterised credit to Danish firms and private individuals during the past half of a century or so. However, some more eclectic interpretations and suggestions on the driving economic forces will be offered.

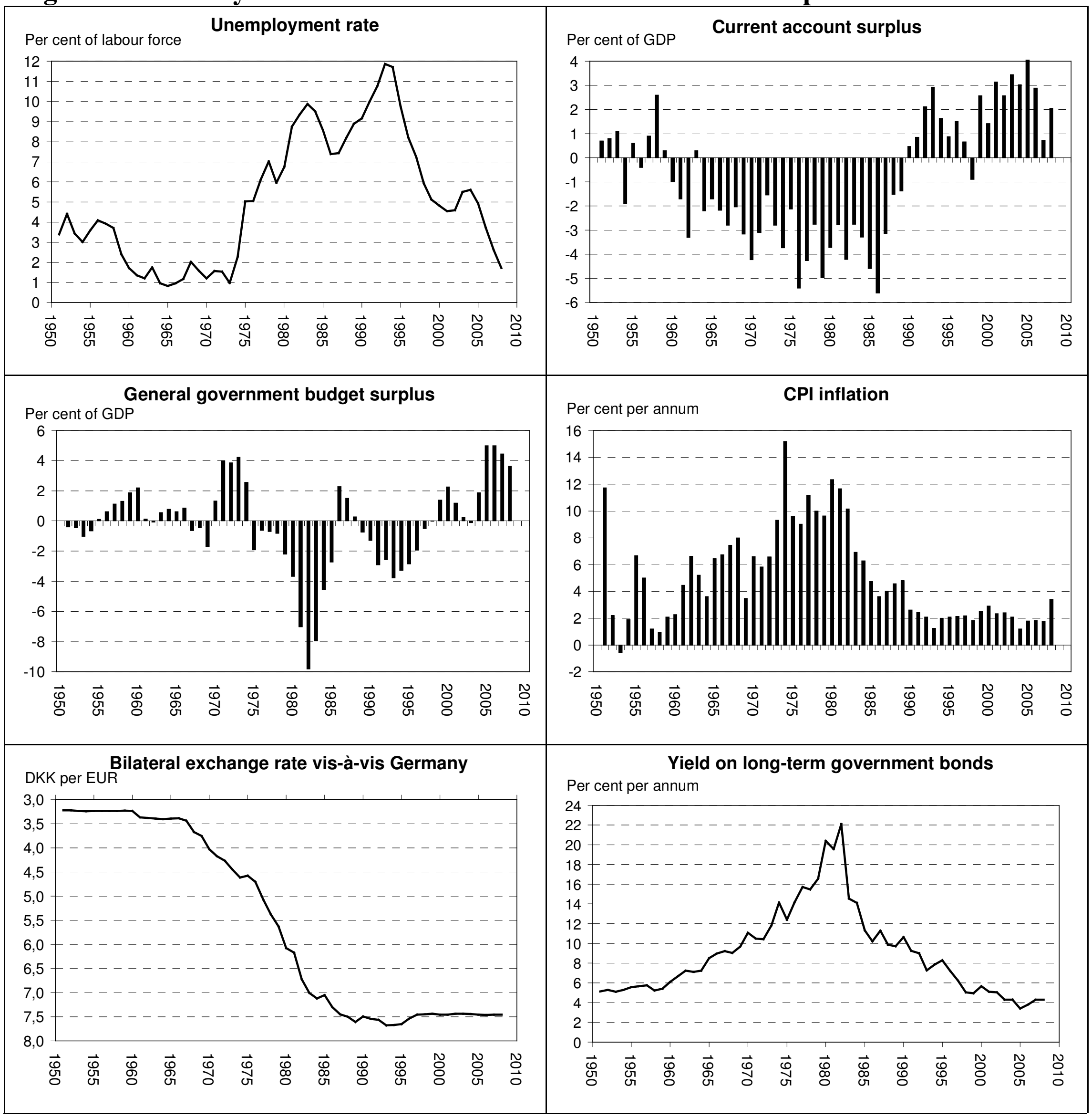
8.2. The monetary and financial system in Denmark since 1951: From credit rationing and exchange controls to liberal financial markets

The early post-war years were still characterised by the excess liquidity of the war reflecting the German occupation forces' expenditures in Denmark during the years 1940-1945 compulsorily financed via German accounts at Danmarks Nationalbank (the central bank of Denmark). However, around 1950 the excess liquidity had been eliminated due to tight fiscal policy (including a one-off tax in 1946 on wealth accumulation during the war) and an increased transaction level, cf. Thygesen (1971).

During the 1930s and the World War II the international economy had developed into a system characterised by a complex net of bilateral clearing and payment arrangements, and deregulation of restrictions on capital account transactions was a slow process both in Denmark as well as in other countries. During the 1950s the Danish business sector was given access to obtain commercial credits related to imports and exports of goods and services, but prior to the restoration of current-account convertibility of the Danish krone in 1958 capital-account transactions were regulated tightly.

Since 1946 Denmark had participated in the Bretton Woods fixed-exchange-rate system. Despite extensive capital controls the modest amount of foreign exchange reserves coupled with a limited access to foreign borrowing resulted *de facto* in a low degree of monetary autonomy in the 1950s. The Nationalbank intended to follow a simple monetary rule – laid out in the so-called letter agreement with the central government in 1951 – stating that a reduction in the level of foreign exchange reserves should be reflected in a reduction of the monetary base. Furthermore, as a general principle the central government's long-term lending to housing purposes should be matched by the sale of government bonds. Until the early 1960s the Nationalbank's open market operations were therefore rather modest.

Figure 8.1: Key macroeconomic variables for Denmark in the period 1951-2008.



Note: Prior to 1999 the bilateral exchange rate vis-à-vis Germany is calculated on the basis of the Deutsche mark exchange rate vis-à-vis Danish kroner and the irrevocably fixed conversion rate between euro and Deutsche mark on 1 January 1999. Since 1999 the bilateral exchange rate vis-à-vis Germany is the krone-euro exchange rate.

Source: Figure 1 in Abildgren (2009c).

At the end of the 1950s the scope for Danish foreign borrowing improved significantly. The main focus point of monetary policy in the 1960s was to moderate the tendency to rising interest rates that followed from strong economic growth, a low level of unemployment and increased inflation, cf. Figure 8.1. In 1961, short-term bank loans for the financing of imports and exports were liberalised and in 1968 non-financial Danish firms were granted permission to take out so-called financial loans abroad within certain maturity and size limits. However, most other private capital account transactions to and from Denmark still required permission from the Nationalbank during the Bretton Woods period. The local government's access to foreign borrowing was also suspended in the years 1964-1966 and thereafter subject to limitations.

In the 1960s the Nationalbank made use of interventions in the market for mortgage-credit bonds in order to influence the long-term bond yields, cf. Hoffmeyer (1993). Furthermore, in the years 1965-1971 loan offers from the mortgage-credit institutes were subject to a quota system imposed by the monetary authorities after negotiations with the mortgage-credit organisations. As a supplement to its discount policy and “open mouth operations” Danmarks Nationalbank in the years 1965-1971 also made use of deposits agreements with the organisations of commercial banks and savings banks as means of regulating bank lending, cf. Mikkelsen (1993).

After a currency crisis in the first half of 1969 the level of foreign exchange reserves reached a critical minimum. The monetary policy had therefore to become more oriented towards external objectives – maintaining the value of the krone and an adequate level of foreign exchange reserves in a situation with a permanent balance-of-payments deficit. In principle, a fixed exchange-rate policy was pursued – from 1972 within the European Exchange Rate Co-operation – but frequent devaluations of the Danish krone occurred up to the early 1980s. The macroeconomic performance of the Danish economy deteriorated significantly during the 1970s, particularly in the second half of the decade. The oil price shocks of the 1970s and the devaluations of the krone caused a continuous upward pressure on inflation and a widening of the long-term interest spread between Denmark and its main trading partners. Furthermore, unemployment increased rapidly and a sizeable deficit of the government budget developed.

In 1969, the Nationalbank issued guidelines for the amount of lending commitments extended by the banking sector, and in 1970 a direct ceiling on lending commitments from individual commercial banks and savings banks was imposed, cf. Blomgren-Hansen (1977). At the beginning the credit ceiling covered only around 20 major commercial banks (with a market share of around 85-90 per cent of the total lending by commercial banks) and 50 major savings banks (covering around 80 per cent of the total lending by savings banks). However, in 1973 the credit ceiling was extended to cover most commercial banks and savings banks. The access to financial loans abroad was tightened in 1973 and at the same time initiatives was taken in order to limit the local government’s foreign borrowing. In 1970 a major mortgage-credit reform had been implemented implying a reduction in the maturity of loans for owner-occupied dwellings and more restricted access to raise mortgage loans against free mortgageable value. During the 1970s the Mortgage Credit Act was amended several times where the terms of the mortgage-credit loans were tightened in an attempt to limit the lending activities of the mortgage-credit institutes. Furthermore, in 1975 Danmarks Nationalbank and the Mortgage Credit Board entered into an agreement on a ceiling of the mortgage-credit institutes total loan offers. In 1979 the lending activity of insurance companies and pension funds also became subject to regulation.

Throughout the 1960s and early 1970s the central government's budgets were generally in surplus and there were ample credit facilities available to banks at Danmarks Nationalbank. The development of significant deficits on the central government finances in the mid-1970s called for new instruments in monetary policy implementation. The former rather liberal access for banks to obtain monetary-policy loans from the Nationalbank against securities as collateral or through the rediscounting of bills of exchange was in 1975 replaced with a system of borrowing limits at ascending interest rates supplemented by interventions in the money market by the Nationalbank. In 1977 the Nationalbank also introduced a deposit system where the banks within certain limits and for short periods could place surplus liquidity in interest bearing sight deposits. Furthermore, the Nationalbank and the central government reached an informal understanding regarding the financing of the budget in order to avoid monetary financing. The huge liquidity effects of the central government's budget deficits should be neutralised as far as possible by open-market sales of government bonds by the Nationalbank on behalf of the Treasury.

During the second half of the 1970s the policy of credit rationing gradually lost its significance, partly due to a shift in credit demand towards other sources (mainly foreign financing and the "grey" market for private mortgage deeds). During the early 1980s it also became clear that the active devaluation policy pursued during the years 1979-1982 combined with a lax fiscal policy and huge external imbalances placed a too heavy burden on monetary policy, which was reflected in the large interest-rate spread between Denmark and Germany.

This paved the way for a radical shift in Danish macroeconomic policy. The post-1980 period was characterised by increased liberalisation of international capital movements as well as deregulation and internationalisation of the domestic financial sector. Furthermore, the devaluation policy was abandoned and the fiscal policy became oriented towards medium-term stability.

The soft peg of the Danish krone of the 1970s within the European exchange-rate co-operation was in the early 1980s replaced by a hard peg vis-à-vis the D-mark (and later the euro). The switch to a fixed-exchange-rate policy was followed by a transition to a system with free cross-border capital movements. The ceiling on financial loans was gradually increased during the 1970s and early 1980s and removed altogether in 1983. The last restrictions on capital account credit-transactions in Denmark – mainly related to loans in kroner to residents from Danish banks' foreign units and private individuals' loans abroad – were removed in 1988.

The quantitative elements in monetary-policy implementation were substantially reduced in the first half of the 1980s. The ceilings on domestic bank lending were dismantled in 1980 and the ceiling of the mortgage-credit institutes loan offers was gradually lifted during the late 1970s and early 1980s. Furthermore, the regulation of the lending activity of insurance companies and pension funds was abolished in 1982. In the first half of the 1980s the Nationalbank still aimed at influencing the growth in bank lending by curtailing the borrowing facilities at the Nationalbank of banks with strong lending growth. However, the private business sector increasingly resorted to borrowing abroad, and the Nationalbank did not control the banks' bond purchases. During the second half of the 1980s and early 1990s monetary policy implementation became therefore gradually more market-oriented with focus on managing the short-term interest rate via standing facilities and operations in the money market. It became also clear that in a regime with a fixed exchange rate and free cross-border movements of capital, there was no room for using monetary policy for domestic stabilisation purposes. In the 1980's the terms and conditions for mortgage-credit loans stated in the Mortgage Credit Act were still occasionally used as a tool in the macroeconomic stabilisation policy. However, the last couple of decades or so has witnessed a gradual easing of the access to raise mortgage loans against free mortgageable value.

The post-1980 period witnessed significant improvements in the macroeconomic performance of the Danish economy. In the early 1980s fiscal policy became oriented towards consolidation and medium-term stability, and the automatic inflation indexation of wages was abolished, cf. Christensen and Topp (1997). The increased credibility of the Danish fixed-exchange-rate policy and the international decline of inflation rates during the 1980s and the beginning of the 1990s caused a marked downward trend in both inflation and nominal interest rates in Denmark. The long-term interest spread between Denmark and Germany decreased rapidly from more than 13 per cent in 1982 to less than 1 per cent in 1991 and 0.29 per cent in 2008. Furthermore, since the early 1990s the level of inflation in Denmark has roughly been equal to that of Germany and from 1999 the euro area. The current account of the balance of payments turned into surplus in 1990 (after more than 25 years with a deficit), and especially since the early 1990s there has been focus on the importance of flexible labour-market structures. The economic incentive structures have also been improved through several tax reforms that have lowered the marginal tax rates and in particular the maximum tax value of interest rate deductions.

8.3. Credit to Danish residents by sector and industry 1951-2008 - Data sources and compilation issues

Statistics Denmark has published detailed figures on the stock of domestic lending extended by resident commercial banks and savings banks covering the period since 1978. The lending figures from Statistics Denmark are broken down by sector (commercial credit and credit to private individuals) with a further drill-down of commercial lending by industry.

Danmarks Nationalbank has published stock data on domestic lending by sector and industry in the period 1951-1977 extended by commercial banks, but no official statistics regarding domestic lending by sector and industry from savings banks is available prior to 1978. The pre-1978 data on credit by sector and industry from savings banks applied in the essay at hand has therefore been estimated on the basis of loan type supplemented with information from the special surveys covering loans from savings banks by sector and industry in 1955 and 1959. Savings banks accounted for around 30 per cent of the total domestic lending extended by resident commercial banks and savings banks in 1978. In 1951 the corresponding figure was 40 per cent. It should also be mentioned that end-of-year figures for domestic lending extended by resident commercial banks and savings banks prior to 1978 is estimated by linear interpolation based on end-March or end-April accounting figures. Finally it should be noted that the official statistics on domestic lending by sector and industry from commercial banks and savings banks since 2000 only covers lending from the major banks accounting for around 95 per cent of the total balance sheet of the banking sector. These figures have been scaled up to a 100 per cent coverage utilising information on the sectoral break-down of lending by the last 5 per cent (i.e. the smallest institutions) in the 2nd quarter of 2000 and total lending figures from Danmarks Nationalbank for the period 2000-2008. The distribution of domestic credit by sector and industry from resident commercial banks and savings banks is therefore surrounded by a certain element of uncertainty, especially prior to 1978.

The Nationalbank has published stock statistics on loans extended by resident mortgage-credit institutes distributed by type of collateral for the period since 1993. Prior to 1993 the stock figures presented are based on accumulated flow of funds. In the period 1972-1992 flow statistics on mortgage-credit loans by type of collateral is available from Danmarks Nationalbank. Prior to 1972, the amount of total lending from mortgage-credit institutes are based on accounting statistics, and the distribution between commercial lending and private lending are based on the development in the property values by category in national-wealth data available for the period.

The data on commercial lending from foreign banks are based on the statistics on Denmark's international investment position and on the financial items in the balance of payment statistics published by Statistics Denmark and Danmarks Nationalbank. For the period since 1993 stock figures are directly available. Prior to 1993 the stock figures have been compiled on an accumulated flow-of-funds basis.

A few remarks should be given on the classification by sector and industry in the data set on credit applied for the analysis in this essay. The data set operates with two institutional sectors, a "commercial sector" and a "private individuals" sector. "Private individuals" covers wage earners, pensioners, etc., but not self-employed persons (even though part of a loan proceed raised by a self-employed person might go to private consumption). It differs therefore from the concept of the "household sector" applied in modern national accounts statistics following the requirements set out in United Nations' System of National Accounts (SNA), which include self-employed persons among households. The "commercial sector" does not include MFIs or the central government, whereas local governments, non-MFI financial intermediaries and self-employed persons are included. The classification of main industries (agriculture, industry and services) follows in broad terms the International Standard Industrial Classification (ISIC).

The applied classification of loans from commercial banks and savings banks by industries and institutional sectors can thus be summarised as follows:

- Loans to agriculture comprise loans to agriculture, fishing and quarrying and includes loans to self-employed farmers etc.
- Loans to industry cover loans to manufacturing, energy and water supply, the private construction industry and handicrafts.
- Loans to services cover loans to wholesale and retail trade, hotels, restaurants, transport, communication, non-MFI financial intermediaries, business activity, local governments, private services not mentioned above, and commercial loans where the type of industry is unknown.
- Private lending covers loans to wage earners, pensioners, etc., but not loans to self-employed persons.

For loans extended by resident mortgage-credit institutes the type of collateral is used as the basis for the sector classification:

- Commercial lending covers loans secured by the following types of properties: Agricultural buildings, buildings used in trade and industry, office buildings, buildings used for private rental housing and subsidised housing, and buildings used for social and cultural purposes etc.
- Private lending covers loans secured by owner-occupied dwellings.

The new set of time series data on credit to Danish residents by sector and industry 1951-2008 is listed in the annex.[256]

Even though an attempt has been made to transform the primary data into a reasonable consistent set of time series on credit, the quality of a data set spanning almost 60 years is always questionable. The results and conclusions of the essay at hand have therefore to be taken with "a pinch of salt".

8.4. Trends in credit growth and loan-to-value ratios

Figure 8.2 shows the annual growth in the private sector real GDP at factor costs and in the outstanding amount of total credit to Danish firms and private individuals (inflation-adjusted

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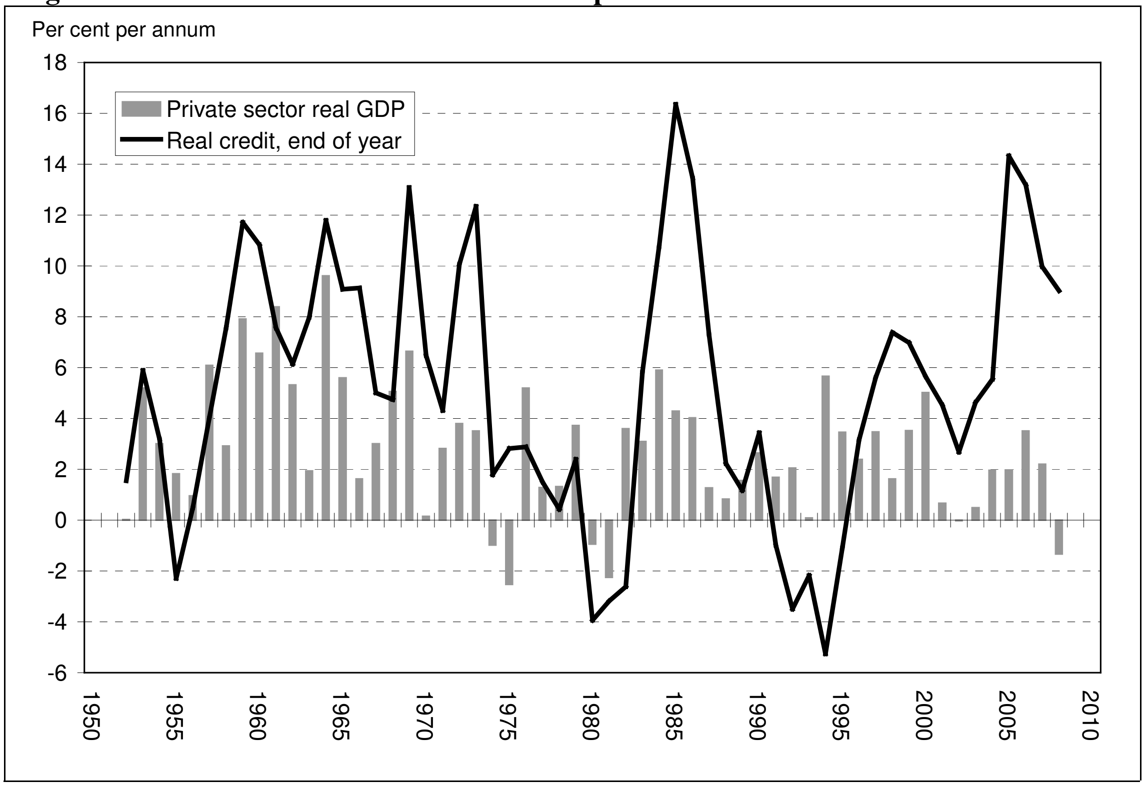
[256] Abildgren (2007c) contains a more detailed description of the sources and compilation methods used to construct the data set on credit presented in the paper at hand.

by the CPI) extended by domestic banks, foreign banks and domestic mortgage-credit institutions. Table 8.1 presents a range of summary statistics for nominal credit and nominal private sector GDP at factor costs broken down by two subperiods.

Figure 8.2: Growth in real credit and real private-sector GDP 1952-2008.



Source: Figure 2 in Abildgren (2009c).

Table 8.1: Nominal credit and private-sector GDP 1952-2008 – Summary statistics.

	Annual growth in nominal credit		Annual growth in nominal private sector GDP		Correlation coefficient between growth in nominal credit and nominal private sector GDP
	Average	Standard deviation	Average	Standard deviation	
	Per cent per annum				
1952-1979	12.1	4.7	9.3	3.3	0.79
1980-2008	8.4	6.0	5.6	3.2	0.37

Source: Table 1 in Abildgren (2009c).

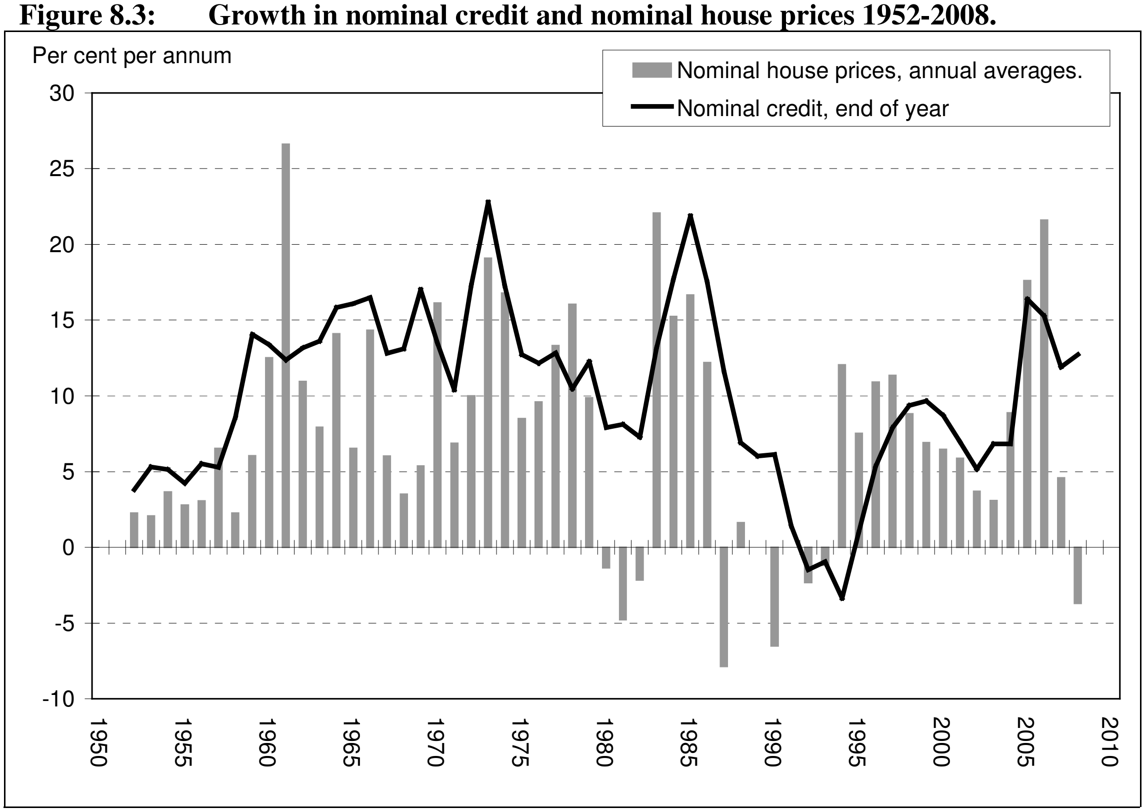
In broad terms growth in credit and real activity has followed the same course during the entire period. However, a structural shift in credit growth seems to have occurred around 1980. In the post-1980 period the swings in the growth of credit have been very large relative to the growth in economic activity compared to the pre-1980 period.

The larger fluctuations in credit growth relative to economic growth in the post-1980 period compared to the pre-1980 period might be related to the movement from an economy with a heavily regulated financial system to a market-based system with liberal access to credit.

Furthermore, the post-1980 period has seen some substantial swings in the growth rate of house prices compared to the pre-1980 period, cf. Figure 8.3. Rising house prices are usually followed by an increased amount of lending when existing houses are traded at new and higher price levels whereas falling housing prices reduce the demand for loans.

Lending opportunities are also closely linked to the value of real property. Rising house prices may increase the borrowing for other purposes than house acquisition using the house as collateral (mortgage equity withdrawal) whereas falling house prices lower the equity that potentially can be mortgaged. The easier access to raise loans against free mortgageable value coupled with the larger movements in the level of house price inflation might therefore have contributed to the substantial swings in credit growth during the post-1980 period.

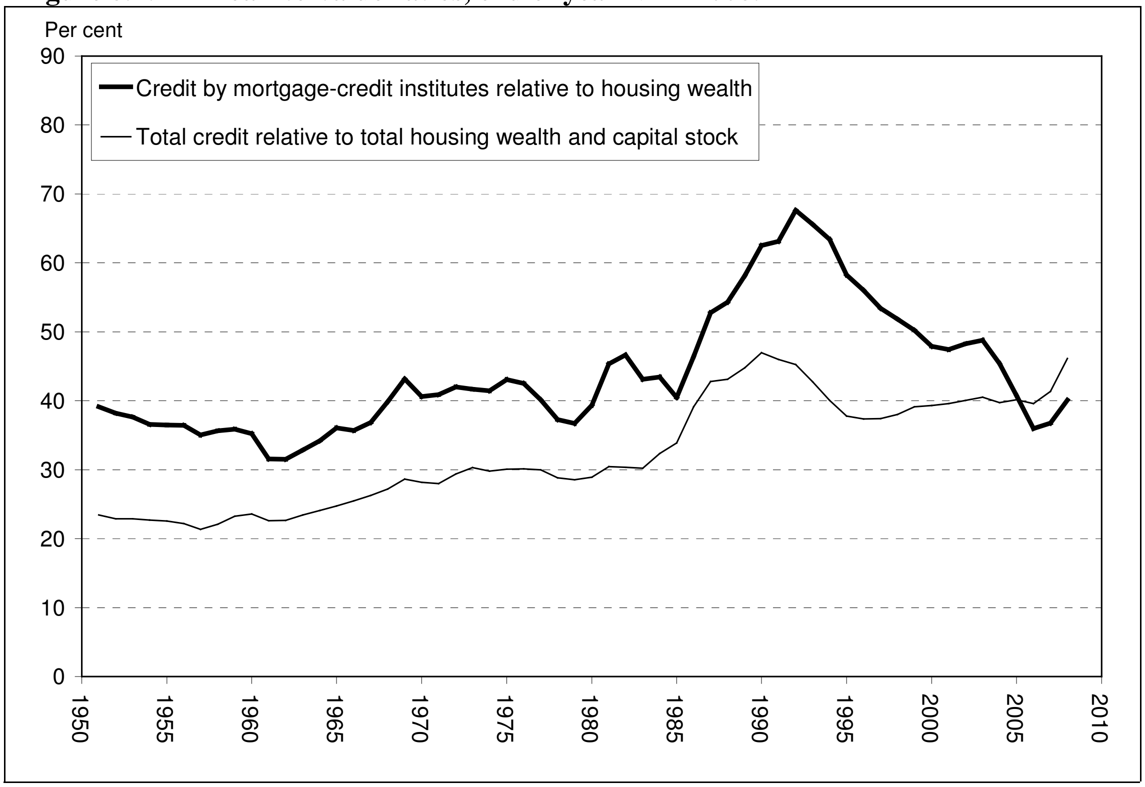
Figure 8.3: Growth in nominal credit and nominal house prices 1952-2008.



Source: Figure 3 in Abildgren (2009c).

The credit expansion during the last six decades or so has increased the level of financial intermediation. However, the total outstanding amount of credit extended by domestic mortgage-credit institutes amounted only to around 40 per cent of the total housing wealth (residential buildings) in 2008, cf. Figure 8.4. Even after the asset price deflation during the late 1980s and early 1990s the loan-to-value ratio never exceeded 70 per cent on a macro level. The total amount of credit from domestic and foreign credit institutions to the Danish private non-financial sector corresponded also only to around 45 per cent of the value of the total housing wealth and capital stock in 2008. Although the figures for the value of the total housing wealth and the capital stock naturally are subject to uncertainty, the robustness of the private non-financial sector against adverse macroeconomic shocks seems to have been good during the entire World War II period.

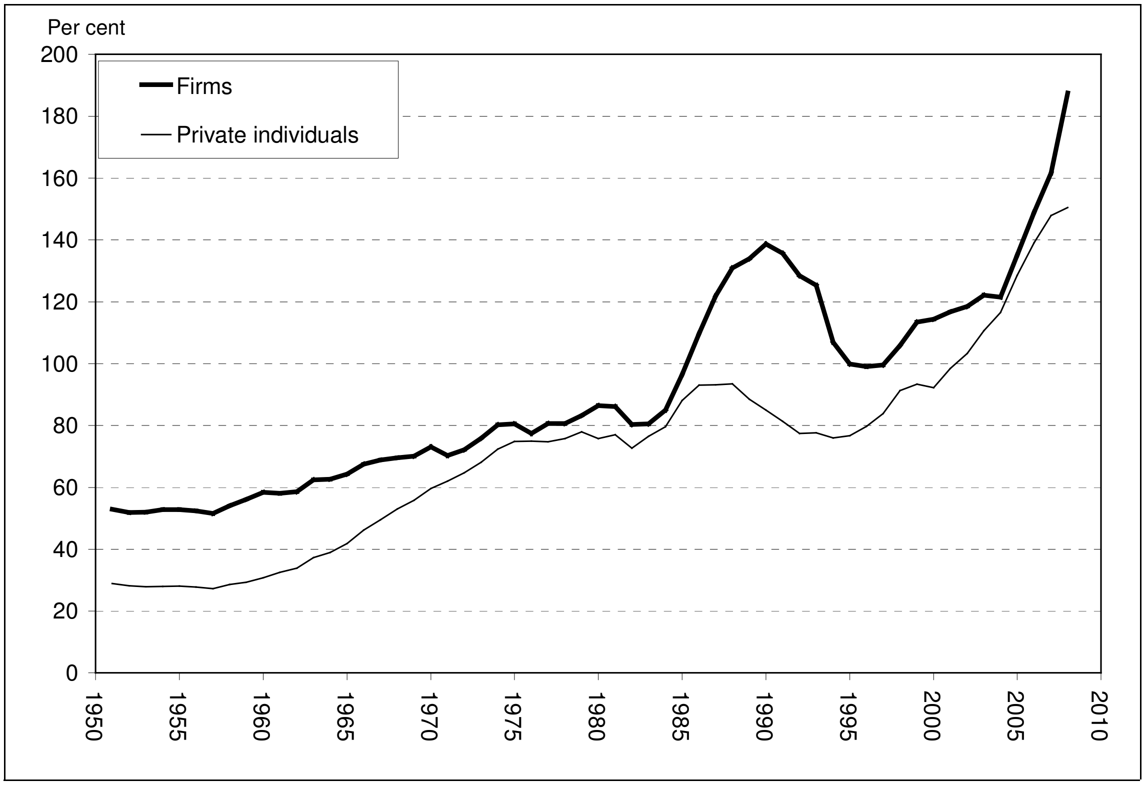
Figure 8.4: Loan-to-value ratios, end of year 1951-2008.



Note: The market value of residential buildings (including land values) for the period since 1980 is based on Olesen & Pedersen (2006). For the period 1965-1980 the development in the market value of residential buildings is estimated on the basis of the value for residential buildings (excluding land values) in constant prices from the capital stock data in the national account statistics and the price index for one-family houses (including land values). For the period before 1965 the market value of residential buildings is based on the national wealth data available for the period. The value of other construction, machinery and transport equipment and agricultural breeding stock is based on the capital stock data in the national account statistics for the period since 1965. For the period before 1965 the value of these capital goods is based on the national wealth data available for the period. Adjustments have been made for break in series.

Source: Figure 4 in Abildgren (2009c).

Figure 8.5: Nominal credit end of year relative to private sector nominal GDP 1951-2008.



Source: Figure 5 in Abildgren (2009c).

The outstanding nominal amount of credit to Danish firms and private individuals relative to the private sector nominal GDP at factor costs is shown in Figure 8.5. The long-term trend increase in these ratios reflect to a high degree the asset price inflation during the same period. Danmarks Nationalbank (2006) offers an analysis of Danish households' debt in 2004 in an international perspective. It appears that households in Denmark have a high level of gross indebtedness relative to the size of the economy, and the financial net worth of Danish households is relatively low. However, the development in the gross debt of Danish households during the last decade does not differ significantly from other European countries. Furthermore, the Danish housing wealth has increased in step with the level of gross indebtedness implying relatively low loan-to-value ratio seen from a macro perspective, cf. also Olesen (2009).

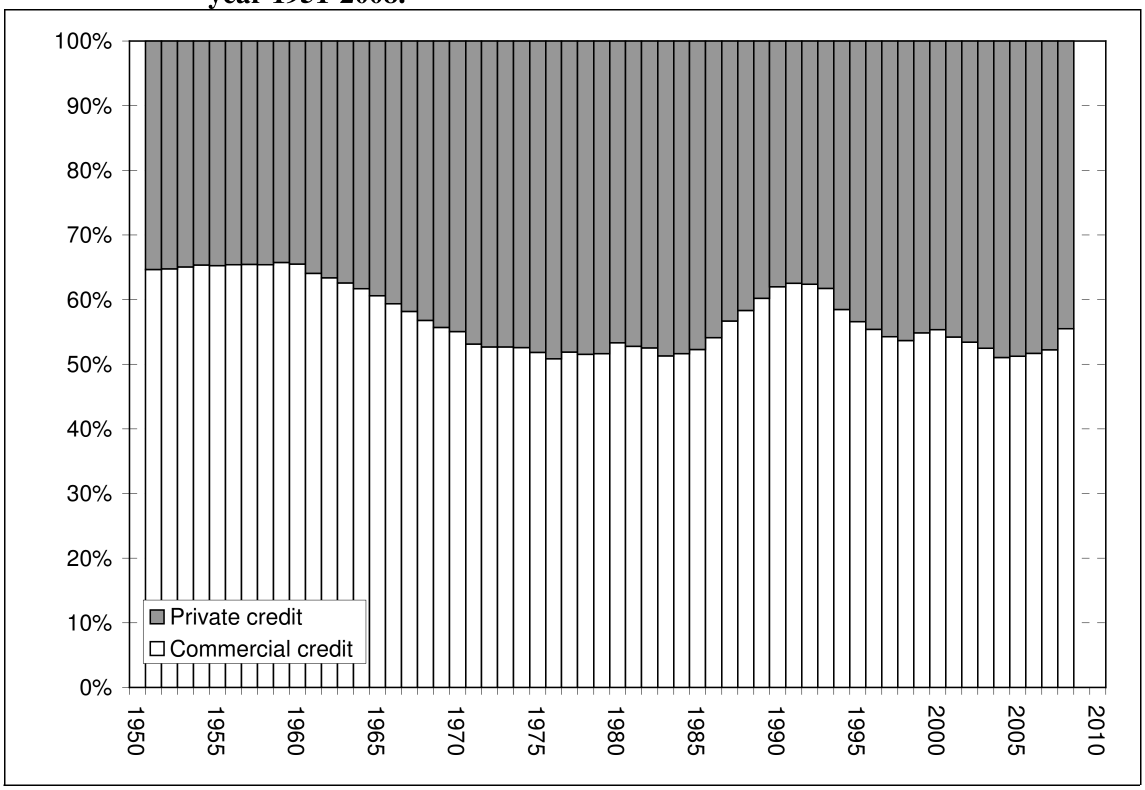
The cross-country differences in the level of household gross indebtedness might be related to the level of financial deepness. Empirical studies indicate that a well-developed mortgage-credit market with good opportunities for borrowing against the free mortgageable value of owner-occupied housing increases the level of mortgage debt, cf. Risbjerg (2006). In Denmark, where the mortgage-credit institutes have relatively fast and easy access to the collateral, even low-income households can obtain mortgage-credit financing, and seen in an

European context Denmark has a well-developed mortgage-credit market in terms of remortgaging opportunities and possibilities for supplementary mortgage credit.

8.5. Trends in credit composition

Figure 8.6 plots the distribution of the total credit to the Danish firms and private individuals since 1951. The distribution between private credit and commercial credit has roughly remained unchanged during the entire post-World War II period although with a slight tendency towards an increased share of private lending.

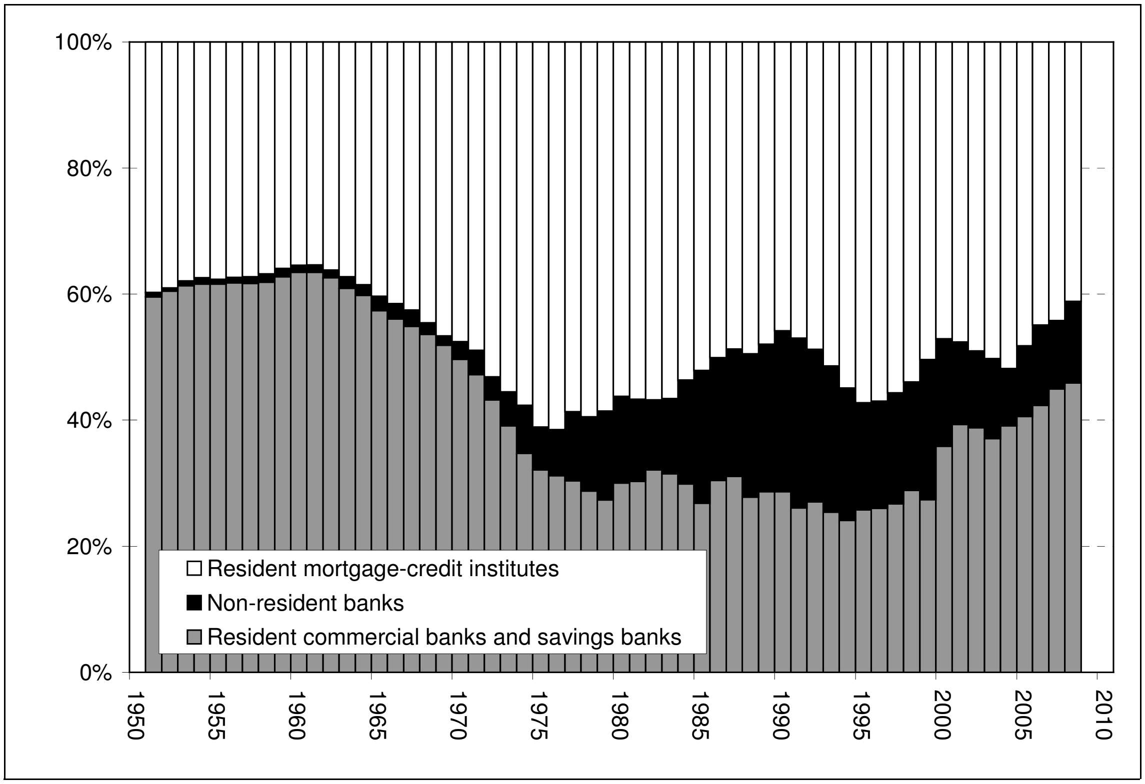
Figure 8.6: Nominal amount of credit to Danish private individuals and firms, end of year 1951-2008.



Source: Figure 6 in Abildgren (2009c).

Figure 8.7 shows the distribution of total bank-credit by source to Danish firms since 1951. During the 1950s and 1960s foreign credit did not play any significant role in the capital structure of Danish enterprises. The post-1970 period has – in step with the deregulation of cross-border capital controls – witnessed an increased importance of commercial lending from non-resident banks and the share of commercial lending from domestic banks has declined. The growing importance of commercial credit from non-domestic banks partly reflects that Danish banks since the mid-1970s has established themselves abroad in order to meet the requirements for banking services of the Danish export sector.

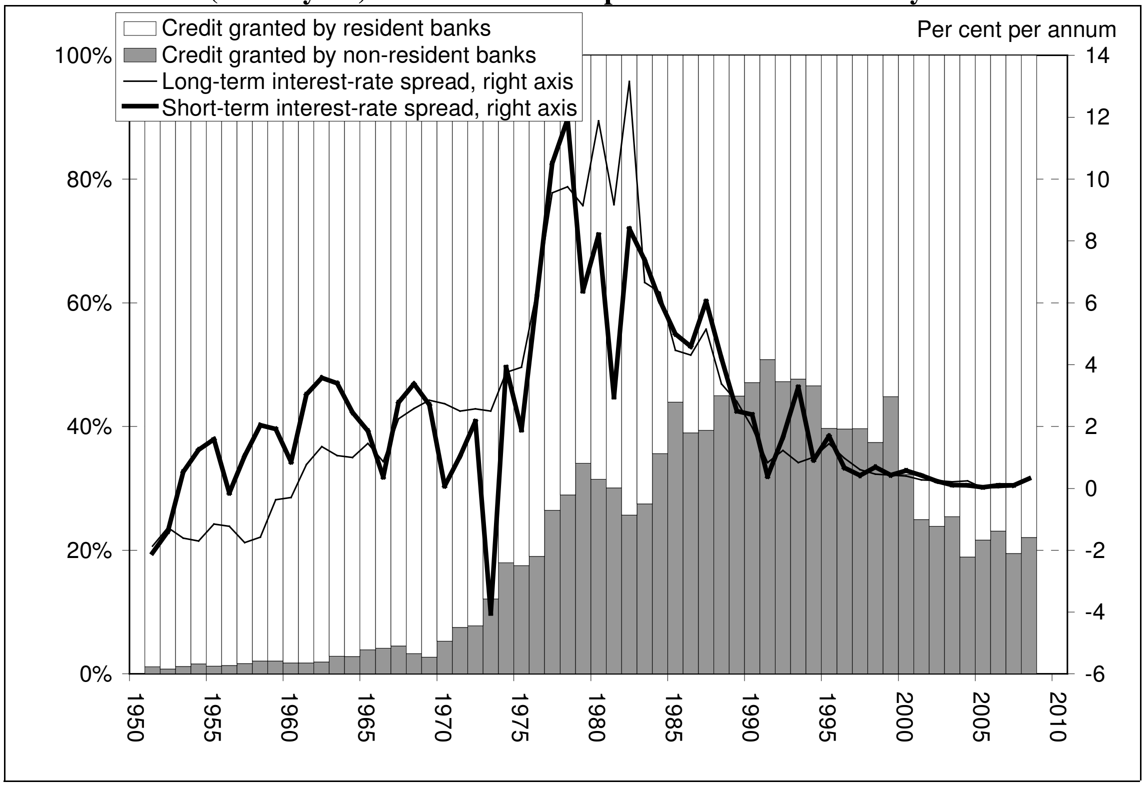
Figure 8.7: Nominal amount of credit to the Danish firms by source, end of year 1951-2008.



Source: Figure 7 in Abildgren (2009c).

Figure 8.8 illustrates the relative distribution of credit to Danish firms from domestic and foreign banks together with the short- and long-term interest-rate spread between Denmark and Germany since 1951. Since the switch to a consistent fixed-exchange-rate policy in the early 1980s the interest-rate spreads between Denmark and Germany have narrowed significantly and in the recent one and a half decade the share of foreign bank credit to Danish firms has declined.

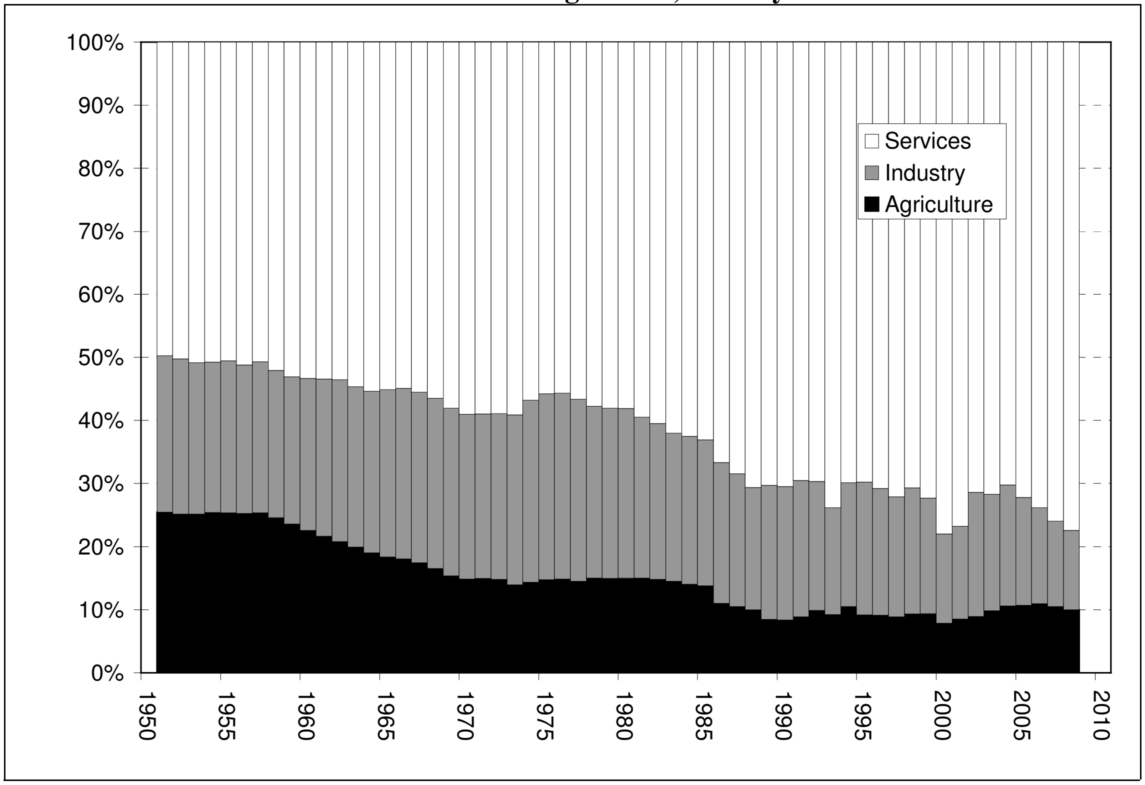
Figure 8.8: Relative distribution of the nominal amount of credit to the Danish firms (end of year) and interest-rate spreads vis-à-vis Germany 1951-2008.



Source: Figure 8 in Abildgren (2009c).

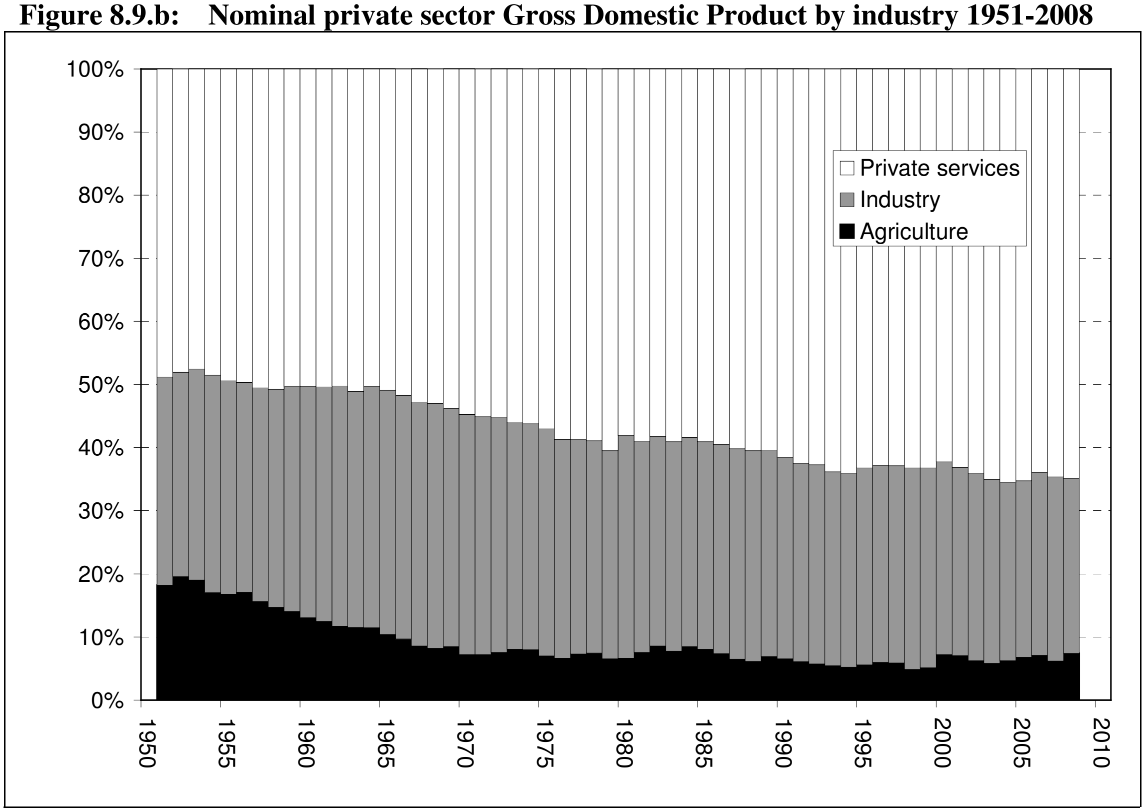
Figure 8.9.a maps the distribution of commercial credit by industry extended by resident commercial banks and savings banks. The share of credit to agriculture and industry has declined over the period in step with the structural transformation of the Danish economy towards increased production of services, cf. Figure 8.9.b.

Figure 8.9.a: Nominal domestic commercial credit by industry extended by resident commercial banks and savings banks, end of year 1951-2008



Source: Figure 8 in Abildgren (2007c) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

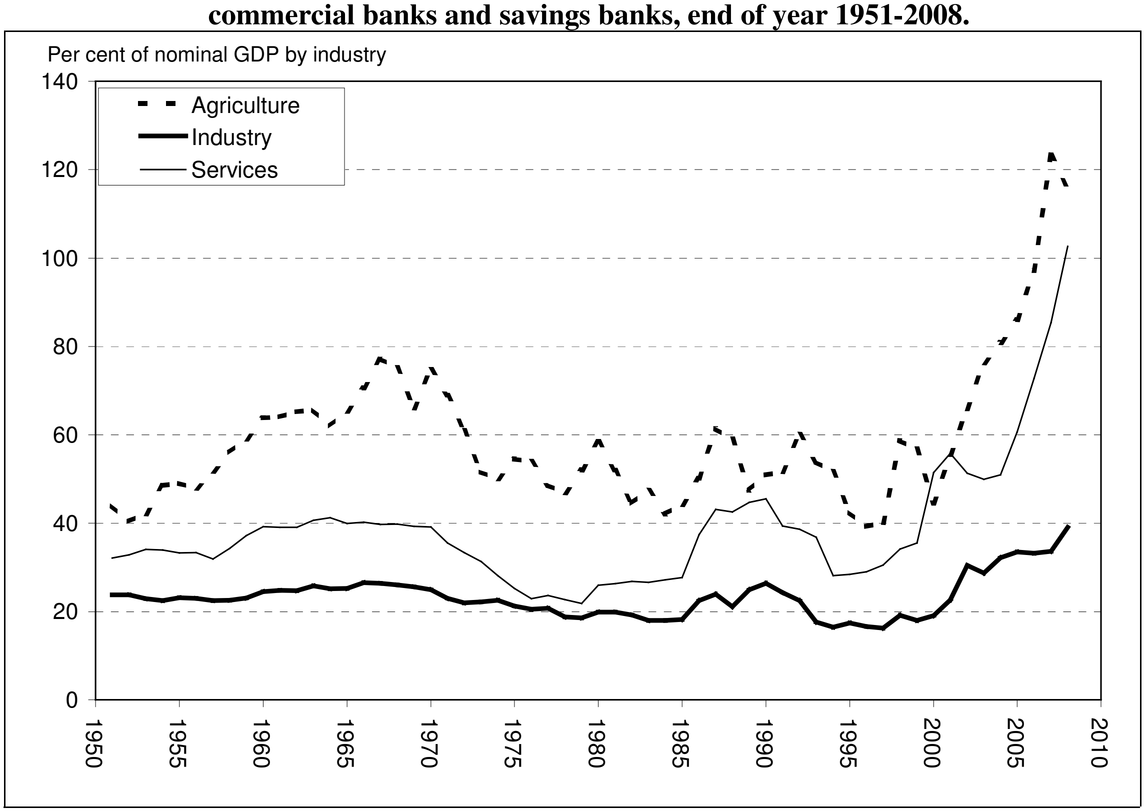
Figure 8.9.b: Nominal private sector Gross Domestic Product by industry 1951-2008



Source: Figure 9 in Abildgren (2007c) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

Figure 8.9.c shows the outstanding amount of commercial credit by industry extended by resident commercial banks and savings banks in per cent of the nominal GDP at factor costs by industry. It is worth noting that commercial credit to agriculture (including quarrying) and services has increased rapidly relative to GDP during the most recent decade. The rapid increase in credit to agriculture is consistent with the strong increase in land prices during the post-2000 period. However, one has to take into account that the share of foreign bank credit to Danish firms has declined during the same period, cf. Figure 8.8. Furthermore, it should be noted that GDP in agriculture and the other parts of the primary sector is very volatile. Finally, in Figure 8.9.c the breakdown of GDP by industry is based on local kind-of-activity units ("workplaces") whereas the breakdown of credit by industry is based on broader institutional units ("firms") classified by main activity. To the extent that firms consist of local units located in different industries, the "numerator" and "denominator" of the series shown in Figure 8.9.c are not fully consistent.

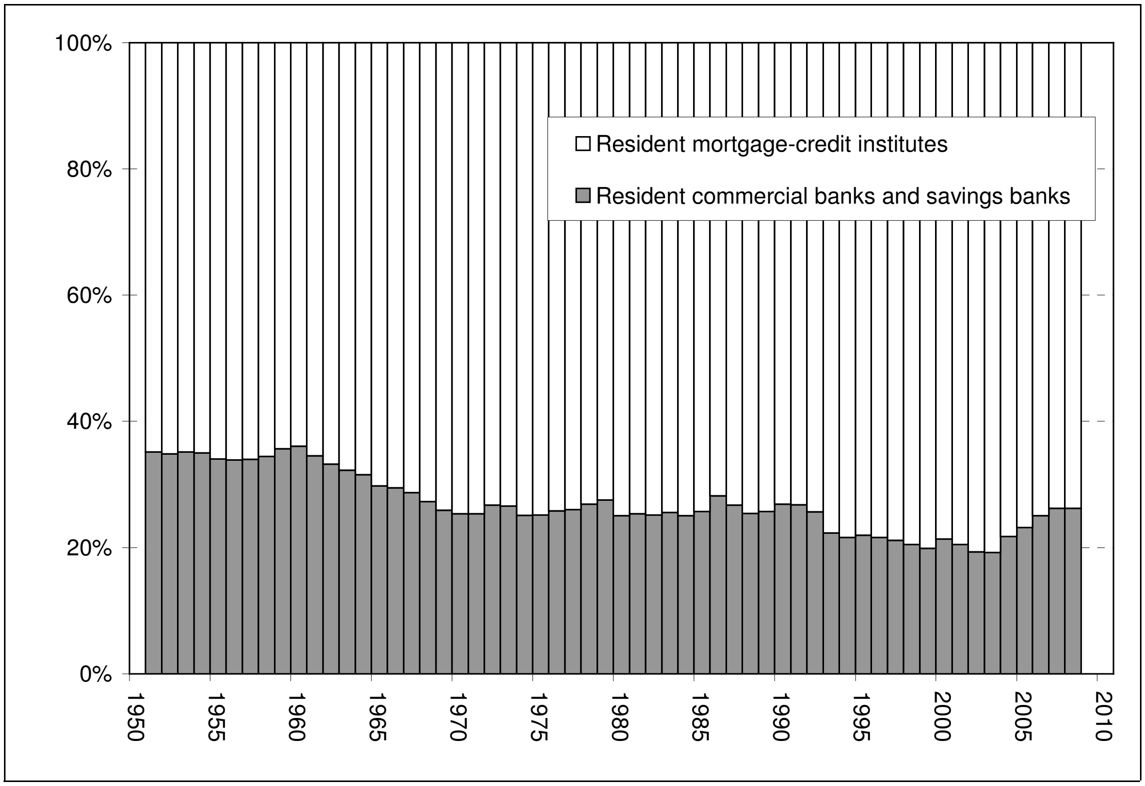
Figure 8.9c: Nominal domestic commercial credit by industry extended by resident commercial banks and savings banks, end of year 1951-2008.



Source: Figure 9 in Abildgren (2009c).

Finally, Figure 8.10 shows the distribution of credit to Danish private individuals since 1951. Overall, the market share of mortgage-credit institutes has increased at the expense of credit from commercial banks and savings banks. During the 1990s and early 2000s this trend might partly be the result of a gradual easing of the access to raise supplementary mortgage-credit loans against free mortgageable value in owner-occupied houses. In 2004 banks began to offer a new type of loans against real property as collateral. These loans compete more directly with loans from mortgage-credit institutions and might therefore have contributed to the increased market share of banks during the most recent years.

Figure 8.10: Nominal credit to Danish private individuals by source, end of year 1951-2008.



Source: Figure 10 in Abildgren (2009c).

8.6. Business-cycle fluctuations in credit by sectors and industries

During the last couple of decades filtering methods have become the standard tools used in the literature for uncovering the more or less "pure" stylised facts and empirical regularities in the cyclical comovement of macroeconomic time series, cf. e.g. Stock and Watson (1999) and Walsh (2003). Filters repack economic time series so a clearer view of their periodic oscillations is obtained. While the results of filtering exercises are purely descriptive - and do not indicate the direction of causality of the underlying economic relationships - they offer an alternative way to look at the time series and may serve as a useful starting point to gain a deeper insight into the credit cycle.

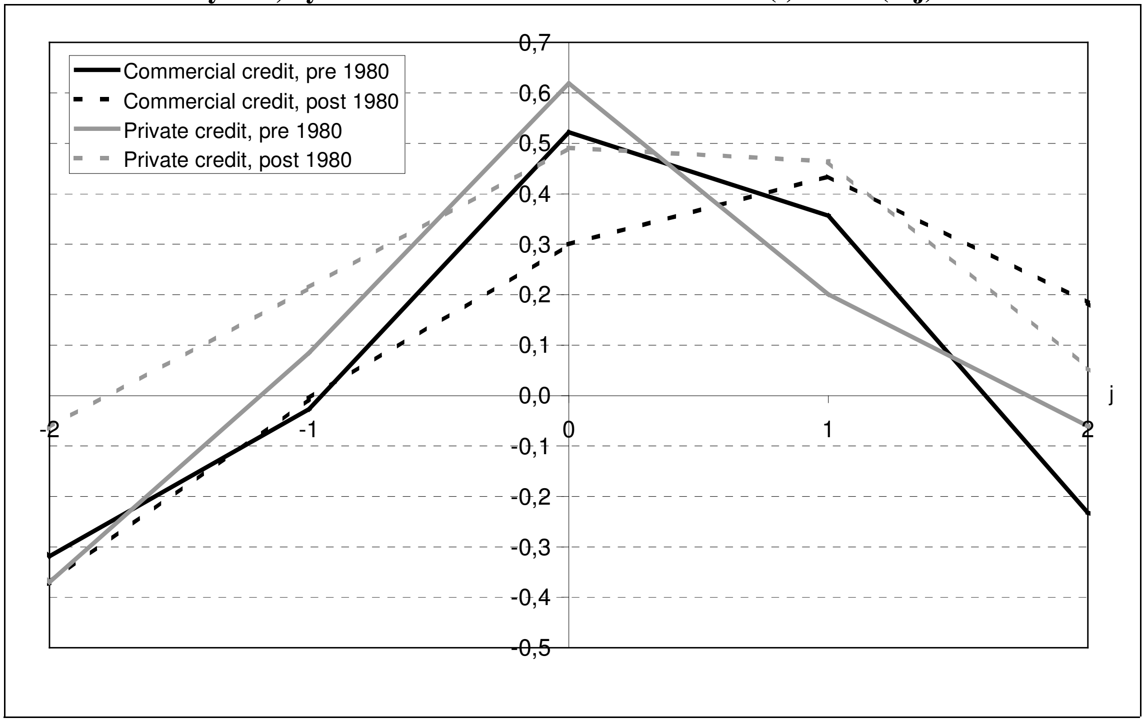
This section reviews the post-World War II cyclical cross-correlation patterns between output and credit to residents by sector and industry. The business cycle component of each time series has been isolated using the Baxter and King (1999) approximate band-pass filter. A band-pass filter eliminates the very high and very low frequencies from the time series in order to isolate the frequencies in the middle range that can be interpreted as the business cycle fluctuations. Furthermore it should be noted that the Baxter and King method ensures that the filtered time series becomes stationary and thereby reduces the risks that the cross-correlation patterns reflect purely spurious cycles.

According to the NBER US business cycles has on average been around 5 years for the post-1854 period and a little more than 6 years in the post-1970 period. However, the post-1974 business cycles in Denmark have been somewhat longer, cf. Hansen and Knudsen (2004). In the following, business cycles will therefore be defined as deviations from the trend lasting from 2 to 8 years. The reason for 2 years as the lower limit (and not zero) is the wish to exclude very short-term random fluctuations from the business cycle component. Naturally, such a limitation of the business cycle frequency is more or less arbitrary but it corresponds to the standard delimitation of the business cycle frequency applied in the literature covering European countries.

A few more technical notes should be given. A symmetric moving average with 3 observations on each side is applied, i.e. the value of the cut-off parameter in the filter is 3. Furthermore, in the essay at hand all the time series have been transformed by natural logarithms before filtering. By transforming a trended input series by natural logarithms before filtering, the cyclical component extracted from the data can (when multiplied by 100) be interpreted as the deviation from the trend measured in per cent. This facilitates the economic interpretation of the filtered time series data.

Like most – if not all – filters the Baxter & King filter has its strengths and weaknesses, and different filters with different choices of parameters can produce very different results, cf. e.g. Gencay, Selcuk and Whitcher (2002) and Mills (2003) for an overview of a broad range of common filtering methods applied in economics and finance. However, the Baxter & King filter still belongs to the group of popular filtering methods in applied economics and the choice of the Baxter & King filter facilitates a comparison with recent studies covering the euro area and the United States.

Figure 8.11: Real private sector GDP (Y) and real credit (C) 1951-2008, cycles of 2-8 years, dynamic cross-correlations between Y(t) and C(t+j).

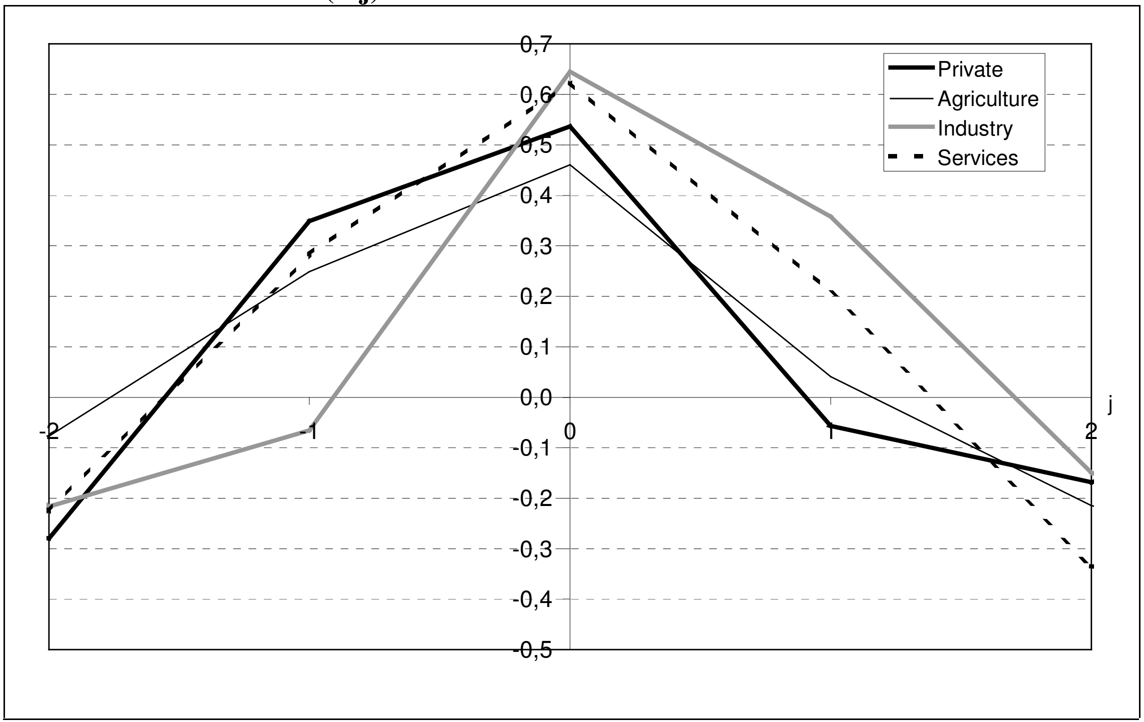


Notes: Y denotes private sector real GDP at factor costs while C denotes the total stock of credit by sector (inflation-adjusted by the CPI) granted by domestic commercial banks and savings banks, domestic mortgage-credit institutes and non-domestic banks. All peak correlations are significant different from zero at a 5 % level. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of real GDP and real credit and a constant included.

Source: Figure 11 in Abildgren (2009c).

Figure 8.11 shows the dynamic cross-correlations between the cyclical components of credit by sector (inflation-adjusted by the CPI) granted by domestic and non-domestic credit institutions and the cyclical component of real private sector GDP at factor costs. A shift in the correlation pattern for commercial credit seems to have occurred over time. In the pre-1980 period commercial credit was contemporaneous with GDP and the contemporaneous correlation coefficient was fairly high (around 0.5). In the post-1980 period the peak correlation coefficient is smaller and commercial credit seems to be lagging the business cycle with one year. A similar shift – although less significant – in the cyclical correlation patterns over time for commercial credit is also visible when the data from domestic banks are viewed in isolation and disaggregated by industry, cf. Figure 8.12.a and 8.12.b.

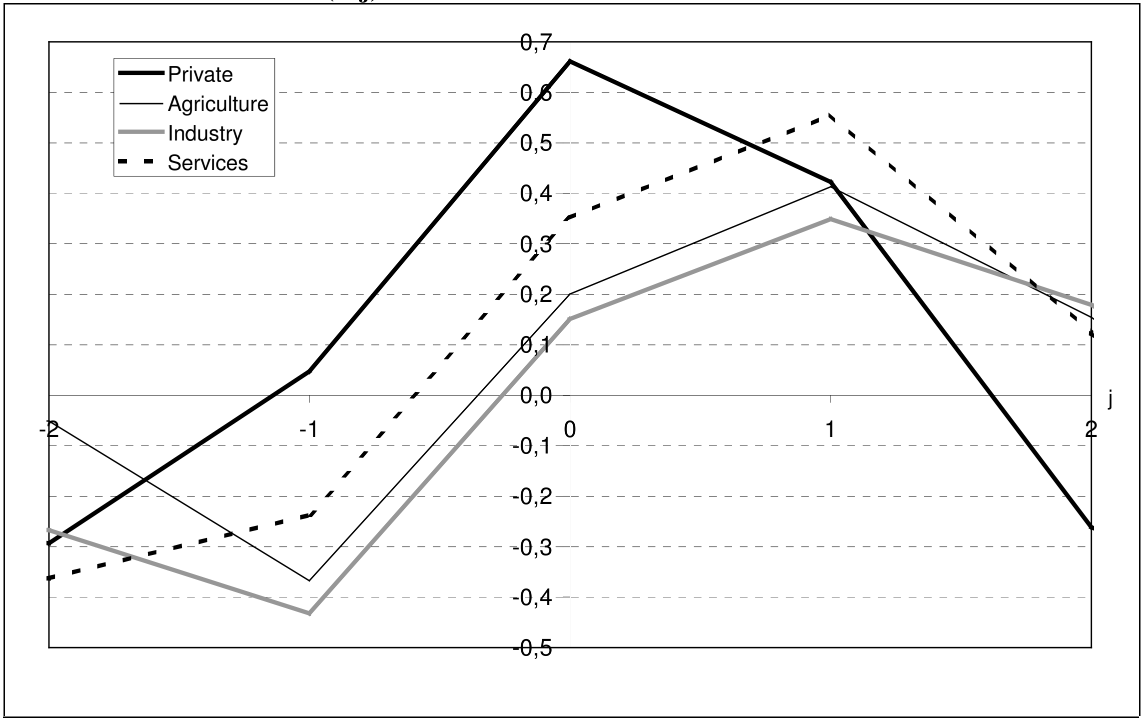
Figure 8.12.a: Real private sector GDP (Y) and real credit from domestic banks (CDB) 1951-1979, cycles of 2-8 years, dynamic cross-correlations between Y(t) and CDB(t+j).



Notes: Y denotes private sector real GDP at factor costs while CDB denotes the total stock of credit by industry (inflation-adjusted by the CPI) granted by domestic commercial banks and savings banks. All peak correlations are significant different from zero at a 5 % level. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of real GDP and real credit and a constant included.

Source: Figure 12a in Abildgren (2009c).

Figure 8.12.b: Real private sector GDP (Y) and real credit from domestic banks (CDB) 1980-2008, cycles of 2-8 years, dynamic cross-correlations between Y(t) and CDB(t+j).



Notes: Y denotes private sector real GDP at factor costs while CDB denotes the total stock of credit by industry (inflation-adjusted by the CPI) granted by domestic commercial banks and savings banks. All peak correlations are significant different from zero at a 5 or 10 % level except for credit to industry where the peak correlation is insignificant different from zero. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of real GDP and real credit and a constant included.

Source: Figure 12b in Abildgren (2009c).

Table 8.2: Nominal private sector GDP (Y) and nominal credit (C) 1951-2008, cycles of 2-8 years, dynamic cross-correlations between cyclical components

	Commercial credit				Private credit			
	pre 1980		post 1980		pre 1980		post 1980	
	Correlation coefficient between Y(t) and C(t+j)	Signi-ficance proba-bility	Correlation coefficient between Y(t) and C(t+j)	Signi-ficance proba-bility	Correlation coefficient between Y(t) and C(t+j)	Signi-ficance proba-bility	Correlation coefficient between Y(t) and C(t+j)	Signi-ficance proba-bility
j = -4	-0.106	0.666	0.057	0.816	0.059	0.810	0.141	0.563
j = -3	0.119	0.618	-0.270	0.250	0.166	0.484	-0.025	0.918
j = -2	-0.140	0.544	-0.262	0.251	-0.212	0.357	-0.059	0.798
j = -1	-0.023	0.920	-0.018	0.938	0.092	0.684	0.110	0.625
j = 0	**0.507**	0.014	0.217	0.321	**0.632**	0.001	0.395	0.062
j = 1	0.369	0.091	**0.384**	0.077	0.287	0.195	**0.507**	0.016
j = 2	-0.278	0.222	0.220	0.338	-0.013	0.955	0.238	0.300
j = 3	-0.250	0.288	0.064	0.788	-0.104	0.663	0.071	0.765
j = 4	0.265	0.273	0.031	0.899	0.241	0.320	0.153	0.532

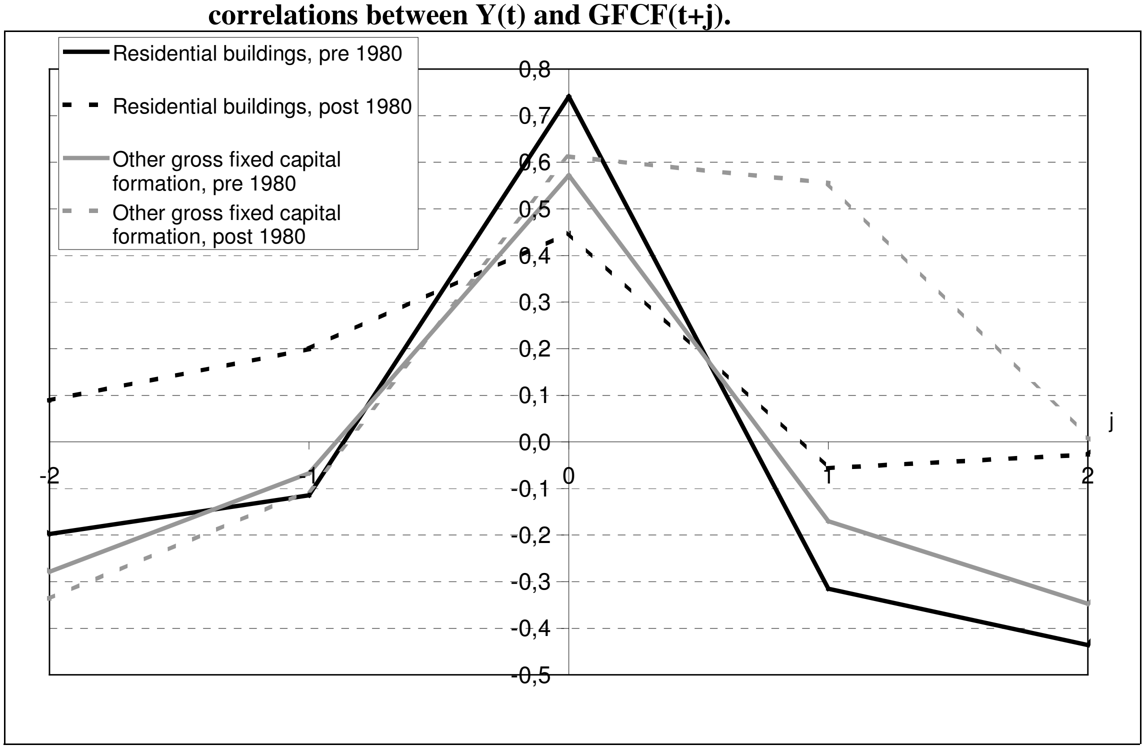
Notes: Y denotes private sector nominal GDP at factor costs while C denotes the total stock of nominal credit by sector granted by domestic commercial banks and savings banks, domestic mortgage-credit institutes and non-domestic banks. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of nominal GDP and nominal credit and a constant included. The Null hypothesis is zero correlation. Bold numbers indicates peak cross-correlations in the table.

Source: Table 2 in Abildgren (2009c).

As a robustness check the calculations from Figure 8.11 are repeated in Table 8.2 based on nominal values. The same change in the cyclical behaviour of commercial credit emerges. In the pre-1980 period nominal commercial credit was contemporaneous with nominal GDP and the contemporaneous correlation coefficients was fairly high (around 0.5). In the post-1980 period the peak correlation coefficient is smaller (around 0.4) and commercial credit seems to be lagging the business cycle with one year.

The change in the cyclical behaviour of commercial credit in the post-1980 period do not seem to be the result of a change in the correlation patterns between economic activity and gross fixed capital formation, cf. Figure 8.13. Measured by the peak correlation coefficients nominal private-sector GDP seems to have been contemporaneous with nominal gross fixed capital formation in both the pre- and post-1980 period. However, gross fixed capital formation excluding residential buildings (i.e. other construction than residential buildings, machinery and transport equipment, and agricultural breeding stocks) seems to a higher degree also to be lagging the business cycle in the post-1980 period than in the pre-1980 period.

Figure 8.13: Nominal private sector GDP (Y) and nominal gross fixed capital formation (GFCF) 1951-2008, cycles of 2-8 years, dynamic cross-correlations between Y(t) and GFCF(t+j).



Notes: Y denotes private sector nominal GDP at factor costs while GFCF denotes nominal gross fixed capital formation in residential buildings or other gross fixed capital formation (i.e. other construction, machinery and transport equipment, and agricultural breeding stocks). All peak correlations are significant different from zero at a 5 % level. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of nominal GDP and nominal gross fixed capital formation and a constant included.

Source: Figure 13 in Abildgren (2009c).

The lagging nature of commercial credit in the post-1980 period may indicate that firms finance their investments via other sources in the initial stages of an economic upturn (e.g. own funds from retained earnings or equity financing[257]), cf. also the analysis of the financing pattern for Danish listed non-financial corporations 1983-2004 in Petersen & Risbjerg (2009). A similar cyclical correlation patterns for total bank credit has been found in a filtering exercise based on quarterly macroeconomic data for the United States and the euro area, cf. Agresti and Mojon (2003). The procyclicallity of commercial credit is also consistent with the theory of "pecking order" within corporate finance according to which firms prefer internal finance rather than financing via debt or equity issuance due to informational asymmetries between firms and external creditors, cf. Myers (1984). This makes external financing more expensive than internally generated funds. The pecking order theory and its implications regarding preference for internal financing has recently found empirical support in studies based on firm-level data for the Netherlands, cf. de Haan and Hinloopen (2003). Using firm-level data for Canada, Covas and Den Haan (2007) also find that equity financing is leading whereas debt financing is lagging the business cycle.

The reason for the change in correlation patterns over time for commercial credit is more open for interpretation and to the knowledge of the author of this essay no studies from other countries have focused on this issue. There is naturally also a question regarding data consistency to consider when time series covering a span of almost sixty years are studied. It would have been preferable if the calculations could be crosschecked on the basis of data on a higher frequency such as monthly or at least quarterly observations. However, if one take the results at face value there might be two possible explanations for the shift in correlation patterns over time: (a) External finance constraints and (b) the role of commercial and industrial foundations.

The closer correlation between commercial credit and output during the pre-1980 period could be a result of the more restricted access to credit during this period. Firms take their intertemporal decisions regarding real investments and financing simultaneously. Credit rationing and exchange controls might therefore have provided an incentive for firms to raise loans at an early stage in the business cycle in order to be sure to have command over the funding necessary for their planned investments. Empirical studies based on US firm-level account data seem to suggest that external finance constraints have an effect on the timing of large investment projects (Whited, 2006) and that financially constrained firms have a different financing pattern than unconstrained firms (Korajczyka and Levy, 2003).

[257] Normally, the costs of equity financing is higher than debt financing but the cost of equity financing usually fall at times with a rising stock market which is typical in the early stage of an economic upturn.

However, Erik Hoffmeyer (Chairman of the Board of Governors of Danmarks Nationalbank in the period 1965-1994) has on several occasions questioned the effectiveness of the pre-1980 quantitative restrictions:

> "... If we look at the period from 1970 to 1980 where the credit ceiling functioned, it has in the debate often been noted that this was a wide-ranging mechanism of credit rationing aiming at a firm regulation of the total extension of credit.
>
> I have often advocated that the crucial element in an assessment of the effect of the credit ceiling has to be how tight the administration was.
>
> We had long periods and several periods where the credit ceiling in reality did not imply any limit on the total extension of credit..."[258]

> "... During the 1960s it became clear that, in the view of the pressures developing in the economy, the instruments available were not adequate, and consequently in 1969 we replaced the deposit scheme with the a credit ceiling.
>
> The credit ceiling functioned throughout the next 10 years, but I would like to emphasize that for us it was very important that the rationing aspect which the credit ceiling represented did not achieve a dominating influence.
>
> It was always our belief that the price element – the interest rate – should be the most import control mechanism..."[259]

Another possible explanation for the change over time in the correlation pattern between commercial credit and GDP could be the increased significance of commercial and industrial foundations in the Danish economy. Industrial foundations are non-profit organisations that typically have been established by the founder of a company or his/her relatives in order to manage a substantial ownership share in the company and operate the company in the "spirit" of the founder. No long-span statistics on the significance of foundation ownership in the Danish economy is available, but a few more sporadic pieces of information can be listed:

- In 2007 there were 1,300 commercial and industrial foundations in the Danish economy. The equity capital of the 50 largest foundations amounted to around 219 billion kroner (around 13 per cent of GDP), cf. Det Økonomiske Råd (2008).
- Nine out of the twenty corporations in the leading Copenhagen Stock Exchange Index (OMXC-20) had in the mid-2000s at least one foundation among the principal shareholders and the commercial and industrial foundations owned around 40 per cent of the share capital in these nine corporations, cf. Danmarks Nationalbank and Økonomi- og Erhvervsministeriet (2006).
- In 1998 the equity capital in firms with foundation ownership amounted to around 150 billion kroner or around 31 per cent of the total equity capital in the Danish business sector, cf. Bjørn and Hovard (2001). The number of employees in firms controlled by a foundation was more than 200,000 in 1998 equivalent to more than 10 pct. of the total employment in the private sector in Denmark, cf. Det Økonomiske Råd (1999).
- Of the 171 companies listed on the Copenhagen Stock Exchange during the period 1996-1999 20 companies were majority-controlled by an industrial foundation, cf. Rose and Thomsen (2002).
- In 1990 foundations controlled 19 out of the 100 largest Danish corporations. This figure is high viewed in an international context. The corresponding numbers were 2 in

[258] English translation of a quotation from page 100 in Hoffmeyer (1985).

[259] Quotation from page 13 in Hoffmeyer (1989).

Sweden, 5 in Germany, 1 in the Netherlands, 0 in the USA and 0 in Japan, cf. Thomsen (1999) and Pedersen and Thomsen (1997).

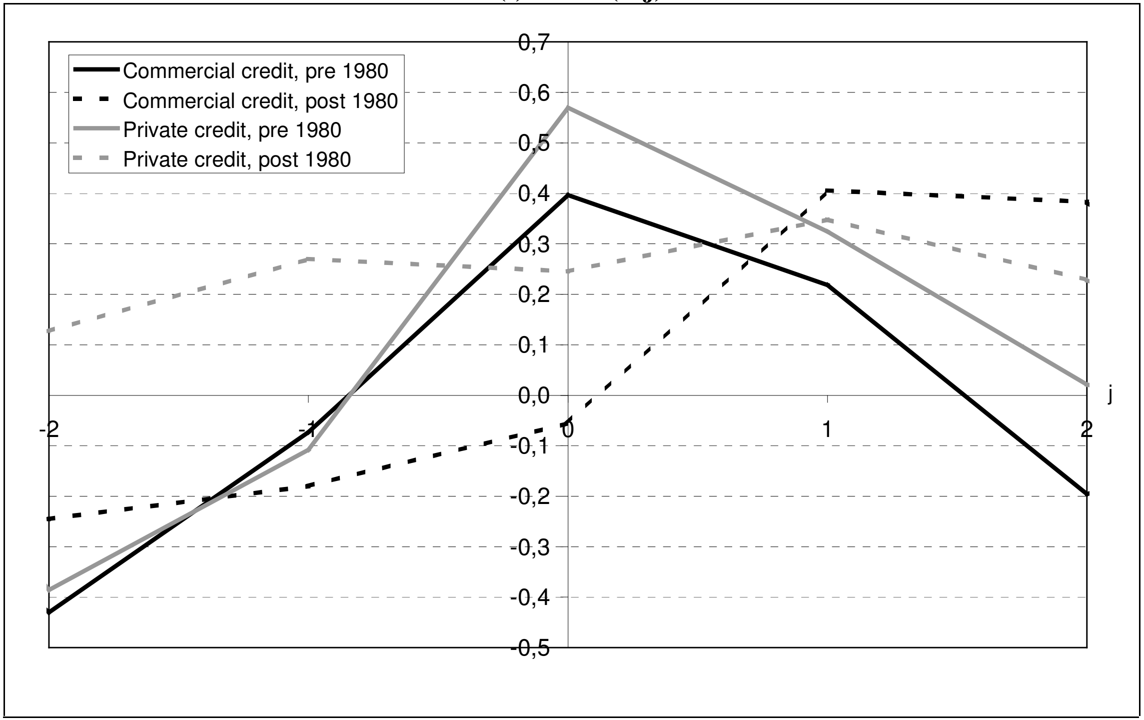
- Among the 30 largest Danish industrial corporations in 1987 respectively 1970 the number of firms controlled by a foundations was 6 respectively 4, cf. Thomsen (1990).

Historically, tax rules might partly explain why foundations have become relatively common in Denmark[260] and the number of commercial and industrial foundations increased rapidly during the 1960s and 1970s, cf. e.g. Andersen (2002) and Boje (1997). Industrial foundations might be seen as “patient owners” without an urgent need for return on equity. In step with the increased capital accumulation in those foundations it might therefore have been possible for Danish firms to finance larger shares of their fixed investments in the initial stages of an upturn with own funds from retained earnings rather than loans from domestic and foreign credit institutes. This source of own financing might also have contributed to the robustness of the Danish business sector and the overall financial system during the years with slow growth and asset price deflation in the late 1980s and early 1990s.

There seems also to have been a shift in the cyclical correlation patterns over time regarding real private credit from domestic mortgage-credit institutes, cf. Figure 8.14. In the pre-1980 period real private credit seems to have been contemporaneous with private sector real GDP. In the post-1980 period the correlation coefficients for private credit are smaller and not very clearly related to the business cycle movements of GDP. This might partly be the result of the gradual easing of the access to raise supplementary loans against free mortgageable value in owner-occupied houses and a more diversified range of flexible products offered for home financing during the most recent decades.

[260] Prior to 1987 foundations in Denmark were subject to very easy taxation. This might have provided the owners of a company with an incentive to donate ownership shares to a foundation. Furthermore, charitable donations by a foundation are tax-deductible, cf. Bjørn and Hovard (2001).

Figure 8.14: Real private sector GDP (Y) and real credit from domestic mortgage-credit institutes (CDM) 1951-2008, cycles of 2-8 years, dynamic cross-correlations between Y(t) and C(t+j).



Notes: Y denotes private sector real GDP at factor costs while CDM denotes the total stock of credit by sector (inflation-adjusted by the CPI) granted by domestic mortgage-credit institutes. All peak correlations are significant different from zero at a 5% or 10 % level except in the post-1980 period where the peak correlation for private credit is insignificant different from zero. The significance probability relates to the slope parameter in an OLS-regression between the cyclical components of real GDP and real credit and a constant included.

Source: Figure 14 in Abildgren (2009c).

8.7. Some final remarks and possible directions for further research

The data set presented in the essay at hand has only been on an annual frequency. It would be interesting if future projects on long-span credit-data construction in Denmark would make an attempt to compile time series on credit by sector and industry at a somewhat higher frequency, preferable monthly or at least quarterly.[261] This would permit more refined investigations of heterogeneity in the short-term cyclical behaviour of credit to different sectors and industries under different monetary regimes, macroeconomic environments and institutional settings, which might be of importance for a better understanding of the dynamics of monetary transmission and potential financial fragility. Furthermore, empirical research on the historical development of the role of commercial and industrial foundations in

[261] In October 2009 Danmarks Nationalbank released monthly time series on credit to the domestic non-MFI sector extended by domestic banks and mortgage-credit institutes broken down by institutional sectors covering the period since 1981, cf. the website of Danmarks Nationalbank (www.nationalbanken.dk).

the financing of the Danish business sector might shed some interesting new light on the monetary transmission process in Denmark.

Abildgren (2008b) has presented a set of historical financial-account stock data for Denmark covering the period 1875-2005 at an annual frequency broken down by 8 institutional sectors (central bank; commercial banks and savings banks; mortgage-credit institutes; life-insurance companies and pension funds; investment associations; central government; other residents; and non-residents) and 6 main types of financial instruments (gold and SDR; currency; loans and deposits; bonds, shares and mutual funds shares; insurance technical reserves; and capital and reserves). However, it would be desirable for analytical purposes if the non-financial private sector in these historical financial accounts could be disaggregated into households and non-financial enterprises. The data set presented in the essay at hand might serve as parts of the building blocks needed for a further disaggregation of the non-financial private sector in future generations of Danish historical financial accounts.

After the outbreak of the sub-prime crises in the summer of 2007, the international financial markets went through a period characterised by turmoil. In the autumn of 2008 the financial crisis escalated and financial stability became a real cause of concern in the USA and many European countries. Governments and central banks responded by supplying ample liquidity and implementing several rescue packages in order to reduce the risk of a "credit crunch" with severe macroeconomic implications. It is yet too early to draw any conclusions regarding the effects of the sub-prime crises on credit dynamics and financial structures. However, issues such as the role of bank capital, bank fund raising, securitisation and financial regulation for the credit channel in the monetary transmission mechanism will without doubt be on the top of the research agenda in the years to come.[262]

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[262] Cf. Borio and Zhu (2008) and Ibañez (2008). Schularick & Taylor (2009) use the data set from Abildgren (2007c) presented in the essay at hand together with data from 11 other developed countries in an empirical examination of the behavior of money, credit, and macroeconomic indicators and the relationship to financial crisis episodes over the years 1870-2008.

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Annex 8.A: Credit to the Danish non-MFI sector 1951-2008, end of year, million kroner

	Credit extended by resident commercial banks and savings banks				Credit extended by resident mortgage credit institutes		Credit extended by non-resident banks	Total
	Agriculture	Industry	Services	Private lending	Commercial lending	Private lending		
1951	1617	1580	3160	2049	4238	3780	75	16499
1952	1690	1648	3372	2103	4329	3930	54	17125
1953	1808	1731	3656	2219	4445	4089	89	18036
1954	1940	1819	3872	2301	4634	4271	126	18963
1955	2016	1911	4017	2337	4854	4524	104	19763
1956	2130	1986	4312	2448	5089	4771	118	20855
1957	2252	2122	4492	2579	5354	5012	149	21959
1958	2375	2252	5024	2842	5736	5407	206	23842
1959	2642	2621	5953	3326	6415	5999	238	27192
1960	2893	3087	6828	3842	7150	6800	228	30827
1961	3053	3510	7525	4298	7847	8148	258	34640
1962	3236	3990	8326	4770	8977	9595	309	39204
1963	3387	4318	9277	5379	10387	11292	503	44542
1964	3616	4884	10535	6239	12248	13527	545	51595
1965	3829	5520	11473	7031	14632	16569	848	59903
1966	4200	6289	12748	8361	17194	19979	1009	69779
1967	4383	6796	13948	9452	19478	23476	1194	78728
1968	4486	7326	15308	10507	22520	27983	914	89044
1969	4625	8011	17489	11966	27050	34218	838	104197
1970	4815	8452	19087	13482	30955	39668	1821	118280
1971	4900	8560	19314	15512	33931	45688	2659	130564
1972	5164	9184	20564	19376	42872	53049	2937	153145
1973	5418	10418	22908	23633	54958	65350	5352	188038
1974	5786	11651	22871	26244	66784	78284	8832	220452
1975	6097	12197	23078	30079	78649	89620	8763	248482
1976	6566	13024	24615	35380	87114	101632	10357	278688
1977	7203	14308	28055	39343	95728	111968	17859	314465
1978	7737	14041	29751	45287	106487	123038	21008	347349
1979	8230	14849	31927	51939	117892	136598	28463	389898
1980	10117	18115	39097	49243	126053	147229	30917	420771
1981	10924	18582	43268	54462	136127	160294	31261	454918
1982	12196	20317	49794	58335	145527	173346	28478	487993
1983	12932	20963	55298	68797	160190	200206	33797	552183
1984	14045	23503	62631	78736	180071	235632	55418	650035
1985	15351	25692	70125	97188	215887	280892	87119	792254
1986	16911	34271	102266	120456	252349	306880	98138	931271
1987	19252	38569	125445	120278	286979	329771	119155	1039448
1988	17984	34971	127257	117700	320737	345412	147300	1111360
1989	17282	43180	142933	120456	340214	348459	165716	1178240
1990	18631	46977	156647	127644	355194	347593	197734	1250420
1991	18327	44661	143651	127406	372468	348106	213434	1268054
1992	20883	43061	146915	120590	379756	349229	188834	1249268
1993	17888	32955	143358	105782	392800	367700	177000	1237483
1994	17699	33123	117804	107167	383600	389500	147000	1195893
1995	16209	37112	122917	115240	391200	409200	116000	1207878
1996	16710	36853	129626	122645	401700	445000	120000	1272534
1997	17658	37946	143809	132973	414900	495000	131000	1373286
1998	21694	46554	164296	142476	434900	552900	139000	1501820
1999	23154	45324	178849	147641	454800	596100	201000	1646868
2000	27833	50371	277342	170653	466800	628600	169000	1790600
2001	34759	60087	313687	179467	494600	697200	136000	1915800
2002	37271	82201	298230	181497	527500	757100	131000	2014800
2003	41220	77383	300475	196692	567300	826200	143000	2152270
2004	48761	87845	322301	244795	607700	880700	107000	2299102
2005	59585	94972	401730	302723	660800	1002000	154000	2675810
2006	73967	102949	498359	373455	716200	1116500	203000	3084430
2007	85271	109371	615411	432576	796600	1216100	196000	3451328
2008	99079	124662	766831	454403	887900	1277500	280000	3890375

Source: Abildgren (2007c) updated with more recent and revised data from the sources stated in Abildgren, *op.cit*.

Essay 9: Monetary Regimes and the Endogeneity of Labour Market Structures – Empirical Evidence from Denmark 1875-2007[263]

Abstract

Essay 9 traces possible links between the monetary regime and the institutional setting of the labour market in Denmark over the past 100 years or so. The results seem to indicate that parts of the labour market structure are endogenous. The longest wage contract terms are found towards the end of the pre-World War I Classical Gold Standard period – characterised by price-level stability – and during the period since the mid-1990s that has seen a firm fixed exchange-rate policy and low and stable inflation. The shortest contract lengths are observed in the interwar period with high inflation volatility. Inflation indexation of wages was used most extensively in the Bretton Woods period and during the soft peg period of the 1970s when inflation was high and rising. The degree of nominal wage rigidity in the economy is therefore not necessarily approximately constant, as it is otherwise assumed in many New Keynesian models.

Key words: Wage formation, labour market structures, monetary regimes, Danish economic history

JEL Classification: E42, J50, N13, N14, N33, N34.

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[263] This essay is based on Abildgren (2008a, 2009b).

9.1. Introduction

In a recent empirical study on Swedish wage contracts since 1908 Klas Fregert and Lars Jonung draw two major conclusions, cf. Fregert & Jonung (2008). First, they find indications of certain links between policy regimes and labour market structures. Their results indicate that the length of wage contracts decreases in step with macroeconomic volatility, whereas the use of inflation indexation of wage agreements increases. Second, they find that the inflation-targeting regime since the mid-1990s stands out as an exceptionally stable regime in Sweden, characterised by relatively long non-indexed wage contracts.

Overall, there are many similarities between Denmark and Sweden as regards economic history, but one noteworthy difference is the choice of monetary regime in the most recent decades, in which period Denmark has had stronger preference for a fixed-exchange-rate regime than Sweden. It is therefore of interest to complement the Swedish study by a closer examination of the possible links between the monetary regime and the institutional setting of the labour market in Denmark in a long-term perspective in order to check the robustness of the two major findings for Sweden. First, can one find similar indications of links between policy regimes and labour market structures in Denmark? If so, it could indicate that elements of the labour market are endogenous, which could have implications for the robustness of results and policy conclusions derived from theoretical models that treat these parts of the economy as exogenous. Second, is the finding of an exceptionally stable regime in Sweden since the mid-1990s the result of a successful adoption of a particular promising monetary-policy strategy (inflation targeting)? Or can one find similar results for Denmark, which has chosen a different monetary-policy strategy (fixed exchange rates) than Sweden during the most recent decades?

The essay at hand is based on two new data sets constructed by the author.[264] The first data set concerns the development in wages, prices and productivity since the introduction of the krone as the Danish currency unit in 1875. The second data set covers the length of collective agreements, the use of automatic inflation indexation in wage agreements and intervention in the renewal of collective agreements by Act of Parliament 1900-2007. On the basis of these two data sets, potential labour market endogeneities are examined and the relation to the monetary regime is explored.

[264] The sources and compilation methods used to construct the data sets applied in this essay and a full listing of all data series is available in a background paper, cf. Abildgren (2008a). As with all historical statistics a word of caution is in order. Compilation methods and practices may vary over time, and a number of judgements and estimations have been necessary to construct the data set applied in this essay. The results and conclusions presented in this essay should therefore be taken with “a pinch of salt”.

9.2. The endogeneity of labour market structures – theoretical aspects and policy implications

A well-established result from the theoretical literature is that the effects of monetary policy and the cyclical sensitivity of the economy depend on the institutional characteristics of the wage formation regime. An assumption on nominal wage stickiness is, for instance, a defining feature of many New Keynesian models and plays a crucial role in the reaction of the economy to shocks, cf. Woodford (2003) and Galí (2008).

However, links from monetary regime to labour market structures can also theoretically be imagined. This direction of causality has e.g. been studied within the context of Optimum Currency Areas, cf. De Grauwe & Mongelli (2004), and in relation to the determinants of nominal wage rigidity in the literature with focus on labour market economics, cf. Gray (1978) and Groth & Johansson (2004).

A credible monetary regime that delivers on the final target of price stability provides a basis for inflation expectations firmly anchored around price stability, which might facilitate the use of multi-year nominal wage contracts among forward-looking workers and employers. Furthermore, an environment with low and stable inflation eases the formation of inflation expectations, which might promote decentralised wage negotiations.

Lack of credibility of a monetary regime that results in high and volatile inflation might make shorter wage contracts more attractive and encourage the use of inflation indexation of nominal wages. Furthermore, high inflation and pronounced inflation volatility require more resources to forecast inflation and form inflation expectations. This might give centralised labour market organisations a larger role to play as they can allocate the necessary professional resources to make inflation forecasts in relation to collective nominal wage bargaining.

If labour market structures to some degree are regime dependent, this could have implications for the robustness of results and policy conclusions derived from theoretical models that treat these parts of the economy as exogenous. In his seminal paper, Lucas (1976) argued that policy conclusions drawn from macroeconomic models could be invalid or questionable if they were not based on models with constant "deep" or "structural" parameters. Many New Keynesian DSGE models are based on an assumption on nominal wage rigidities, and the degree of nominal wage stickiness is usually assumed to be approximately constant (a "deep" or "structural" parameter) which should make these models robust to the Lucas critique. However, if labour market structures are endogenous the degree of nominal wage stickiness will not necessarily be constant across monetary regimes. This could have implications for the effectiveness of stabilisation policy in different regimes and make such models unsuitable for the analysis and comparison of alternative monetary regimes.

Whether labour market structures are endogenous or not is ultimately an empirical question. However, if labour market structures are endogenous at least to some extent, it would enhance the empirical realism of the New Keynesian framework – as well as increase the robustness of these models to the Lucas critique – if such endogeneities were to be taken explicitly into account in the modelling framework.

9.3. A brief review of the empirical literature on the endogeneity of labour market structures

A number of empirical short-term studies seem to confirm that the length of wage contracts decreases in step with rising inflation uncertainty, and that inflation uncertainty increases the degree of indexation in wage contracts, cf. e.g. Christofides & Peng (2006).

However, only few empirical long-term studies have focused on the possible monetary-regime dependence of the institutional characteristics of the wage formation process and other parts of the labour market settings. A notable exception is the works by Klas Fregert and Lars Jonung, who have studied the length of collective wage agreements and the use of inflation indexation of wages in the industrial sector in Sweden since 1908, cf. Fregert & Jonung (1998, 2008). They find that the length of wage contracts in general decreases in step with uncertainty concerning the macroeconomic policy regime. Contract terms were longest during the Classical Gold Standard period 1908-1914, towards the end of the Bretton Woods period 1966-1974 and in the recent period 1995-2005 with an inflation-targeting regime. Inflation indexation was most pronounced during World War II and in the period 1977-1990. These two periods were characterised by high volatility in nominal wages and prices. The inflation-targeting regime since the mid-1990s stands out as an exceptionally stable regime in Sweden characterised by relatively long non-indexed wage contracts.

Only a few studies have focused on long-term empirical analysis of the Danish labour market structures and the Danish wage-formation process. They include a detailed study of the Phillips curve relationship for the Danish economy 1904-1970, cf. Kærgård (1991), and a comprehensive study of a wide range of topics related to the Danish labour market in the 20th century, cf. Pedersen (1984). However, none of these studies focus directly on the possible monetary-regime dependence of labour market structures.

9.4. General outline of the Danish labour market in a historical perspective

The modern Danish labour market setting was shaped in the first five decades following the abolition of the medieval guild system in the middle of the 19th century with the Freedom of Trade Act of 1857 (effective from 1862).

After 1862, many of the master's guilds carried on as voluntary organisations. Some of them became employer organisations, while other, newer, industries formed separate employer organisations. In the mid-1880s, the first major employer association was established.

The journeymen guilds can only in a very general sense be seen as predecessors of trade unions. After the implementation of the Freedom of Trade Act, most of the journeymen guilds continued as voluntary sick and burial societies, although some took an interest in the more general working conditions of their members and also concluded written collective agreements with their former masters. However, a number of actual local trade unions were established during the 1860s and 1870s, and worker unionisation gained pace during the 1880s with the formation of local joint organisations covering all trade unions within a local area. In the late 1880s national trade unions also emerged.

One legacy from the guild system might be the tendency to establish separate trade unions for skilled blue-collar workers, unskilled blue-collar workers and white-collar workers and a certain degree of conflict of interest between the groups. The majority of the early trade unions required journeyman status as a condition for membership. Trade unions for unskilled blue-collar workers and white-collar workers therefore developed relatively late. However, towards the end of the nineteenth century also the main unions organising unskilled workers had been established.

During the last decade up to the turn of the century, collective bargaining became more widespread, cf. section 9.6, and the two main labour market organisations were established towards the end of the 1890s. The Danish Employers' Confederation (DA) was founded by merger in 1898 and has since been the main private-sector employer organisation in the Danish labour market. The main national workers' organisation, the Danish Confederation of Trade Unions (LO), was also founded in 1898 as a federation of several national and local trade unions covering both skilled and unskilled workers.

In 1899 a minor strike among carpenters in Jutland escalated into a nationwide lockout covering a large part of the building sector and the iron industry. The lockout lasted for three months. In September 1899 DA and LO concluded the "September Compromise" with the following main elements:

- Mutual recognition by workers and employers of the right to form organisations.
- Recognition of both parties' right to effect work stoppages through strikes and lockout subject to the observance of certain rules (14 days' notice to the other party and approval of the work stoppage by a majority of three-fourths in a competent assembly).
- Fulfilment of collective agreements concluded by the two parties.
- Recognition of the employers' right to manage and allocate work and employ the amount of labour deemed necessary (the "managerial prerogative" of the employers).
- Termination of collective agreements at three months' notice.
- Work supervisors were allowed not to be members of the workers' organisations.
- Neither of the two parties were allowed to support industrial actions violating the rules of the game stated in the September compromise.

- The occurrences of breaches of collective agreements were first to be handled by the competent assembly of the parties' organisations. If agreement could not be reached, the issue was to be taken to court.

The September Compromise – with subsequent amendments – still serves as the "constitution" of the Danish labour market.

After a major conflict in 1898, DA and LO agreed to establish a joint body, the Joint Commission of 1898, to interpret and deal with breaches of collective agreements. As a result of the September compromise of 1899, the Permanent Arbitration Board replaced the Joint Commission in 1900. The purpose of the Permanent Arbitration Board was to handle breaches of the September 1899 compromise. It consisted of 7 members: 3 appointed by DA, 3 by LO and a chairman jointly elected by the two parties.

Following another major work stoppage, the government set up a commission in 1908 with participants from DA and LO. The aim was to review the existing collective bargaining system and make suggestions for improvements. An impartial chairman appointed by the government headed the commission's work, which had three main outcomes:

- In 1910 DA and LO agreed on the "Norm for dealing with industrial strife". The norm established standard rules for dealing with disputes on rights. Issues regarding the interpretation of existing collective agreements should be handled via arbitration boards at local or centralised level, whereas breaches of existing collective agreements should be handled by legal proceedings. Furthermore, the norm emphasised the obligation to maintain industrial peace outside the periods when collective agreements were due for renewal. The only exceptions from the peace obligation were areas not covered by collective agreements, matters of "life, honour and welfare" or cases where wages were withheld.
- On the basis of the report from the commission, the Labour Court Act of 1910 was adopted. The Labour Court replaced the Permanent Arbitration Court from 1900 and had jurisdiction to deal with breaches of all collective agreements (not only violations of the September 1899 compromise). The Labour Court was to have 7 members: 3 appointed by DA, 3 by LO and a presiding judge nominated jointly by the partisan members and formally appointed by the government. The decisions of the Labour Court were to be final and legally binding, and the Court should have the power to impose fines.
- Finally a temporary Act on a Public Conciliator of 1910 was also implemented as a result of the commission's work. The Public Conciliator was to mediate in disputes between the parties in connection with the conclusion of collective agreements. The Public Conciliator was appointed on a two-year basis by the government after recommendation from the members of the Labour Court.

With only few deviations, the initiatives of 1910 have constituted the framework for the settlement of disputes in the Danish labour market ever since, cf. section 9.8.

The figures presented below shows that trade union membership only amounted to around 10-20 per cent of the total labour force (including farm workers and self-employed persons) in the first quarter of the twentieth century. However, the degree of unionisation was much higher among urban (industrial) workers, around 50-70 per cent in the major cities in 1900, cf. Christensen et al. (2007). The collective agreements reached between DA and LO might also have had an influence on the rest of the Danish labour market since DA established a statistics on wages already in 1907. Later, in 1914, DA's wage statistics became an important input to the official wage statistics compiled by Statistics Denmark, cf. Dansk Arbejdsgiver- og Mesterforening (1907), DA (2007) and Arbejds- og Socialministeriet (1958).

Today's Danish labour market system is often characterised as a system based on collective bargaining between the workers' and employers' organisations on pay and all other major issues relating to working conditions. Trade union membership is widespread and the level of organisation among employers is also higher than in most other countries. The emphasis is on self-regulation via voluntary agreements among the labour market parties rather than legislation[265]. As described above, most of these characteristics of the current Danish system of labour market regulation date back to the last decades of the 19th century and the early decades of the 20th century.[266]

Figure 9.1 presents a range of key figures for the Danish labour market since 1875. The following observations and trends can be noted:

- Trade union membership has gradually increased from less than 10 per cent of the total labour force in the last quarter of the 19th century to more than 70 per cent in the early 2000s.
- The same period has witnessed a substantial increase in the level of real hourly earnings and a significant reduction in annual working time.
- The wage share of factor income has remained roughly unchanged at a level around 60-70 per cent, although with some local upward and downward trends.
- In general the Danish labour market system has delivered a high degree of industrial peace. The average number of working days lost due to work stoppages has amounted to less than 0.1 per cent of the total number of working days. Except for the years following immediately after the end of World War I – where syndicalism temporary influenced the Danish labour movement – pronounced stability in labour market relations has characterised the whole period since 1875.
- The rate of unemployment displays marked persistence with peaks around the Great Depression in the 1930s and again during the 1980s and early 1990s.
- Finally, there has been an upward long-run trend in the unemployment compensation rate since the introduction of public subsidies to unemployment benefit associations in 1907. The swings in unemployment compensation seem to mirror the swings in the unemployment rate.

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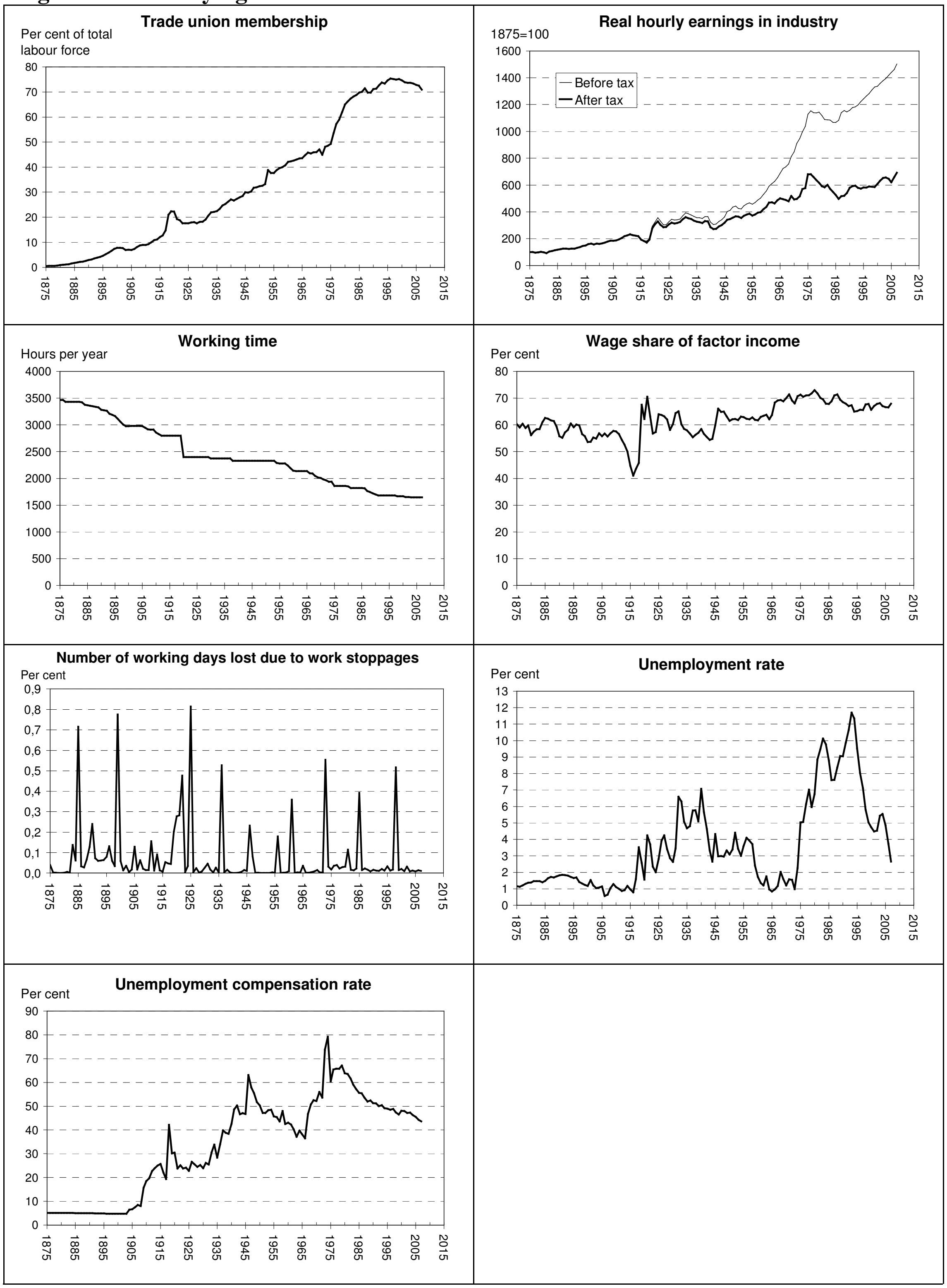
[265] One exception has been the 1973 Act on Equal Pay between men and women. Most other labour-market-related legislation (e.g. on holidays with pay) is usually only processed by Parliament after agreement has been reached by the labour market partners, and there is e.g. no statutory minimum wage in Denmark.

[266] The origin and development of the Danish labour market institutions since the early 19th century is described in more detail in a background paper, cf. Abildgren (2008a). Christensen *et al.* (2007) offers a detailed list of references.

Figure 9.1: Key figures of the Danish labour market 1875-2007



Source: Figure 1 in Abildgren (2009b).

Note: The deflator for real hourly earnings in industry is the CPI. The tax rate applied to the calculation of real hourly earnings in industry after tax includes all direct and indirect taxes to the general government. The wage share of factor income is measured as the total wage sum in current prices in per cent of GDP at current factor cost. The number of working days lost due to work stoppages is measured in per cent of total number of working days. The unemployment rate is measured in per cent of the total labour force. The unemployment compensation rate is calculated as unemployment benefit in current prices per unemployed person in per cent of wage sum in current prices per employed person.

9.5. Monetary regimes and the anchoring of price and wage inflation

Table 9.1 shows a range of summary descriptive statistics on nominal wage inflation, labour productivity and consumer price inflation since 1875 broken down by sub-periods determined by the Danish exchange-rate policy, cf. Abildgren (2005c).

Table 9.1: Monetary regimes and wage inflation in Denmark – summary statistics 1875-2007

		Growth in nominal hourly earnings in industry			Growth in hourly labour productivity[a]			CPI inflation		
		Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
		per cent per annum								
1875-1913	The Classical Gold Standard	2.2	6.4	-5.0	2.4	7.1	-2.7	0.0	8.5	-10.6
1914-1945	World Wars and interwar period	5.8	72.9	-21.5	1.4	17.7	-14.0	3.8	24.4	-15.0
1946-1971	Bretton Woods	8.2	13.7	2.7	4.8	13.4	0.6	4.4	11.7	-0.7
1972-1986	European exchange-rate cooperation - The "soft peg" period	10.4	19.9	4.6	2.6	4.0	1.0	9.1	15.2	3.6
1987-2007	European exchange-rate cooperation - The "hard peg" period	4.0	9.4	2.4	2.2	3.9	0.3	2.4	4.8	1.2
1875-2007	Total	5.5	72.9	-21.5	2.6	17.7	-14.0	3.2	24.4	-15.0

Source: Table 1 in Abildgren (2009b).

[a] Compiled as annual growth in real total economy GDP per working hour.

During the Classical Gold Standard period 1875-1913 Denmark participated in the gold-based Scandinavian Currency Union together with Sweden and (from 1877) Norway. During this period all other major trading partners participated in the international fixed-exchange-rate Gold Standard system as well. The price level in Denmark was roughly unchanged in the period 1875-1913 overall, and average nominal wage inflation was low (2.2 per cent per annum).

The period 1914-1945 saw rather frequent changes in the monetary regime. World War I *de facto* terminated the Scandinavian Currency Union and the international Classical Gold Standard. After the war, Denmark and its major trading partners gradually returned to the Gold Standard, but the system collapsed again after a few years when the UK went off gold in September 1931. Denmark left the Gold Standard in the same month, and in 1932 a comprehensive exchange-control system was introduced. Apart from a major Danish devaluation in 1933, the Danish krone was pegged to the pound sterling most of the time until the outbreak of World War II. The average level of nominal wage inflation in the period 1914-1945 was still moderate (5.8 per cent per annum), but volatility was substantial.

In the period 1946-1971, Denmark participated in the Bretton Woods fixed-exchange-rate system. In the late 1940s the UK was still Denmark's largest trading partner and the devaluation of the pound sterling by 30.5 per cent in September 1949 was mirrored fully by Denmark. During the 1950s and 1960s, Denmark's trade pattern gradually shifted towards higher export shares to continental Europe, and the devaluation of the pound sterling in November 1967 by 14.3 per cent vis-à-vis the US dollar was only followed partly by Denmark (7.9 per cent). In the Bretton Woods period there was a sustained upward trend in the level of nominal wage inflation without a single year with negative wage inflation, whereas nominal wage deflation frequently occurred during the Classical Gold Standard period and several times in the interwar period.

After the breakdown of the Bretton Woods system in the beginning of the 1970s, Danish exchange-rate policy became part of the European exchange-rate cooperation. In principle, a fixed exchange-rate policy was pursued, but frequent devaluations of the Danish krone were observed until the early 1980s. During the period 1972-1986, average nominal wage inflation reached double-digit figures and volatility was fairly high.

The last realignment of the central parity for Danish kroner vis-à-vis Deutsche Mark within ERM occurred at the beginning of 1987. Since then Denmark has pursued a "hard" peg against the D-mark and later the euro. The period since 1987 has seen an average level of wage inflation of 4.0 per cent – the lowest level since the Classical Gold Standard – and volatility has been very low.

The analysis above shows that wage inflation was lowest in those periods when Denmark pursued a consistent fixed-exchange-rate policy: The pre-1914 Classical Gold Standard period and the hard peg vis-à-vis the D-mark (later the euro) since 1987. The latter period has also seen the lowest volatility in wage inflation. The historical evidence shows that in the case of Denmark a consistent fixed-exchange-rate policy has provided the best foundation for anchoring inflation expectations.

It is also worth noticing that in all the sub-periods since 1875 shown in Table 9.1, average annual consumer price inflation has been approximately equal to average annual nominal wage inflation less average annual growth in hourly labour productivity. The advances in real hourly earnings before tax have approximately followed the development in labour productivity – irrespective of the type of monetary regime. In a long-run perspective, the growth in real hourly earnings thus seems to be determined by real factors (productivity) rather than nominal factors (the size of nominal wage increases). The role played by the monetary regime seems in the longer run only related to nominal variables – the ability to create a stable nominal anchor for the economy. However, as Figure 9.1 shows, the largest drops in real hourly earnings after tax occurred around World War I and II and in the decade following the mid-1970s. Those periods were characterised by high levels of CPI inflation. It seems thus to have its price if inflation expectations lose their anchor.

9.6. Length of collective agreements

For the period 1875-1899 only sparse and fragmented information on the length of collective agreements in Denmark is available. For the earliest period – before collective agreements became common – the "schedules of wages" were in some cases changed several times a year. By 1899 collective agreements were common in Copenhagen and the major Danish provincial cities, cf. Galenson (1952). The metal trade industry gained a leading position by establishing a nation-wide collective agreement in 1897, and several other trades followed suit during the second half of the 1890s, cf. Christensen *et al.* (2007). However, the duration was seldom specified in the agreements. In many cases it was just stated that an agreement could be terminated after at least one year. There might have been a tendency towards somewhat longer duration than one year in the 1890s, especially in the second half of the decade, cf. Nørregaard (1943) and Galenson (1952).

For the post-1900 period, Figure 9.2 shows the length of new collective agreements in the industrial sector. Table 9.2 presents a range of summary statistics. A few comments should be given on the nature of the data. For the period 1900-1910 the information is only based on the collective agreements for the members of The Danish National Union of Smiths and Fitters, whereas the period since 1911 covers most of the industrial sector. The relatively low coverage ratio prior to 1911 raises the issue of whether the results for the Classical Gold Standard period could be biased and calls for careful interpretation of the data. However, the Danish National Union of Smiths and Fitters was the largest trade union for skilled workers and accounted for 9 per cent of members of LO in 1900, cf. Jensen & Olsen (1901). Furthermore, the degree of unionisation among smiths and fitters were high, around 75-85 per cent in the period 1899-1912, cf. Maigaard (1999), and the collective agreements concluded by the Danish National Union of Smiths and Fitters seems to have had a significant influence on other parts of the private labour market. In the period 1897-1914 the average working time in Copenhagen was quite closed to the agreed working time in the collective agreements concluded by the Danish National Union of Smiths and Fitters, cf. page 51 in Christensen (1975).

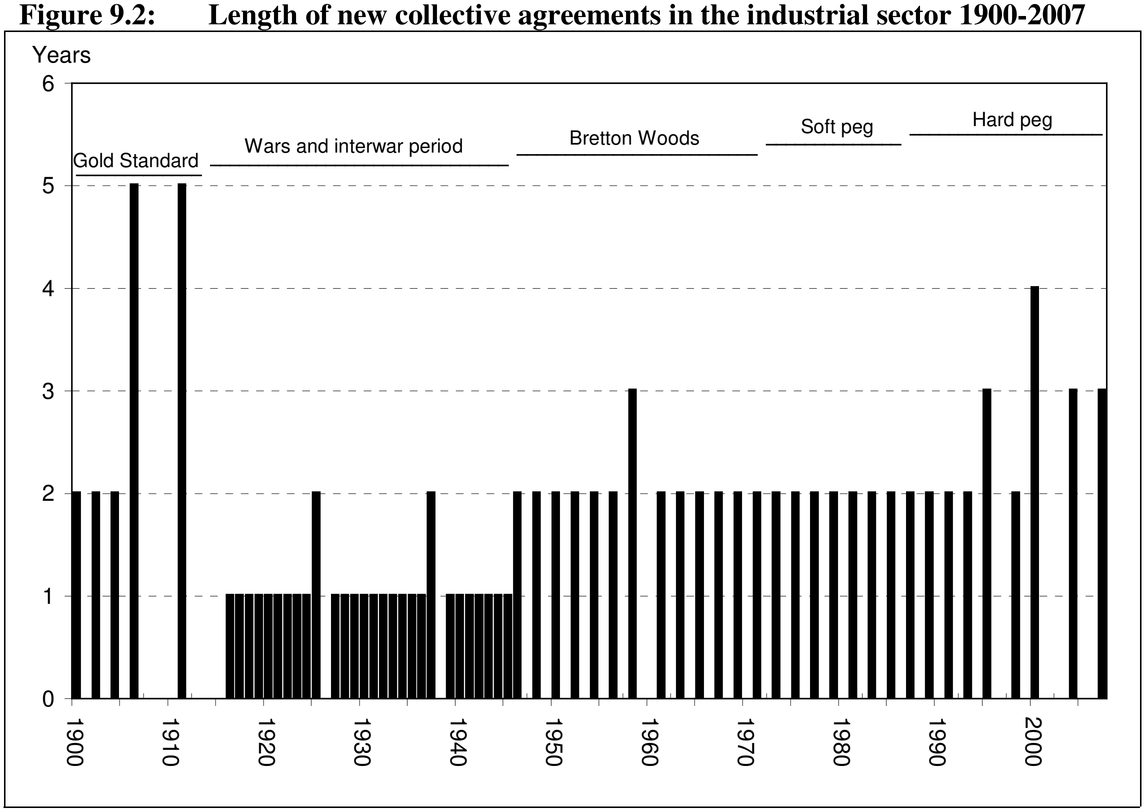
In Table 9.2 and Figure 9.2, the lengths of new collective agreements are only reported as a whole number of years. However, during most of the period contracts in the private-sector labour market in Denmark have been negotiated for a whole number of years. If negotiations on new contracts are not completed until the expiry of the previous contract term, the new contracts usually enter into force retrospectively. The potential bias from rounding is therefore believed to be insignificant.

Table 9.2: Monetary regimes and length of new collective wage agreements in the industrial sector in Denmark – summary statistics 1900-2007

		Length of new wage agreements, years			
		Mean	Standard deviation	Maximum	Minimum
1900-1913	The Classical Gold Standard	3.2	1.6	5	2
1914-1945	World Wars and interwar period	1.1	0.3	2	1
1946-1971	Bretton Woods	2.1	0.3	3	2
1972-1986	European exchange-rate cooperation - The "soft peg" period	2.0	0.0	2	2
1987-2007	European exchange-rate cooperation - The "hard peg" period	2.6	0.7	4	2
1900-2007	Total	1.8	0.9	5	1

Source: Table 2 in Abildgren (2009b).

Figure 9.2: Length of new collective agreements in the industrial sector 1900-2007



Source: Figure 2 in Abildgren (2009b).
Note: The length has been rounded to a whole number of years.

During the latter part of the Classical Gold Standard period, the length of collective agreements increased from 2 to 5 years – the longest duration in the entire post-1900 period.

This might reflect the credibility of the Classical Gold Standard, which by then had delivered on the final target of price stability for quite some time, cf. section 9.5. This provided the basis for inflation expectations firmly anchored around price stability and facilitated the use of multi-year nominal wage contracts among forward-looking workers and employers.

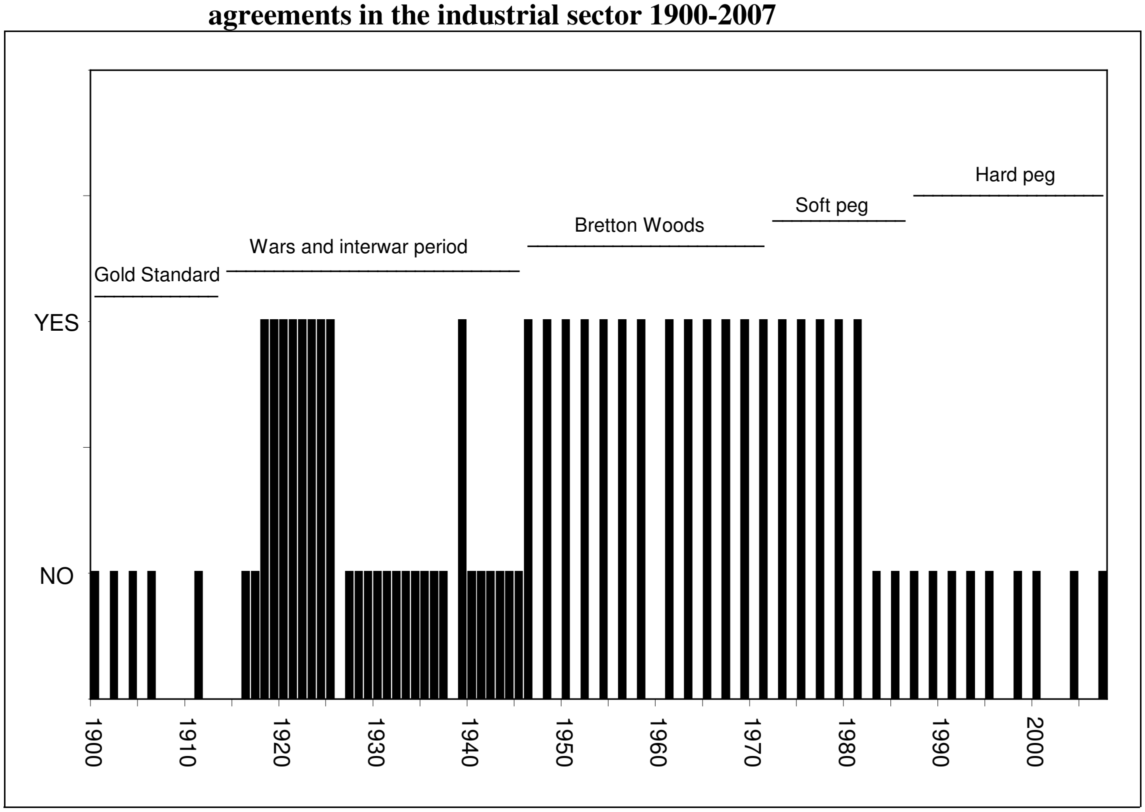
Wartime inflation reduced the term to one year, which, with a few exceptions, was the standard length of collective agreements in the interwar period. The world wars and the interwar period were characterised by higher and more volatile inflation than the Classical Gold Standard period, cf. section 9.5, and the lack of credibility of the monetary regime might – despite negotiation costs – have made shorter wage contracts more attractive.

In most of the post-World War period, the standard length of new collective agreements has been 2 years. However, in the last decade or so, contract lengths of 3 or 4 years have dominated. This might reflect the increased credibility of the Danish fixed-exchange-rate regime and the international decline of inflation rates during the 1980s and the beginning of the 1990s.

9.7. Use of automatic cost-of-living indexation in wage agreements

Figure 9.3 plots the use of automatic inflation indexation of wages in collective agreements in the industrial sector since 1900.

Figure 9.3: Use of automatic cost-of-living indexation of wages in collective agreements in the industrial sector 1900-2007



Source: Figure 3 in Abildgren (2009b).

Inflation indexation was first introduced in light of the soaring inflation towards the end of World War I. It was a standard element in collective agreements during the first half of the 1920s. From 1927 automatic inflation indexation was no longer an element in the collective agreements until just before the outbreak of World War II.

After World War II, automatic cost-of-living indexation returned as a standard element in collective agreements until the early 1980s. Inflation indexation was suspended by an Act of Parliament as part of a set of income-policy initiatives in 1982 and abolished altogether in 1986. Since then automatic inflation indexation has not been part of the collective agreements in the industrial sector even though legislation does not prevent reintroduction by agreement between the labour market partners.

The Danish experience with automatic cost-of-living indexation of wages thus indicates that a monetary regime that results in high and volatile inflation encourages the use of inflation indexation of nominal wages among forward looking agents, whereas a regime with low and stable inflation makes inflation indexation unnecessary.

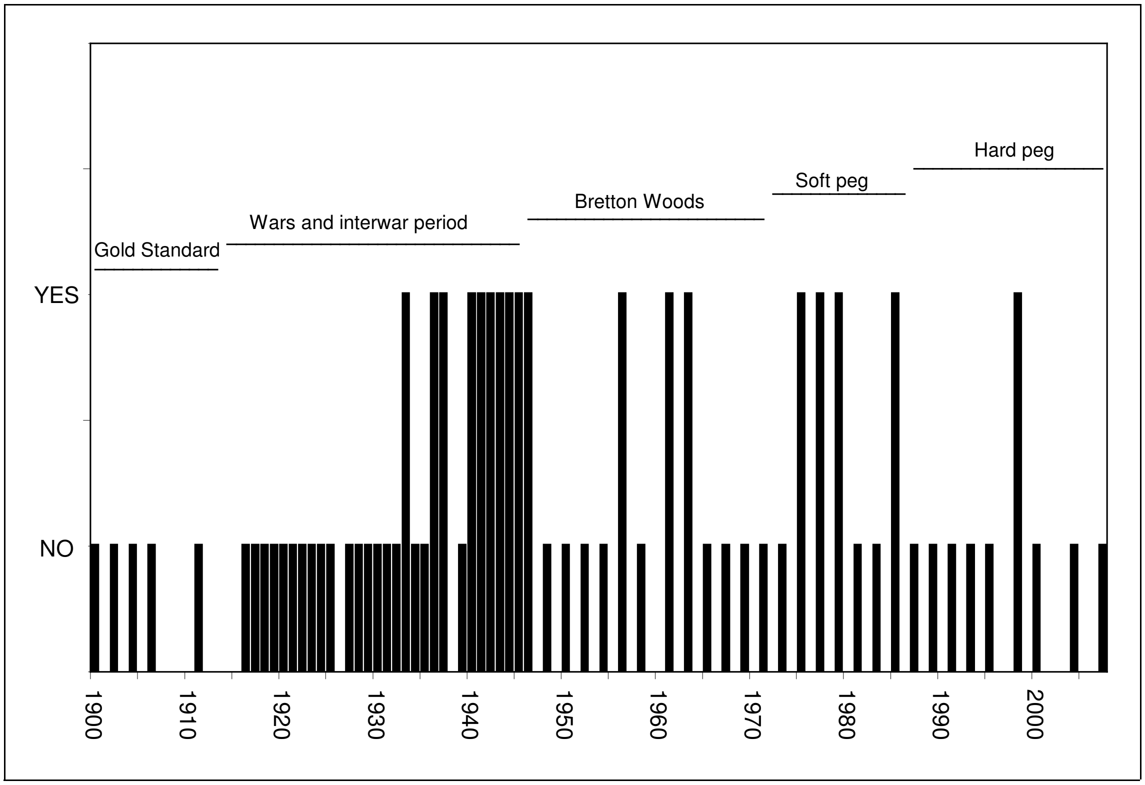
9.8. Intervention in the renewal of collective agreements by Act of Parliament

Figure 9.4 shows the level of intervention in the renewal of collective agreements by Act of Parliament in the period since 1900. The permanent compulsory arbitration enacted in 1940 and in force during the German occupation of Denmark until 1945 has been classified as "intervention" for all of the years 1940-1945.

Disregarding the World War II period, the labour market partners have most of the time reached collective agreements without any governmental intervention. However, starting with the "Kanslergade Agreement" in 1933, there have been a few cases where the partners in the labour market have failed to agree on renewal of collective agreements and where the government has had to intervene. Intervention has usually been in the form of an Act of Parliament based on a compromise proposed by the Public Conciliator, cf. section 9.4.

No clear links can be established between the level of intervention in the renewal of collective agreements and the type of monetary regime. However, so far the most recent "hard peg" period has seen only one case of intervention.

Figure 9.4: Intervention in the renewal of collective agreements by Act of Parliament 1900-2007



Source: Figure 4 in Abildgren (2009b).

Note: Parliament intervention is usually based on a compromise proposed by the Public Conciliator, which again normally builds on negotiation results reached by several of the sub-organisations in the labour market in various trades. There may thus be intervention that also covers the industrial sector, even though the worker and employer organisations within the industrial sector have managed to reach agreements prior to the involvement of the Public Conciliator and Parliament. Such cases have also been classified as intervention. The figure therefore shows the occurrence of interventions related to a large part of the private-sector labour market rather than interventions to settle disputes solely within the industrial sector.

9.9. Degree of centralisation in the collective bargaining system

The degree of centralisation in the collective bargaining system is difficult to measure. Intervention by Act of Parliament in a sense represents a high degree of centralisation. However, Parliament intervention is usually based on a compromise proposed by the Public Conciliator, which again normally builds on negotiation results reached by several of the sub-organisations in the labour market in various trades.

The degree of centralisation in the Danish collective bargaining system in the time-span from 1934 to 1993 has previously been subject to closer analysis, cf. Due *et al.* (1994). Due *et al.* apply a classification system with 7 centralisation degrees. Degree 1 represents the most decentralised type of bargaining where the sub-organisations in the labour market obtain the negotiation results, while degree 7 represents situations with political intervention. Degrees 2 to 6 depend on the scale of involvement of the main labour market organisations (DA and LO) and the Public Conciliator. The analysis indicates that the period 1934-1993 can be divided into three phases characterised by their own form of collective bargaining, although the authors underline that each phase contains atypical bargaining situations. In the first phase 1934-1950 and the third phase 1981-1993 the sub-organisations played a key role in the collective bargaining process, whereas the main organisation played a larger role in the second phase 1951-1979. Furthermore, in the first phase DA maintained a high degree of control of the bargaining conducted by its members. The most decentralised collective bargaining with the largest involvement of the sub-organisations has thus occurred in the post 1980 period. The study furthermore notes that the negotiations since 1991 might even be seen as the beginning of a new fourth decentralised phase where the details are filled in at firm level.

The Danish Economic Council has also emphasised the trend towards decentralisation in collective bargaining in the most recent decades, cf. Det Økonomiske Råd, Formandskabet (2007). Since the late 1980s the wage systems have changed towards more flexible pay systems (minimum-wage agreements, minimum-pay agreements and agreements without minimum rate), where the actual pay is fixed at firm level. In 2004 these flexible wage systems covered 84 per cent of the LO/DA area compared with 66 per cent in 1989. The share of normal-wage agreements, in which pay is mainly determined centrally by the main organisations, has declined correspondingly from 34 per cent in 1989 to 16 per cent in 2004.

Prior to World War I, the main organisations played only a limited role in the collective agreements. There might therefore be a tendency towards more marked decentralisation in periods when the monetary regime delivers on the final target of price stability, i.e. the pre-1914 Classical Gold Standard period and the hard peg period since 1987, cf. section 9.5. An environment with low (and stable) inflation eases the formation of inflation expectations, which might promote decentralised wage negotiations. High inflation and pronounced inflation volatility require more resources to forecast inflation and form inflation expectations. This might give centralised labour market organisations a larger role to play as they can allocate the necessary professional resources to make inflation forecasts in relation to collective nominal wage bargaining.

9.10. Regime classification and identification issues

In this essay, the regime division has been based on the monetary regime. Naturally, it is difficult to identify whether low inflation and inflation volatility is due to the absence of shocks or the success of the monetary regime. Inflation expectations – and thereby labour market structures – might depend more on the actual economic outcome than on the monetary regime as such.

This issue can be emphasised by a comparison of the results since the mid-1990s from the Swedish and Danish studies. In Fregert & Jonung (2008), the period since the mid-1990s stands out as an exceptionally stable regime characterised by relatively long non-indexed wage contracts. According to Fregert and Jonung, the reduced macroeconomic uncertainty is attributable to successful implementation of inflation targeting in Sweden during this period. The essay at hand shows that Denmark has seen the same tendency towards longer wage contracts since the mid-1990s. In this period Denmark has pursued a firm fixed-exchange-rate policy – not inflation targeting.

One reading of these results would be that it is the success of the monetary regime – and other economic policies – in delivering on the final target of price stability that matters, rather than the choice of monetary-policy strategy (inflation targeting versus fixed exchange rates) as such.

Another interpretation could be that the low and stable inflation observed in both Denmark and Sweden during the most recent decades is primarily attributable to global inflationary trends rather than the monetary regimes in Denmark and Sweden. The same might have been the case towards the end of the pre-World War I Classical Gold Standard era characterised by gobal price-level stability.

However, the apparent correlation between monetary regimes and labour market structures in Denmark and between policy regimes and labour market structures in Sweden seems to suggest that labour market structures depend on the macroeconomic environment and outcomes and are thus to some degree endogenous.

9.11. Concluding remarks

Based on the historical evidence for Denmark over the past century or so, it seems that parts of the labour market structure are endogenous. Contract terms were longest towards the end of the Classical Gold Standard period and during the period since the mid-1990s with a hard peg vis-à-vis the D-mark and later the euro. Both periods were characterised by low and stable inflation. The shortest contract lengths were found in the interwar period with high inflation volatility. Inflation indexation was used most extensively in the Bretton Woods period and during the soft peg of the 1970s when inflation was high and raising.

Similar indications of policy-regime dependence of labour market structures have previously been found in a long-term study for Sweden. The empirical evidence from Denmark and Sweden thus indicate that the degree of nominal rigidities in the economy is not necessarily approximately constant, as it is otherwise assumed in many New Keynesian DSGE models. Explicit modelling of the links between monetary regime and labour market structures might be particularly important if such models are to be used for analysis and comparison of alternative monetary regimes without being subject to the Lucas critique.

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Essay 10:
Consumer Prices in Denmark 1502-2007[267]

Abstract

Essay 10 presents a consumer price index for Denmark 1502-2007 and discusses some of the more conceptual issues relating to compilation of historical price indices and measurement of inflation. For the post-1815 period the CPI index is based on existing figures whereas new data have been constructed for the pre-1815 period. Due to limited data availability the CPI is based on "silver prices" for the period 1502-1640. Since the Danish currency depreciated vis-à-vis silver during this period, the pre-1640 CPI figures clearly underestimate the actual level of inflation. Disregarding periods with actual war inflation and the deflation during the first two decades or so after the end of the Napoleonic Wars, there seems only to have been one major exception from the overall picture of price stability in the post-1640 period: The first four decades following the end of the Second World War where inflation expectations lost their anchor.

Key words: Inflation, consumer prices index, price history.
JEL Classification: C43; E31; N13; N14.

[267] This essay is based on Abildgren (2009a; 2010).

10.1. Introduction

The focus on price stability within the central-banking community during the most recent decades has created a renewed research interest in long-span historical time series on price developments. Norges Bank published e.g. a comprehensive collection of historical monetary statistics in 2004[268] and 2007[269], which included a new consumer price index for Norway 1516-2003[270]. More recently Sveriges Riksbank has published a consumer price index for Sweden 1290-2006.[271]

An "official" consumer price index (CPI) for Denmark is available from Statistics Denmark for the period since 1914, but data back to 1815 have been constructed in relation to various historical studies on economic growth and cost of living. However, so far no Danish CPI or cost of living index has been available for the period prior to 1815.

The essay at hand presents a consumer price index for Denmark 1502-2007. For the post-1815 period the index is based on existing CPI figures whereas new data have been constructed for the pre-1815 period. For the earliest years 1502-1712 the new CPI covers only the price of corn, whereas the period 1712-1800 is based on the comprehensive price material collected in relation to the Danish Price History Project 1660-1800, which was initiated in 1939 and completed in 2004. Furthermore, the essay offers a brief review of the inflationary development in Denmark during the past five centuries based on the new CPI data.

10.2. Conceptual issues and main pre-1815 compilation methods

According to international statistical guidelines CPIs are:

> "...index numbers that measure changes in the prices of goods and services purchased or otherwise acquired by households, which households use directly, or indirectly, to satisfy their own needs and wants. Consumer price indices can be intended to measure either the rate of price inflation as perceived by households, or changes in their cost of living (that is, changes in the amounts that the households need to spend in order to maintain their standard of living). ... In practice, most CPIs are calculated as weighted averages of the percentage price changes for a specified set, or ''basket'', of consumer products, the weights reflecting their relative importance in household consumption in some period."[272]

Numerous different kinds of mathematical formulas have been proposed in relation to compilation of CPIs[273] so choices have to be made. The approach taken in this essay has been

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[268] Cf. Eitrheim *et al* (eds.) (2004).

[269] Cf. Eitrheim *et al*. (eds.) (2007).

[270] Cf. Grytten (2004).

[271] Cf. Edvinsson & Söderberg (2007).

[272] Quotation from §1.3 in ILO *et al.* (2004).

[273] ILO *et al.* (2004) offers a comprehensive exposition of a wide range of formulas and a discussion of their strengths and weaknesses seen in a theoretical as well as a practical perspective.

to follow as close as possible the main line of methodology currently used by Statistics Denmark to compile the Danish CPI. This implies application of a two-step procedure.

In the first step the available individual price series are divided into M consumption groups. For each of the M consumption groups a price index is compiled based on an unweighted geometric[274] average (known as a Jevons index) of the percentage development in the individual prices within the group. The relative change in the price index for consumption group j (P^j) from year t-1 to year t is given by:

$$[10.1]\ \frac{P_t^j}{P_{t-1}^j} = \prod_{i=1}^{n^j}\left(\frac{p_t^i}{p_{t-1}^i}\right)^{\frac{1}{n^j}}$$

where n^j is the number of prices in consumption group j and p^i is the individual price on commodity i.

In the second step the total CPI can then be compiled as a Laspeyres type index (a so-called Lowe index) utilising a set of budget weights. The relative change in the total CPI index from year t-1 to year t is given by:

$$[10.2]\ \frac{CPI_t}{CPI_{t-1}} = \sum_{j=1}^{M} w^j \cdot \frac{P_t^j}{P_{t-1}^j} \text{ where } \sum_{j=1}^{M} w^j = 1$$

where w^j is the budget weight related to consumption group j.

The compilation method described above has been used to construct the CPI index for the period 1712-1815 and the budget weights used are based on the private consumption expenditures in 1844 in the Danish historical national account statistics[275]. The year 1844 is the earliest year where a detailed commodity breakdown of private consumption is available and it seems to be a fairly representative choice of base year due to the absence of war, epidemics, major domestic and international crises *etc*. Naturally, it would have been preferable if one could use a base year from the period 1712-1815. Furthermore, if information on the composition of private consumption for every year in the period 1712-1815 had been available one could also have taken changes in the pattern of consumption over time into account via an annual chain index. However, as with all other kinds of historical research data availability limits the choice of methodology.

For the period 1502-1712 the new CPI covers only the price of corn, and for this period the CPI index is based on an unweighted geometric average of the percentage development in the available price series.

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[274] A geometric average at this stage of the calculations is also in line with the recommendation in ILO *et al*. (2004).

[275] Cf. Hansen (1983).

An important issue to consider in relation to long-term historical price studies is the choice of currency unit (mint standard) in periods where notes and coins based on several different currency units circulated simultaneously. The aim of the essay at hand has been – as far as possible – to use prices quoted in the currency unit most frequently used for transactions purposes at the time of transaction and then subsequently chain these indices together in order to avoid break in series. The choice of currency units used in different periods is illustrated in Table 10.1.

Table 10.1 Currency unit of the price quotations used for the Danish CPI 1502-2007

Period	Currency unit	Memo: Selected official conversion rates
Silver prices:		
1502-1640	Speciedaler (a)	
Nominal prices:		
1640-1671	Kroner (also denoted "sletdaler")	1625: 1 1/3 speciedaler = 1 krone
1671-1813	Kurantdaler	1671: 1 krone = 2/3 kurantdaler
1813-1875	Rigsbankdaler (renamed "rigsdaler" in 1854)	1813: 6 kurantdaler = 1 rigsbankdaler
1875-2007	Kroner	1875: 1 rigsdaler = 2 kroner

Notes:
(a) The speciedaler was first minted in Denmark in 1541. However, in the data source behind the CPI the prices for the whole period 1502-1640 has been converted to speciedaler with a fixed silver content.

A few remarks should be given in relation to Table 10.1. Earlier generations of price historians often stated prices in silver in order to adjust the price development for exchange rate fluctuations. In the data sources behind the CPI the prices in the period 1502-1640 are quoted in rigsdaler with fixed silver content, i.e. the prices in this period are "silver prices". However, the Danish currency depreciated vis-à-vis silver during this period, so the pre-1640 CPI figures therefore clearly underestimate the actual level of inflation. Unfortunately, there are great difficulties in making a transformation of the silver prices back to nominal values based on the existing works on the Danish mint history[276], so at present this challenge has to be left for further research.

In some cases the sources are not clear on which currency unit has been used for the price quotation, especially in the period 1620-1725 when speciedaler gradually was replaced by sletdaler and later kurantdaler. The sources just quote the prices in rigsdaler and skilling.

[276] Cf. Scharling (1869); and Wilcke (1931).

However, Table 10.1 represents the best “guess”. Scharling has e.g. examined the farm gate prices used for the assessment of tithes in Sjællands Stift in the period 1640-1672 and concludes that the original prices were fixed in sletdaler.[277]

Finally it should be noted that the geographical coverage of the CPI index prior to 1920 is the Kingdom of Denmark excluding Norway[278], the Royal Duchies Schleswig and Holstein[279] and other former Danish territories[280]. Since 1920 the coverage correspond to the current geographical delimitation of Denmark.

Due to the limited data availability the quality of the pre-1815 CPI index can not be expected to be at the same level as modern consumer price indices. Furthermore, both retail and wholesale markets have changed a lot during the period regarding e.g. the organisation and structure of the trade sector, the degree of product differentiation, the composition of private consumption, the size of ordinary households *etc*., cf. also Kackmeister (2007). The results and conclusions of the essay at hand have therefore to be taken with “a pinch of salt” and the CPI index can only be expected to give a rough picture of the development in the cost of living.

10.3. A CPI for Denmark 1502-2007 - Data sources and compilation methods in details

The description of the data sources applied for the construction of the CPI for Denmark 1502-2007 can be divided into eight parts covering eight different time spans, cf. the exposition below. For each subperiod a CPI was constructed, and these indices were subsequently chained together to the overall index. Annex 10.A lists the new CPI data set.

1502-1660

Consistent information on the price development in Denmark in the period prior to 1660 is very scarce. However, following the death of professor Holdt in 1867, the University of Copenhagen arranged a competition in relation to the open position as professor in economics. The contestants were given one year to deliver a dissertation on the price development in Denmark since 1492. Scharling and Falbe-Hansen were the only participants

[277] Page 236-237 in Scharling (1869).

[278] With the peace settlement in Kiel in January 1814 Norway became independent of Denmark after more than 400 years of union.

[279] Schleswig and Holstein were attached to the Danish monarchy in 1460 but became part of Germany after the Second Schleswig War in 1864. In June 1920 Sønderjylland (the northern part of the old Duchy of Schleswig) was reunited with Denmark after a referendum in accordance with the Versailles Treaty.

[280] Skåne, Halland, Blekinge were lost to Sweden following the end of the First Karl Gustav War in 1658. Iceland – originally attached to Denmark in 1380 - became a sovereign state in personal union with Denmark in 1918. The personal union between Denmark and Iceland ceased in 1944.

in the competition and their contributions[281] contain information on the corn price development in Denmark 1502-1660.[282] For this period corn prices has therefore been used as a proxy for the development in the consumer prices.

For the 1552-1600 period Scharling and Falbe-Hansen offer annual observations on prices on rye and barley and for 1600-1660 on rye, barley and oats based mainly on accounting records from the University of Copenhagen supplemented with farm gate prices used for the assessment of tithes in Sjællands Stift. Scharling notes that Sjællands Stift is normally believed to be representative for the corn price development in Denmark during this period.[283] For the period 1552-1660 the price series are fairly complete with only a few years of missing observations.

Scharling and Falbe-Hansen also list prices on rye and barley prior to 1552. However, this information is more fragmented and based on a wider range of sources. Reliable price information is only available for 1502, 1510, 1525, 1531, 1532, 1538, 1539, 1545 and 1546.

For the period 1502-1660 the CPI index is based on an unweighted geometric average of the percentage development in the corn prices stated above. Due to the nature of the price material and the simple calculation method the CPI data for the period 1502-1660 can only be expected to give a rough picture of the general price development in Denmark. Furthermore, as mentioned the prices used for the Danish CPI in the period 1502-1640 are "silver prices" and therefore underestimate the actual level of inflation due to debasement of the Danish currency (i.e. reduction in the silver content of the coins).

1660-1712

For the period 1660-1712 consistent information on the price development in Denmark is still limited. For this period the CPI index is based on the farm gates prices on rye, barley and oats reported by Statistics Denmark (1904). The CPI is compiled as an unweighted geometric average of the percentage development in 27 individual price series on the three corn products mentioned above.

The price material from Statistics Denmark consists of average winter prices used for the assessment of tithes in 6 dioceses[284] and there are no missing observations. The farm gates

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[281] Scharling (1969) and Falbe-Hansen (1869). Scharling won the competition and thereby the professorship, whereas Falbe-Hansen joined the staff of Statistics Denmark instead. However, in 1877 Falbe-Hansen obtained a professorship in economics at the University without the need to participate in a new competition, cf. Hansen (1976a, 1976b).

[282] On page 39 in Falbe-Hansen (1869) information on the prices of corn in 1467 is also stated. However, Falbe-Hansen notes that these prices - related to the payment of the 1467 tax - are probably fixed at a too low level in order to encourage payment of the tax in cash rather than in kind.

[283] This assumption seems plausible. For the period 1660-1712 the correlation coefficient between the annual increases in corn prices in Sjællands Stift and Denmark as a whole was 0.95.

[284] Sjælland, Fyn, Aalborg, Viborg, Aarhus and Ribe.

prices were not actual market prices but prices used to determine taxes. However, the farm gates prices were fixed on the basis of market prices. The basic fixing rules were stated by regulation, and Statistics Denmark notes that although minor differences in the methods of calculation might have occurred from region to region this source of error is believed to be of insignificant importance. Statistics Denmark furthermore notes, that although the farm gate prices used for the assessment of tithes might have differed from market prices, they are still representative for the price development of at least a part of the households budget expenditures during the pre-1712 period. Part of the land rent was e.g. often paid in grain, and grain probably constituted a larger share in the average consumer basket than in later periods. Earlier Danish mint and price historians have also found the price material from Statistics Denmark to be of a high quality suitable for historical studies.[285]

1712-1800

For the period 1712-1800 the new consumer price index is based on the outcome of the Danish Price History Project 1660-1800. The project was initiated in 1939 by The Danish Institute of Political and Economic Research and followed the main lines laid down by the International Scientific Committee on Price History, which was funded in 1931 under the auspices of Sir William Beveridge. The International Committee suggested that the national research projects focused on transcribing prices and wages from the accounts of large institutions with a long history. However, the Danish project took a different turn than projects in other countries. The Danish archives did not contain the same comprehensive and unbroken accounting records from long-lived institutions such as hospitals and charitable institutions. Instead the Danish project focused on accounting material from Danish estates, provincial town churches and treasuries and from trading companies in Copenhagen. Furthermore, due to scarce resources the Danish project was first completed in 2004.

Two comprehensive studies from the Danish Price History Project have been published. Andersen & Pedersen (2004) present annual weighted averages on purchase and sales prices 1661-1800 for a wide range of commodities based on accounting records from 19 estates and manors[286] in the Danish countryside. The prices are free market prices from actual transactions[287], and a large number of the goods covered were common in private consumption. Even though manors were large economic units compared to ordinary households, the purchase prices on consumption goods reported in this study are probably the

[285] Cf. Nielsen (1904, 1906).

[286] On Zealand: Giesegaard, Bregentved, Gisselfeld, Herlufsholm, Holsteinborg, Fuirendal, Sorø, Løvenborg, Gaunø and Juellinge. On Funen: Taasinge, Frederiksgave and Erholm. In Jutland: Frijsenborg, Fussingsø, Støvringgaard, Støvringgaard household accounts, Lindenborg and Odden.

[287] Transactions involving payment in kinds (e.g. manorial dues) are excluded.

closest that one can come to transaction-based consumer prices for the pre-1800 period Denmark outside Copenhagen based on sources currently available. None of the estate accounts contains data for the entire period since 1660. Especially for the pre-1700 period the price series are relatively few and fragmented, but for the period 1712-1800 they are fairly complete.

Friis & Glamann (1958) present the Magistrate's official prices (assizes) of bread and meat in Copenhagen in the period 1684-1800. Thestrup (1971) has compared a selection of these official prices with information on transaction prices from five Danish estates, the Asiatic Company and the merchant Niels Ryberg. The overall impression is that the official prices track the transaction prices quite well.[288]

Table 10.2 Commodities and budget weights in the Danish CPI 1712-1800

Consumption group	Commodities	Budget weight
Bread, flour and groats	Flour, buckwheat groats, pearl-barley, hulled rice, coarse rye bread, fine rye bread, wheat bread	0.15
Meat and fish	Pigs, lambs, geese, ducks, hens, capons, chickens, beef, veal, pork, herring, train oil	0.29
Fat, milk, eggs and cheese	Butter, cheese, eggs, milk, cream	0.10
Vegetables and fruit	Peas, apples, lemons, raisins, currants, olive oil	0.02
Sugar and chocolate	Sugar, cocoa	0.04
Spices, tea and coffee	Black pepper, mace, cinnamon, cardamom, cloves, ginger, coffee, tea, salt	0.02
Beverages and tobacco	Beer, Danish brandy	0.11
Footwear, textiles and clothing	Cloth, linen	0.14
Light and fuel	Charcoal, tallow, tallow candles, coal	0.08
Other goods	Green soap	0.04
Total		1.00

Utilising the data from the Danish Price History Project individual price series for 50 representative commodities divided into 10 consumption groups were established, cf. Table 10.2. Missing observations in the individual price series were filled by geometric interpolation. For each of the 10 consumption groups a price index was subsequently compiled based on an unweighted geometric average of the percentage development in the individual prices within the group. The total CPI for 1712-1800 could then be compiled as a Laspeyres type index utilising the budget weights shown in Table 10.2. These budget weights

[288] The bakers normally adjusted the weight of different kinds of bread in line with fluctuation in the corn prices in order to make a profit when they had to sell bread at the officially fixed prices. However, the price series for bread in Friis & Glamann, *op.cit.* are calculated for bread of a fixed weight.

are based on the composition of private consumption expenditures in 1844 in the Danish historical national accounts in Hansen (1983). The 10 commodity groups represented 81 per cent of the private consumption expenditures in 1844. The items within the private consumption not covered by the CPI in the period 1712-1800 are transport, services, durable goods and rent.

Table 10.3 compares the budget weights described above with the weights used for the Norwegian historical CPI index[289] for 1830-1871 based on private consumption expenditures in 1850.

Table 10.3 Budget weights in the Danish CPI 1712-1800 and the Norwegian CPI 1830-1871

Consumption group	Budget weights from 1844 in the Danish CPI	Budget weights from 1850 in the Norwegian CPI
Bread, flour and groats	0.15	0.18
Meat and fish	0.29	0.15
Fat, milk, eggs and cheese	0.10	0.14
Vegetables and fruit	0.02	0.07
Sugar and chocolate	0.04	0.01
Spices, tea and coffee	0.02	0.04
Beverages and tobacco	0.11	0.05
Footwear, textiles and clothing	0.14	0.16
Light and fuel	0.08	0.20
Other goods	0.04	...
Total	1.00	1.00

One notable difference in Table 10.3 is the size of the weight for "Bread, flour and groats" relative to the size of the weight for "Meat and fish". In the Danish CPI the weight for bread *etc*. only amounts to 52 per cent of the weight for meat and fish whereas the weight for bread *etc*. is larger than the weight for meat and fish in the Norwegian index. In the 1860 consumption figures from the Danish historical national accounts the weight for bread *etc*. amounted to 73 per cent of the weight for meat and fish. This could indicate that the weight allocated to bread *etc*. in the Danish CPI is too small.

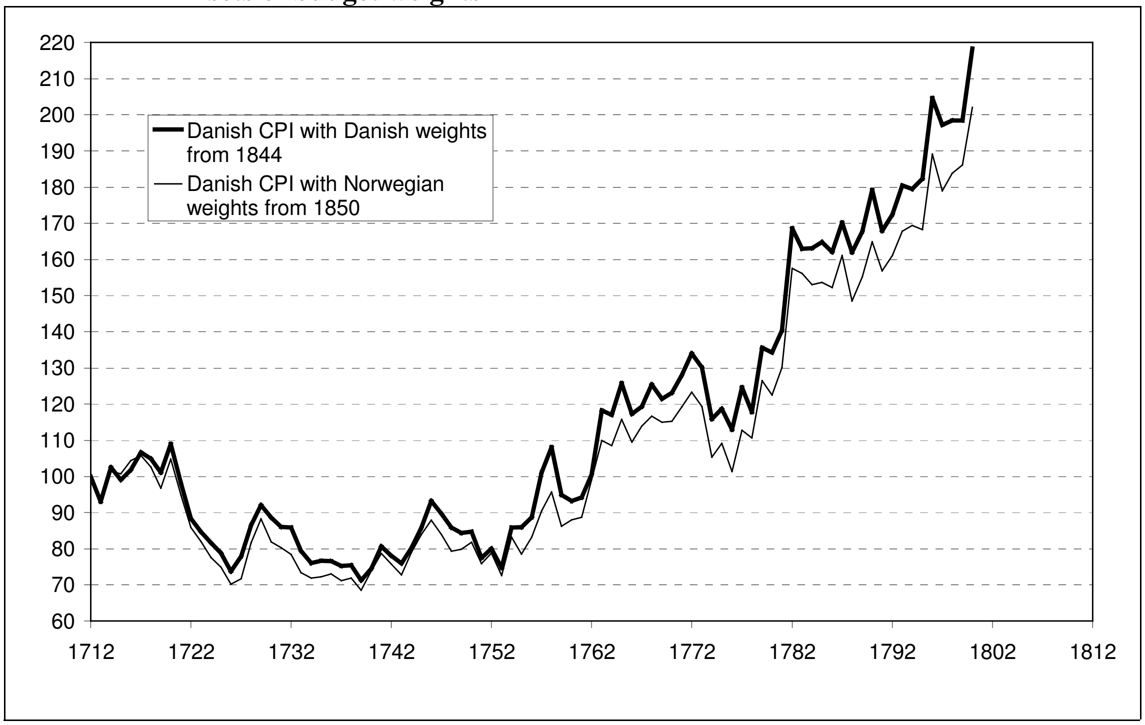
As a robustness check the Danish CPI for the period 1712-1800 has also been calculated utilising the weights from the Norwegian CPI. The result is shown in Figure 10.1. Taken into account that a time span of almost a century is covered the differences between the to series are relative small. Utilising the Norwegian weights the average annual inflation rate[290] during the period 1712-1800 was 0.8 per cent compared to 0.9 per cent using the Danish weights. The weights from the Danish historical national accounts have therefore been used in the index presented in annex 10.A. However, the comparison with the Norwegian weights

[289] Cf. Grytten (2004).

[290] All average annual growth rates presented in this essay are compound growth rates.

indicates that the composition of private consumption could deserve some extra attention in future generations of historical national accounts in Denmark. During the last couple of decades several authors has pointed out the need for a new set of historical national accounts in Denmark.[291]

Figure 10.1 Consumer price index for Denmark 1712-1800, 1712=100. Alternative sets of budget weights



Source: Figure 1 in Abildgren (2010).

1800-1815

This period causes a number of special problems for the construction of a Danish CPI. During the Napoleonic Wars the huge central-government budget deficits was to a large extent financed by a massive issuing of kurant-denominated bank notes. The result was a period with very high inflation and a collapse of the Danish monetary system.

By a monetary reform in January 1813 the two existing note-issuing banks within the Danish monarchy were closed and a new temporary state-owned bank, the Rigsbank, was established. The Rigsbank was granted the privilege to issue rigsbankdaler-denominated bank notes with the status of being the sole legal tender within Denmark, Norway and in the Royal Duchies Schleswig and Holstein. At the same time Kurantbank notes in circulation was written down by being exchanged for the new Rigsbank notes at the ratio 6 to 1. The same

[291] Cf. Mogensen (1987); Hyldtoft (1994); Christensen *et al.* (1995); and Nilsson (1991, 2004).

ratio was applied to kurant-denominated central-government debt.[292] The monetary reform were therefore given the nickname the "bankruptcy of the state".[293] However, the market value of Kurantbank notes vis-à-vis silver was far below par just before the monetary reform. By the monetary reform in 1813 kurantbank notes were thus by and large written down according to market rates.[294]

The Rigsbank could not initially ensure convergence towards the new par value vis-à-vis silver of the rigsbankdaler notes. The market value of rigsbankdaler notes reached a low point equivalent to 9 per cent of the new par value in the middle of September 1813. The Rigsbank began to withdraw notes from circulation in 1814, but the market value of rigsbankdaler notes did not pass a level above 30-40 per cent of the par value in the nearest following coupe of years. The weakness of the rigsbankdaler notes in these years should be viewed in light of the reestablishment of Schleswig-Holstein as a separate currency area within the Danish monarchy in October 1813 and the separation of Denmark and Norway after the peace settlement in Kiel in January 1814. These events limited the area of circulation for the rigsbankdaler notes but without a corresponding reduction of the stock of bank notes in circulation.

The regulation from 1813 on the Rigsbank included a promissory clause stating that the Rigsbank would be restructured into a private joint stock company. This promise was fulfilled when the Nationalbank was established in 1818. Parity of the rigsbankdaler notes vis-à-vis silver coins was first achieved in 1838.

Price information for the period 1800-1815 is scarce. For this period, the CPI index is based on 60 individual farm-gate price series on 10 representative commodities reported by Statistics Denmark (1904). As mentioned above this price material consists of prices used for the assessment of tithes and the information covers 8 dioceses[295]. In the background material prices are quoted in kurantdaler for the period from 1800-1812 and rigsbankdaler for the period 1813-1815[296]. However, in order to avoid an artificial break in series the prices quoted in rigsbankdaler been converted to kurantdaler at the ratio 1:6 – otherwise the price index would show a large fictive deflation in 1813 just because of the technical replacement of one currency unit by another.

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[292] If the creditor called the loan. Kurant-denominated central-government debt could be converted at the ratio 1 to 1 if the creditor was willing to declare the bond irredeemable and accept a certain cut in interest-rate payments.

[293] Another reason for the nickname the "bankruptcy of the state" was the fact that the Kurantbank had been owned by the central government since 1773. The Danish monetary reform in 1813 is described in more details in e.g. Hansen & Svendsen (1968); and Hansen (1990).

[294] Cf. page 248 in Olsen (1962).

[295] Sjælland, Bornholm, Fyn, Lolland-Falster, Aalborg, Viborg, Aarhus and Ribe.

[296] Data for Ribe Stift are also quoted in rigsbankdaler in 1812.

Table 10.4 Commodities and budget weights in the Danish CPI 1800-1815

Consumption group	Commodities	Budget weight
Corn and groats	Rye, barley, oats, wheat, buckwheat	0.25
Vegetables	White peas, grey peas	0.04
Fat	Butter	0.17
Meat	Bacon	0.48
Sugar	Honey	0.06
Total		1.00

The 60 price series on the 10 representative commodities were divided into 5 consumption groups, cf. Table 10.4. For each of the 5 consumption groups a price index was subsequently compiled based on an unweighted geometric average of the percentage development in the individual price series within the group. The total CPI for 1800-1815 could then be compiled as a Laspeyres type index utilising the budget weights in Table 10.4 based on the composition of private consumption expenditures in 1844 in the Danish historical national account statistics in Hansen (1983). The 5 commodity groups represented 49 per cent of the private consumption expenditures in 1844.

Due to the nature of the price material, the simple calculation method and the occurrence of very high inflation, the CPI data for the period 1800-1815 can only be expected to give a rough picture of the general price development in Denmark in this period, cf. also the discussion in the next section.

1815-1870

The CPI for the period 1815-1870 builds on the CPI (nominal values) constructed and documented by Hansen (1983) in relation to his work on Danish historical national accounts. The weights are based on non-published figures for the composition of the private consumption in 1840, and the price information is based on a collection of prices on a comprehensive selection of consumer goods. Hansen notes that many of the prices are wholesale prices from market places rather than actual retail prices. However, in many areas local retail stores did first emerge only during this period.

1870-1872

In his doctoral thesis at the University of Copenhagen Pedersen (1930) presents and document four different series for the cost of living in Denmark 1855-1913. The indices are based on budgets for different types of workers (skilled versus unskilled workers, urban versus farm workers). For the period 1870-1872 the development in the CPI data in the essay at hand is based on an unweighted geometric average of the percentage development in these four data series. The price material behind these series comes mainly from shops located in Odense, Aarhus and Varde supplemented with price information from departments of the Danish military located in Copenhagen, Odense, Aarhus and Næstved and from a large hospital in Copenhagen (Københavns Kommunehospital).

1872-1914

Statistics Denmark began publication of an "official" CPI for Denmark in 1914. However, on their website Statistics Denmark presents a CPI for Denmark for the period 1900-1914. For the latter period Statistics Denmark uses the index compiled by Dalgaard (1926). Dalgaard presents and document a retail price index for Denmark 1872-1924 based mainly on price information made available by staff at Statistics Denmark. The weights used by Dalgaard are furthermore almost identical to the weights applied in the official CPI from 1914.

In order to be consistent with Statistics Denmark, the CPI data from 1872 to 1914 in the essay at hand is based on the index (excluding direct taxes) calculated by Dalgaard. The average annual CPI inflation implied by the figures from Dalgaard is 0.2 per cent for the period 1873-1913 which is equal to the average inflation level in the same period based on the cost of living series computed by Pedersen (1930).

1914-2007

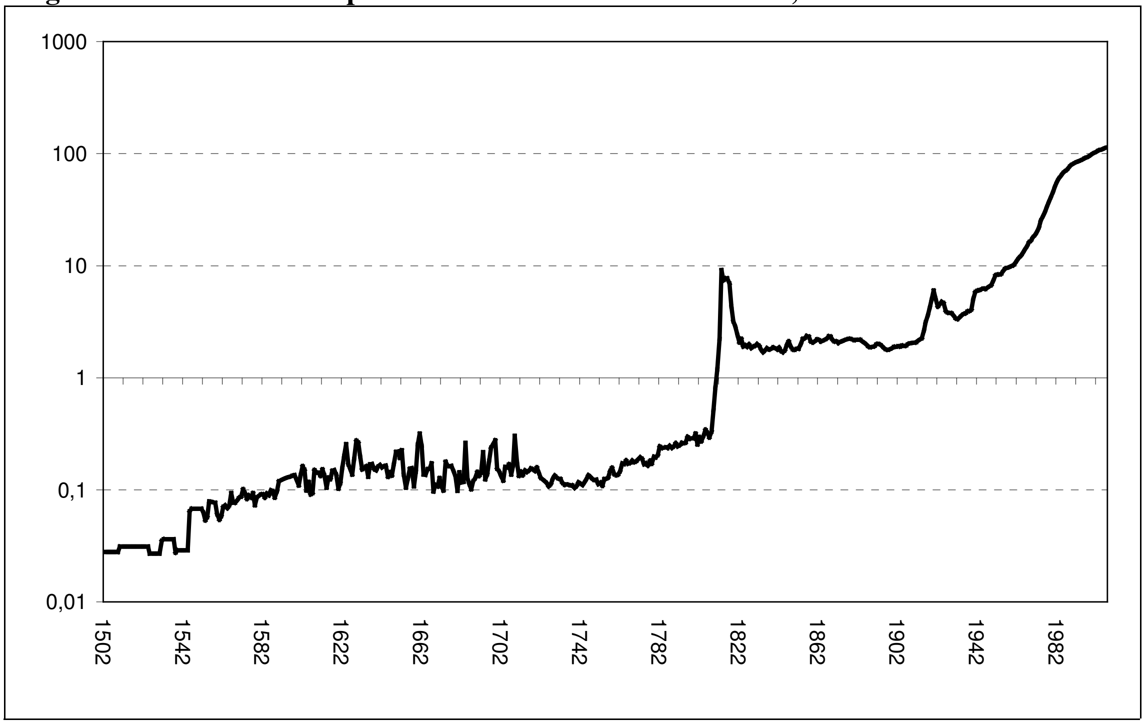
As mentioned Statistics Denmark began publication of an "official" CPI for Denmark in 1914.[297] The index is a Laspeyres type index with occasionally changes in weights. For the years 1914-1963 the original official CPI included direct taxes. However, on their website Statistics Denmark presents a recalculated CPI excluding direct taxes for the period 1914-2007. The CPI data for the period since 1914 in the essay at hand are based on these figures.

10.4 Price level and inflation in Denmark 1502-2007 – A brief review

Figure 10.2 shows the CPI for Denmark 1502-2007 on a semi-logarithmic scale. The annual inflation rate in Denmark 1503-2007 (smoothed) is displayed in Figure 10.3, whereas Table 10.5 presents a range of summary statistics broken down by subperiods. Table 10.6 offers a closer look on selected war periods.

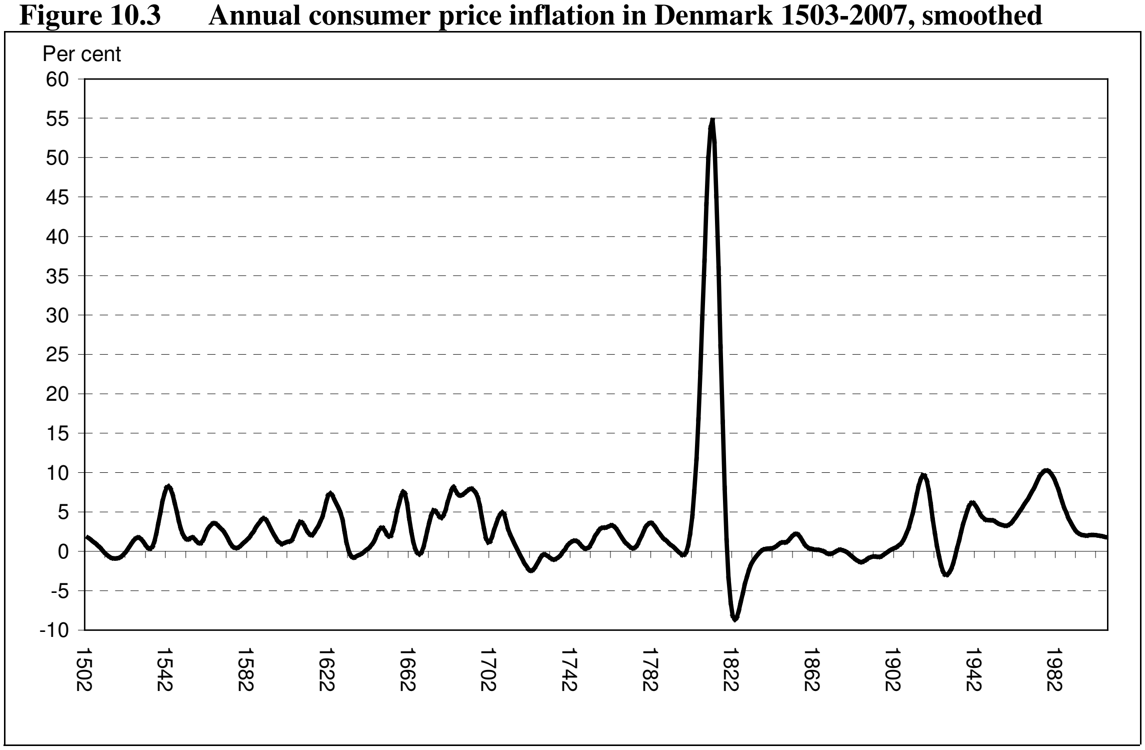
[297] Cf. the documentation in Statistics Denmark (1985, 2004).

Figure 10.2 Consumer price index for Denmark 1502-2007, 2000=100



Note: Semi-logarithmic scale.
Source: Figure 2 in Abildgren (2010).

Figure 10.3 Annual consumer price inflation in Denmark 1503-2007, smoothed



Note: Smoothed (using PCGive) via a HP filter with a smoothing parameter of 100.
Source: Figure 3 in Abildgren (2010).

Table 10.5 Inflation in Denmark 1503-2007 - summary statistics

Period	Average (a)	Max	Min	Standard deviation	Coefficient of variation (b)	Deflation frequency (c)
	Per cent per annum					Per cent
Silver prices:						
1503-1539	0.1	5.1	-4.5	2.9	33.7	57
1540-1640	1.7	60.5	-34.7	16.4	9.6	44
Total 1503-1640	1.3	60.5	-34.7	14.2	11.1	47
Nominal prices:						
1641-1671	-0.7	74.7	-44.5	25.3	-34.2	39
1672-1736	-0.2	122.6	-51.4	27.7	-132.9	57
1737-1807	1.4	20.1	-19.9	7.6	5.5	41
1808-1813	77.5	311.2	12.5	108.5	1.4	0
1814-1838	-6.3	7.1	-37.5	11.0	-1.8	56
1839-1874	0.4	13.3	-11.0	5.1	11.9	47
1875-1913	0.1	3.9	-4.2	2.1	22.3	46
1914-1918	14.0	18.0	2.4	6.7	0.5	0
1919-1939	-0.2	19.3	-15	8.9	-45.6	48
1940-1945	7.4	24.4	0.8	9.7	1.3	0
1946-1989	5.9	15.3	-0.7	3.7	0.6	5
1990-2007	2.1	2.9	1.2	0.4	0.2	0
Total 1641-2007	1.8	311.2	-51.4	23.0	12.7	38

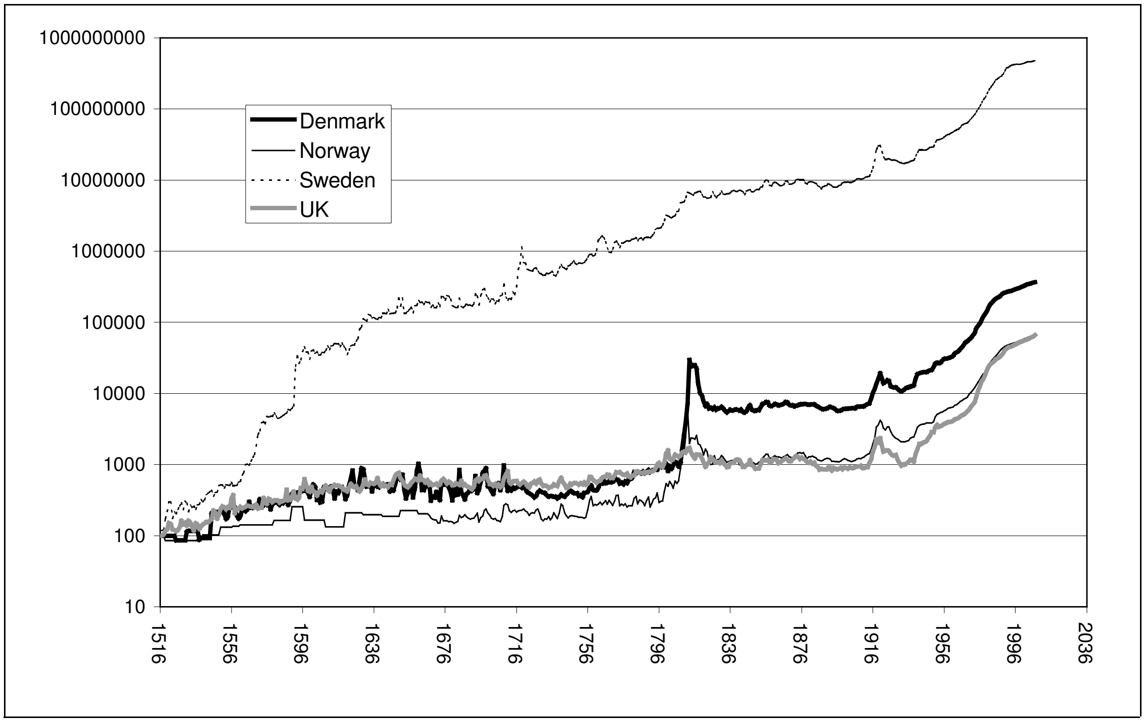
(a) The average inflation rates are calculated as compound growth rates.
(b) Standardderivation divided by average.
(c) Number of years with deflation in per cent of the total number of years in the period.
Source: Table 5 1 in Abildgren (2010).

Table 10.6 Inflation in Denmark during selected war periods

Period	War	Average (a)	Max	Min
		Per cent per annum		
With Danish participation:				
1563-1570	The Nordic Seven Years War	2.3	27.8	-17.5
1611-1613	The Kalmar War	-1.3	14.1	-10.9
1625-1629	The Kaiser War	1.5	46.7	-34.0
1643-1645	The Torstensson War	-6.0	2.5	-20.3
1657-1660	The Karl Gustav Wars	13.2	74.7	-31.5
1675-1679	The Scania War	-5.9	1.1	-10.9
1709-1720	The Great Nordic War	-0.4	83.6	-42.2
1808-1813	The Napoleonic Wars	77.5	311.2	12.5
1848-1851	The First Schleswig War	-3.7	2.4	-11.0
1864	The Second Schleswig War	1.0	1.0	1.0
1940-1945	World War II	7.4	24.4	0.8
Without Danish participation:				
1756-1763	The Prussian Seven Years' War	4.1	17.7	-12.2
1853-1856	The Crimean War	6.8	10.5	1.9
1914-1918	World War I	14.0	18.0	2.4
1950-1953	The Korean War	5.5	11.7	-0.5

(a) The average inflation rates are calculated as compound growth rates.
Source: Table 6 in Abildgren (2010).

Figure 10.4 Consumer prices in Denmark, Norway, Sweden and UK 1516-2007, 1516=100



Note: Semi-logarithmic scale.
Source: Figure 4 in Abildgren (2010).

Overall prices have risen by a factor of more than 700 since 1640. However, the past four centuries or so have been dominated by price stability. The average inflation rate in the period 1640-2007 has only been 1.8 per cent per annum. There does not appear to have been a continuously rise in the price level, but rather some periods with price stability, other periods where prices fell, and some periods with a strong and more sustained inflation.

As mentioned in section 10.2 the prices used for the Danish CPI in the period 1502-1640 are "silver prices" and therefore underestimate the actual level of inflation due to debasement of the Danish currency. However, looking at the prices in silver, the first part (1503-1539) was roughly characterised by price level stability in contrast to the second part (1540-1640) where the average annual inflation rate was 1.7 per cent. The same transition from price level stability to a positive inflation rate during the sixteenth century has also been found in many other European countries, including Norway[298], Sweden[299] and U.K[300] and various European cities[301], cf. also Figure 10.4. The extraordinary rapid increase in the price level in Sweden

[298] Cf. Grytten (2004); and Qvigstad (2005).
[299] Cf. Edvinsson & Söderberg (2007).
[300] Brown & Hopkins (1956); and Clark (2005).
[301] Cf. e.g. Van Zanden (1999); Allen (2001); and Pamuk (2005).

from the mid-1500s to the mid-1600s was related to depreciation of the Swedish currency vis-à-vis silver.[302]

The period from the mid-1500s to the mid-1600s is usually termed the "Price Revolution" in the economic-historical literature. Traditionally the inflationary tendency during this period has been attributed to the inflow of precious metal from Central and South America, but it has been questioned whether this monetary factor was the only cause.[303] Population growth after the Black Death is another frequently mentioned factor. Population appears to have increased substantially in many European countries during the second half of the sixteenth century and the first half of the seventeenth century. No solid data are available for Denmark but population seems also to have increased rapidly in regions close to Denmark, such as Norway and Schleswig-Holstein.[304]

In Figure 10.4 it is worth to notice that the increase in the price level from 1516 to the 1570s is much smaller in Norway than in Denmark. In his doctoral thesis at the University of Copenhagen Hansen[305] reports figures for the development in corn prices in Holsten, Utrecht and Lübeck measured in silver from 1510-1519 to 1570-1579. According to these figures the price development in Holstein corresponded rather closely to the development in the silver prices for corn in Denmark as shown in Figure 10.4. The price developments in Utrecht and Lübeck were also much closer to the development in Denmark than those reported for Norway in Figure 10.4. A closer analysis and comparison of the Price Revolution in Denmark and Norway – taking into account possible methodological differences between the CPI figures compiled for these two countries – seems therefore to be an interesting subject for future research.

The period 1540-1640 saw also several cases of major wars in Europe and Denmark, cf. Table 10.6. These wars might have had an influence on the price development. However, the CPI for this period is only based on corn prices, which are highly dependent on variations in the weather conditions. The price effects from wars are therefore difficult to distinguish from the "normal" weather-related supply shocks. Furthermore, it is possible that the war activities during this period mainly affected prices in selected regions rather than the country as a whole.

For the period 1641-1671 prices are measured in sletdaler (kroner). The average annual rate of inflation during this period was slightly negative (-0.7 per cent). However, during the Karl Gustav Wars against Sweden 1657-1660 the average annual inflation reached double-digit

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[302] Cf. page 12 in Edvinsson & Söderberg (2007).

[303] Cf. e.g. the brief surveys in Kindleberger (1993); and Davies (2002).

[304] Page 84-85 in Hansen (1964).

[305] Page 86 in Hansen (1964).

figures. In the period 1641-1671 the average depreciation of kroner vis-à-vis silver amounted to around 0.4 per cent per annum.[306]

In the following period 1672-1813 prices are measured in kurantdaler. The period can be divided in two parts. During the first part (1672-1736) price level stability occurred, and there was only a modest depreciation of kurantdaler vis-à-vis silver.[307]

In the second part (1737-1807) the average annual rate of inflation was higher, around 1.4 per cent per annum. The first note-issuing bank within the Danish-Norwegian monarchy, Kurantbanken[308], was established in 1736 and opened for business in 1737. The Kurantbank was not subject to any rules regarding the reserve backing of its bank notes issues, but its notes were redeemable on demand into silver coins. Convertibility of the Kurantbank notes was temporary suspended in 1745-1747 and again in 1757, this time *de facto* on a permanent basis. From 1760 more than half of the outstanding amounts of loans made by the Kurantbank were claims on the central government and in 1773 the Kurantbank was taken over by the central government. The silver parities implied a par exchange rate of 122.50 rigsdaler kurant per 100 rigsdaler banco[309]. During the period 1737-1782 the Danish exchange rate for Kurantbank notes vis-à-vis Hamburg banco fluctuated between 112 and 132. However from 1782 to 1787 the exchange rate depreciated from 132 to 141, which initiated a reorganisation of the Danish monetary system. The reorganisation was first implemented in the Royal Duchies Schleswig and Holstein. In 1788 the note issuing Schleswig-Holstein Specie Bank was founded as a governmental institution in Altona. It took over the responsibilities of the Kurantbank in the Royal Duchies Schleswig and Holstein whereby Schleswig-Holstein became a separate currency area within the Danish monarchy. The Kurantbank notes continued to depreciate and reached a level of 162 rigsdaler kurant per 100 rigsdaler banco in 1789. Part of the reason was probably that a large amount of the Kurantbank notes withdrawn from the Royal Duchies was not destroyed but re-circulated in Denmark-Norway. A new note-issuing bank for Denmark-Norway, the Danish-Norwegian Specie Bank, was established in Copenhagen in 1791.[310] Its notes and coins were based on the speciedaler whereby the monetary unity within the Danish monarchy was restored. In 1794 the Kurantbank notes returned to par vis-à-vis Hamburger banco.

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[306] Calculated on the basis of Wilcke (1924).

[307] In the period 1672-1736 the average depreciation of kurantdaler vis-à-vis silver amounted to around 0.3 per cent per annum calculated on the basis of Friis & Glamann (1958)*;* and Wilcke (1929).

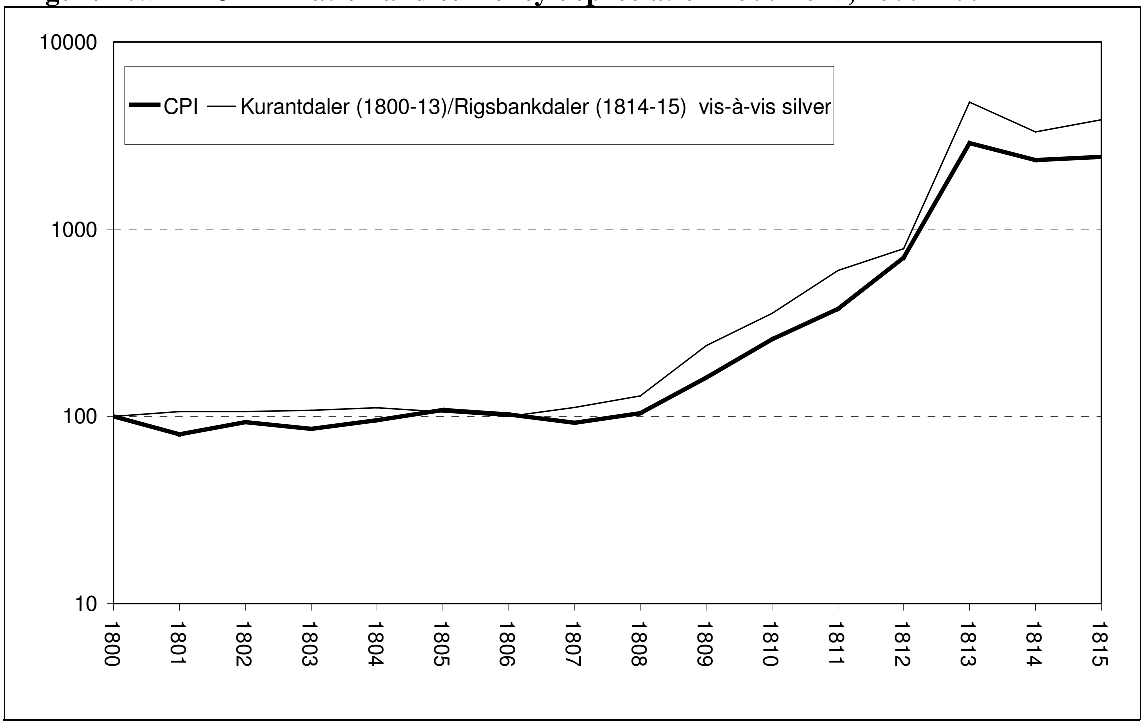
[308] The official name of the bank was "Den Kiøbenhavnske Assignation-, Vexel- og Laane-Banqve". The history of the Kurantbank is covered by Rasmussen (1950, 1955).

[309] The Hamburg banco was not a coin but simply a specifically defined amount of fine silver.

[310] At the same time the Kurantbank was closed for new business activities. The circulating amount of Kurantbank notes was not to be increased, and the Kurantbank notes were planned to be gradually withdrawn from circulation during a period of 20 years.

During the years 1808-1813 Denmark experienced a state of very high inflation with an average inflation rate around 80 per cent per annum. The background was huge central-government budget deficits due to large war expenditures and lower tax revenue. The budget deficits were financed by the issuing of kurant-denominated bank notes, which caused a massive drop in the silver value of the kurantdaler, cf. Figure 10.5.

Figure 10.5 CPI inflation and currency depreciation 1800-1815, 1800=100



Note: Semi-logarithmic scale. Annual averages. An increase in the currency index describes a depreciation vis-à-vis silver.
Source: Figure 5 in Abildgren (2010).

Figure 10.5 shows a high correlation between the movement in prices and the exchange rate. However, the levels indicate a large difference between currency depreciation and price development. The depreciation of the currency during the period 1808-1813 was much larger than the accumulated inflation. This might indicate that the CPI index underestimates the level of inflation during this period. Another explanation could be exchange rate “overshooting”. Existing studies on the high inflation in Denmark during the years immediately prior to the bankruptcy of the state in 1813 are few and rather superficial, so this would also be an area where future research could make important contributions.

Figure 10.2 indicates that the price volatility was significantly smaller in the period 1712-1800 than during the preceding periods. A contributing factor is that the price index for the period 1712-1800 is based on a broad range of consumer products and not only corn.

The decades following Napoleonic wars were characterised by deflation. The central bank focused on withdrawing bank notes in order to increase the silver value of the currency, and parity of the rigsbankdaler notes vis-à-vis silver coins was achieved in 1838. The rest of the Silver Standard period (1839-1874) and the Classical Gold Standard period (1875-1913) were dominated by price level stability, cf. Table 10.5.

During the First and Second World War inflation rose to a level significantly higher than the average – although to levels far less than those inflation rates prevailing during the Napoleonic wars – whereas the interwar period on average saw a mild deflation.

In a historical perspective the development during the first four decades following the Second World War stands out as an exception with an average inflation rate significant above the historical mean even though the country was not in a state of war. The last two decades, inflation has again reached an average around 2 per cent per annum. From Table 10.5 one can also notice that the post-World War II period has only witnessed a few years with a drop in the consumer price level whereas deflation frequently occurred during the preceding four and a half century except in actual war periods.

10.5. Finalising remarks and scope for further research

So far, no Danish CPI has been available for the period prior to 1815. This essay has offered a new consumer price index for Denmark 1502-2007. For the post-1815 period the index is based on existing CPI figures whereas new data have been constructed for the pre-1815 period. For the earliest years 1502-1712 the new CPI covers only the price of corn, whereas the period 1712-1800 is based on the comprehensive price material collected in relation to the Danish Price History Project, which was completed in 2004.

The past four centuries or so the average inflation rate in Denmark has been 1.8 per cent per annum. Disregarding periods with actual war inflation and the deflation during the first two decades or so after the end of the Napoleonic Wars, there seems only to have been one major exception from the overall picture of stability: The first four decades after the end of the Second World War where inflation expectations lost their anchor.

The study in this essay has identified four areas where further research could be useful. First, the aim of the study at hand has not been collection of new primary data but rather to utilise the information collected in earlier studies on Danish price history. However, in the data sources behind the CPI the prices in the period 1502-1640 are stated as "silver prices" and the Danish currency depreciated vis-à-vis silver during this period. The pre-1640 CPI figures therefore clearly underestimate the actual level of inflation. The existing data sources do not contain information that allow for an easy transformation of silver prices back to nominal prices, so further work in this area could be interesting.

Second, a comparison of the composition of private consumption expenditures in Denmark in 1844 with Norwegian data from 1850 indicates that the composition of private consumption expenditures could deserve some extra attention in future generations of historical national accounts in Denmark. The consumption of bread *etc*. relative to meat and fish appears to be very low in the Danish figures compared to the figures from Norway.

Third, the increase in the CPI from 1516 to the 1570s is much smaller in Norway than in Denmark. A closer analysis and comparison of the sixteenth century Price Revolution in Denmark and Norway seems to be an interesting subject for future research.

Forth and finally, the depreciation of the Danish currency during the period 1808-1813 was much larger than the accumulated inflation measured by the CPI compiled in the essay at hand. This might indicate that the CPI index underestimates the level of inflation during this period. Another explanation could be exchange rate "overshooting". Existing studies on the high inflation in Denmark during the years immediately prior to the bankruptcy of the state in 1813 are few and rather superficial, so this would also be an area where future research could make important contributions.

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Annex 10.A: CPI for Denmark 1502-2007

Table 10.A.1: CPI for Denmark 1502-2007 (silver prices 1502-1640; nominal prices 1640-2007)

Year	Index	Annual growth	Year	Index	Annual growth	Year	Index	Annual growth
	2000=100	per cent		2000=100	per cent		2000=100	per cent
1502	0.02797	...	1572	0.10133	16.3	1642	0.1579	-4.9
1503	...	...	1573	0.09324	-8.0	1643	0.1619	2.5
1504	...	...	1574	0.08309	-10.9	1644	0.1644	1.6
1505	...	...	1575	0.08917	7.3	1645	0.1311	-20.3
1506	...	...	1576	0.08514	-4.5	1646	0.1435	9.5
1507	...	...	1577	0.09324	9.5	1647	0.1343	-6.4
1508	...	...	1578	0.07298	-21.7	1648	0.1692	26.0
1509	...	...	1579	0.08502	16.5	1649	0.2190	29.4
1510	0.03110	...	1580	0.08911	4.8	1650	0.2199	0.4
1511	...	...	1581	0.09117	2.3	1651	0.1921	-12.6
1512	...	...	1582	0.09120	0.0	1652	0.2260	17.6
1513	...	...	1583	0.08532	-6.5	1653	0.1368	-39.5
1514	...	...	1584	0.09287	8.9	1654	0.1048	-23.4
1515	...	...	1585	0.08917	-4.0	1655	0.1259	20.1
1516	...	...	1586	0.09931	11.4	1656	0.1544	22.7
1517	...	...	1587	0.09731	-2.0	1657	0.1563	1.2
1518	...	...	1588	0.08514	-12.5	1658	0.1071	-31.5
1519	...	...	1589	0.09731	14.3	1659	0.1453	35.7
1520	...	...	1590	0.1196	22.9	1660	0.2539	74.7
1521	...	...	1591	0.1219	1.9	1661	0.3183	25.4
1522	...	...	1592	0.1240	1.8	1662	0.2467	-22.5
1523	...	...	1593	0.1262	1.7	1663	0.1370	-44.5
1524	...	...	1594	0.1282	1.6	1664	0.1360	-0.7
1525	0.02693	...	1595	0.1302	1.5	1665	0.1528	12.4
1526	...	...	1596	0.1321	1.5	1666	0.1543	0.9
1527	...	...	1597	0.1339	1.4	1667	0.1718	11.4
1528	...	...	1598	0.1357	1.3	1668	0.0970	-43.6
1529	...	...	1599	0.1232	-9.2	1669	0.1112	14.7
1530	...	...	1600	0.1095	-11.2	1670	0.1072	-3.6
1531	0.03519	...	1601	0.1359	24.2	1671	0.1276	19.0
1532	0.03627	3.1	1602	0.1620	19.2	1672	0.1075	-15.8
1533	...	...	1603	0.1509	-6.8	1673	0.0988	-8.1
1534	...	...	1604	0.0985	-34.7	1674	0.1781	80.3
1535	...	...	1605	0.1182	19.9	1675	0.1648	-7.5
1536	...	...	1606	0.0910	-23.0	1676	0.1622	-1.5
1537	...	...	1607	0.0937	3.0	1677	0.1639	1.1
1538	0.02748	...	1608	0.1504	60.5	1678	0.1461	-10.9
1539	0.02889	5.1	1609	0.1441	-4.2	1679	0.1311	-10.3
1540	...	...	1610	0.1410	-2.1	1680	0.0981	-25.2
1541	...	...	1611	0.1333	-5.5	1681	0.1434	46.2
1542	...	...	1612	0.1521	14.1	1682	0.1158	-19.2
1543	...	...	1613	0.1354	-10.9	1683	0.1181	2.0
1544	...	...	1614	0.1045	-22.8	1684	0.2629	122.6
1545	0.06443		1615	0.1288	23.2	1685	0.1277	-51.4
1546	0.06754	4.8	1616	0.1248	-3.1	1686	0.1127	-11.8
1547	...	...	1617	0.1480	18.5	1687	0.1014	-10.0
1548	...	...	1618	0.1503	1.6	1688	0.1191	17.4
1549	...	...	1619	0.1366	-9.1	1689	0.1268	6.5
1550	...	...	1620	0.1023	-25.1	1690	0.1443	13.8
1551	...	...	1621	0.1149	12.3	1691	0.1335	-7.5
1552	0.06278	...	1622	0.1575	37.1	1692	0.1423	6.6
1553	0.05362	-14.6	1623	0.2016	28.0	1693	0.2162	52.0
1554	0.05705	6.4	1624	0.2559	26.9	1694	0.1244	-42.5
1555	0.07902	38.5	1625	0.1688	-34.0	1695	0.1375	10.5
1556	0.07831	-0.9	1626	0.1527	-9.5	1696	0.1814	31.9
1557	0.07761	-0.9	1627	0.1363	-10.7	1697	0.2379	31.2
1558	0.07691	-0.9	1628	0.1875	37.5	1698	0.2582	8.5
1559	0.06065	-21.1	1629	0.2750	46.7	1699	0.2760	6.9
1560	0.05423	-10.6	1630	0.2649	-3.7	1700	0.1538	-44.3
1561	0.05816	7.2	1631	0.1971	-25.6	1701	0.1458	-5.2
1562	0.07072	21.6	1632	0.1521	-22.8	1702	0.1330	-8.7
1563	0.07298	3.2	1633	0.1566	2.9	1703	0.1207	-9.3
1564	0.06846	-6.2	1634	0.1624	3.7	1704	0.1605	33.0
1565	0.07298	6.6	1635	0.1309	-19.4	1705	0.1588	-1.0
1566	0.09324	27.8	1636	0.1685	28.7	1706	0.1690	6.4
1567	0.07691	-17.5	1637	0.1700	0.9	1707	0.1368	-19.1
1568	0.07691	0.0	1638	0.1525	-10.3	1708	0.1655	20.9
1569	0.08107	5.4	1639	0.1491	-2.3	1709	0.3038	83.6
1570	0.08514	5.0	1640	0.1607	7.8	1710	0.1757	-42.2
1571	0.08715	2.4	1641	0.1661	3.4	1711	0.1337	-23.9

Table 10.A.1 (continued)

Year	Index	Annual growth	Year	Index	Annual growth	Year	Index	Annual growth
	2000=100	per cent		2000=100	per cent		2000=100	per cent
1712	0.1455	8.8	1782	0.2453	20.1	1852	1.818	0.0
1713	0.1354	-6.9	1783	0.2372	-3.3	1853	2.009	10.5
1714	0.1492	10.2	1784	0.2374	0.1	1854	2.220	10.5
1715	0.1441	-3.4	1785	0.2398	1.0	1855	2.262	1.9
1716	0.1482	2.8	1786	0.2358	-1.7	1856	2.368	4.7
1717	0.1552	4.7	1787	0.2476	5.0	1857	2.326	-1.8
1718	0.1526	-1.7	1788	0.2357	-4.8	1858	2.114	-9.1
1719	0.1472	-3.6	1789	0.2440	3.5	1859	2.072	-2.0
1720	0.1585	7.7	1790	0.2608	6.9	1860	2.114	2.0
1721	0.1427	-9.9	1791	0.2444	-6.3	1861	2.199	4.0
1722	0.1286	-9.9	1792	0.2509	2.7	1862	2.178	-1.0
1723	0.1233	-4.1	1793	0.2626	4.7	1863	2.114	-2.9
1724	0.1188	-3.6	1794	0.2612	-0.5	1864	2.136	1.0
1725	0.1147	-3.4	1795	0.2653	1.6	1865	2.178	2.0
1726	0.1074	-6.4	1796	0.2977	12.2	1866	2.241	2.9
1727	0.1133	5.5	1797	0.2869	-3.6	1867	2.347	4.7
1728	0.1259	11.1	1798	0.2887	0.6	1868	2.326	-0.9
1729	0.1340	6.4	1799	0.2887	0.0	1869	2.178	-6.4
1730	0.1290	-3.7	1800	0.3177	10.1	1870	2.114	-2.9
1731	0.1253	-2.8	1801	0.2545	-19.9	1871	2.114	0.0
1732	0.1249	-0.3	1802	0.2962	16.4	1872	2.049	-3.1
1733	0.1155	-7.6	1803	0.2720	-8.2	1873	2.099	2.5
1734	0.1107	-4.2	1804	0.3033	11.5	1874	2.122	1.1
1735	0.1115	0.8	1805	0.3436	13.3	1875	2.172	2.4
1736	0.1114	-0.1	1806	0.3250	-5.4	1876	2.194	1.0
1737	0.1095	-1.7	1807	0.2937	-9.6	1877	2.220	1.1
1738	0.1097	0.2	1808	0.3305	12.5	1878	2.217	-0.1
1739	0.1037	-5.4	1809	0.5123	55.0	1879	2.192	-1.1
1740	0.1085	4.6	1810	0.8205	60.2	1880	2.164	-1.3
1741	0.1173	8.2	1811	1.194	45.6	1881	2.187	1.0
1742	0.1136	-3.2	1812	2.231	86.8	1882	2.184	-0.1
1743	0.1106	-2.6	1813	9.174	311.2	1883	2.181	-0.1
1744	0.1167	5.6	1814	7.416	-19.2	1884	2.106	-3.5
1745	0.1247	6.9	1815	7.739	4.4	1885	2.053	-2.5
1746	0.1356	8.7	1816	7.739	0.0	1886	1.975	-3.8
1747	0.1305	-3.7	1817	6.935	-10.4	1887	1.896	-4.0
1748	0.1249	-4.3	1818	4.335	-37.5	1888	1.869	-1.5
1749	0.1228	-1.7	1819	3.193	-26.3	1889	1.891	1.2
1750	0.1233	0.4	1820	2.876	-9.9	1890	1.914	1.2
1751	0.1126	-8.6	1821	2.411	-16.2	1891	1.986	3.8
1752	0.1165	3.4	1822	2.072	-14.0	1892	2.009	1.1
1753	0.1087	-6.6	1823	2.220	7.1	1893	1.979	-1.5
1754	0.1250	15.0	1824	1.903	-14.3	1894	1.923	-2.8
1755	0.1251	0.1	1825	1.945	2.2	1895	1.842	-4.2
1756	0.1291	3.2	1826	1.882	-3.3	1896	1.786	-3.0
1757	0.1471	13.9	1827	1.988	5.6	1897	1.781	-0.3
1758	0.1573	6.9	1828	1.840	-7.4	1898	1.801	1.1
1759	0.1381	-12.2	1829	1.903	3.4	1899	1.843	2.4
1760	0.1356	-1.8	1830	1.924	1.1	1900	1.889	2.4
1761	0.1371	1.1	1831	2.009	4.4	1901	1.886	-0.1
1762	0.1462	6.6	1832	1.924	-4.2	1902	1.911	1.3
1763	0.1721	17.7	1833	1.776	-7.7	1903	1.908	-0.1
1764	0.1702	-1.1	1834	1.692	-4.8	1904	1.934	1.3
1765	0.1831	7.5	1835	1.755	3.8	1905	1.926	-0.4
1766	0.1707	-6.8	1836	1.840	4.8	1906	1.940	0.8
1767	0.1736	1.7	1837	1.797	-2.3	1907	2.008	3.5
1768	0.1826	5.2	1838	1.818	1.2	1908	2.029	1.1
1769	0.1767	-3.2	1839	1.861	2.3	1909	2.044	0.7
1770	0.1792	1.4	1840	1.840	-1.1	1910	2.058	0.7
1771	0.1863	4.0	1841	1.797	-2.3	1911	2.065	0.3
1772	0.1950	4.7	1842	1.861	3.5	1912	2.145	3.9
1773	0.1893	-2.9	1843	1.734	-6.8	1913	2.202	2.7
1774	0.1686	-11.0	1844	1.692	-2.4	1914	2.253	2.4
1775	0.1727	2.4	1845	1.755	3.8	1915	2.659	18.0
1776	0.1643	-4.9	1846	1.988	13.3	1916	3.132	17.8
1777	0.1814	10.4	1847	2.114	6.4	1917	3.627	15.8
1778	0.1714	-5.5	1848	1.882	-11.0	1918	4.236	16.8
1779	0.1973	15.1	1849	1.797	-4.5	1919	5.024	18.6
1780	0.1954	-1.0	1850	1.776	-1.2	1920	5.994	19.3
1781	0.2042	4.5	1851	1.818	2.4	1921	5.095	-15.0

Table 10.A.1 (continued)

Year	Index	Annual growth
	2000=100	per cent
1922	4.331	-15.0
1923	4.513	4.2
1924	4.783	6.0
1925	4.650	-2.8
1926	3.952	-15.0
1927	3.818	-3.4
1928	3.795	-0.6
1929	3.772	-0.6
1930	3.591	-4.8
1931	3.386	-5.7
1932	3.363	-0.7
1933	3.453	2.7
1934	3.588	3.9
1935	3.724	3.8
1936	3.769	1.2
1937	3.905	3.6
1938	3.952	1.2
1939	4.066	2.9
1940	5.058	24.4
1941	5.802	14.7
1942	6.005	3.5
1943	6.053	0.8
1944	6.186	2.2
1945	6.254	1.1
1946	6.211	-0.7
1947	6.391	2.9
1948	6.550	2.5
1949	6.708	2.4
1950	7.318	9.1
1951	8.174	11.7
1952	8.354	2.2
1953	8.312	-0.5
1954	8.470	1.9
1955	9.038	6.7
1956	9.490	5.0
1957	9.604	1.2
1958	9.690	0.9
1959	9.893	2.1
1960	10.12	2.3
1961	10.58	4.5
1962	11.27	6.6
1963	11.86	5.2
1964	12.29	3.6
1965	13.07	6.4
1966	13.96	6.8
1967	15.00	7.4
1968	16.20	8.0
1969	16.76	3.5
1970	17.85	6.5
1971	18.91	5.9
1972	20.15	6.6
1973	22.03	9.3
1974	25.40	15.3
1975	27.84	9.6
1976	30.34	9.0
1977	33.71	11.1
1978	37.08	10.0
1979	40.64	9.6
1980	45.64	12.3
1981	50.98	11.7
1982	56.13	10.1
1983	60.00	6.9
1984	63.78	6.3
1985	66.78	4.7
1986	69.25	3.7
1987	72.02	4.0
1988	75.26	4.5
1989	78.87	4.8
1990	80.92	2.6
1991	82.87	2.4
1992	84.61	2.1
1993	85.71	1.3
1994	87.42	2.0
1995	89.26	2.1
1996	91.13	2.1
1997	93.14	2.2
1998	94.81	1.8
1999	97.18	2.5
2000	100.0	2.9
2001	102.4	2.4
2002	104.9	2.4
2003	107.1	2.1
2004	108.3	1.2
2005	110.3	1.8
2006	112.4	1.9
2007	114.3	1.7

Dansk sammenfatning af afhandlingen
(Danish summary of the thesis)

Kvantitative studier af Danmarks monetære og finansielle historie

Denne afhandling indledes med nogle refleksioner omkring karakteren og nytten af kvantitative økonomisk-historiske analyser efterfulgt af ti artikler indeholdende kvantitative studier af Danmarks monetære og finansielle historie.

Der er formentlig ingen generel accepteret definition eller afgrænsning af disciplinen "kvantitativ økonomisk historie" som sådan, men kvantitative studier i økonomisk historie er dog normalt karakteriseret ved at lægge vægt på følgende forhold:

- konstruktion af økonomisk-historiske datasæt[311], som ikke tidligere har været tilgængelige, eller rekonstruktion af eksisterende økonomisk-historiske datasæt med henblik på at forbedre deres kvalitet eller udvide deres informationsindhold.

og/eller

- anvendelse af teoretisk statistik eller økonometriske metoder i forbindelse med empiriske analyser af økonomisk-historiske emner eller den økonomisk-historiske udvikling.

Litteraturhenvisninger er anført i tilknytningen til hver enkelt artikel. Selv om alle artiklerne belyser aspekter af Danmarks monetære og finansielle historie, repræsenterer de alle selvstændige analyser, som kan læses hver for sig. Nedenfor følger et resume af de vigtigste resultater indeholdt i hver af afhandlingens ti artikler. Alle de datasæt, som er blevet konstrueret i forbindelse med studierne, kan fås i elektronisk form ved henvendelse til forfatteren.

Artikel 1: Monetære udviklingstendenser og konjunkturcykler i Danmark 1875-2008 – Nye resultater ved anvendelse af finansielle statuskonti som ramme for organisering af historisk finansiel statistik [312]

I artikel 1 konstrueres et sæt finansielle statuskonti for Danmark 1875-2008 bestående af årlige beholdningsdata. Endvidere analyseres den strukturelle og cykliske monetære og finansielle udvikling i Danmark siden 1875 på baggrund af det nye datasæt.

De årlige finansielle statuskonti, som konstrueres i artiklen, er baseret på en omfattende mængde historisk finansiel statistisk. Der præsenteres data fordelt på 8 institutionelle sektorer (centralbanken; banker og sparekasser; realkreditinstitutter; livsforsikringsselskaber og pensionskasser; investeringsforeninger; staten; andre residenter; udlandet) og 6 hovedtyper af

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[311] I denne afhandling defineres et historisk datasæt som et datasæt, der konstrueres retrospektivt på et tidspunkt fjernt fra referenceperioden som en del af en historisk analyse og ikke som en del af samtidens statistikproduktion.

[312] Denne artikel er baseret på Abildgren (2006b, 2008b).

finansielle instrumenter (guld og SDR; sedler og mønt; lån og indskud; obligationer, aktier og investeringsforeningsbeviser; forsikringstekniske reserver; kapital og reserver).

Penge- og realkreditinstitutter spillede en vigtig kreditgivende rolle i dansk økonomi allerede i slutningen af det 19. århundrede og i begyndelsen af det 20. århundrede. Et vendepunkt indtraf i begyndelsen af 1930'erne, og i midten af 1950'erne var udlånet opgjort i forhold til bruttofaktorindkomsten faldet betydeligt. Siden er tendensen vendt, men niveauet fra før første verdenskrig blev først nået igen i tiåret fra midten af 1970'erne til midten af 1980'erne. Udviklingen i reale aktivpriser synes i en vis udstrækning at have vist et tilsvarende udviklingsmønster. Der har været en massiv vækst i formuen forvaltet af livsforsikringsselskaber og pensionskasser siden midten af 1970'erne og af investeringsforeninger siden midten af 1990'erne.

Der har været en meget højere grad af positiv samvariation mellem pengemængde og priser i lange økonomiske cykler (bølger med en periodelængde af 8-40 år) end i konjunkturcykler (med en varighed på 2-8 år), men i perioden efter 2. verdenskrig synes bevægelser i priser at være gået forud for bevægelser i pengemængden uanset bølgelængde. I perioden 1875-1945 fandt svingninger i huspriser sted adskillige år (6 år) forud for bevægelser i realkreditinstitutternes udlån i de lange bølger – i perioden efter 2. verdenskrig har periodeforskydningen været betydelig mindre (1 år). Gennem hele perioden siden 1875 har bevægelsen i penge- og realkreditinstitutternes reale udlån være stort set sammenfaldende med bevægelsen i den reale bruttofaktorindkomst, og de største korrelationskoefficienter har været at finde i de lange cykler.

Den overordnede konklusion i artiklen er, at finansielle statuskonti er en nyttig ramme til at organisere og analysere finansielle data, selv når datakilderne er mere fragmenterede og sparsomme, hvilket ofte er tilfældet i relation til historisk finansiel statistik. Dette kan være nyttigt i et forsøg på at tegne et mere sammenhængende billede af den historiske udvikling i det finansielle system og den finansielle struktur. Ved at udnytte regnskabsmæssige identiteter muliggør finansielle statuskonti fx udregning af den ikke-finansielle private sektors finansielle nettoformue, selv om der ikke foreligger særskilt balancestatistik for denne sektor.

Indtil nu har projekter med opstilling af historiske nationalregnskaber – såvel i Danmark som i andre lande – kun fokuseret på den reale side af økonomien. Det kunne være interessant, såfremt fremtidige projekter vedrørende historiske nationalregnskaber i Danmark vil gøre et forsøg på at opstille lange tidsserier af finansielle konti omfattende såvel beholdnings- som transaktionsdata.

En række af de vigtigste tidsserier fra det nye sæt af historiske finansielle statuskonti for Danmark 1875-2008 er tabuleret i appendiks 1.A. I appendiks 1.B er der foretaget en sammenligning for perioden 1994-2005 mellem de nye historiske finansielle statuskonti og de konti, som Danmarks Statistik har udarbejdet for denne periode. Endelig indeholder appendiks 1.C en kort beskrivelse af de vigtigste egenskaber ved det Baxter-King filter, som benyttes i artiklen.

Artikel 2: Udviklingen i renter og inflationsforventninger i Danmark 1875-2008[313]

Artikel 2 præsenterer et nyt sæt årlige rentedata for Danmark 1875-2008 og belyser renteudviklingen i Danmark siden 1875. Endvidere beskrives og diskuteres de "stiliserede fakta" for den historiske udvikling i realrenter og inflationsforventningerne i Danmark.

I perioden 1875-1945 lå de korte og lange nominelle renter på et niveau omkring 4-5 pct. p.a. En stigende tendens i de nominelle renter i løbet af 1960'erne og 1970'erne blev efterfulgt af en faldende tendens gennem 1980'erne og 1990'erne. I 2004-2005 nåede de danske pengemarkeds- og statsobligationsrenter det laveste niveau siden 1875. I denne forbindelse er det ligeledes værd at bemærke, at der de seneste tre årtier ikke har været et eneste år med negative forbrugerprisstigninger, mens deflation eller prisfald hyppigt forekom i perioden før 2. verdenskrig. Alt andet lige er præmien for inflationsrisiko indeholdt i den lange statsobligationsrente derfor formentlig højere i dag end i perioden med guldstandard.

Traditionelle opgørelser af *ex ante* realrenten (den nominelle rente fratrukket inflationen) viser, at de korte og lange realrenter i gennemsnit har befundet sig omkring et niveau på 3 pct. p.a. i perioden siden 1875. Endvidere indikerer sådanne beregninger, at de lange realrenter befandt sig på et forholdsvist højt niveau i slutningen af 1980'erne og den første den af 1990'erne. Dette resultat kan dog skyldes en høj grad af træghed i inflationsforventningerne. Beregninger af inflationsforventningerne på de finansielle markeder på grundlag af nominelle obligationsrenter og den reale BNP-vækst antyder, at inflationsforventningerne var relativt stabile under første verdenskrig og i mellemkrigstiden trods store udving i det faktiske inflationsniveau. De finansielle markeder synes ligeledes vedvarende at have undervurderet det faktiske inflationsniveau gennem 1960'erne og første halvdel af 1970'erne, mens inflationsniveauet permanent er blevet overvurderet siden midten af 1970'erne.

I appendiks 2.A præsenterer de kilder og metoder, som er anvendt til konstruktion af det nye sæt årlige rentedata for Danmark 1875-2008. Det nye data sæt består af tre forskellige tidsrækker for den korte rente (den officielle diskontosats, pengeinstitutternes gennemsnitlige indlånsrente og den private vekseldiskonto/pengemarkedsrenten) og to forskellige tidsrækker for den lange rente (statsobligationsrenten og realkreditobligationsrenten). Disse tidsserier er tabuleret i appendiks 2.B.

[313] Denne artikel er baseret på Abildgren (2005a, 2005b).

Artikel 3: Reale effektive valutakurser og relativ købekraftsparitets-konvergens for Danmark 1875-2003[314]

I artikel 3 udarbejdes årlige handelsvægtede nominelle og reale effektive valutakursindeks for Danmark 1875-2003, og der præsenteres en første eksplorativ empirisk undersøgelse af holdbarheden af den relative købekraftsparitetsteori (PPP) på langt sigt for Danmark på basis af de nye historiske tidsserieindex.

For at undgå bias i resultaterne som følge af ekstreme observationer omkring den tyske hyperinflation analyseres to separate delperioder (1875-1913 og årene efter 1923). Resultaterne baseret på endimensionale enhedsrodstests af en real effektiv kronekurs med engrospriser som deflatorer understøtter en hypotese om relativ PPP konvergens på langt sigt. Halveringstiden for en afvigelse fra relativ PPP estimeres til omkring 4 år i perioden efter 1923 og 2 år i perioden under den Klassiske Guldstandard før 1914. Den hurtigste konvergens mod relativ PPP synes at have fundet sted i de perioder, hvor Danmark har ført fastkurspolitik overfor flertallet af landets samhandelspartnere og dermed i de perioder, hvor udsvingene i den nominelle effektive kronekurs har været mindst.

I artiklen findes ikke støtte for en hypotese om konvergens mod relativ PPP på langt sigt, når der ses på en real effektiv kronekurs med forbrugerpriser som deflatorer. Dette resultat synes at være i overensstemmelse med de a priori forventninger, som man kunne have ud fra teoretiske overvejelser og understreger betydningen af valget af prisdeflator i studier af den relative købekraftsparitetsteori.

I appendiks 3.A præsenterer de kilder og metoder, som er anvendt til konstruktion af det nye sæt årlige handelsvægtede nominelle og reale effektive valutakursindeks for Danmark 1875-2003. Der udarbejdes to indeks for den reale effektive kronekurs med henholdsvis forbrugerpriser og engrospriser som deflatorer. Alle indeks er beregnet som geometrisk vejede kædeindeks med løbende (dvs. årligt opdaterede) vægte baseret på Danmarks udenrigshandel med 15 større handelspartnere. I hvert eneste af årene siden 1875 tegnede disse 15 lande sig for mindst 77 pct. af Danmarks vareomsætning med udlandet. De nye tidsserier for effektive kronekurser er tabuleret i appendiks 3.B.

[314] Denne artikel er baseret på Abildgren (2004a, 2004b, 2004c, 2005c).

Artikel 4: Potentialet for reduktion af ledigheden i Danmark i 1930'erne via Valutacentralen[315]

Artikel 4 præsenterer en analyse af de beskæftigelsesmæssige effekter af den danske valutakontrol i 1930'erne. Formålet er at belyse omfanget af den merbeskæftigelse, som kunne være skabt i 1934 via en ren omfordeling af importen sammenlignet med den faktiske importfordeling i 1934.

Analysen er baseret på en input-output lineær programmeringsmodel, hvori grundstammen udgøres af en ny historisk input-output tabel for Danmark 1934. Modellen anvendes til at beregne beskæftigelsesniveauet ved alle tænkelige fordelinger af importen og finde frem til den importfordeling, som – under visse antagelser og restriktioner – ville have givet størst mulig beskæftigelse i 1934.

Beregningerne antyder, at det ville have været muligt at øge beskræftigelsen med mellem 34.000 og 82.000 personer (svarende til mellem 1,7 og 4,2 pct. af arbejdsstyrken) i 1934 ved at implementere en sådan alternativ beskæftigelsesmaksimerende importfordeling.

I appendiks 4.A præsenteres de vigtigste kilder og metoder, som er anvendt til konstruktionen af den nye historiske input-output tabel for Danmark 1934, som er betydelig mere detaljeret end den "officielle" input-output tabel for 1934 udarbejdet af Danmarks Statistik i slutningen af 1930'erne og begyndelsen af 1940'erne. Dette appendiks illustrerer styrken ved at anvende varebalancemetoden selv om (eller specielt når) datagrundlaget er sparsomt, hvilket ofte er tilfældet i forbindelse med udarbejdelse af historiske nationalregnskaber. Den nye input-output tabel for 1934 er i appendiks 4.A optrykt i en aggregeret version med 23 erhvervssektorer. Som et supplement præsenteres ligeledes et sæt beskæftigelsestal opgjort efter input-output tabellens erhvervsgruppering. Endvidere beregnes et sæt input-output multiplikatorer, som viser det direkte og indirekte import- og beskæftigelsesindhold i efterspørgslen efter erhvervenes produktion og i de endelige anvendelser baseret på den statiske åbne Leontief-model.

Artikel 5: Konjunkturernes indflydelse på den offentlige budgetsaldo i Danmark 1875-2005[316]

I artikel 5 præsenteres et nyt datasæt for den danske offentlige sektors nettofordringserhvervelse 1875-2005, og der foretages en analyse af konjunkturernes indflydelse på den offentlige budgetsaldo i perioden 1875-2005.

[315] Denne artikel er baseret på det fælles arbejde med Anders Nørskov, som blev præsenteret i Abildgren & Nørskov (1991, 1992) og Abildgren (1992a, 1992b). Bidraget til dette arbejde fra Anders Nørskov og Kim Abildgren har lige vægt, jf. forfatternes deklaration på side iv i Abildgren & Nørskov (1991). Abildgren & Nørskov (1991) blev tildelt Københavns Universitets Zeuthen Pris i 1992.

[316] Denne artikel er baseret på Abildgren (2005d, 2006c).

Selv om den offentlige sektor i Danmark i dag relativt set er blandt de største i Europa, har det offentlige budgetunderskud kun markant oversteget 3 pct. af BNP under 2. verdenskrig samt i begyndelsen af 1980'erne. Konjunkturernes indflydelse på den offentlige budgetsaldo er normalt forholdsvis beskeden sammenlignet med påvirkningen fra diskretionære finanspolitiske ændringer eller ændringer fra ekstraordinære og strukturelle faktorer. Dog antyder beregninger af udsvingene i de offentlige budgetter også, at det er nødvendigt at have overskud på den kunjunkturrensede offentlige budgetsaldo i perioder med høj økonomisk vækst, såfremt de automatiske stabilisatorer skal have mulighed for at fungere frit i perioder med lav økonomisk vækst uden at budgetunderskuddet overskrider en grænse på 3 pct. af BNP (som er referenceværdien i Maastricht Traktaten).

Det nye datasæt for den offentlige sektors nettofordringserhvervelse 1875-2005 er tabuleret i appendiks 5.A.

Artikel 6: Et input-output baseret mål for underliggende indenlandsk inflation i Danmark 1903-2002[317]

I artikel 6 foretages en analyse af inflationsudviklingen i Danmark gennem det seneste århundrede. Der konstrueres en ny tidsserie for den underliggende indenlandske inflation i Danmark i perioden 1903-2002 ved at rense udviklingen i den private forbrugsdeflator for prisstigninger forårsaget af import, afgifter og husleje. Beregningerne bygger på en årlig input-output baseret dekomponering af det private forbrug i dets direkte og indirekte indhold af import, afgifter, husleje og andre faktorer. En detaljeret beskrivelse af beregningsmetoderne samt en tabulering af de væsentligste data findes i appendiks 6.A-6.C.

Artiklen behandler desuden en række mere generelle konceptionelle problemstillinger omkring fortolkningen og anvendelsen af input-output baserede inflationsmål. Formålet med et input-output baseret indenlandsk inflationsmål er at fange udviklingen i den indenlandske markedsbestemte inflation, som er forholdsvis tæt knyttet til prisen på bruttoværditilvækst i den indenlandske private erhvervssektor.

Analysen indikerer, at udviklingen i et således beregnet input-output baseret underliggende inflationsmål adskiller sig markant fra udviklingen i forbrugsdeflatoren i perioder med store strukturelle ændringer i de relative priser og høj volatilitet i inflationen. Det mest markante eksempel herpå er perioden 1973-1986, der var karakteriseret ved store stigninger i indirekte skatter og huslejer samt et højt og volatilt element af importeret inflation som følge af store bevægelser i oliepriserne og hyppige devalueringer af den danske krone.

Et lavt niveau af den input-output beregnede underliggende inflation er ikke nødvendigvis ensbetydende med et lavt fremtidigt inflationsniveau. Det input-output baserede mål for den

[317] Denne artikel er baseret på Abildgren (2006a, 2007b).

underliggende inflation afspejler udviklingen i lønninger og avancer pr. produceret enhed i indenlandske varer og tjenester leveret til privat forbrug. Et midlertidigt fald i niveauet for den underliggende inflation, fx omkring den 2. oliekrise, kan derfor delvist afspejle en midlertidig nedgang i avanceprocenterne, som senere redresseres.

Input-output baserede underliggende inflationsmål kan give en insigt i de inflationære processer, som ikke med samme lethed kan afdækkes via andre økonomiske indikatorer. Et input-output baseret mål for den underliggende inflation kan derfor - på trods af den relativt omfattende beregningprocedure - være et nyttigt supplement til anden information (fx omkring lønudvikling, produktionsgab etc.) i forbindelse med både historiske studier af inflationsudviklingen og som input i en bred vurdering af de aktuelle inflationsforhold.

Artikel 7: Kortsigtede valutakurspåvirkninger fra kapitalbevægelser i en lille åben økonomi med fastkurspolitik – Empiriske resultater fra Danmarks nyere valutakurshistorie 1984-2004[318]

I artikel 7 analyseres den kortsigtede sammenhæng mellem kapitalbevægelser relateret til grænseoverskridende porteføljeinvesteringer og ændringer i kronekursen over for euro (D-mark før 1999) på baggrund af et unikt datasæt over månedlige private brutto og netto porteføljestrømme til og fra Danmark 1984-2004.

Hovedresultatet af analysen er, at porteføljeinvesteringer er vigtige for den kortsigtede valutakursdannelse, og at fortegnet på den estimerede effekt er som forventet: Nettoindstrømning af kapital styrker kronekursen. Dette resultat er robust over for en opdeling af datamaterialet i delperioder samt inddragelse af Nationalbankens interventioner i valutamarkedet og ændringer i det korte rentespænd over for valutaankeret som endogene forklarende variable. Porteføljeinvesteringer i danske obligationer synes at være afgørende for resultatet i perioden før introduktionen af euroen. Siden har porteføljestrømme i udenlandske aktier været den drivende faktor.

Effekten på kronekursen fra porteføljestrømme synes at have aftaget over tid, hvilket muligvis kan tilskrives fastkurspolitikkens øgede troværdighed.

Artikel 8: Kreditudviklingen i Danmark i perioden siden afslutningen af 2. verdenskrig.[319]

Lange tidsserier over udlån fordelt på institutionelle sektorer og brancher er ikke umiddelbart tilgængelige i Danmark. I artikel 8 opstilles årlige tidsserier (tabuleret i appendiks 8.A) for udlån til danske residenter fordelt på sektor og branche for perioden 1951-2008. Endvidere undersøges de udviklingstendenser og konjunkturbevægelser, som har karakteriseret kreditgivningen gennem de seneste halvtreds år.

[318] Denne artikel er baseret på Abildgren (2007a, 2008c).

Der ser ud til at være indtruffet et strukturelt skift i forholdet mellem realvækst i udlån og økonomisk aktivitet omkring 1980, som muligvis har sammenhæng med den generelle udvikling i det monetære og finansielle system. Perioden siden 1980, der har været karakteriseret ved øget markedsorientering som følge af liberalisering og internationalisering af den finansielle sektor, har været kendetegnet ved meget store udsving i den reale udlånsvækst i forhold til den økonomiske vækst sammenlignet med perioden før 1980, hvor kreditrationering og valutakontrol var centrale instrumenter i den økonomiske politik.

Kreditekspansionen de seneste fem til seks årtier har medført øgede belåningsgrader. Den ikke-finansielle sektors gæld har dog gennem hele perioden udgjort en forholdsvis begrænset andel af værdien af de reale aktiver, selv efter boligprisfaldet i slutningen af 1980erne og begyndelsen af 1990erne.

Der synes at være indtruffet et skift over tid i de kortsigtede konjunkturbevægelser i udlånet til forskellige erhverv. Bevægelserne i reale udlån til erhverv var sammenfaldende med bevægelsen i den reale bruttofaktorindkomst i den private sektor i perioden før 1980 men har i perioden efter 1980 fulgt konjunkturcyklen med en forsinkelse på omkring 1 år. Dette afspejler muligvis den mere restriktive adgang til kredit i perioden før 1980, som gav virksomhederne et incitament til at låne på et tidlig stadie i konjunkturcyklen for at være sikker på at råde over de nødvendige midler finansiering af planlagte investeringer. En anden mulig forklaring er den stigende betydning af erhvervsdrivende fonde i dansk erhvervsliv. Erhvervsdrivende fonde kan betragtes som en "tålmodig ejerkreds", der ikke har et akut behov for afkast af deres ejerandele. I takt med formuevæksten i disse fonde har det formentlig været muligt for virksomhederne at finansiere en større andel af deres faste bruttoinvesteringer i begyndelsen af et konjunkturopsving via tilbageholdt indtjening frem for lån fra kreditinstitutter i ind- og udland.

Der forekommer også at være indtruffet et skift i den cykliske variation i indenlandske realkreditlån til privatpersoner. I perioden før 1980 var bevægelsen i realkreditinstitutternes reale udlån sammenfaldende med bevægelsen i den reale bruttofaktorindkomst i den private sektor. I perioden efter 1980 har korreationskoefficienterne været mindre, at der synes ikke længere at være en klar sammenhæng mellem det reale udlån og den reale bruttofaktorindkomst. Dette er muligvis et resultat af den lettere adgang til at optage lån i friværdien i ejerboliger og det større udbud af mere fleksible realkreditprodukter gennem de seneste årtier.

[319] Denne artikel er baseret på Abildgren (2007c, 2009c).

Artikel 9: Afhænger strukturerne på arbejdsmarkedet af det monetære regime? – En empirisk analyse Danmark 1875-2007[320]

Erfaringen fra de seneste hundrede år kunne ifølge analysen i artikel 9 tyde på, at strukturerne på arbejdsmarkedet i Danmark delvist afhænger af det monetære regime. Et troværdigt monetært regime, som leverer på endemålet om stabile priser, giver basis for en fast forankring af inflationsforventningerne omkring prisstabilitet, hvilket gør det lettere at anvende flerårige lønkontrakter og en højere grad af decentral løndannelse blandt fremadskuende lønmodtagere og arbejdsgivere. Fravær af et troværdigt monetært regime, som resulterer i høje og volatile inflationsrater, gør det mere attraktivt at anvende kortere overenskomstperioder og centraliseret løndannelse samt tilskynder til prisindeksering af lønningerne. For Sverige er der ligeledes i en undersøgelse dækkende de seneste hundrede år fundet empirisk belæg for, at strukturerne på arbejdsmarkedet er endogent afhængige af politikregimet.

Hvis strukturerne på arbejdsmarkedet i nogen grad er endogent afhængig af det monetære/makroøkonomiske regime, kan resultater og politik konklusioner fra teoretiske modeller, som behandler disse forhold som eksogent givne, muligvis være tvivlsomme. Eksempelvis er det normalt en antagelse i nykeynesianske DSGE-modeller, at graden af nominel lønstivhed er approximativ konstant (en "dyb strukturel parameter"). Antagelsen implicerer, at sådanne modeller ikke er robuste over for Lucas-kritikken og derfor ikke velegnede til at analysere og sammenligne funktionaliteten af forskellige makroøkonomiske regimer.

Artikel 10: Forbrugerpriser i Danmark 1502-2007[321]

I artikel 10 præsenteres et forbrugerprisindeks for Danmark 1502-2007 (tabuleret i appendiks 10.A). Endvidere behandles nogle af de mere konceptionelle problemstillinger i relation til konstruktion af historiske forbrugerprisindeks og måling af inflation. For perioden efter 1815 er indekset baseret på eksisterende forbrugerprisindeks, mens der konstrueres nye data for perioden før 1815. For de tidligste år 1502-1712 omfatter det nye forbrugerprisindeks udelukkende kornpriser, mens perioden 1712-1800 er baseret på det omfattende prismateriale, som er indsamlet i relation til det nyligt afsluttede projekt om Dansk Prishistorie.

Grundet manglende datagrundlag er forbrugerprisindekset baseret på "sølvpriser" i perioden 1502-1640. Da den danske valuta tabte værdi i forhold til sølv i denne periode, vil forbrugerprisindekset undervurdere inflationsudviklingen i perioden før 1640.

[320] Denne artikel er baseret på Abildgren (2008a, 2009b).

Hvis man ser bort fra egentlige krigsperioder og deflationen i de første to årtier efter statsbankerotten i 1813, har de sidste knap fire århundrede i Danmark været domineret af prisstabilitet. Der synes kun at have været én enkelt undtagelse fra det overordnede billede af prisstabilitet: De første fire årtier efter afslutningen af 2. verdenskrig, hvor inflationsforventningerne mistede deres anker.

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