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175 YEARS OF FINANCIAL RISKS AND RETURNS IN CENTRAL BANKING

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RESUME

Afkast og risiko ved centralbankvirksomhed gennem 175 år
Centralbankerne rundt omkring i verden har betydelige indenlandske og udenlandske finansielle aktiver og passiver på deres balance, hvilket afspejler deres rolle som pengepolitiske myndigheder. Dette papir belyser de langsigtede tendenser i risiko og afkast ved centralbank-virksomhed med Danmarks Nationalbank som eksempel. Papiret præsenterer nye årlige tidsrækkedata for Nationalbankens balance og finansielle resultat 1839-2014 og analyserer udviklingen i basisindtjeningen og indtjeningen fra yderligere risikotagning inden for en simpel aktiv/passiv ramme. Gennem de seneste godt 175 år har basisindtjeningen forbundet med de funktioner og risici, som uundgåeligt følger af at være centralbank, gennemsnitligt set tegnet sig for hovedparten af Nationalbankens finansielle resultat. Siden begyndelsen af 1980'erne har der dog været en nedadgående tendens i basisindtjeningen i takt med det generelle fald i renteniveauet. I denne periode har indtjeningen fra yderligere risiko taget som en finansiel virksomhed ud fra en afvejning af forventet afkast versus risiko bidraget væsentligt til det finansielle resultat. Papiret bidrager til litteraturen med et langsigtet historisk perspektiv, som gør det muligt at belyse det potentielle samspil mellem de makroøkonomiske vilkår, den pengepolitiske strategi og finansielle risici og afkast ved centralbankvirksomhed.

ABSTRACT

175 years of financial risks and returns in central banking
Central banks around the world have substantial domestic and foreign financial assets and liabilities on their balance sheets reflecting their role as monetary authorities. This paper explores the long-term trends in risk and return in central banking using the central bank of Denmark, Danmarks Nationalbank, as a case study. The paper presents new annual time series data on Danmarks Nationalbank's balance sheets and profit from financial items 1839-2014 and analyses developments in core earnings and earnings from assuming additional risks within a simple asset/liability framework. During the past 175 years or so core earnings associated with the basic functions and the risks that unavoidable follow from being a central bank have on average accounted for the main part of the Nationalbank's financial return. There has, however, been a downward trend in core earnings since the early 1980s in step with the general decline in the interest-rate level. During this period earnings from additional risks taken as a financial institution by evaluating the expected risk-return trade-off have contributed significantly to the financial return. The paper adds to the literature by taking a long-term historical perspective that makes it possible to trace potential links between the macroeconomic environment, the monetary-policy strategy and financial risks and returns in central banking.

KEY WORDS

Central banking. Risk management. Accounting. FX reserves. Monetary history.

JEL CLASSIFICATION

E42. E51. E52. E58. F33. G11. N23. N24.

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175 Years of Financial Risks and Returns in Central Banking

by

Kim Abildgren

January 2016

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1. Introduction

Central banks around the world have substantial domestic and foreign financial assets and liabilities on their balance sheets reflecting their role as monetary authorities. As a consequence, they are exposed to a variety of financial risks that also have a huge impact on the financial returns in their income statements (i.e. profit and loss accounts).

Due to policy constraints derived from their overall objectives – which typically are centred around price stability and financial stability (Reis, 2013) – central banks differ from private investors, and the risk-management methodologies and accounting frameworks applied by the private fund management industry might not always be directly transferable to central banks (Foster, 2004; Bindseil *et al*., 2009; Bank for International Settlements, 2011; Archer, 2015). However, prudent financial risk management is usually considered to be crucial to central-bank creditability and financial independence and thereby to the central banks' ability to reach their primary objectives.

Since the eruption of the most recent financial crisis many central banks have seen a significant expansion of their balance, which might have an impact on their earnings and risk in the years ahead. In this paper we offer a long-term historical perspective on financial risks and returns in central banking using the central bank of Denmark, Danmarks Nationalbank, as a case study. We compile an annual data set that spans more than 175 years and covers Danmarks Nationalbank's balance sheets as well as its profit from financial items. Our long-span time series cover periods with different monetary regimes, other institutional differences and variations in the rate of real and monetary shocks to the economy. We are therefore able to trace potential links between the macroeconomic environment, the monetary-policy strategy and the central bank's financial risks and returns.

We find that the Nationalbank's core earnings associated with the basic functions and the risks that unavoidable follow from being a central bank have on average accounted for the main part of the Nationalbank's financial return. This reflects a conservative choice of risk level. There has, however, been a downward trend in core earnings since the early 1980s in step with the general decline in the interest-rate level. During this period earnings from assuming additional risks has contributed significantly to the financial return.

2. A brief review of related literature

The paper at hand relates most closely to two strands of the literature on central banking. The first is the part of the literature that analyses central-bank balance sheets and income statements from a financial risk-management perspective. Some contributions have focused on managing currency risks, credit risks, interest-rate risks and the liquidity of foreign-exchange (FX) reserves (Bernadell *et al*., eds., 2004), whereas others mainly have analysed

interest-rate risk on domestic portfolios (Rudebusch, 2011; Christensen *et al*., 2015; Del Negro and Sims, 2015). Several papers have also focused on the appropriate level of central-bank capital in order to ensure credibility, flexibility and independence in the implementation of monetary policy (Martínez-Resano 2004; Bindseil *et al*., 2004; Stella, 2005, 2007; Ize, 2005; Klüh and Stella, 2008; Cukierman, 2011; Goodfriend, 2011). Furthermore, the massive expansion of the central banks' balance sheets during the most recent financial crisis has created a renewed research interest in the potential impact hereof on monetary-policy implementation (Borio and Disyatat, 2010; Adler *et al*., 2012; Karakitsos *et al*., 2015; Hall and Reis, 2015; Carpenter *et al*., 2015). Furthermore, Pihlman and van der Hoorn (2010) have analysed procyclicality in central bank FX reserve management prior to and during the most recent financial crisis. However, to the best of our knowledge this strand of the literature has so far only focused on more contemporary issues and not analysed the long-term historical trends in central banks' financial risk and returns.

A second strand of related literature takes a historical perspective on the evolution of central banks. Several contributions have focused on compilation of long-span time series on central-bank balance sheet statements and purely descriptive accounts of the development, e.g. for Sveriges Riksbank (Fregert, 2014), Norges Bank (Hvidsten, 2013), Bank of England (Bank of England, 1967), Switzerland (Halbeisen and Maurer, 2007) and De Nederlandsche Bank (Pattipeilohy, 2013). However, with Halbeisen and Maurer, *op. cit*., as a noticeable exception these studies have not compiled time series on central-bank income statements that allow for the study of financial returns. Other studies have taken a more analytical approach. In a recent paper, Ferguson *et al*. (2015) studied the evolution of central banks' balance sheets and the links to inflation in twelve developed countries since 1900, whereas Jobst and Ugolini (2014) analysed the links between monetary-policy implementation and the balance-sheet composition of ten central banks in seven selected benchmark years since 1835. Furthermore, a number of papers have studied the role of gold and various national currencies as international reserves during the past century or so (Bordo and Eichengreen, 2004; Eichengreen and Flandreau, 2009, 2012 and 2014; Flandreau and Jobst, 2009; Chiţu *et al*., 2014). However, this strand of the literature has so far not focused on the historical development in central-bank balance sheets from a risk-management perspective. Furthermore, with the exception of Flandreau (2008) and Ugolini (2012) previous contributions within this line of research have only analysed central-bank balance sheets and not their income statements in a historical perspective. Flandreau, *op. cit*., analysed potential corporate governance issues related to some central banks' role as both a central bank and a private company during the 1800s whereas Ugolini, *op. cit*., analysed foreign reserve management at the National Bank of Belgium in the 1850s.

The paper at hand adds to the literature by taking a long-term historical perspective on financial risks and returns in central banking using Denmark as a case study. Our data set spans more than 175 years and covers Danmarks Nationalbank's balance sheets as well as its profit from financial items. The long time span includes periods with different monetary regimes, other institutional differences and variations in the rate of real and monetary shocks to the economy. We are therefore able to trace potential links between the macroeconomic environment, the monetary-policy strategy and the central bank's financial risks and returns.

3. Data on Danmarks Nationalbank's balance sheets and financial returns

For the analysis in this paper, we have compiled annual time series for Danmarks Nationalbank's balance sheets and profit from financial items for the period 1839-2014. Danmarks Nationalbank was founded in 1818. However, no complete consolidated balance sheets for Danmarks Nationalbank are available prior to 1839 (Johansen, 1985, p. 248). The first year covered by our time series data is therefore 1839.

Our main data source is the various issues of Danmarks Nationalbank's annual *Report and Accounts*. Furthermore, we draw on results from earlier research, which partly draw on archival sources and internal material from Danmarks Nationalbank. To the extent possible, we have made an attempt to adjust for major changes in accounting principles.

A comprehensive description of the main sources and methods used to construct the data set as well as a detailed description of the content of each item in the balance sheet and the profit from financial items is offered in the Appendix. An electronic version of the data set is available from the authors on request.

4. Risk exposures

According to its charter of 1818 the objective of the Nationalbank was to "... provide a safe and secure currency system..."[1] and to "... promote currency circulation, facilitate production and trade through the extension of credit..." [2]. In the 1936 Act the Nationalbank's objective is "... to maintain a safe and secure currency system and to facilitate and regulate the traffic in money and the extension of credit"[3]. The legal basis for Danmarks Nationalbank's activities is still the Nationalbank Act of 1936 with a few minor amendments. Fundamentally, the primary objectives of the Nationalbank have therefore remained unchanged compared to the legislative basis from 1818: Price stability, financial stability and stable payment systems.

[1] Own translation to English from the reprint of the charter in Rubow (1918).
[2] Own translation to English from the reprint of the charter in Rubow (1918).
[3] §1 in the Nationalbank Act of 7 April 1936. The English translation of this quote is from Danmarks Nationalbank (2003a, p. 114).

Right from the beginning in 1818 Danmarks Nationalbank was granted monopoly right to issue bank notes, whereas the central bank of Sweden (Sveriges Riksbank) – often referred to as the oldest central bank in the world due to the establishment of one of its predecessors in 1668 – only acquired a monopoly in this area in 1897 (Wetterberg, 2009, p. 163 and p, 463). It can be difficult to define the nature of a central bank and to determine the precise year of establishment in case a central bank has been restructured or established as a "successor institution" to an earlier institution. Danmarks Nationalbank also had a number of predecessors of which the earliest was Kurantbanken, which was founded in 1736 with the privilege to issue banknotes (Rasmussen, 1950, 1955). Seen in an international perspective, central banking emerged relatively early in Denmark, whether one traces the roots of central banking to the founding of Kurantbanken in 1736 or the Nationalbank in 1818, cf. Table 1.

Table 1: Year of establishment of selected central banks

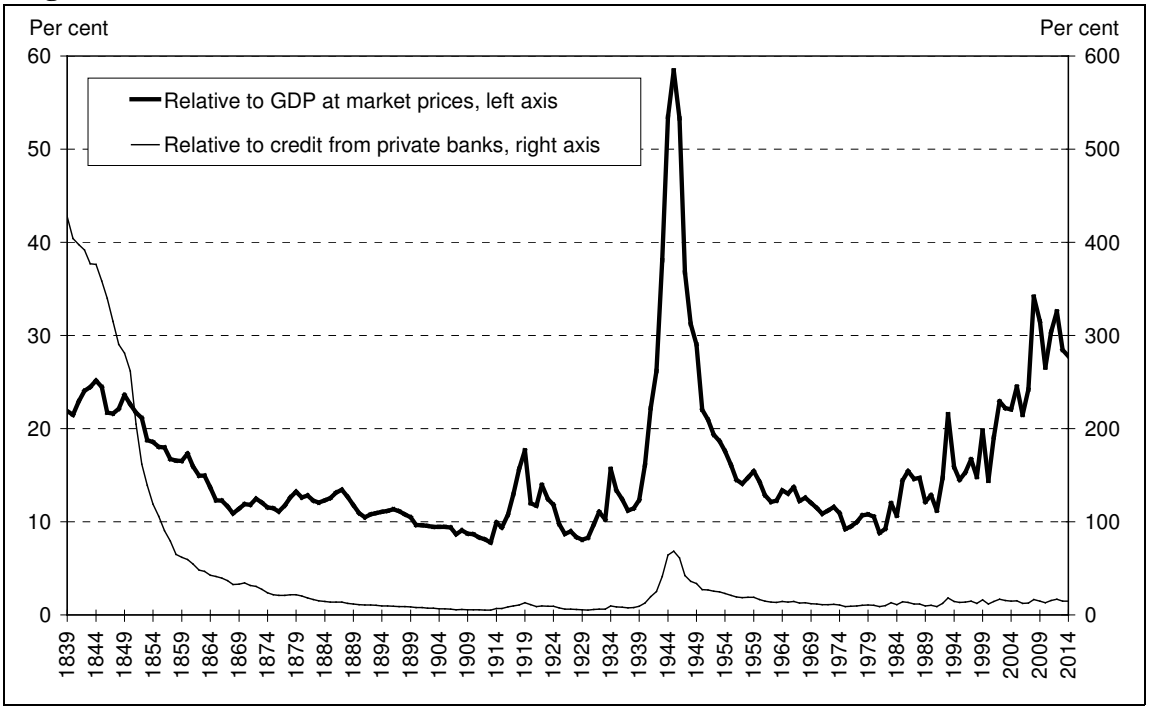
Year	Central bank	Country
1668	Sveriges Riksbank	Sweden
1694	Bank of England	United Kingdom
1791	First Bank (closed 1811)	United States
1800	Banque de France	France
1811	Soumen Pankki	Finland
1814	De Nederlandsche Bank	Netherlands
1816	Second Bank (closed 1836)	United States
1816	Norges Bank	Norway
1816	Österreichische Nationalbank	Austria
1818	**Nationalbanken i Kjøbenhavn**	**Denmark**
1846	Banca de Portugal	Portugal
1850	Banque Nationale de Belgique	Belgium
1856	Banco de España	Spain
1875	Reichbank (restructured into a new Reichbank in 1924, replaced by Bank Deutscher Länder in 1948 and by Deutsche Bundesbank in 1957)	Germany
1882	Nippon Ginco	Japan
1893	Banca d'Italia	Italy
1907	Swiss National Bank	Schwitzerland
1913	Federal Reserve System	United States
1928	Bank of Greece	Greece
1935	Bank of Canada	Canada
1943	Central Bank of Ireland	Ireland
1960	Reservebank of Australia	Australia
1998	Banque Centrale du Luxembourg	Luxembourg
1998	European Central Bank	Euro ares

Source: Grossman (2001), Mooij (2005) and the web-sites of various central banks.

Also right from the beginning in 1818, Danmarks Nationalbank was to be independent of the government in its implementation of monetary policy. The background was Denmark's very considerable military expenditures during the Napoleonic Wars which to a large extent was financed by a massive issuing of banknotes (Abildgren, 2010). As a result, the value of the banknotes was almost completely eroded and the establishment of Danmarks Nationalbank was part of a plan to rebuild the monetary system. On the background of the high inflation in Denmark during the Napoleonic Wars, central-bank independence may have been particularly important in relation to the establishment of Danmarks Nationalbank in

order to gain the population's confidence in the bank's ability to maintain the purchasing power of the currency (Danmarks Nationalbank, 2003a, p. 136). The current consensus in the theoretical and empirical academic literature is that central bank independence plays a crucial role for maintaining price stability (Cukierman, 2008). The Maastricht Treaty of 1992 also states that the central banks of the European Union member states must be independent, even if the member state in question is outside the euro area as is the case of Denmark. In 1998 the Council of the European Monetary Institute performed an assessment of the issue of independence and assessed that the Act on Danmarks Nationalbank from 1936 fulfilled the criteria for independence (Abildgren *et al*., 2010, p. 19).

Figure 1: Total assets of Danmarks Nationalbank 1839-2014



Notes: Current prices. Credit from private banks covers non-bank domestic credit from resident deposit banks and mortgage banks.

Source: For total assets of Danmarks Nationalbank: See Appendix. For GDP: Statistics Denmark and the author's calculations based on Hansen (1983) and Hansen and Henriksen (1984a, 1984b). For credit: Danmarks Nationalbank and the author's calculations based on Hansen and Svendsen (1968), Hansen (1960, 1969), Hoffmeyer (1960) and Abildgren (2012).

Figure 1 shows the total assets of Danmarks Nationalbank since 1839 measured relative to the Gross Domestic Product (GDP) as well as relative to the domestic non-bank credit from resident private banks. In the last quarter of the 1800s private banks had already developed into significant credit-supplying institutions (Abildgren, 2008). In most of the period since the late 1800s the total amount of assets managed by Danmarks Nationalbank has been relatively small. Only the years around World War II and the period since the liberalisation of the financial sector and cross-border capital flows in the 1980s show a significant increase in the level of central-bank assets relative to GDP. The balance sheets of the private banking sector

have also expanded significantly during the most recent decades, so the ratio between Danmarks Nationalbank's total assets and domestic non-bank credit has been fairly stable since the 1960s. In contrast, the size of the central bank's balance sheets declined in many other countries in the decades preceding the most recent global financial crisis (Ferguson *et al*., 2015).

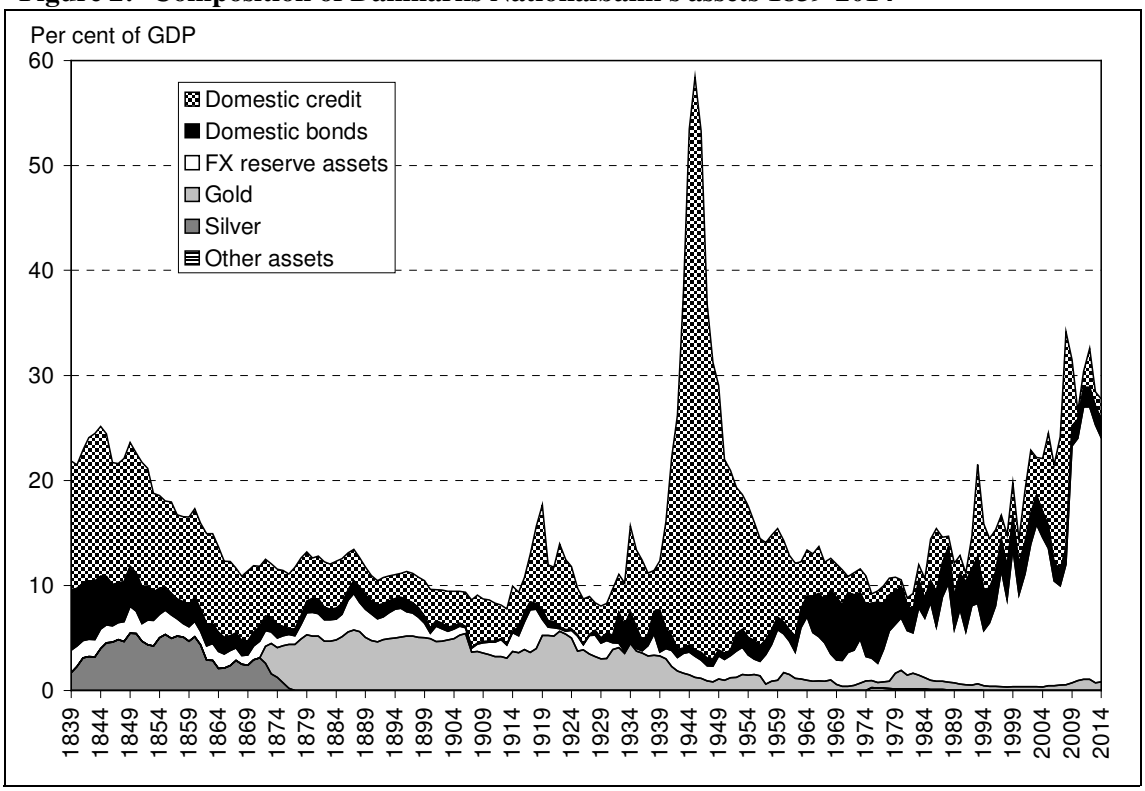
The temporary massive increase in the balance sheets around World War II was caused by the German occupation forces expenditures in Denmark 1940-1945 that were financed by drawings on Danmarks Nationalbank against a guarantee from the Danish central government (Hoffmeyer and Olsen, 1968, p. 233). Despite German requests, Danmarks Nationalbank continued to publish its balance sheets during World War II, which allowed the public to follow the development in the German expenditures. In contrast, Norges Bank ceased to publish its weekly statements in April 1940 (Espeli, 2014). The German occupation forces expenditures in Denmark were never paid by Germany and are therefore not included in the net FX exposure of Danmarks Nationalbank in our data set. They are treated as a claim on the Danish central government under the item "Domestic credit".

The significant increase in Danmarks Nationalbank's balance sheets after 2007 reflected 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 Danish kroner, euro and US dollars during the most recent global financial crisis (Abildgren and Thomsen, 2011; Schrøder and Thamsborg, 2012).

Figure 2 illustrates the composition of Danmarks Nationalbank's assets during the past 175 years or so. The massive credit expansion during World War II reflected as mentioned to a high degree the Nationalbank's claim on the central government that resulted from the German occupation forces expenditures in Denmark. During the years 1946-1952 a significant share of this claim was redeemed by the central government via proceeds from the issuing of government bonds and extraordinary taxes – including a one-off tax in 1946 on wealth accumulation during the war (Hoffmeyer and Olsen, 1968, pp. 258-259; Landt and Østergaard, 1998). Furthermore, an increased transaction level during the early post-war years also reduced the size of the claim measured relative to GDP (Thygesen, 1971, p. 15).

Denmark followed a silver standard from 1839 and until the mid-1870s. With the Coin Act of 1873 a gold standard was adopted, and Denmark participated in the pre-World War I Classical Gold Standard as well as in the restored gold-exchange standard in the interwar period. Silver and gold holdings constituted therefore a significant share of Danmarks Nationalbank's assets prior to World War II. After World War II Danmarks Nationalbank's gold exposure has been relatively modest whereas non-gold foreign-exchange (FX) reserves has increased significantly, particularly since the removal of the last restrictions on cross-border capital movements in 1988.

Figure 2: Composition of Danmarks Nationalbank's assets 1839-2014



Notes: Current prices.
Source: For Danmarks Nationalbank balance sheet data: See Appendix. For GDP: See Figure 1.

According to the Nationalbank Act of 1936 the circulation of banknotes must be covered by the Nationalbank's holding of gold and other assets. Gold shall cover at least 25 per cent of the total active banknote circulation. However, every quarter since September 1939 an exception from the gold coverage provision has been granted by the Board of Directors of Danmarks Nationalbank with the consent of the Royal Bank Commissioner (Denta, 2015, p. 187).

In the post World War II period Denmark has maintained its long-standing tradition for basing its monetary policy on an exchange-rate target.[4] The first decades after World War II Denmark participated in the dollar-based fixed-exchange-rate system established under the auspices of the International Monetary Fund, the so-called Bretton Woods system. This system broke down in the early 1970s. Subsequently the Danish krone has been linked to various European exchange-rate systems, initially the "Snake" and since 1979 the Exchange Rate Mechanisms (ERM I and II).

[4] At the first reading of the bill leading to the 1936 Act of Danmarks Nationalbank, Trade Minister Hauge remarked that "... A safe and secure currency system means that exchange rates will be kept stable in so far as this is possible for the bank and the society...". The English translation of this quote from the Deliberations of the Folketing (the Parliament) is from Danmarks Nationalbank (2003a, p. 114).

Danmarks Nationalbank's non-gold FX reserves have increased markedly in the most recent years. At the peak of the international financial crisis in the autumn of 2008 the size of the Nationalbank's foreign-exchange reserve came into focus. Rumours were circulating in the market that the FX reserves were insufficient to maintain the fixed-exchange-rate peg vis-à-vis the euro, especially since many Danish deposit banks in the years leading up to the crisis had developed a large customer funding gap and based a significant part of their lending on funding in the international money and credit markets. In the following months the Nationalbank therefore increased the size of its FX reserves in order to signal its commitment to the fixed exchange rate policy (Abildgren and Thomsen, 2011).

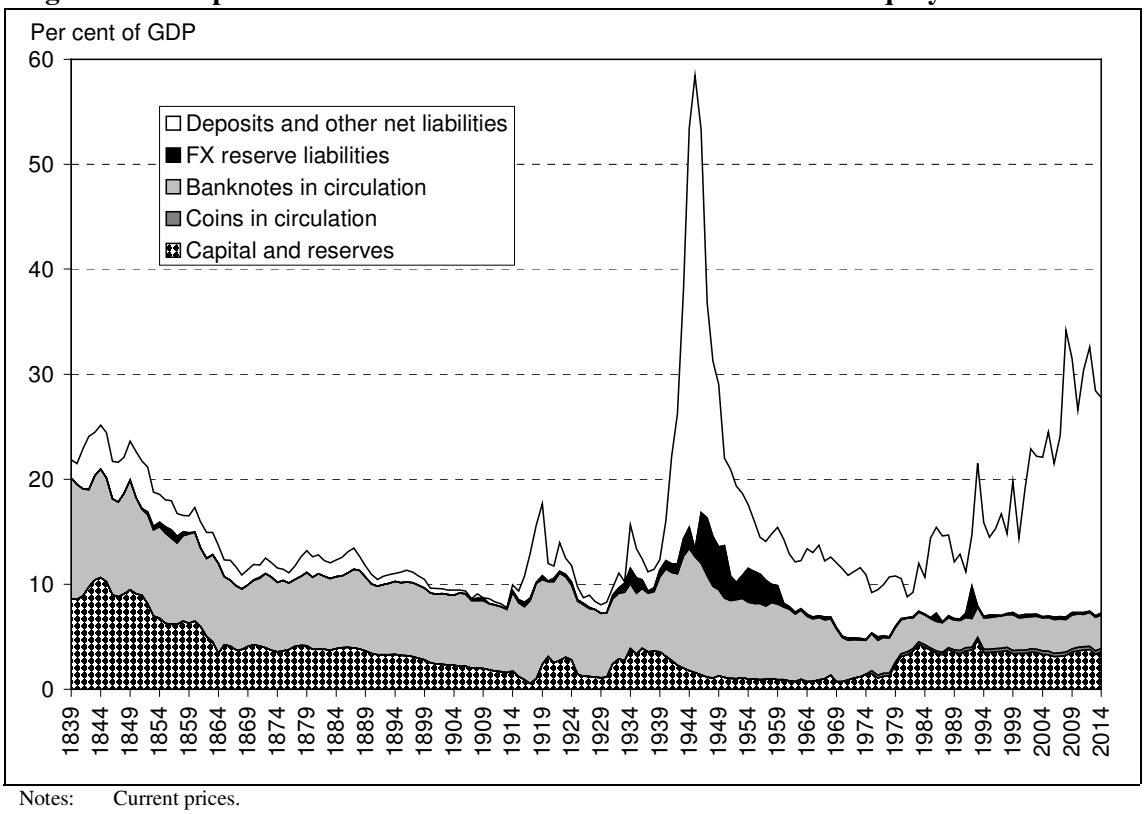
Furthermore, for a number of euro area member states faced by macroeconomic imbalances, the recent financial crisis developed into an outright sovereign debt crisis during 2010 and the years thereafter. The debt crisis led to increased demand for non-euro denominated government securities with a high credit rating such as Danish central-government bonds. This demand was further stimulated by quantitative easing and very low interest rates in the euro area. The resulting capital inflow to Denmark lead to a further increase in Danmarks Nationalbanks FX reserves and upward pressure on the Danish exchange rate vis-à-vis the euro. In July 2012 Danmarks Nationalbank introduced a negative rate of interest on its certificates of deposit to counter a sustained inflow of foreign exchange and a tendency for the krone to strengthen. This was the first time ever that one of the Nationalbank's monetary-policy interest rates became negative.

Danmarks Nationalbank's exposure to domestic bonds have usually been relatively small. The largest exposures occurred in the 1960s when the Nationalbank made use of outright transactions in domestic bonds in order to limit the rise in long-term bond yields (Mikkelsen, 1993, pp. 90-91). The liberalisation of capital flows in the course of the 1970s and first half of 1980s meant that the Nationalbank no longer was able to influence the long-term bond yields via purchase and sale of krone-denominated bonds in the market as had been the case in the 1960s. The summer of 1986 was the last time the Nationalbank sought to intervene outright in the bond market with a view to managing bond prices. The impact was short-lived, and from then on the Nationalbank's bond portfolio was purely seen as a portfolio of investment securities (Abildgren *et al*., 2010, p. 83).

The composition of Danmarks Nationalbank's liabilities and equity is shown in Figure 3. Again the episodes with ample liquidity during World War II and the period since the liberalisation of the financial sector in the 1980s are clearly visible. The latter reflects to a high degree the increase in Danmarks Nationalbank's foreign-exchange reserves. When Danmarks Nationalbank purchases foreign exchange from private banks, the payment in Danish kroner for the purchase is credited to the private banks' accounts at Danmarks Nationalbank. Since the autumn of 1993 there has also been an agreement between the central

government and the Nationalbank government according to which the Kingdom of Denmark, if needed, raises loans in foreign currency in order to maintain an adequate foreign-exchange reserve at Danmarks Nationalbank (Abildgren *et al*., 2010, pp. 47-49). When the central government in such cases raises foreign loans, Danmarks Nationalbank buy the foreign-exchange proceeds from the central government. The equivalent value in Danish kroner is then credited to the central government's account at Danmarks Nationalbank.

Figure 3: Composition of Danmarks Nationalbank's liabilities and equity 1839-2014



Notes: Current prices.
Source: For Danmarks Nationalbank balance sheet data: See Appendix. For GDP: See Figure 1.

One might also note that the circulation of banknotes relative to GDP in general has declined over time in step with the development of close substitutes to cash offered by the private banking system. There was, however, a temporary increase in banknotes relative to GDP during World War II. During the war, Danmarks Nationalbank had secretly printed a new series of bank notes (Sørensen, 2013b). Immediately after the war a changeover to the new series of bank notes was arranged which at the same time allowed for the registration of large amounts of cash. This made it possible to expose some of the large amounts of profits from collaborators and black marketeers and prevented also the occupational forces from leaving the country with large amount of cash.

Another observation from Figure 3 is that Danmarks Nationalbank's capital and reserves relative to GDP gradually declined significantly during the silver standard period in the 1800s

and the pre-World War I Classical Gold Standard period. This high level of capital and reserves in the first half of the 1800s might reflect the need to gain credibility for a relatively new central bank with an objective to increase the value of the currency. Parity of the Nationalbank's banknotes vis-à-vis silver coins was achieved in 1838, and with the price stability during the silver and gold standard period the need for a high level of solvency of the central bank gradually diminished.

The fluctuations in Danmarks Nationalbank's capital and reserves relative to GDP in the interwar period partly reflect value adjustments of the Nationalbank's gold holdnings. The increase in capital and reserves in the early 1980s also to a large extent reflected value adjustments, mainly of FX reserves and holdings of domestic bonds. During the most recent decades, Danmarks Nationalbank's capital and reserves has increased at a rate more or less equivalent to the rate for Denmark's nominal GDP, which also has been the guiding principle for the Nationalbank (Danmarks Nationalbank, 2003b, p. 21; 2015, p. 33). According to the Nationalbank Act of 1936, the Nationalbank's profits after retained earning are transferred to the central government.

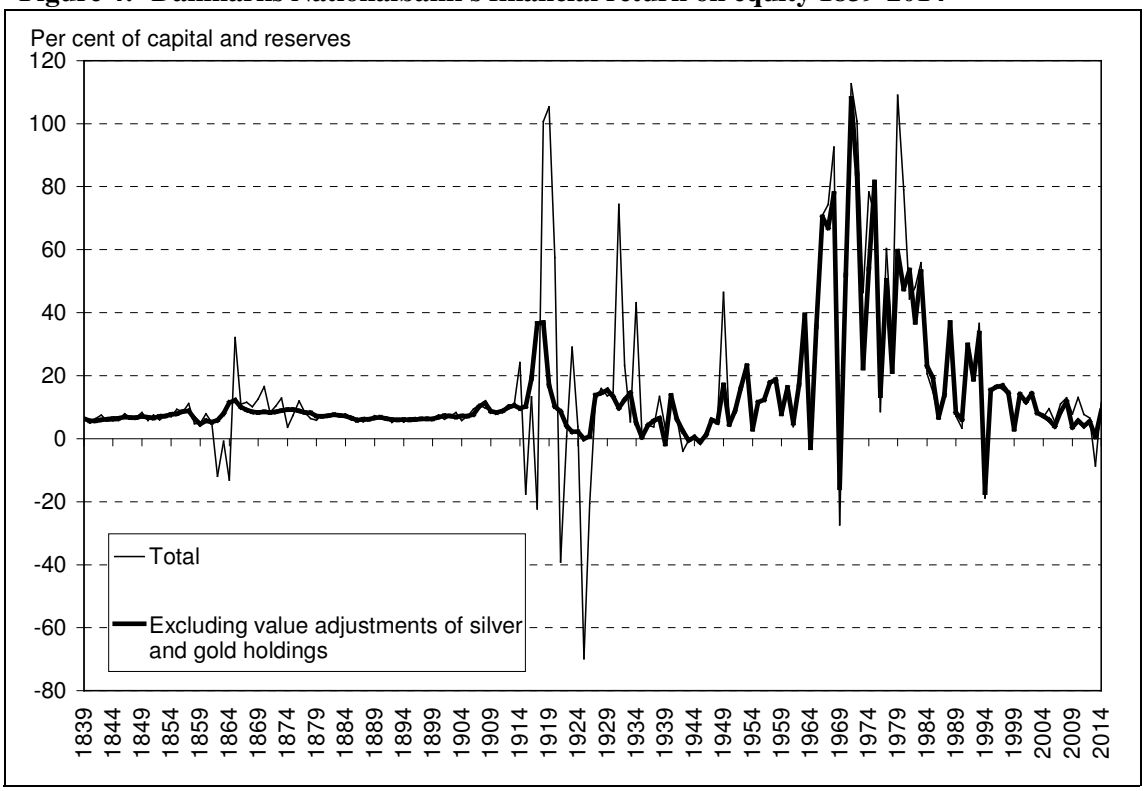
5. Financial return and risk management

Figure 4 shows Danmarks Nationalbank's financial return on equity defined as profit from financial items in per cent of capital and reserves. Profit from financial items comprises net income from interest, commission and brokerage fees *etc*., dividend from shares, market-value adjustment of silver, gold and securities, exchange-rate adjustment of net FX reserves and loan impairment charges. On average the financial return on equity has been 15.5 per cent per annum over the period 1839-2014 (or 13.7 per cent per annum excluding value adjustments of silver and gold holdings). The long-term nominal yield on Danish central government bonds has been 5.8 per cent per annum on average over the same period.

The volatility in the financial return on equity has in some periods been quite high. A large part of the fluctuations in the pre-World War II relates to the market valuation of the Nationalbank's silver and gold holdings applied in the data behind Figure 4. There was e.g. large fluctuations in the Danish krone-value of the Nationalbank's gold exposure following the suspension of the Classical Gold Standard at the outbreak of World War I and in the decade immediately after the end of World War I, where the international monetary system was characterised by first floating exchange rates, then a return to Gold and later the breakdown of the Interwar Gold Exchange Standard in the early 1930s. Later the volatility in the market value of gold measured in Danish kroner reflected the devaluation of the US dollars vis-à-vis gold in 1934 and the devaluation of Danish kroner vis-à-vis the U.S. dollar in 1949 during the Bretton Woods period. A large part of the volatility in the Nationalbank's

financial return on equity from the first half of the 1960s to the first haft of the 1990s can be attributed to fluctuations in bond prices and exchange rates.

Figure 4: Danmarks Nationalbank's financial return on equity 1839-2014



Note: Current prices. Financial return on equity defined as profit from financial items in per cent of capital and reserves. Averages of capital and reserves beginning and end of year.
Source: See Appendix.

It should be noted that the volatility in the financial return on equity related to silver- and gold-price fluctuations in the pre-World War II period was not reflected in the official annual accounts published by Danmarks Nationalbank. Full market valuation of gold has only been applied in the published annual accounts since 1983, cf. the Appendix for details. It might be argued that the Nationalbank's silver and gold exposure during the silver and gold standard period was lower than implied by Figure 4 due to the silver and gold convertibility of the banknotes issued by the Nationalbank. However, the Nationalbank's obligation to convert its banknotes into gold was suspended in August 1914, resumed in January 1927 and suspended again in September 1931.

Loan impairment charges were significant during the banking crisis in the 1920s, where many Danish banks ran into troubles, including all of the five main deposit banks (Hansen, 1996). It is worth to notice that the big banking crisis of the interwar period occurred in the 1920s in Denmark whereas the banking sector in many other countries – including the US – suffered more during the Great Depression in the 1930s (Abildgren, 2009). Loan losses have not played any significant role for the Nationalbank's financial return in the post-World War

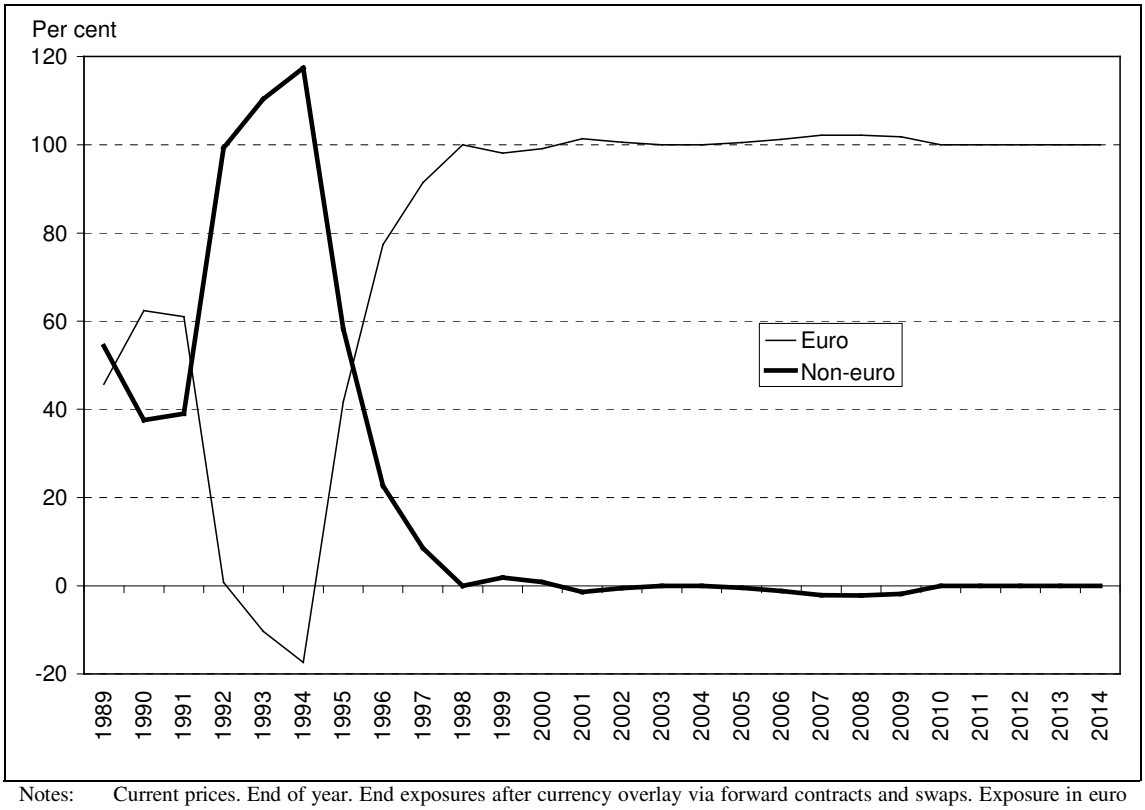
II period. Very few banks came into financial distress until the 1980s, and the Nationalbank switched towards collateralised lending in its monetary-policy operations and extension of intraday credit during the late 1980s and the 1990s (Mikkelsen, 1993; Abildgren *et al*., 2010). Furthermore, the Nationalbank's involvement in special solution schemes for a few distressed banks in the early 1990s and during the most recent financial crises took place against a guarantee from the central government.

In Figure 4 we can clearly identify three periods with relative low volatility in Danmarks Nationalbank's financial return on equity. The first was the period from the mid-1870s to World War I where Denmark and around 60 other countries adhered to the Classical Gold Standard system. This resulted in stable gold prices and foreign exchange rates measured in Danish kroner (Abildgren, 2005a). The pre-World War I era was also characterised by a high degree of stability in long-term interest rates in Denmark and many other countries (Abildgren, 2005b; Gerlach *et al*., 2006). During this period the Nationalbank's financial return on equity was therefore only affected by relative small value adjustments of financial items.

The second period spans from the early 1950s and until the early 1960s. During this period Denmark and most of its main trading partners participated in the Bretton Woods system (Reinhart and Rogoff, 2004). This period was characterised by relative stable foreign exchange rates and long-term interest rates.

The third period runs from the mid-1990s and until the end of the sample period in 2014. This period has been characterised by increased focus on financial risk management at Danmarks Nationalbank. The Nationalbank began to publish information on the interest-rate sensitivity of its FX reserves and its domestic bond portfolio in its annual *Report and Accounts* in 1997, information on value-at-risk followed in 1999 and results of stress tests came in 2001. Furthermore, Danmarks Nationalbank's reduced its exchange-rate exposures in other currencies than the euro towards which the Danish fixed-exchange-rate policy was oriented, cf. Figure 5. This resulted in a significant reduction in the effect from exchange-rate adjustments on the Nationalbank's financial return on equity, cf. Figure. 6.

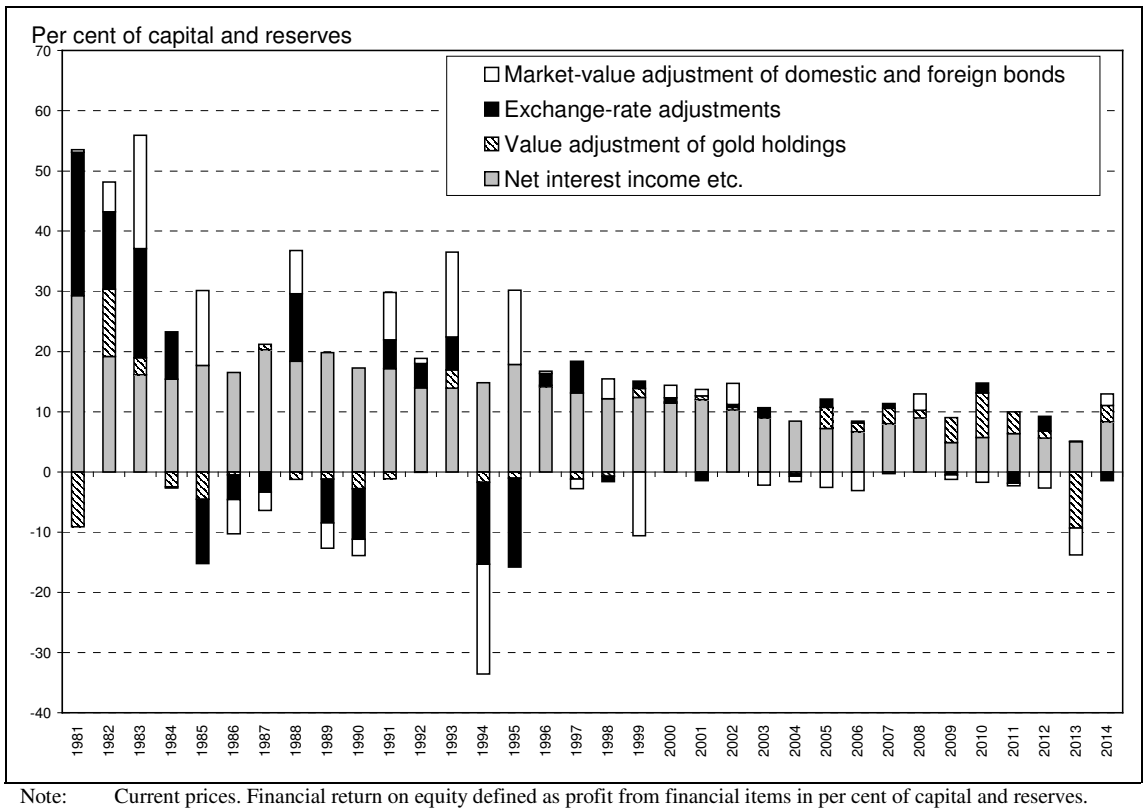
Figure 5: Currency composition of Danmarks Nationalbank's net FX reserves 1989-2014



Notes: Current prices. End of year. End exposures after currency overlay via forward contracts and swaps. Exposure in euro consists of exposure vis-à-vis Deutsche mark, French franc, Netherlands guilder, Belgian francs and ECU prior to 1999. Exposure in euro also includes net exposures in Danish kroner vis-à-vis non-residents. The value of SDR has been distributed on the respective currencies

Source: See Appendix.

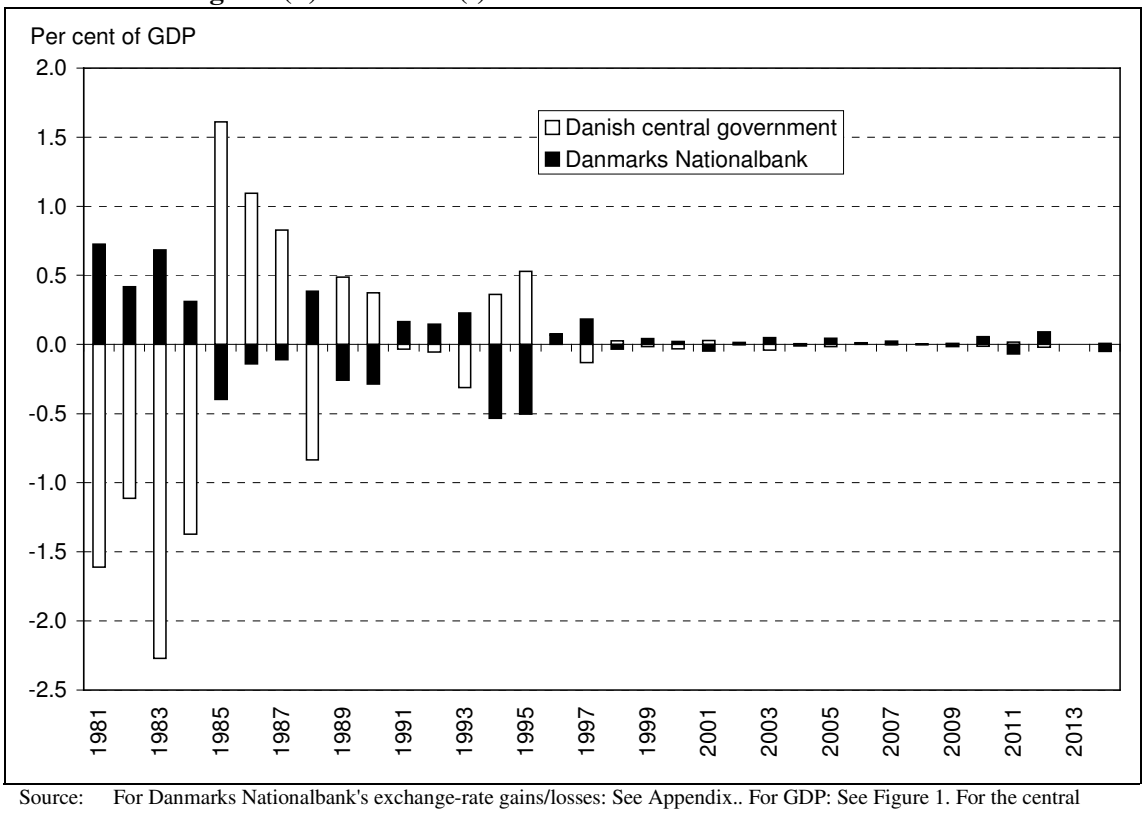
Figure 6: Detailed composition of Danmarks Nationalbank's financial return on equity 1981-2014



Note: Current prices. Financial return on equity defined as profit from financial items in per cent of capital and reserves. Averages of capital and reserves beginning and end of year.
Source: See Appendix.

The large share of exposure vis-à-vis non-euro currencies in the first half of the 1990s might at first seem surprising given that Denmark had participated in the European exchange-rate co-operation since the early 1970s and since January 1987 had followed a hard peg vis-à-vis the Deutsche mark and the other core currencies within the ERM. The background for the exposure vis-à-vis non-euro currencies was the co-ordinated net currency-risk management of Danmarks Nationalbank's FX reserves and the central government's foreign debt which was introduced in 1992 (Abildgren *et al*., 2010, pp. 270-273). During the 1980s the Danish central government's foreign debt in US dollars, Japanese yen and Swiss francs by far exceeded the Nationalbank's placements in the same currencies. The general objective of the co-ordinated net currency-risk management introduced in 1992 was to ensure that the central government did not borrow in one currency, while the Nationalbank invested in another. Under co-ordinated currency-risk management the Nationalbank's gains and losses would to a higher degree be offset by the central government's losses and gains, and vice versa, cf. Figure 7. In this way, the overall exchange-rate risk could be limited.

Figure 7: The Danish central government's and Danmarks Nationalbank's exchange-rate gains (+) and losses (-) 1981-2014



Source: For Danmarks Nationalbank's exchange-rate gains/losses: See Appendix.. For GDP: See Figure 1. For the central government's exchange-rate gains/losses: Author's calculations based on Abildgren *et al*. (2010); Finansministeriet, *Statens låntagning og gæld*, various issues; Danmarks Nationalbank, *Danish Government Borrowing and Debt*, various issues; and Danmarks Nationalbank's website.

The combined net currency distribution of the central government and the Nationalbank was initially determined on a quarterly basis aided by a mean-variance portfolio model in the tradition of Markowitz (1952) to trade off expected currency risks and returns. However, experience from the first couple of years of co-ordinated net currency-risk management showed that it was also necessary to attach importance to the gross currency exposures of the two institutions. The central government and Danmarks Nationalbank still published separate accounts, and in the Nationalbank's accounts unrealised value adjustments of foreign-exchange positions were reflected directly in the financial result. In 1994, both the government's and the Nationalbank's FX positions were e.g. subject to considerable exchange-rate adjustments since the US dollar in the course of the year depreciated by approximately 10 per cent vis-à-vis the Danish krone. As a consequence Danmarks Nationalbank suffered a large exchange-rate loss, while the government had a large exchange-rate gain. Although the government's and the Nationalbank's overall exposure to the dollar was limited, it was difficult for the Nationalbank to accept gross distributions of debt and FX reserves that entailed a risk of large exchange-rate losses for the Nationalbank. Ultimately this

could have a potential negative impact on the Nationalbank's credibility as a monetary-policy authority. Since neither the government nor the Nationalbank gained any particular benefits from gross risks of this magnitude, it was in 1995 decided to reduce the foreign-exchange risk on the gross distributions. Subsequently, the co-ordinated management of exchange-rate exposures took the form of co-ordinated gross management. In a relative short time-span both the government's and the Nationalbank's significantly reduced their gross exposures in other currencies than euro. From 2001 it was decided that the end-exposure of the central government's foreign debt was mainly to be in euro. Since most of Danmarks Nationalbank's foreign-exchange reserve also had an end-exposure in euro, a formalised co-ordinated exchange-rate risk management was no longer required.

6. Core earnings and earnings from assuming additional risks

Hansen and Ølgaard (2000), Danmarks Nationalbank (2003b, pp. 17-20), Abildgren *et al*. (2010, pp. 286-287) and Schrøder and Thamsborg (2012) have previously applied a simple asset/liability framework to analyse the financial risks to which the Nationalbank has been exposed during the last couple of decades and the earnings related to those risks. Below we formalise a simple general model inspired by this framework and apply it to get a rough picture of the evolution of the Nationalbank's financial risk and returns over the past 175 years or so.

Table 2 illustrates a stylised outline of the balance sheet of a generic central bank. The balance sheet has for analytical purposes been structured to reflect the major responsibilities of a typical central bank.

Table 2: A stylised central-bank balance sheet – outstanding amounts

Assets		Liabilities and equity	
Item	Outstanding amount	Item	Outstanding amount
Silver and gold	SG	Coins and banknotes in circulation	M
Net FX reserves	FX	Deposits, *etc*.	D
Domestic bonds	B	Equity	E
Domestic credit, *etc*.	C		

The assets include silver and gold holdings (SG) which historically have backed the issuing of banknotes in many countries and more recently have been seen as part of the total international reserves, which also includes net FX reserves (FX). Other assets are domestic bonds (B) and domestic credit, *etc*. (C). The liabilities consists of coins and banknotes issued (M), deposits, *etc*. (D) and equity (E).

Table 3 summarises how the assets and liabilities are assumed to be remunerated within this framework.

Table 3: A stylised central-bank balance sheet – total returns

Assets		Liabilities and equity	
Item	Total returns	Item	Total returns
Silver and gold	vasg + glf	Coins and banknotes in circulation	0
Net FX reserves	isf + tpf + fblf + evafx + mvafx + crfx	Deposits, *etc*.	isd
Domestic bonds	isd + tpd + dblf + mvab + crb	Equity	tpfi
Domestic credit, *etc*.	isd + imc + crc		

The return on silver and gold consists of value adjustments (vasg). Furthermore, the central bank might earn a fee on their gold holdings (glf) by lending gold to commercial banks *etc*. in the international gold-lending market.

If the FX reserves only were placed in risk-free money market instruments the remuneration would be the risk-free foreign short-term interest rate (isf). However, parts of the FX reserves might be invested in instruments with longer maturites, so the remuneration will also include a term premium (tpf), which depends on the average duration of the FX reserves and the slope of the yield curve abroad. There might also be a fee (fblf) from lending foreign bonds to commercial banks *etc*. Furthermore, there might be value adjustments related to the FX reserves due to exchange-rate adjustments (evafx) and market value adjustments of foreign bonds (mvafx). Finally, there might be an element of earnings (crfx) from assuming credit risks on the FX reserves.

In a similar way the domestic bond portfolio is assumed to earn the risk-free domestic short-term interest rate (isd) plus a term premium (tpd) that depends on the duration of the portfolio and the slope of the domestic yield curve. There might also be a fee (dblf) from lending domestic bonds to commercial banks *etc*. Furthermore, there might be market value adjustments of domestic bonds (mvab) and an element of earnings from assuming credit risks (crb) on the domestic bond portfolio.

Domestic credit, *etc*. is assumed to earn the risk-free domestic short-term interest rate (isd). Furthermore, the central bank might chose to charge an interest margin on its domestic credit extension (imc) that might be seen as an intermediation fee. There might also be an element of earnings from assuming credit risks (crc) on the domestic lending.

Finally, coins and banknotes issued are assumed to earn a zero interest rate whereas deposits with the central bank earns the risk-free domestic short-term interest rate.

We can then calculate the central bank's total profit from financial items (tpfi) as:

[1] tpfi = (vasg + glf)·SG
+ (isf + tpf + fblf + evafx + mvafx + crfx)·FX
+ (isd + tpd + dblf + mvab + crb)·B
+ (isd + imc + crc)·C
– isd·D

Utilising that the foreign short-term interest rate (isf) can be written as the sum of the domestic short-term interest rate (isd) plus an interest-rate spread (isf – isd), we can also write the central banks total profit from financial items as:

[2] tpfi = [vasg·SG + (FX + B + C – D)·isd + {(isf – isd) + evafx}·FX]
+ [imc·C]
+ [glf·SG + (tpf + fblf + mvafx + crfx)·FX + (tpd + dblf + mvab + crb)·B + crc·C]

The central banks total profit from financial items thus consists of three parts:

- The first part of the total profit from financial items can be considered as the central bank's "core earnings". The core earnings is the earnings that the central bank will achieve if it only takes the basic risks that unavoidable goes with the business of being a central bank. Core earnings consists of value adjustments on silver and gold holdings (vasg·SG), interest income from placing all other assets in risk-free money market instruments without taking any additional interest-rate risk ({FX + B + C – D}·isd) and earnings from taking FX risks ({(isf – isd) + evafx}·FX) due to the need of holding FX reserves.
- The second part of total profit from financial items is earnings if the central bank chooses to charge an interest margin on its domestic credit extension (imc·C).
- The third part of total profit from financial items is earnings from assuming additional risks. This part of the earnings does not reflect risks that are unavoidable as part of being a monetary authority but risks that are taken as a financial institution by evaluating the expected risk-return trade-off. It might be discussed whether a central bank can avoid credit risk due to its role as lender of last resort vis-à-vis the domestic banking sector. However, here we assume that such risks can be addressed by appropriate collateral requirements.

For a central bank in a country pursuing a fixed-exchange-rate policy, like Denmark during most of the period since 1839, it might be argued to move the exchange-rate adjustments

related to the net FX reserves (evafx·FX) from the core earnings to the earnings from assuming additional risks:

$$
\begin{aligned}
[2'] \; tpfi = {} & [vasg \cdot SG + (FX + B + C - D) \cdot isd + (isf - isd) \cdot FX] \\
& + [imc \cdot C] \\
& + [glf \cdot SG + (tpf + fblf + evafx + mvafx + crfx) \cdot FX + (tpd + dblf + mvab + crb) \cdot B + \\
& \quad crc \cdot C]
\end{aligned}
$$

This reflect that the value adjustments related to the net FX reserves under a successful fixed-exchange-rate policy can be eliminated if the FX reserves are only denominated in the currency toward which the fixed-exchange-rate policy is oriented.

Figure 8 shows a decomposition of Danmarks Nationalbank's financial return on equity since 1839. Core earnings have been calculated using the first square bracket of equation [2']. As a proxy for the short-term foreign interest in the silver standard period (1839-1874) we make use of the German short-term interest rate. The UK is usually considered to be the core country during the gold standard period, and after the breakdown of the gold standard in 1931 the Danish exchange-rate policy was oriented vis-à-vis the British pounds until 1939. As a proxy for the short-term foreign interest rate we have therefore used the UK money market rate for the period 1875-1938. From 1939 the Danish exchange-rate policy was oriented vis-à-vis the US dollar, from 1946 within the Bretton Woods system that ended in 1971. We have chosen the US money market rate as a proxy for the short-term foreign interest rate for the period 1939-1971. Since 1972 the Danish exchange-rate policy has been anchored within the European exchange rate cooperation. As a proxy the short-term foreign interest rate since 1972 we make use of the German money market rate for the period 1972-1998 and the euro area money market rate since 1999. The short-term domestic interest rate applied for the calculations is Danmarks Nationalbank's discount rate.

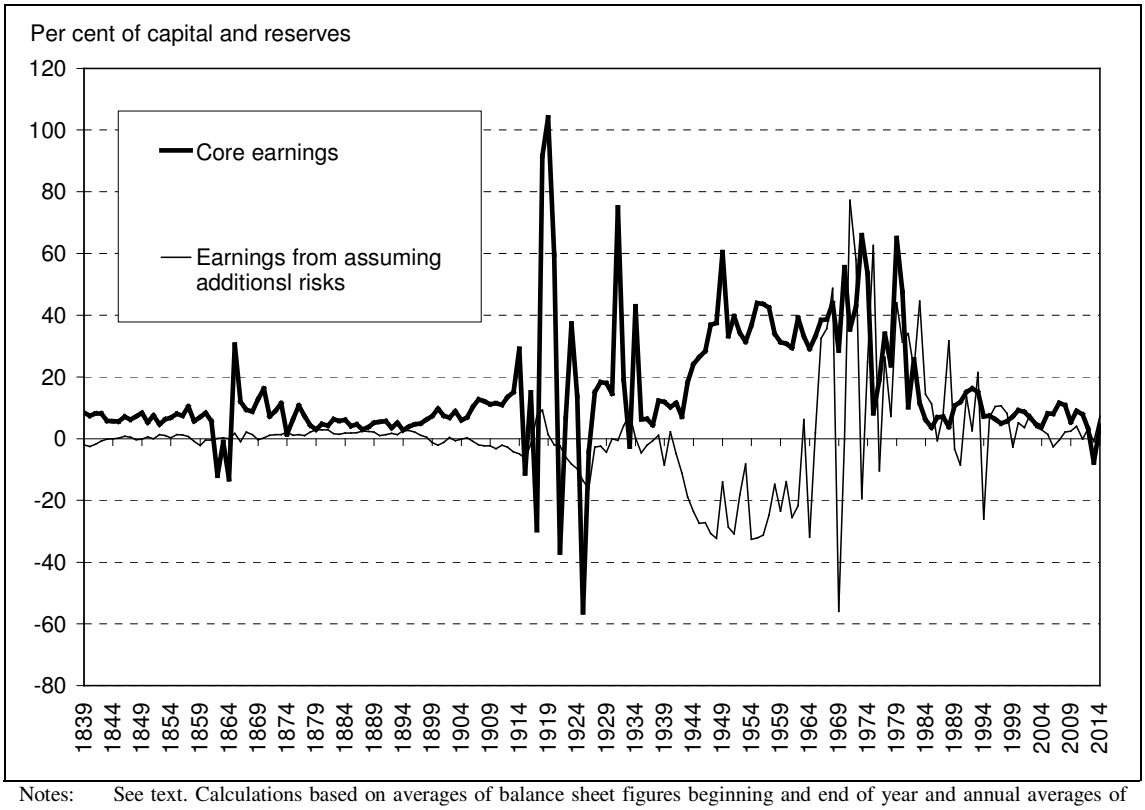
The earnings from assuming additional risks in Figure 8 have been compiled on a residual basis as the difference between total profit from financial items and core earnings. It therefore also includes interest margin on domestic credit extension in certain periods.

Core earnings has an average accounted for the main part of the earnings which reflects a conservative choice of risk level by Danmarks Nationalbank. There has, however, been a downward trend in core earnings since the early 1980s in step with the general decline in the interest-rate level. During this period earnings from assuming additional risks has contributed significantly to the financial return on equity.

It should be mentioned that the calculations behind Figure 8 due to data limitations naturally are based on a number of crude assumptions and simplifications, cf. the description

above. The figures can therefore only be expected to give a rough picture of the general development in core earnings and earnings for assuming additional risks.

Figure 8: Danmarks Nationalbank's core earnings and earnings from assuming additional risk 1839-2014



Notes: See text. Calculations based on averages of balance sheet figures beginning and end of year and annual averages of interest rates.

Source: For Danmarks Nationalbanks earnings and balance sheet items, see Appendix. For sources on interest rates: Homer and Sylla (1996); Mitchell (1988); Mordhorst (1968), Danmarks Nationalbank, *Report and Accounts*, various issues; Danmarks Nationalbank's website; St. Louis Fed's Federal Reserve Economic Data (FRED) Database; and OECD, *Main Economic Indicators*, various issues.

7. Final remarks

During the most recent decades the contribution to the Nationalbank's financial return on equity from core earnings has declined significantly. Central banks in other countries have also experienced lower return on assets during the low-interest-rate environment in the 2000s (Bank for International Settlements, 2009).

In order to address the low levels of core earnings and increase diversification, the Nationalbank decided in 2013 to build up exposure to new risk classes such as equity, corporate bonds and government bonds with lower credit ratings as well as to increase the share of bonds with longer maturities. Danmarks Nationalbank (2014, p. 33; 2015, p. 20) expects that the new investment strategy will improve future earnings but also result in larger fluctuations in earnings from year to year. However, the Nationalbank, *op. cit*., also notes that its future investment strategy will still be subject to a conservative risk level and high

liquidity and credit-quality requirements for the foreign exchange reserve due to the fixed-exchange-rate policy.

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Appendix: Danmarks Nationalbank's balance sheets and financial returns 1839-2014 – Data sources and compilation issues

This appendix outlines the main sources and methods used to construct an annual data set on Danmarks Nationalbank's balance sheets and financial results since 1839.

The Danish currency unit of account changed from "riksbankdaler" (introduced in 1813) to "rigsdaler" in 1854[5] and from "rigsdaler" to "kroner" (DKK) in 1875. Our figures are stated in DKK prior to 1875 and have been converted using the following official conversion rates: 1 rigsbankdaler = 1 rigsdaler = 2 DKK.

Our figures refer to the consolidated accounts of Danmarks Nationalbank and its branches. The official name of the bank was originally "Nationalbanken in Kjøbenhavn", but it was changed to "Danmarks Nationalbank" in 1936. Branches were opened in Aarhus (1837), Flensborg (1844), Ålborg (1881), Nykøbing Falster (1882), and Kolding and Odense (1901). The branches were later closed again, the last two in 1989.

A.1. Balance sheets

The breakdown of our balance-sheet figures for Danmarks Nationalbank into sub-items is shown in Table A.1. All balance-sheet figures are as far as possible stated at market prices end of year. Figures prior to 1900 have been converted from end-July to end-of-December basis by simple linear interpolations. It should, however, be mentioned that the accounting year of the branches prior to 1869 ended one month (30 June) before the accounting year of the main office in Copenhagen (31 July). We have not adjusted for this minor discrepancy between year-end at the main office and the branches.

[5] Schleswig and Holstein were attached to the Danish monarchy in 1460 but became part of Germany after the Second Schleswig War in 1864 in accordance to the Treary of Vienna. Shortly after the eruption of The First Schleswig War in 1848 the newly established Schleswigian government abolished the rigsbankdaler as legal tender. In November 1853 – a couple of years after the end of the War – the Danish minister of finance introduced a bill to the Parliament to restore monetary unity within the Danish monarchy and by regulation of 1854 the name of the Danish currency changed from "rigsbankdaler" to "rigsdaler". The omission of "bank" from the name was according to Sørensen (2013a, p. 225) an attempt to counter local resistance to the currency in Schleswig-Holstein. Even though the rigsdaler was the only legal tender in Schleswig-Holstein, the Schleswigian courant and various coins from Lübeck and Hamburg continued to circulate (Hansen, 1982). In order to facilitate the monetary transition various decrees and legislation was implemented. Schools were for instance instructed only to use rigsdaler as unit of account in calculus classes. However, the Schleswigian courant continued to circulate in the duchies and the scheduled phase-out had to be postponed (Sørensen, 2013a, p. 226). Sønderjylland (the northern part of the old Duchy of Schleswig) was reunited with Denmark in 1920 following a referendum in accordance with the Versailles Treaty.

Table A.1: Breakdown of Danmarks Nationalbank's balance sheet into sub-items

Assets		Liabilities and equity	
	Silver		Coins in circulation
+	Gold	+	Banknotes in circulation
+	FX reserve assets	+	FX reserve liabilities
+	Domestic bonds	+	Deposits and other net liabilities
+	Domestic credit	+	Capital and reserves
+	Government guarantee for coins put into circulation prior to 1975		
=	**Total assets**	=	**Total liabilities and equity**

Silver

This item covers Danmarks Nationalbank's exposures in silver (bars as well as coins).

During the first decades after its establishment the Nationalbank focused on withdrawing banknotes in order to increase the value of the currency. Parity of the rigsbankdaler notes vis-à-vis silver coins was achieved in 1838, and in 1845 the notes were made convertible into silver coins on demand. In 1847, the Nationalbank furthermore partly became subject to an obligation to purchase silver bars at a fixed price. The Coin Act of 1873 changed the monetary standard in Denmark from silver to gold. At the same time, the Act implied a transition from the rigsdaler to the krone as the Danish currency unit. According to the Coin Act of 1873 kroner should be legal tender on 1 January 1875 at latest. However, the new gold 10- and 20-koner coins were made legal tender already with effect from 1 January 1874. The Coin Act of 1873 furthermore specified that the rigsdaler ceased to be legal tender by the end of 1878 for main coins and end-1881 for token coins. However, in practice, the old token coins quickly went out of circulation, and on 1 November 1875 the smallest token coins ceased to be legal tender. The rest of the old token coins lost their status as legal tender on 31 December 1875. Finally, the old main coins ceased to be legal tender by 1 October 1876.

The silver holdings were stated at the par value of the rigs(bank)daler in the balance sheets of the official annual accounts of Danmarks Nationalbank for the period prior to 1877. We have adjusted the silver holdings (and the liability item "Capital and reserves") to reflect international market valuation of the silver stock.

The sources for the figures on silver holdings are various issues of Danmarks Nationalbank's annual *Report and Accounts*. We have relied on silver prices in USD per fine ounce silver from the *NBER Macrohistory Database* and exchange rates from the sources stated in Abildgren (2014).

Gold

The item covers Danmarks Nationalbank's exposures in gold (bars as well as coins).

The gold holdings have been stated at market values in the balance sheets of the official annual accounts of Danmarks Nationalbank since 1988. Prior to 1969 the Nationalbank's gold stock was stated in the balance sheet at the krone's gold-parity value according to the Coin

Act of 1873. From 1969 to 1978 the gold stock was booked at the parity notified to the International Monetary Fund (IMF), and from 1979-1987 the gold stock was booked at the average market price for the last six months or at the market price at the penultimate working day of the year, whichever was the lower. This valuation principle implied that the gold stock *de facto* also was stated at market prices for period 1983-1987.

For the period prior to 1983, we have adjusted the value of gold holdings (and the liability item "Capital and reserves") to reflect international market valuation of the gold stock.

A few remarks regarding the treatment of special transactions should be given:

- In 1885 Danmarks Nationalbank, Sveriges Riksbank and Norges Bank entered into an agreement on a trans-Scandinavian payment system as a supplement to the agreement on the Scandinavian Currency Union (SCU) of 1873. The agreement of 1885 allowed each of the three central banks within the SCU – Sveriges Riksbank, Norges Bank and Danmarks Nationalbank – to issue bills of exchange (drafts) drawn on the other two central banks at par. As part of the arrangement the three central banks granted each other the right to have overdrafts on their reciprocal accounts. However, according to the agreement a central bank with a net credit position had the right to require settlement on demand in gold or foreign currency. A country with a net debit position had the right to settle the debt in Scandinavian gold coins at par value if no agreement regarding other means of settlement (i.e. settlement in foreign currency or gold in other kinds) was concluded (Nielsen, 1917; Øksendal, 2007). We have therefore included the net claims on Sveriges Riksbank and Norges Bank in relation to the trans-Scandinavian payment system as part of the gold holdings of Danmarks Nationalbank. The payment-system arrangement between Denmark and Sweden came into force immediately, and Norway joined in 1888. World War I *de facto* terminated the Scandinavian Currency Union.
- The gold holdings include gold deposited by Danmarks Nationalbank with the European Monetary Co-operation Fund and the European Monetary Institute during the period 1979-1997.
- For the period 1951-1958 we have adjusted the figures on the Nationalbank's gold holdings to include gold originally registered under net foreign exchange exposures in the publications from Danmarks Nationalbank.
- In some periods since 1987 Danmarks Nationalbank has participated as a lender in the international gold-lending market. The figures for gold includes gold lend out to commercial banks *etc*. in this market.

The sources for the figures on gold holdings are Mordhorst (1968), Bie and Pedersen (1999) and various issues of Danmarks Nationalbank's annual *Report and Accounts*. Furthermore, we have relied on gold prices in USD or GDP per Troy Once from Officer and Williamson (2013) and St. Louis Fed's Federal Reserve Economic Data (FRED) Database and exchange rates from the sources stated in Abildgren (2014).

FX reserve assets and liabilities

The non-gold and non-silver foreign-exchange (FX) reserve assets and liabilities include positions in Danish kroner vis-à-vis non-residents.

The German occupation forces expenditures in Denmark during World War II – financed by drawings on Danmarks Nationalbank against a guarantee from the Danish central government – were never paid by Germany. The expenditures are therefore not included in the net FX exposure of Danmarks Nationalbank but are treated as a claim on the Danish central government under the item "Domestic credit".

A few remarks regarding special transactions should be given:

- Deposits in foreign currency by the US Federal Reserve and ECB in 2008 under the swap line mentioned below under the item "Domestic credit" are stated under the liability item "Deposits and other net liabilities".
- Deposits denominated in foreign currency by the central government and domestic banks are stated under the liability item "Deposits and other net liabilities".

The sources for the figures on FX reserve assets and liabilities are Rubow (1918, 1920), Mordhorst (1968) and various issues of Danmarks Nationalbank's annual *Report and Accounts*.

Domestic bonds

The figures for holdings of domestic bonds (including Treasury Bills) are stated excluding bonds obtained as collateral as part of repo-transactions. Prior to 1876 this item also includes minor amounts of shares and foreign bonds.

The sources for the figures on domestic bonds are Mordhorst (1968), Mikkelsen (1993) and various issues of Danmarks Nationalbank's annual *Report and Accounts*.

Domestic credit

The item "Domestic credit" covers credit to the monetary-policy counterparties, the government and the non-financial domestic private sector.

In step with the development of a private credit market via deposit banks and mortgage banks in the second half of the 1800s, the Nationalbank switched gradually from direct lending to private enterprises towards loans to the banks. In 1914 the Nationalbank also became the sole banker of the central government. Credits to private enterprises were gradually reduced over time. In 1967, the last of the relationships with private firms were terminated. From then on, the Nationalbank was only banker to the banks and the central government. With the introduction of Stage 2 of the European Monetary Union in 1994, the prohibition on monetary financing entered into force. Since then, the central government's account at Danmarks Nationalbank can not be overdrawn.

A few remarks regarding special transactions should be given:

- 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, established. The notes issued by the Rigsbank were backed by a 6 per cent first-priority

mortgage in the value of all properties in Denmark (the so-called "bank mortgage"). 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. The "bank mortgage" could be redeemed in silver – otherwise an annual interest of 6.5 per cent had to be paid to the Riksbank and later the Nationalbank.[6] In 1839 people subject to the "bank mortgage" were given the opportunity to convert the bank mortgage into ownership shares in Danmarks Nationalbank. The value of the bank mortgage is included in the domestic-credit item for the period 1839-1871. In 1872 the remaining bank mortgage claims were written off in the balance sheet of the Nationalbank.

- With the 1936 Act the Nationalbank was transformed from a private joint-stock company into a self-governing institution whose profits were to be transferred to the central government. The share capital from private share holders was replaced by a General Capital Fund paid in by the central government. The government issued a guarantee certificate for the amount and gradually redeemed the amount over the following years. The value of the government guarantee certificate is included in the item "Domestic credit". The last outstanding amount of the certificate was redeemed in 1956.
- For the period 1900-1984 the central government's current accounts at Danmarks Nationalbank have been stated on a net basis on the liability side of Danmarks Nationalbank's balance sheet in order to ensure consistency across time.
- As mentioned under the item "FX reserve assets and liabilities", the claims on Germany as a result of the German occupation forces expenditures in Denmark during World War II against a guarantee from the central government are treated as a claim on the Danish central government. The claim was gradually redeemed and the remaining debt was finally repaid in June 1971.
- For the period 1989-1991 the item "Domestic credit" includes loans against bonds as collateral, which in the official annual accounts of Danmarks Nationalbank were stated under the item "Domestic bonds".
- Loans and deposits related to settlement accounts are stated on a net basis (equal to zero) for the period 1995-2003 in order to ensure comparability over time.
- The item "Domestic credit" includes loans in US dollars and euro in 2008 to the monetary-policy counterparties based on Danmarks Nationalbank's temporary swap lines with the US Federal Reserve and ECB.

The sources for the figures on domestic credit are Rubow (1918, 1920), Mordhorst (1968) and various issues of Danmarks Nationalbank's annual *Report and* Accounts.

Government guarantee for coins put into circulation prior to 1975

In 1975 the Royal Mint was transferred from the central government to Danmarks Nationalbank against a central-government guarantee for coins put into circulation prior to 1 January 1975.

In 1994 the European Monetary Institute found that the central-government guarantee was in conflict with the prohibition against monetary financing, as Danmarks Nationalbank held a non-negotiable claim with an indefinite maturity on the central government. Consequently, the guarantee was dissolved, cf. Abildgren *et al*. (2010, p. 216).

[6] However, the property owners could deduct 5/6 of the interest amount paid on the "bank mortgage" from their property taxes to the central government (Olsen, 1962, p. 248).

The source for the figures on central-government guarantee for coins put into circulation prior to 1 January 1975 is various issues of Danmarks Nationalbank's annual *Report and* Accounts.

Total assets (= Total liabilities and equity)

Total assets have been compiled as a the sum of the following items: "Silver", "Gold", "FX reserve assets", "Domestic bonds", "Domestic credit" and "Government guarantee for coins put into circulation prior to 1975".

Our figures for total assets differ from the total assets stated in the official annual accounts of Danmarks Nationalbank due to the market valuation of silver and gold, the net treatment of a certain asset and liability items, and the conversion of the pre-1900 figures to an end-of-December basis.

Coins in circulation

In 1975, coins in circulation became a liability of the Danmarks Nationalbank in its annual accounts, cf. the description above regarding "Government guarantee for coins put into circulation prior to 1975".

The source for the figures on coins in circulation is the various issues of Danmarks Nationalbank's annual *Report and* Accounts.

Banknotes in circulation

Prior to 1908, the holdings of banknotes by Danmarks Nationalbank's main office in Copenhagen and its branch offices were shown as asset items on the balance sheets in the official annual accounts. In our data set, we show the banknotes in circulation excluding the holdings of banknotes by Danmarks Nationalbank's main office and its branch offices.

The sources for banknotes in circulation are Rubow (1918), Mordhorst (1968) and various issues of Danmarks Nationalbank's annual *Report and* Accounts.

Deposits and other net liabilities

Deposits and other net liabilities have been compiled on a residual basis as total liabilities and equity less coins and banknotes in circulation, FX reserve liabilities and capital and reserves. The item includes thus on a net basis all liabilities and assets not stated anywhere else in the balance sheet, including minor holdings of tokin coins and shares and the value of the Nationalbank's fixed assets such as buildings.

Capital and reserves

The figures for capital and reserves have been adjusted to reflect market valuation of silver and gold holdings, cf. the description above in relation to the items "Silver" and "Gold". Our figures for capital and reserves differ therefore from the figures stated in the official annual accounts of Danmarks Nationalbank.

The sources for capital and reserves are Mordhorst (1968) and various issues of Danmarks Nationalbank's annual *Report and Accounts*.

Memorandum items

As memorandum items we have compiled time series for the currency composition (end exposures after currency overlay via forward contracts and FX swaps) of Danmarks Nationalbank's net FX reserves end of year since 1989. The currencies are US dollar (USD), British Pound (GBP), Japanese Yen (JPY), Swiss Franc (CHF) and euro (EUR). Prior to 1999, exposure in euro consists of exposure vis-à-vis Deutsche mark, French franc, Netherlands guilder, Belgian francs and ECU. Exposure in euro also includes net exposures in Danish kroner vis-à-vis non-residents. The value of SDR has been distributed on the respective currencies.

As another memorandum item we have compiled a time series of Danmarks Nationalbank's holdings of foreign bonds (excluding bonds obtained as collateral as part of repo-transactions) since 1991.

The sources for the memorandum items are various issues of Danmarks Nationalbank, *Danish Government Borrowing and Debt*, Danmarks Nationalbank, *Financial Statistics* and Danmarks Nationalbank, Report and Accounts.

A.2. Profit from financial items

The breakdown of our figures for Danmarks Nationalbank's profit from financial items is shown in Table A.2.

Table A.2: Breakdown of Danmarks Nationalbank's profit from financial items

	Value adjustments of silver
+	Value adjustments of gold
+	Other profit from financial items
=	**Total profit from financial items**

Value adjustments of silver

Value adjustments of silver holdings were not included in the profit and loss accounts of Danmarks Nationalbank prior to 1877. They have been compiled on the basis of the value of silver holdings stated in various issues of Danmarks Nationalbank's annual *Report and*

Accounts, silver prices in USD per fine ounce silver from the NBER Macrohistory Database and exchange rates from the sources stated in Abildgren (2014).

Value adjustments of gold

Prior to 1983, gold holdings of Danmarks Nationalbank were not stated at market values in the balance sheets in the official annual accounts, and the value adjustments in the accounts did therefore not reflect full mark-to-market valuation of gold. We have compiled figures on value adjustments on gold holdings reflecting full mark-to-market valuation on the basis of information on the gold stock in Mordhorst (1968), Bie and Pedersen (1999) and various issues of Danmarks Nationalbank's annual *Report and Accounts*. Furthermore, we have relied on gold prices in USD or GDP per Troy Once from Officer and Williamson (2013) and St. Louis Fed's Federal Reserve Economic Data (FRED) Database and exchange rates from the sources stated in Abildgren (2014).

Other profit from financial items

Other profit from financial items covers net income from interest, market-value adjustment of domestic and foreign bonds, exchange-rate adjustment of net FX reserves, market-value adjustment of shares, dividend from shares, loan impairment charges, commission and brokerage fees *etc*.

A few supplementary remarks should be given:

- Excludes Danmarks Nationalbank's losses in relation to supporting Danish Ship Finance in the period 1964-2005 and the Nationalbank's income in 2005 relating to the restructuring of Danish Ship Finance as a limited liability company.
- Excludes the removal of the central government's guarantee for coins in circulation in 1994.
- Excludes Danmarks Nationalbank's net losses in relation to an insurance scheme for Danish ships during World War II.
- Excludes profit from the expire of encashment obligations for coins, profit from encashment of damaged notes and extraordinary profit from the exchange of notes.
- Excludes profit from sale of medals *etc*.
- Excludes income from the IMF.
- Includes Danmarks Nationalbank's losses in relation to The Danish Export Finance Corporation 1975-2000, cf. Dalgaard (2000).

Figures prior to 1937 have been adjusted to follow the calendar year by simple linear interpolations of figures on accounting-year basis.

The sources for the figures on the item "Other profit from financial items" are various issues of Danmarks Nationalbank's annual *Report and Accounts* and Jayaswal (2004).

Total profit from financial items

Total profit from financial items have been compiled as a the sum of the following items: "Value adjustments of silver", "value adjustments of gold" and "other profit from financial items".

Memorandum items

As memorandum items we have compiled time series for the market-value adjustment of Danmarks Nationalbank's holdings of domestic bonds since 1934, exchange-rate adjustment of Danmarks Nationalbank's net foreign-exchange exposures since 1981 and the market-value adjustment of Danmarks Nationalbank's holdings foreign bonds since 1981.

The market-value adjustment of bonds excludes Danmarks Nationalbank's losses on acquisition of bonds at par in relation to supporting Ship Finance and includes mathematical price adjustment (pull to par) on bonds as a result of maturity reduction.

The sources for the memorandum items are Abildgren *et al*. (2010), Jayaswal (2004) and Danmarks Nationalbank, Report and Accounts, various issues.