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An Input-Output Based Measure of Underlying Domestic Inflation in Denmark 1903-2002[1]

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Abstract

The paper analyses the development in inflation in Denmark during the last century. New annual input-output based time-series data for the underlying domestic inflation in Denmark 1903-2002 is constructed by stripping the development in the private consumption deflator for 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 as well as large 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. An input-output based measure of the underlying inflation can be a useful supplement to other types of information (e.g. the development in wages, output gap etc.) in relation to both an 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.

Key words: Underlying inflation, core inflation, history of inflation, input-output price models.

JEL Classification: C67, C82, E31, E52, N13, N14.

Resumé (Danish summary)

I papiret 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 (såkaldt "stripning"). Stripningen 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.

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 underliggende inflation afspejler udviklingen i lønninger og avancer pr. produceret enhed i indenlandske leverer 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 dog 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 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. På trods af den relativt omfattende beregningprocedure kan input-output baserede mål for den underliggende inflation derfor være et værdifuldt supplement til den vifte af øvrige underliggende inflationsindikatorer, som finder anvendelse blandt centralbanker.

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1. Introduction

Broad-based inflation measures such as the annual growth in the Consumer Price Index (CPI) or the private consumption deflator may not always be suitable measures of the underlying inflationary development in a small open economy. Firstly, such broad inflation measures reflect the price development of imported goods. Secondly, they are affected by changes in the level of indirect taxation such as VAT and excise duties. And finally, the price development of some goods and services may not be fully market based but subject to administrative regulation by the public authorities (in the Danish case for instance gross rents). The development in "headline" inflation measures can therefore not stand alone in a broad assessment of the underlying inflationary development.

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. However, there do not seem to be any consensus in the academic literature on how to measure underlying inflation in the most appropriate way, and different measures of underlying inflation may paint different pictures of the inflationary trend.[2]

In Denmark there is a long-standing tradition for the use of supplementary price measures for economic-policy purposes and in the analysis of the underlying inflation trends. In 1963 Statistics Denmark started to compile an index for consumer prices excluding indirect taxes and subsidies for the use in cost-of-living clauses in wage agreements[3], and in 1974 an input-output approach was introduced to determine the impact of import prices on the domestic price development in a report on cost-of-living clauses in wage agreements.[4]

Danmarks Nationalbank (the central bank of Denmark) regularly calculates and monitors an input-output based measure of underlying inflation.[5] These calculations were first introduced to the public in the May 1984 issue of the Nationalbank's Monetary Review. Today, the Nationalbank publishes statistics on a quarterly frequency on the development in the domestic market-determined inflation (the so-called IMI-index). The IMI-index is based on the net price index[6] adjusted for a number of special factors (energy, imports, foodstuffs, gross rents

[2] Cf. e.g. BIS (1999) and Roberts (2005).
[3] Cf. Danmarks Statistik (1985).
[4] Cf. Betænkning om dyrtidsregulering. Afgivet af det af arbejdsministeren den 7. august 1973 nedsatte udvalg, København 1974; and Holdt & Thage (1976).
[5] Cf. Lauritzen (1987), Christensen (1994) and Hansen & Knudsen (2005). Knudsen & Nielsen (2002) constructs an alternative measure of underlying inflation in Denmark 1981-2000 based on a trimmed mean of the components in the "headline" consumer price index.
[6] An index on consumer prices excluding indirect taxes and subsidies.

and public services), and the Nationalbank has presented data going back to 1975 in relation to various analytical works[7].

The paper at hand analyses the inflationary development in Denmark during the last century. New time-series data for the underlying domestic inflation 1903-2002 is constructed by stripping the development in the private consumption deflator for price increases caused by imports, indirect taxes and gross rents. The stripping builds on an annually updated input-output based decomposition of the private consumption into its direct and indirect content of imports, indirect taxes net of subsidies, gross rents and other items.

The rest of this paper proceeds as follows: Section 2 describes the methods used for the compilation of an input-output based measure of underlying domestic inflation for Denmark 1903-2002 followed by an outline of the data sources in section 3. Section 4 presents input-output multipliers for the Danish economy 1903-2002 whereas section 5 analyses the historical development in the private consumption deflator, import prices, gross rents, indirect taxes and the underlying domestic inflation during the last century. Finally, section 6 and 7 contain a discussion and some concluding remarks regarding the interpretation and use of input-output based inflation measures. Appendix A describes briefly the input-output price model 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. Appendix B present a post-1975 comparison of the measure of the underlying domestic inflation calculated in section 2 and the Nationalbank's IMI-index. Appendix C lists all the key time-series data analysed in this paper, while Appendix D outlines the sources and compilation methods in details.

2. An input-output based underlying inflation measure for Denmark 1903-2002 - Methodological approach

The basic idea behind the input-output based measure of underlying domestic inflation compiled in this paper is to strip the actual development in the 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. Assuming fixed input-output coefficients (and thereby fixed input-output multipliers) in a given year this measure of underlying domestic inflation thus reflects the development in wages and gross profit per produced unit in domestic goods and services delivered for private consumption

Using the following mnemonics:

[7] Cf. e.g. Danmarks Nationalbank (2004).

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:

$$[1]\quad PCP_t = \frac{a_t^{IT} \cdot PIT_t + a_t^{M} \cdot PM_t + a_t^{H} \cdot PH_t + \left(100 - a_t^{IT} - a_t^{M} - a_t^{H}\right) \cdot UNDPCP_t}{100}$$

The domestic underlying rate of inflation ($UNDPCP_t$) is not directly observable, but it can be calculated from [1] on a residual basis as:

$$[2]\quad UNDPCP_t = \frac{100 \cdot PCP_t - a_t^{IT} \cdot PIT_t - a_t^{M} \cdot PM_t - a_t^{H} \cdot PH_t}{100 - a_t^{IT} - a_t^{M} - a_t^{H}}$$

Appendix A describes briefly the input-output price model 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. Like all other model-based calculations the underlying domestic inflation presented in this paper is by nature an abstraction. Production technology may change somewhat even in the short run, so the assumption of fixed input-output coefficient during a given year may not hold entirely. However, due to the use of annually updated input-output coefficients during the whole period 1903-2002 the assumptions of fixed input-output coefficient during a given year is not assumed to be very restrictive.[8]

[8] Cf. also the results from the analysis of the Nationalbank's input-output based measure for the domestic market-determined inflation presented in Lauritzen (1987). Based on the period 1980-1983 he finds that changes in input-output coefficients can only explain a very small part of the changes in the net price index.

3. Data sources

The annual changes in the implicit deflator for the total private consumption (PCP_t), indirect taxes (PIT_t), imports of goods and services (PM_t) and private consumption of gross rents (PH_t) has mainly been derived from the current and earlier versions of the official Danish national accounts statistics and the Danish historical national accounts figures presented in Hansen (1983).

For the period since 1966 the direct and indirect content in private consumption of imports of goods and services (a^M_t)[9] is based on the input-output multipliers published by Statistics Denmark as part of the existing and earlier versions of the official Danish national accounts statistics. Statistics Denmark has derived these input-output multipliers from detailed input-output tables with more than 100 industries.

An input-output table for Denmark 1934 with 23 industries based on a detailed commodity-flow system is found in Abildgren (1992a, 1992b). Based on this table the direct and indirect content of imports of goods and services in the private consumption in 1934 has been calculated using the standard static input-output price model described in appendix A.

Kærgård (1991) presents annual input-output tables for Denmark 1903-1939 and 1948-1970 with the economy divided into two main sectors (a "rural" sector and an "urban" sector). The direct and indirect content of imports of goods and services in the private consumption in the periods 1903-1914, 1922-1933, 1935-1939 and 1948-1965 have been calculated on basis of Kærgård (1991) using the standard static input-output price model from appendix A.[10] Adjustments have been made to avoid break in the series in 1934 and 1966.

For most of the period since 1966 the direct and indirect content of indirect taxes net of subsidies (a^{IT}_t)[11] in private consumption is based on the input-output multipliers published by Statistics Denmark as part of the current and earlier versions of the official Danish national accounts statistics. For the pre-1966-period the figures have been interpolated from the development in indirect taxes (excluding custom duties) net of subsidies in per cent of the private consumption.

The content of gross rents in the private consumption at current prices (a^H_t) is based on current and earlier versions of the official Danish national accounts statistics from Statistics Denmark and the Danish historical national accounts statistics in Hansen (1983). The gross rent item covers both rental housing as well as imputed rents in owner-occupied housing.

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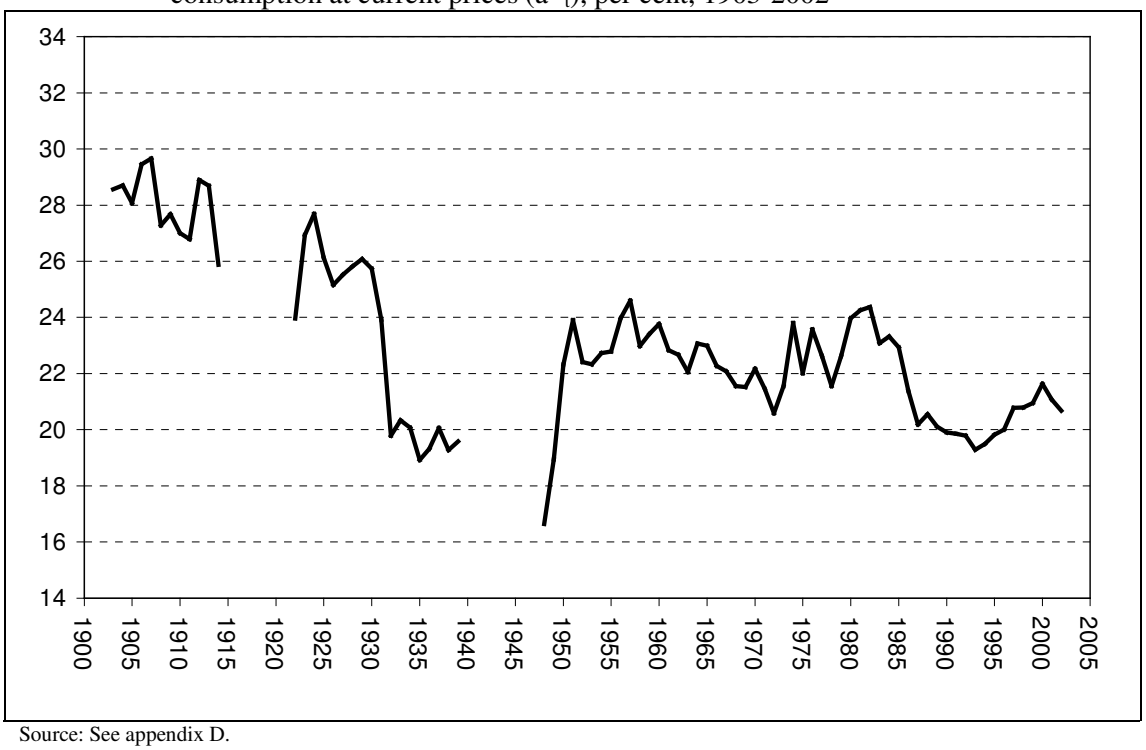
[9] Measured in basic values, i.e. including custom duties.

[10] Official input-output tables for Denmark has also been compiled by Statistics Denmark as an integrated part of the national account statistic for the years 1930-39 (10 industries), 1946 (16 industries), 1947 (20 industries), 1949 (20 industries), 1953 (19 industries) and 1958 (9 industries). Non-official historical input-output tables for each year in the period 1921-31 (10 industries) have been compiled by Jørgensen (1946). The information content contained in these tables have been taken into consideration in the construction of the set of historical national account figures in Hansen (1983) that forms the basis for the input-output tables in Kærgård (1991), cf. p 309 in Kærgård (1991) and p. 332 and forward in Hansen (1983).

4. Input-output multipliers for Denmark 1903-2002

The calculated direct and indirect content of imports in private consumption since 1903 is shown in figure 1. During most of the period, the Danish economy can be characterised as a small, open economy. On average the 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 the World War II where the international economy was characterised by a high degree of protectionism and a complex net of bilateral trading arrangements.[12]

Figure 1: Direct and indirect import content (including custom duties) in private consumption at current prices (a^M_t), per cent, 1903-2002



Source: See appendix D.

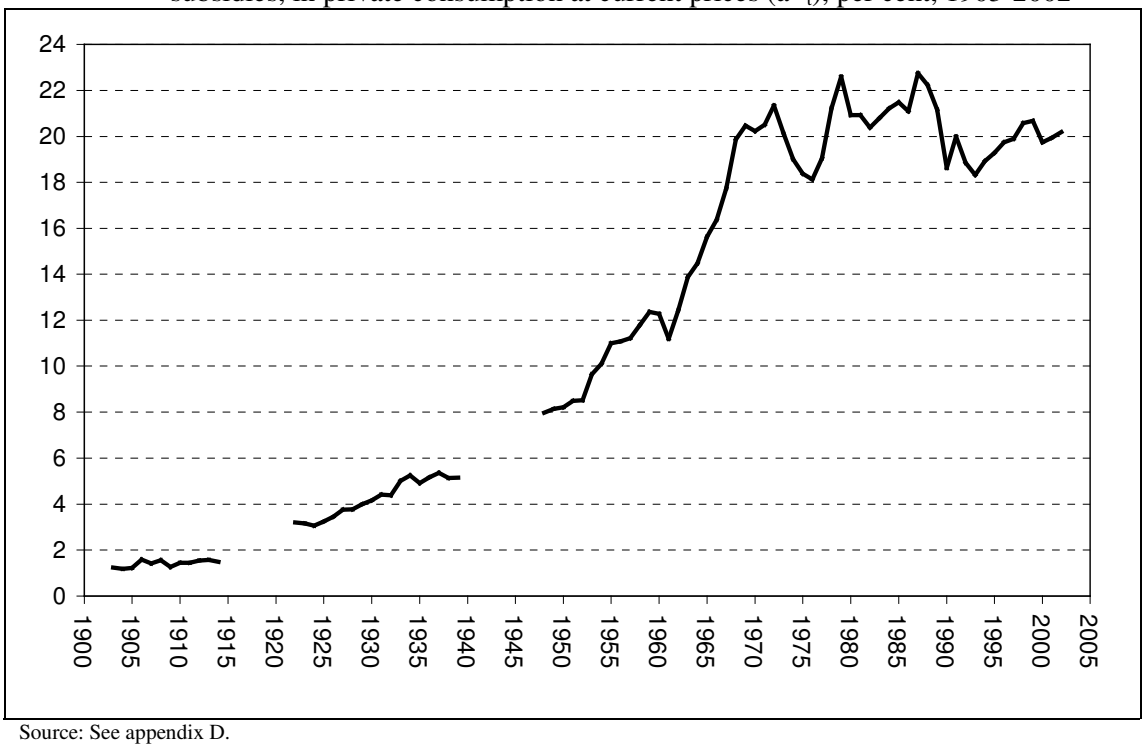
The direct and indirect content of indirect taxes in private consumption since 1903 is shown in figure 2. The content of taxes increased gradually from close to 1 per cent in the early 1900s to around 20 per cent in the post-1970 period. Seen as one the period has been

[11] Excluding custom duties.

[12] The Danish Exchange Control in the 1930s is covered by e.g. Boserup (1947) and Abildgren & Nørskov (1992). In the pre-World War II period imports of services are only partly covered in the data series in figure 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.

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.[13]

Figure 2: Direct and indirect content of indirect taxes (excluding custom duties), net of subsidies, in private consumption at current prices (a^{IT}_t), per cent, 1903-2002



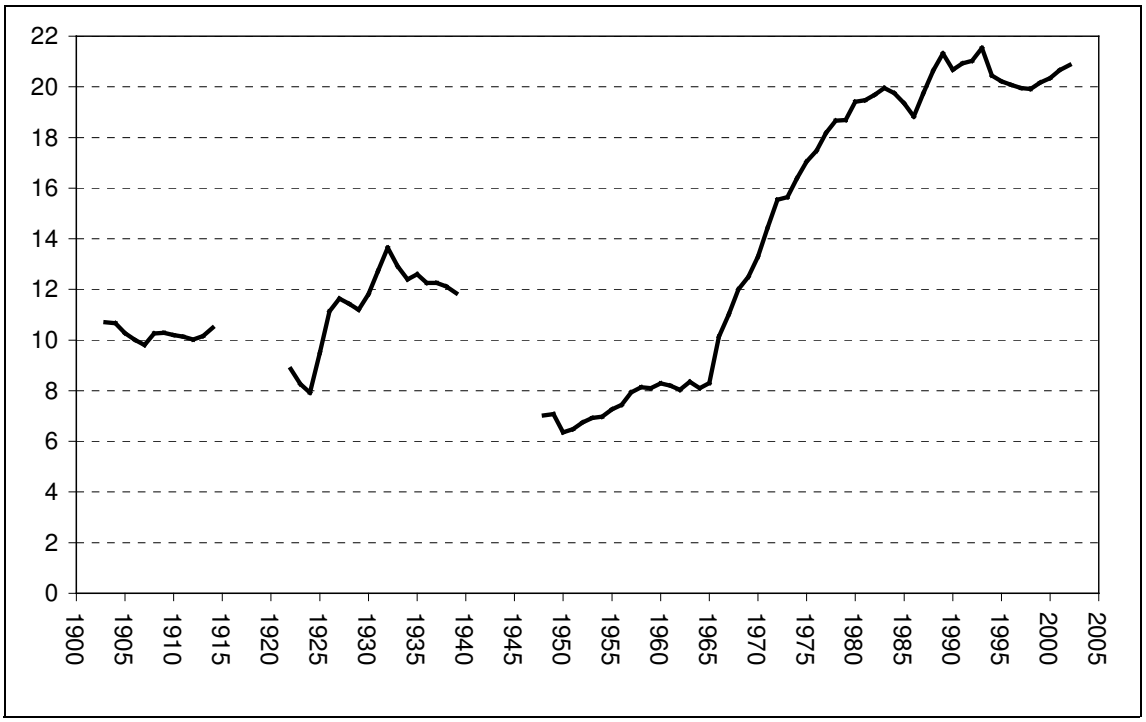
Source: See appendix D.

Figure 3 shows the content of gross rents in the private consumption since 1903. In the pre-1970 period gross rents accounted for around 6-14 per cent of the private consumption expenditures. 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 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.[14] The rental housing market were 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.[15]

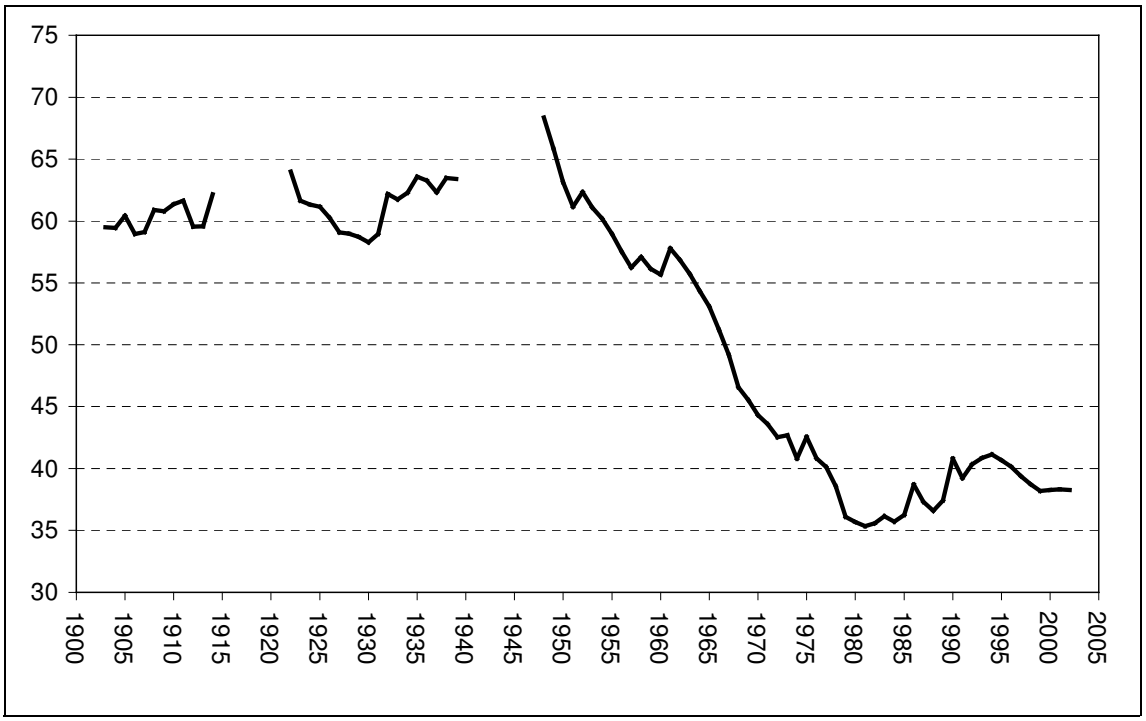
[13] The development in public finances in Denmark in the period 1875-2003 is covered by e.g. Abildgren (2005c).
[14] Cf. e.g. Andersen, Matthiessen & Ølgaard (1989).
[15] Cf. e.g. pp. 121-122 and pp. 145-147 Johansen (1987).

Figure 3: Content of gross rents in the private consumption at current prices (a^H_t), per cent, 1903-2002



Source: See appendix D.

Figure 4: Content of other items in the private consumption at current prices, per cent, 1903-2002



Source: See appendix D.

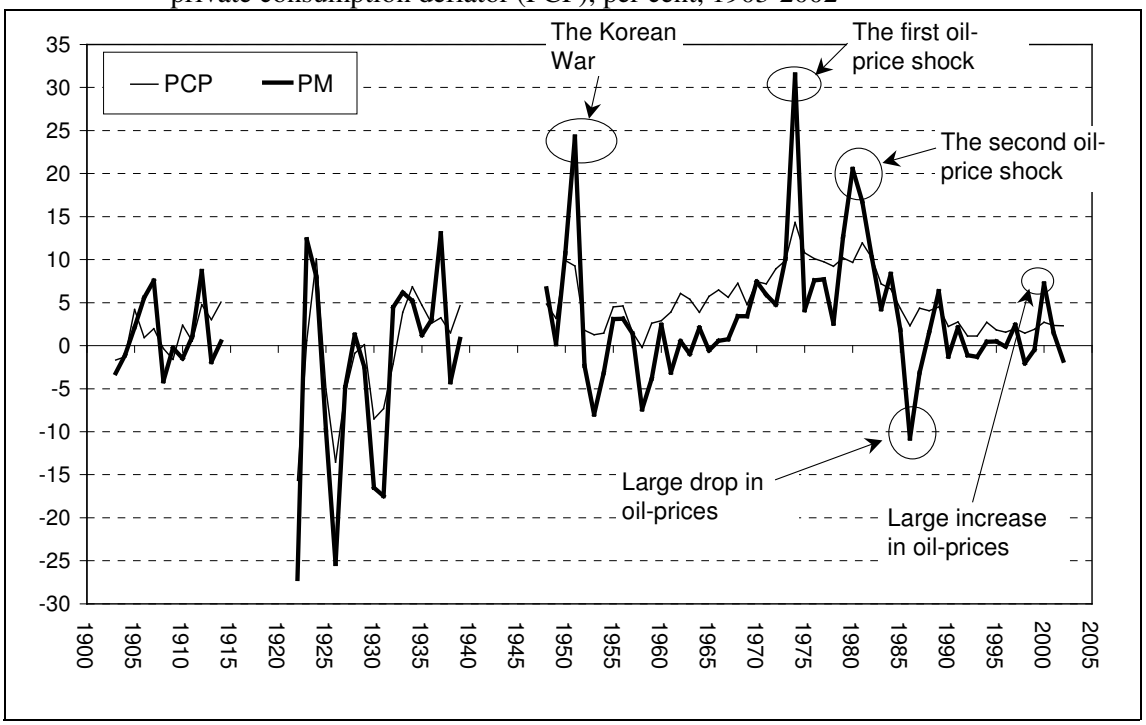
Figure 4 shows the content of "other items" in private consumption since 1903, i.e. the share of goods and services in private consumption excluding the direct and indirect content

of imports, indirect taxes and gross rents. The share of other items – reflecting the direct and indirect content of value added (wages and gross profit) in domestic 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.

5. The inflationary development in Denmark 1903-2002 - Empirical findings

Figure 5 shows the annual growth in import prices (PM) together and 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 PM has most of the years been lower than the 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 5.

Figure 5: Annual growth in import prices (including custom duties) (PM) and the total private consumption deflator (PCP), per cent, 1903-2002

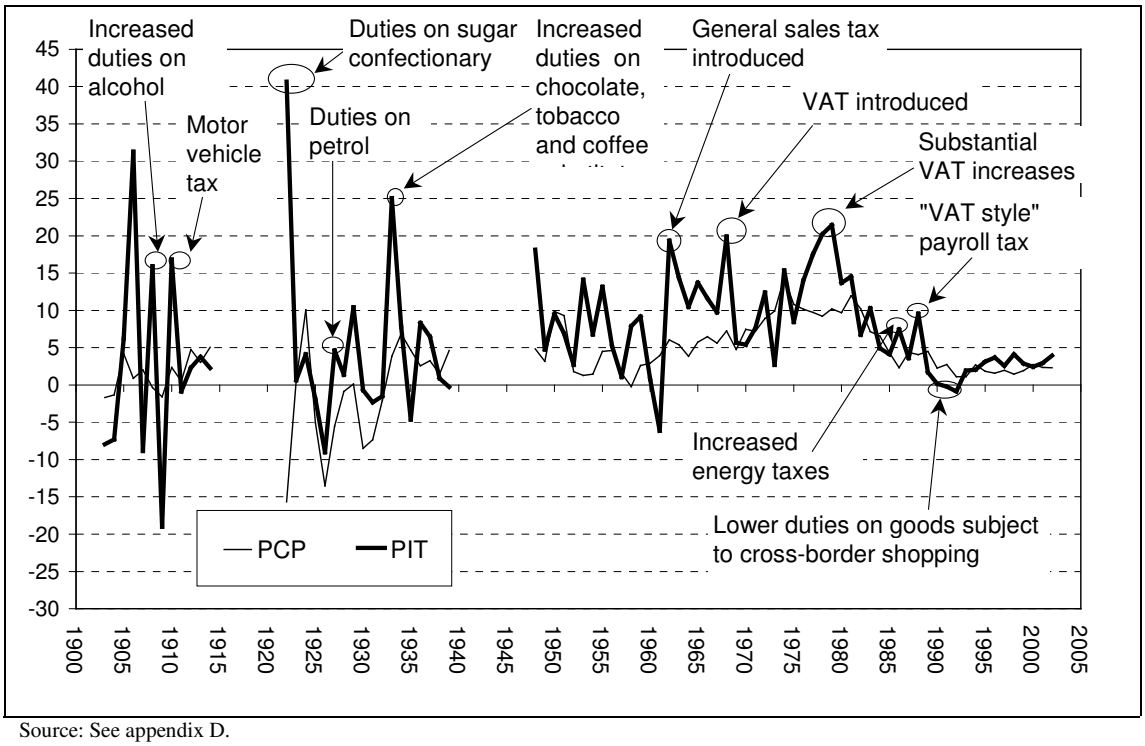


Source: See appendix D.

The annual growth in the deflator for indirect taxes (PIT) is illustrated in figure 6 together with the annual growth in the total private consumption deflator (PCP) in the period since 1903. During most of the period the PIT have been higher than the 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, cf. also figure 2. Most of the volatility in PIT on this period is caused

by increased excise duties.[16] In the post-World War II period several of the large swing in PIT are related to the introductions and increases of more general sales taxes and VAT.[17]

Figure 6: Annual growth in the deflator for indirect taxes (excluding custom duties), net of subsidies (PIT) and the total private consumption deflator (PCP), per cent, 1903-2002



Source: See appendix D.

Figure 7 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 PH have been somewhat larger the PCP.

Finally, the compiled input-output based measure of the domestic underlying rate of inflation (UNDPCP) is shown in figure 8 together with the annual growth in the total private consumption deflator (PCP).[18] In the pre-1960 period the development in the PCP and the UNDPCP seems to be quite similar. This reflects a rather high weight to "other items" in the total private consumption (55-70 per cent) during this period, cf. figure 4. In the post-1960

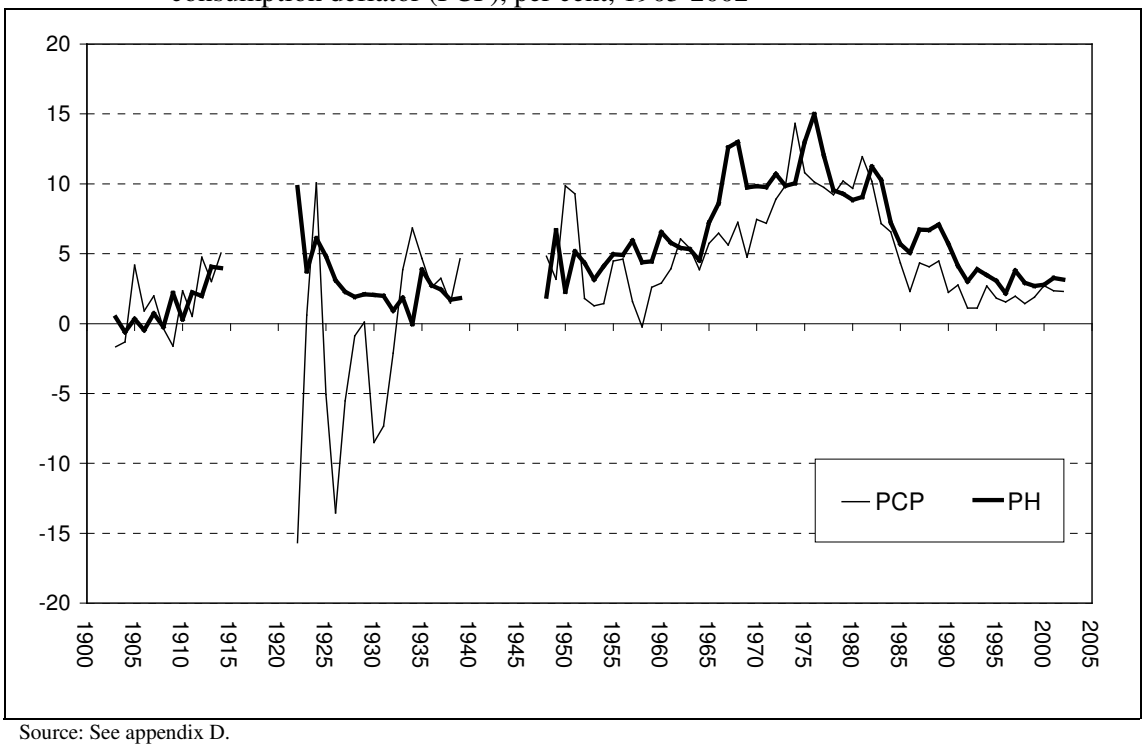
[16] Figure 6 indicates only a few selected examples of changes within the areas of excise duties. A major work in several volumes on the history of the Danish taxation system prepared by Told- og Skattehistorisk Selskab is currently under publication.

[17] 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. A general 10 per cent VAT replaced it 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.

[18] Appendix B contains a post-1975 comparison of the domestic underlying rate of inflation compiled in this paper and the Nationalbank's measure for the domestic market-determined inflation.

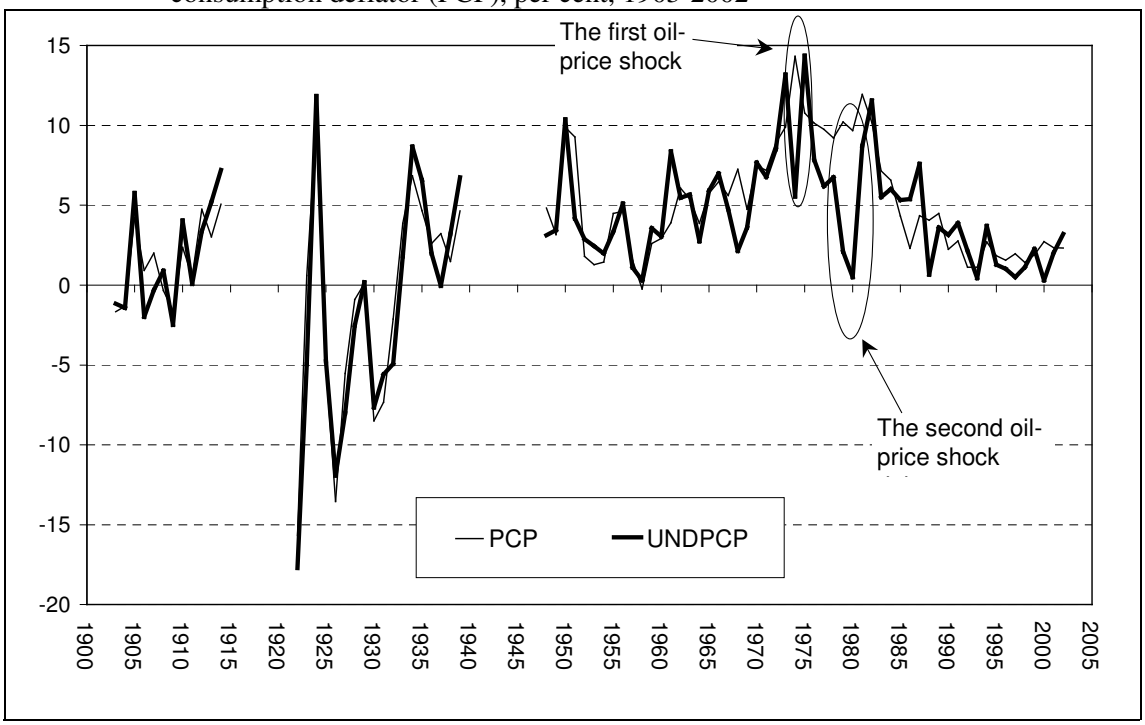
period the differences between PCP and UNDPCP has in general been somewhat larger and the two oil-price shocks in the 1970s and early 1980s are clearly visible.

Figure 7: Annual growth in the deflator for gross rents (PH) and the total private consumption deflator (PCP), per cent, 1903-2002



Source: See appendix D.

Figure 8: Annual growth in underlying domestic inflation (UNDPCP) and the total private consumption deflator (PCP), per cent, 1903-2002



Source: See appendix D.

Table 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.[19] 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 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 inflation has on average been lower than the private consumption inflation, but in general more volatile.

Table 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: Inter-war 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

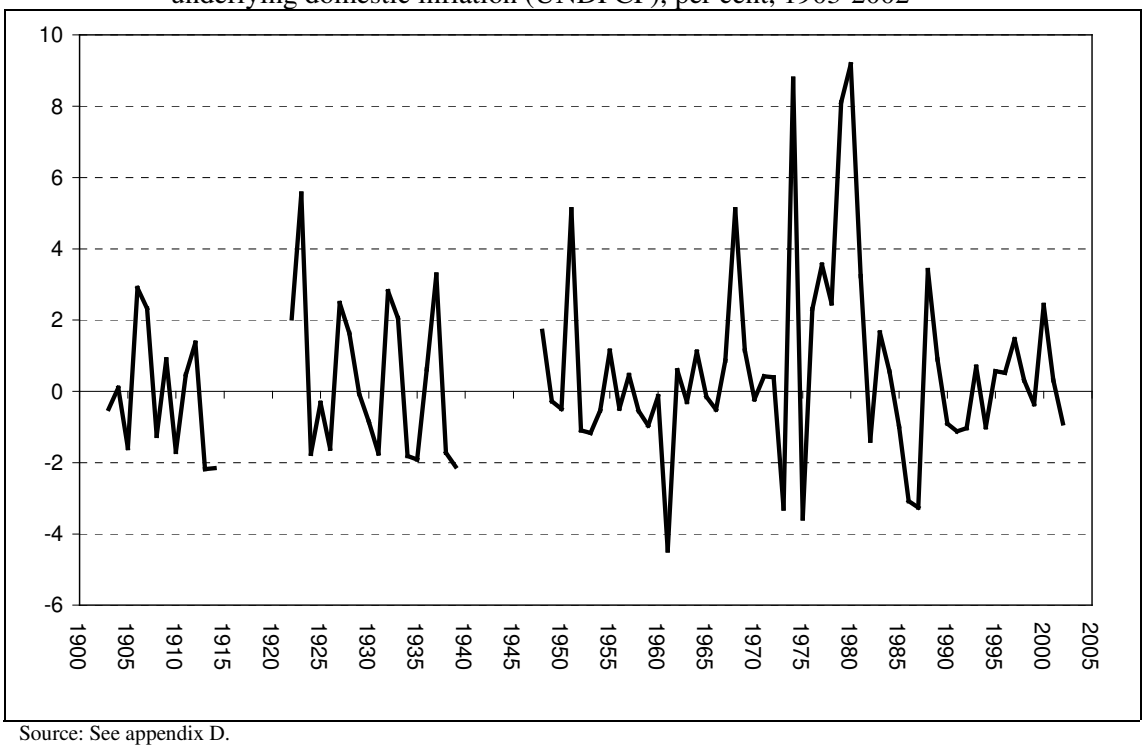
Source: See appendix D.

Figure 9 shows the difference in the growth of private consumption deflator (PCP) and the underlying domestic inflation (UNDPCP) in the whole period 1903-2002. The figure seems to suggest that the 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

[19] For a fact-oriented chronology of the Danish exchange-rate policy since 1875, see Abildgren (2004a). Abildgren (2005a) covers the development in nominal and real effective exchange rates in Denmark since 1875 while Abildgren (2005b) presents and discuss the development in nominal and real interest rates and financial-market inflation expectations in Denmark during the same period.

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.[20]

Figure 9: Difference in the annual growth of private consumption deflator (PCP) and the underlying domestic inflation (UNDPCP), per cent, 1903-2002

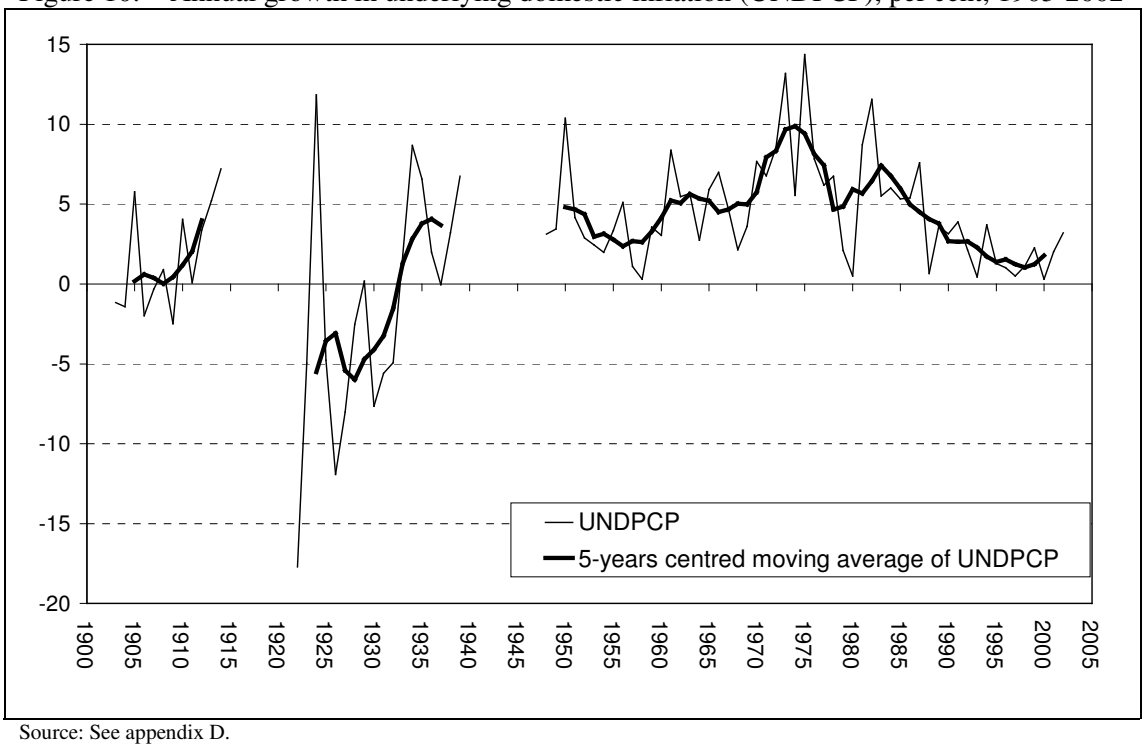


Source: See appendix D.

A 5-years centred moving average of the domestic underlying rate of inflation (UNDPCP) is shown in figure 10. It illustrates that the underlying 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 inflation were found during in the pre-World War II period where deflation frequently occurred.

[20] In the late 1970s Germany became Denmark's largest single export market.

Figure 10: Annual growth in underlying domestic inflation (UNDPCP), per cent, 1903-2002



Source: See appendix D.

6. The interpretation and use of input-output based underlying 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, cf. e.g. Rich & Steindel (2005). Also input-output based measures of underlying inflation do not exempt a forecaster from the work related to a broader assessment of the future inflation prospects. 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 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, cf. Lauritzen (1987). Another example could be "second round effects" related to a rise in the level of indirect taxation. Since the input-output measure of underlying inflation is stripped for the content of indirect taxes, the input-output measure will tend to show a rate of underlying inflation below the "headline" figure immediately after the tax increase. A tax increase may indeed lead to lower future underlying 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, cf. Christensen (1994). A low (high) level of input-output based current underlying inflation does therefore not necessarily imply a low (high) future level of inflation.

A difference between the current rate of headline inflation and the current rate of input-output based underlying inflation may cause the headline inflation to move closer towards the underlying inflation in the following period. However, as indicated above, a gap between the headline inflation and the underlying inflation could also 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 inflation does not necessarily make the input-output based underlying 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, cf. e.g. Mankikar & Paisley (2004). This result highlights the importance of having an open mind for using a multiplicity of underlying inflation measures in both economic-historical analysis as well as in central bankers monitoring of the current inflationary outlook.

7. Some concluding remarks

An input-output based underlying inflation measure may provide insights into the inflation process that can not be easily uncovered from other economic indicators. An input-output based measure of the underlying inflation can therefore be a useful supplement to other types of information (e.g. the development in wages, output gap etc.) in relation to both an 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.

In the paper at hand the input-output based underlying 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 environment 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. Monthly input-output based price calculations has been carried out 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, cf. Hansen & Knudsen (2005). However, input-output based measures of underlying inflation may be less obvious as the choice of quantitative target for monetary policy within an inflating-targeting regime since the relatively complicated calculation procedure makes such inflation measures less transparent and therefore more difficult to communicate to the general public than the headline CPI.

8. References

Abildgren, K. (1992a), *Compilation of an input-output table for Denmark 1934*, Nationalregnskabsnotat, Arbejdsnotat No. 36, Copenhagen: Statistics Denmark (in Danish).

Abildgren, K. (1992b), *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.

Abildgren, K. (2004a), A chronology of Denmark's exchange-rate policy 1875-2003, *Danmarks Nationalbank Working Paper*, No. 12, April.

Abildgren, K. (2004b), Nominal and real effective krone rate indices for Denmark 1875-2002, *Danmarks Nationalbank Working Paper*, No. 13, April.

Abildgren, K. (2004c), An empirical examination of the purchasing-power-parity hypothesis for Denmark 1875-2002, *Danmarks Nationalbank Working Paper*, No. 14, April.

Abildgren, K. (2005a), Real Effective Exchange Rates and Purchasing-Power-parity Convergence: Empirical Evidence for Denmark, 1875-2002, *Scandinavian Economic History Review*, Vol. 53, No. 3, 2005, pp. 58-70.

Abildgren, K. (2005b), Interest-Rate Development in Denmark 1875-2003 – A Survey, *Danish Journal of Economics*, Vol. 143, No. 2, pp. 153-167.

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

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

Andersen, E, Matthiessen, P. C. & Ølgaard, A. (1989), Boligmasse of boligbyggeri i første halvdel af dette århundrede, *Økonomi & Politik*, Vol. 62(2), pp. 6-19.

Betænkning om dyrtidsregulering. Afgivet af det af arbejdsministeren den 7. august 1973 nedsatte udvalg, København 1974.

BIS (1999), *Measures of Underlying Inflation and Their Role in the Conduct of Monetary Policy*, Proceedings of the workshop of central bank model builders held at BIS on 18-19 February 1999.

Blair, P. D. & Miller, R. E. (1985), *Input-Output Analysis: Foundations and Extensions*, New Jersey: Prentice-Hall.

Blaug, M. (1985), *Economic Theory in Retrospect*, Fourth Edition, Cambridge: Cambridge University Press.

Boserup, E. (1947), Dansk importregulering gennem 15 aar, *Nationaløkonomisk Tidsskrift*, Vol. 85, pp. 37-67.
Christensen, A. M. (1994), Price Increases and Inflation, *Danmarks Nationalbank Monetary Review*, February, pp. 9-13.
Danmarks Nationalbank (2004), *Domestic market-determined inflation, IMI*, box 5 in Danmarks Nationalbank Monetary Review, 2nd Quarter, p. 18.
Danmarks Statistik (1985), *Indeksberegninger i Danmarks Statistik*, Copenhagen: Danmarks Statistik.
Finansministeriet, Budgetdepartementet (1979), Input-output kvoter 1973, *Småtryk*, No. 5, Copenhagen: Finansministeriet, Budgetdepartementet.
Hansen, S. Aa. (1983), *Økonomisk vækst i Danmark. Bind II: 1914-1983*, Third Edition, Copenhagen: Akademisk Forlag.
Hansen, B. W. & Knudsen, D. (2005), *Domestic Market-Determined Inflation*, Danmarks Nationalbank Monetary Review, 4th Quarter, pp. 27-39.
Holdt, J. & Thage, B. (1976), En input-output prismodel for Danmark, Danmarks Statistik, *Arbejdsnotat*, No. 7.
Johansen, H. C. (1985), *Danish historical statistics 1814-1980*, Copenhagen: Gyldendal.
Johansen, H. C. (1987). *The Danish Economy In the Twentieth Century*, London: Croom Helm.
Jørgensen, H. C. (1946), *Hvor stor en del af indtægten unddrager skattesnyderne det offentlige?,* Copenhagen: P. Hansens Bogtrykkeri.
Knudsen, D. & Nielsen, H. (2002), Robust estimation of the expected inflation, *Danmarks Nationalbank Working Paper*, No. 1, March.
Kærgård, N. (1991), *Økonomisk vækst. En økonometrisk analyse af Danmark 1870-1981*, Copenhagen: Jurist- og Økonomforbundets Forlag.
Lauritzen, F. (1987), Fortsat lav inflation, *Samfundsøkonomen*, No. 5, pp. 10-16.
Loentief, W. (1936), Quantitative Input and Output Relations in the Economic System of United States, *Review of Economics and Statistics*, Vol. 18, 105-125.
Leontief, W. (1986), *Input-Output Economics*, Second Edition, Oxford: Oxford University Press.
Mankikar, A. & Paisley, J. (2004), *Core inflation: a critical guide*, Bank of England Working Paper, No. 242.
Mitchell, B. R. (2003), *International Historical Statistics*, London: Palgrave Macmillan.
Rich, R. & Steindel, C. (2005), A Review of Core Inflation and an Evaluation of Its Measures, *Federal Reserve Bank of New York Staff Reports*, No. 236, December.
Rasmussen, P. N. (1956), *Studies in Inter-sectoral Relations*, Amsterdam: North-Holland.
Roberts, I. (2005), Underlying Inflation: Concepts, Measurement and Performance, *Reserve Bank of Australia Research Discussion Paper*, No. 2005-05.
Statistics Denmark, *StatBank Denmark*, Statistics Denmark's website (www.dst.dk).
Statistics Denmark, *Statistical ten-year review*, various issues.
Statistics Denmark (1995), *50-year review*, Copenhagen: Statistics Denmark.
Statistics Denmark (2001a), *National Accounts ESA95. Macroeconomic Time Series 1966-1997*, Copenhagen: Statistics Denmark.
Statistics Denmark (2001b), *50-year review*, 2nd Edition, Copenhagen: Statistics Denmark.
Statistics Denmark, Import-, employment- and energy multipliers, *Nationalregnskabsnotat*, various issues.
Statistics Denmark, *Danish Input-Output Tables and Analyses*, various issues.
United Nations (1968), *A System of National Accounts*, Studies in Methods, Series F No. 2 Rev. 3, New York: United Nations.
United Nations (1973), *Input-Output Tables and Analysis*, Studies in Methods, Series F No. 14, Rev. 1, New York: United Nations.

Appendix A: Input-output tables and input-output price models – A quick refresher

The basic idea behind input-output tables can be traced back to Quesnay's famous Tableau Economique from 1758.[21] In "modern times" the pioneer work on input-output tables and models has mainly been associated with Leontief who in 1936 published his first input-output table for the U. S. economy in the year 1919.[22]

An input-output table gives a statistical description of the flows of goods and services in the economy for a given year. Figure A.1 shows a simplified input-output table in algebraic form.[23] 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 an 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 paper.

Figure 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 A.1 as follows, cf. also figure A.2:

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

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

[22] Cf. table 6 in Loentief (1936). A general introduction to input-output tables and models is found in e.g. Rasmussen (1956), United Nations (1973), Blair & Miller (1985) and Leontief (1986).

[23] All data in the input-output table are expressed in current prices (million 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". Figure A.1 is a modified version of table 3.13 in United Nations (1968).

In this appendix 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 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 $\mathbf{A}\mathbf{A}^{-1} = \mathbf{A}^{-1}\mathbf{A} = \mathbf{I}$ where **I** is the identity matrix. The letters or numbers shown in brackets in figure A.1 and A.2 denotes the dimensions of the matrices and vectors.

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

$$\mathbf{he'} = \mathbf{hf'}\langle \mathbf{f} \rangle^{-1}$$

$$\mathbf{sb'} = \mathbf{su'}\langle \mathbf{g} \rangle^{-1} \qquad \mathbf{se'} = \mathbf{sf'}\langle \mathbf{f} \rangle^{-1}$$

$$\mathbf{yb'} = \mathbf{yu'}\langle \mathbf{g} \rangle^{-1}$$

Figure A.2: Input-output coefficients

	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:

$$\mathbf{pf'} = [\mathrm{pm}\mathbf{mb'}(\mathbf{I}-\mathbf{DZB})^{-1} + \mathrm{ps}\mathbf{sb'}(\mathbf{I}-\mathbf{DZB})^{-1} + \mathrm{py}\mathbf{yb'}(\mathbf{I}-\mathbf{DZB})^{-1}]\mathbf{DZE} + \mathrm{pm}\mathbf{me'} + \mathrm{ph}\mathbf{he'} + \mathrm{ps}\mathbf{se'}$$

or:

$$\begin{aligned}[A.1]\quad \mathbf{pf'} &= \mathrm{pm}[\mathbf{mb'}(\mathbf{I}-\mathbf{DZB})^{-1}\mathbf{DZE} + \mathbf{me'}] \\ &+ \mathrm{ps}[\mathbf{sb'}(\mathbf{I}-\mathbf{DZB})^{-1}\mathbf{DZE} + \mathbf{se'}] \\ &+ \mathrm{ph}\mathbf{he'} \\ &+ \mathrm{py}\mathbf{yb'}(\mathbf{I}-\mathbf{DZB})^{-1}\mathbf{DZE}\end{aligned}$$

Using this notation in equation [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 value added. 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.

Appendix B: A post-1975 comparison with Danmarks Nationalbank's measure for the domestic market-determined inflation (IMI)

As mentioned in the introduction the Nationalbank regularly publishes an index on the development in the domestic market-determined inflation.

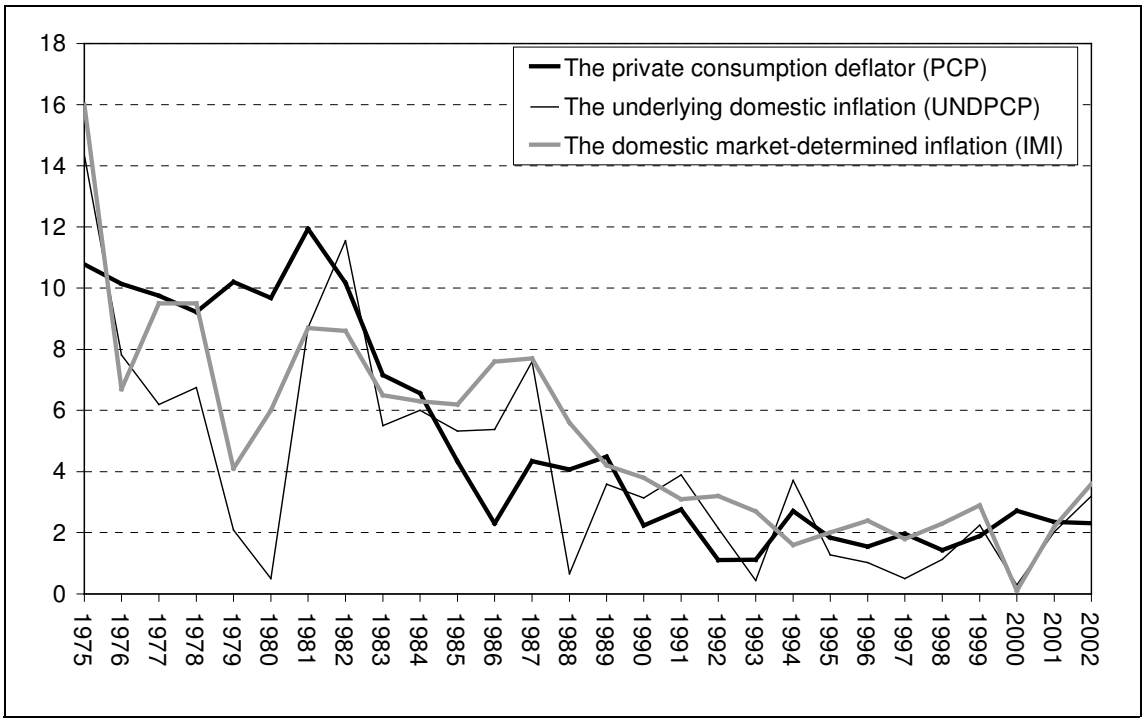
Methodologically the main differences between the domestic underlying rate of inflation (UNDPCP) calculated in the paper at hand and the Nationalbank's measure for the domestic market-determined inflation (IMI) are as follows:

- The IMI-index is based on a decomposition of the net price index[24] 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 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 1975s to 2-3 per cent in the late 1990s and early 2000s. Furthermore, both indices of underlying inflation shows a significant different development that the headline inflation around the large movements of oil prices in 1979, 1986 and 2000.

[24] An index on consumer prices excluding indirect taxes and subsidies.

Figure B.1: Annual growth in two different indices of underlying inflation, per cent, 1975-2002



Source: See appendix D.

Appendix C: Data

Table C.1: Input-output based decomposition of private consumption at current prices 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 C.1 (continued): Input-output based decomposition of private consumption at current prices 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
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

Table C.2: Input-output based decomposition of the annual growth in the total private consumption deflator, per cent, 1903-2002

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): Input-output based decomposition of the annual growth in the total private consumption deflator, per cent, 1903-2002

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

Appendix D: Data sources and calculation methods

Direct and indirect import content (including custom duties) in private consumption at current prices, per cent

Sources:

Various issues of: Statistics Denmark, Import-, employment- and energy multipliers, *Nationalregnskabsnotat*; Statistics Denmark, *Danish Input-Output Tables and Analyses*. Other sources: Abildgren (1992a, 1992b); Kærgård (1991); Johansen (1985); Mitchell (2003); and Statistics Denmark (2001a).

Comments:

(1) Imports of goods and services. (2) The figure for 1934 is calculated on the basis of the input-output table with 23 industries in Abildgren (1992a, 1992b) using the static open static Leontief-model. In the calculations it has been assumed that purchases in Denmark by non-resident households are delivered by the sector "Restaurants and hotels". (3) Since 1966: Input-output multipliers from Statistics Denmark based on the current and earlier version of the official national-accounts statistics. (4) For the years 1903-1914, 1922-1933, 1935-1939 and 1948-1965 calculated on the basis of the input-output tables with 2 industries (a "rural" sector and an "urban" sector) listed in Kærgård (1991) using the static open static Leontief-model. Figures for custom duties are taken from Johansen (1985) and Mitchell (2003) and have been converted from fiscal-year basis to calendar-year basis. (6) In the pre-World War II period imports of services are only partly covered in the data series. 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. (7) Adjusted for break in series in 1934 and 1966.

Direct and indirect content of indirect taxes (excluding custom duties), net of subsidies, in private consumption at current prices, per cent

Sources:

Various issues of: Statistics Denmark, *Import-, employment- and energy multipliers*, Nationalregnskabsnotat; Statistics Denmark, *Danish Input-Output Tables and Analyses*; and Statistics Denmark, *Statistical ten-year review*. Other sources: Finansministeriet, Budgetdepartementet (1979); Hansen (1983); Johansen (1985); Mitchell (2003); Statistics Denmark (2001a); and Statistics Denmark, *StatBank Denmark*, Statistics Denmark's website.

Comments:

(1) For the years 1966, 1973, 1975, 1977, 1979-1992 and 1995-2000: Input-output multipliers from Statistics Denmark based on the current and earlier version of the official national

accounts statistics. (2) For other years: Interpolated from the development in indirect taxes net of subsidies (excluding custom duties) in per cent of private consumption.

Content of gross rents in the private consumption at current prices, per cent

Sources:

Other sources: Hansen (1983); and Statistics Denmark, *StatBank Denmark*, Statistics Denmark's website.

Total private consumption deflator, year-on-year growth

Sources:

Other sources: Kærgård (1991); Statistics Denmark (2001b); and Statistics Denmark, *StatBank Denmark*, Statistics Denmark's website.

Comments:

(1) 1903-1948: Based on national-account figures in constant 1929-prices. (2) 1949-1966: Based on national-account figures in constant 1995-prices. (3) 1967-1990: Based on national-account figures in constant chain-weighted 1995-prices. (4) Since 1991: Based on national-account figures in constant chain-weighted 2000-prices.

Deflator for gross rent, year-on-year growth

Sources:

Other sources: Hansen (1983); and Statistics Denmark, *StatBank Denmark*, Statistics Denmark's website.

Comments:

(1) 1903-1965: Deflator for dwellings. (2) 1903-1966: Based on national-account figures in constant 1929-prices. (3) 1967-1990: Based on national-account figures in constant chain-weighted 1995-prices. (4) Since 1991: Based on national-account figures in constant chain-weighted 2000-prices.

Deflator for imports (including custom duties), year-on-year growth

Sources:

Various issues of: Statistics Denmark, *Statistical ten-year review*. Other sources: Abildgren, K. (2004b, 2004c); Johansen (1985); Mitchell (2003); and Statistics Denmark, *StatBank Denmark*, Statistics Denmark's website.

Comments:

(1) 1903-1966: Based on an index for import unit values for imports of goods. Covers the main part of Denmark's total foreign trade in goods after 1934. Before 1934 the import unit value index covers around 50 per cent of the total imports of goods. (3) 1967-1990: Based on national-account figures for imports of goods and services in constant chain-weighted 1995-prices. (4) Since 1991: Based on national-account figures for imports of goods and services in constant chain-weighted 2000-prices.

Deflator for indirect taxes net of subsidies (excluding custom duties), year-on-year growth

Sources:

Various issues of: Statistics Denmark, *Statistical ten-year review*. Other sources: Hansen (1983); Kærgård (1991); Johansen (1985); Mitchell (2003); and Statistics Denmark, *StatBank Denmark*, Statistics Denmark's website.

Comments:

(1) 1903-1966: Based on national-account figures in constant 1929-prices. (2) 1967-1990: Based on national-account figures in constant chain-weighted 1995-prices. (3) Since 1991: Based on national-account figures in constant chain-weighted 2000-prices.

Nationalbank's measure for the domestic market-determined inflation (IMI)

Sources:

Various issues of: Danmarks Nationalbank, *Monetary Review*. Other sources: Danmarks Nationalbank (2004) and Lauritzen (1987).