



Danmarks Nationalbank

Risk Management in The Danmarks Nationalbank

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PREFACE

The following 4 articles which has been published by The Danmarks Nationalbank illustrates how risk management is handled in The Danmarks Nationalbank.

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Report on Danmarks Nationalbank's Accounts (Annual report 2000)

The Nationalbank's financial risks mainly comprise market risks. The market risk is related primarily to the interest-rate and foreign-exchange sensitivity. The interest-rate sensitivity was augmented during the year. Euro-denominated assets account for the major part of the foreign-exchange sensitivity. The credit risk is very small, since the Nationalbank exclusively holds claims on counterparties with a high credit standing, and to a significant extent requires the pledging of collateral.

The Nationalbank's accounts for 2000 show a profit of kr. 5.7 billion, compared to kr. 1.5 billion in 1999. The improvement is related mainly to the increase in value adjustments by kr. 4.4 billion to kr. 1.3 billion. Of the profit for the year, kr. 3.1 billion is payable to the central government. The Nationalbank's net capital has increased by kr. 2.7 billion to kr. 44.4 billion in 2000.

THE NATIONALBANK'S MANAGEMENT OF FINANCIAL RISKS

The Nationalbank holds financial assets and liabilities. This entails that the Nationalbank is exposed to a number of financial risks which can affect the financial result. The principal assets are foreign deposits and securities, domestic bonds and loans to Danish banks. The principal liabilities are banknotes and coins in circulation, deposits and certificates of deposit, and the deposits of the central government. The Nationalbank is primarily exposed to market risks and to a lesser degree to other types of risk, e.g. credit risks.

Market risk

The market risk is the risk of the Nationalbank suffering a loss as a consequence of price fluctuations on the financial markets. The nature of the Nationalbank's financial assets and liabilities entails that losses will arise primarily as a consequence of fluctuations in interest and exchange rates.

Generally, a distinction is drawn between sensitivity and risk. Sensitivity is the extent to which the Nationalbank will incur losses on a given

INTEREST-RATE SENSITIVITY OF THE NATIONALBANK		Table 10
Capital loss in kr. billion on a general 1-per-cent increase in interest rates	End-1999	End-2000
Kroner	1.1	1.3
Euro	0.9	1.1
Pound sterling	0.2	0.2
Dollar	0.5	0.8
Yen	0.2	0.1
Total	2.8	3.4

change in a specific risk factor, such as the interest rate. The compilation of the foreign-exchange sensitivity is based on market values of foreign-exchange outstandings. Interest-rate sensitivity indicates the capital loss to the Nationalbank as a consequence of an increase in interest rates by 1 percentage point.

On compiling the risk the probability of losses is evaluated by combining sensitivity with the probability of a change in the risk factor concerned. For example, Value-at-Risk is used to compile the total market risk. It indicates the maximum loss that with a given probability can be expected within a given time frame.

Interest-rate risk

The interest-rate risk indicates the capital loss which the Nationalbank will suffer as a consequence of a change in interest rates. For the Nationalbank, which holds significantly more fixed-rate assets than liabilities, an increase in interest rates will impose a loss. Experience shows that in the long term fixed-rate bonds yield higher returns than placements at floating interest rates. Over an extended period, the bank will therefore increase its return by assuming a certain interest-rate risk.

At the beginning of 2000 the interest-rate sensitivity of the domestic and foreign portfolios was augmented by kr. 0.5 billion to kr. 3.4 billion, cf. Table 10.

The sensitivity to changes in interest rates of the foreign portfolio was 63 per cent of the total interest-rate sensitivity at the end of 2000.

The sensitivity to changes in Danish interest rates can be related to the Nationalbank's portfolio of securities, comprising government bonds, Danish Ship Finance bonds, and municipal- and mortgage-credit bonds. Mortgage-credit bonds are usually callable, and the compilation of the interest-rate sensitivity of these bonds takes the bonds' call option into account.

FOREIGN-EXCHANGE EXPOSURE OF THE NATIONALBANK Table 11

Market value, kr. billion	End-1999 total	End-2000		
		Placements	Forward contracts	Total
Euro	164	70	57	127
Pound sterling	1	9	- 7	2
Dollar	0	36	- 37	-2
Yen	2	9	- 8	1
Gold	5	5	0	5
Total	172	130	5	134

Note: Negative amounts indicate that the Nationalbank holds liabilities. The value of SDR is distributed on the respective currencies.

Foreign-exchange risk

Foreign-exchange risk is the risk of capital losses as a consequence of fluctuations in exchange rates. The Nationalbank holds considerable foreign-exchange assets, first and foremost the foreign-exchange reserve. Like other central banks, the Nationalbank therefore cannot avoid exposure to a foreign-exchange risk.

The exchange-rate risk on the foreign-exchange-denominated assets is limited by forward sale of dollars, sterling and yen against euro. This reduces the exchange-rate risk on the Nationalbank's bond and money-market placements in those currencies. For example, at the close of 2000 the Nationalbank held pound sterling assets for kr. 9 billion, but had sold sterling forward for kr. 7 billion. The total net sterling outstandings thereby amounted to kr. 2 billion in net terms.

The Nationalbank's foreign-exchange sensitivity almost entirely concerns the euro, cf. Table 11. The bank's profit is thus to only a moderate degree affected by fluctuations in the krone's exchange rate vis-à-vis the dollar, yen and pound sterling.

The Nationalbank's foreign-exchange outstandings had fallen by kr. 38 billion to kr. 134 billion at end-2000. This decline is related mainly to the foreign-exchange reserve.

Since 1992 the Nationalbank's foreign-exchange risk has been subject to coordinated management with the foreign-exchange risk of the central government's foreign debt. The net position, i.e. the difference between the Nationalbank's foreign-exchange-denominated assets and the central government's foreign-exchange-denominated liabilities, has in recent years been primarily in the euro. In view of the Danish fixed-exchange-rate policy the euro is found to be the currency entailing the lowest risk. As the exchange-rate risk on the central government's liabilities and the Nationalbank's assets is primarily in euro, the

THE NATIONALBANK'S VALUE-AT-RISK		Table 12
Value-at-Risk in kr. billion with a 1-year horizon	End-1999	End-2000
Interest-rate risk	3.6	3.0
Exchange-rate risk	1.1	1.2
Gold	1.6	1.0
Reduction due to diversification	-2.2	-1.9
Total	4.1	3.2

Note: For the sake of comparison the same calculation technique for both 1999 and 2000 is used. Therefore the figures for 1999 deviate from the equivalent VaR figures in the 1999 Annual Report, cf. also footnote 1.

coordinated management was discontinued at the beginning of 2001. It is still the objective not to raise loans in one currency and then place the proceeds in another currency and thus not to expose the central government to a considerable indirect exchange-rate risk via the Nationalbank.

Calculation of market risk

In order to evaluate the market risk the Nationalbank employs various risk measures. One of these is Value-at-Risk (VaR), which besides the probability of interest and exchange-rate losses based on historical fluctuations also includes the covariation between them. VaR is supplemented with stress scenarios to calculate the impact on the portfolio of extreme fluctuations in interest and exchange rates.

At the close of 2000 the Nationalbank's VaR was kr. 3.2 billion¹, cf. Table 12. There was thus only a 5 per cent probability that during the coming year the Nationalbank will have total losses exceeding kr. 3.2 billion. At the close of 1999 VaR was kr. 4.1 billion. The decrease in VaR is related to the reduced volatility of the financial markets in 2000 compared to 1999.

The exchange-rate risk on the euro is not a traditional market risk, since the Nationalbank not only may, but is also obliged to, influence the krone/euro rate. The Nationalbank will only sustain a loss if the krone strengthens against the euro. It can therefore be of interest to evaluate VaR without the exchange-rate risk related to the euro. VaR excluding the exchange-rate risk on the euro is kr. 2.8 billion. Elimination of the exchange-rate risk related to the euro thus entails a decrease in VaR by 10 per cent.

¹ VaR is calculated on the basis of estimated volatilities and correlations between relevant risk factors for the last 160 days. VaR is determined by combining these estimates with the portfolio composition at end-2000. The implementation of new software in 2000 to calculate VaR has made it possible to include the gold stock in the VaR calculations.

Liquidity risk

The principal purpose of the foreign-exchange reserve is for the Nationalbank to be able to intervene in the foreign-exchange market. In the management of the foreign-exchange reserve it is therefore very important to ensure that the greater part of the reserve can quickly be converted to liquid funds. Therefore a large proportion of the reserve is placed in the money market or in bonds with a high degree of security and liquidity, so that they can easily be realised or used as collateral in various liquid markets.

The placement of the domestic securities portfolio does not take the liquidity aspect into consideration.

The Nationalbank also has access to liquidity via the central government's Commercial Paper programme amounting to 12 billion dollars. Moreover, there is an opportunity to borrow at the ECB in accordance with the ERM II agreement.

Credit risk

The credit risk is the risk of loss due to a counterparty's default on obligations.

To reduce the credit risk the Nationalbank seeks to spread its assets among counterparties with a high credit standing. Moreover, to a large extent collateral is required. The credit risk is therefore very small.

The credit risk on the foreign claims, i.e. claims on foreign governments, banks, etc., is managed on the basis of the ratings given by international rating agencies. Moreover, all significant outstandings are subject to maximum limits.

For deposits with foreign banks repo agreements with government bonds as collateral are used to a great extent. Should a repo counterparty be subject to compulsory liquidation, the Nationalbank's deposit is covered by the collateral provided.

The Nationalbank's foreign bond holdings are issued or guaranteed¹ by states with a high rating, or issued by supranational institutions. The Nationalbank thus does not hold corporate bonds or bonds issued by governments with a low credit rating.

The credit risk on domestic assets is reduced via collateral requirements. When Danish banks borrow at the Nationalbank, they provide bonds as collateral. This applies to loans related to the monetary-policy operations, the banks' intra-day credits and cash depots.

¹ The government-guaranteed securities include securities with an implicit government guarantee.

TOTAL CREDIT EXPOSURE ON THE FOREIGN-EXCHANGE RESERVE AND
THE DOMESTIC SECURITIES PORTFOLIO, ETC., END-2000

Table 13

Kr. billion	1999 Total	Bonds		Bank claims		Supra- national institu- tions	Total
		Govern- ments	Others	Collater- alised	Uncollater- alised		
Aaa	73.4	51.4	10.7	-	2.8	1.6	66.6
Aa1	17.2	5.9	1.2	0.4	3.4	-	11.0
Aa2	13.5	0	0.9	5.0	6.5	-	12.4
Aa3	63.4	11.7	13.4	14.7	12.9	-	52.8
A1	3.8	-	-	3.4	1.8	-	5.1
A2	3.0	-	-	-	2.2	-	2.2
A3	0.2	-	-	2.4	-	-	2.4
Not rating	28.8	-	6.6 ¹	1.4	0.2	7.5 ²	15.7
Total	203.3	69.1	32.7	27.3	29.8	9.1	168.0

Note: Moody's credit rating is used.

¹ A few Danish mortgage-credit institutes and similar.

² Solely covers BIS and IMF.

On placement of the domestic securities portfolio great weight is attached to the high credit standing of the issuers. The securities portfolio thus almost exclusively comprises government bonds, mortgage-credit bonds and Danish Ship Finance bonds.

Since approximately 90 per cent of the foreign-exchange reserve and the domestic securities portfolio are placed with supranational institutions or in assets with a rating of Aa3 or higher, the credit risk is very small, cf. Table 13.

Danmarks Nationalbank's Risk Management (Monetary Review – 2nd quarter 2000)

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INTRODUCTION

Like other financial institutions, Danmarks Nationalbank is exposed to a number of financial risks. This article presents an overview of the financial risks to which the Nationalbank is exposed, as well as the risk management principles applied.

The Nationalbank's primary tasks are to issue banknotes and coins and to conduct the foreign-exchange and monetary policy. The Nationalbank therefore holds assets in Danish kroner and in other currencies. As a consequence, the Nationalbank cannot avoid certain risks. For example, the foreign-exchange reserve will always be associated with exchange-rate risk. Other risks – such as interest-rate risk – are more a reflection of the weighing of risk against earnings.

The Nationalbank's policy is to measure the inherent risks which cannot be avoided, while the risks which can be avoided are to reflect explicit decisions and a weighing of risk against benefit. As a consequence, the Nationalbank's risks are considered on an overall basis. The interest-rate risk is thus not considered in isolation for respectively the foreign-exchange reserve and the portfolio of domestic securities, and the size of the foreign-exchange reserve as such does not affect the total interest-rate risk to the bank. The foreign-exchange reserve is placed in several markets in order to reduce the interest-rate risk to the bank. Foreign exchange is traded on forward terms to ensure that the exchange-rate exposure is predominantly in euro, thereby minimising the exchange-rate risk.

The bank's credit risks are kept at a very low level, and the objective is to avoid credit losses completely. The very high credit standing of counterparties, the diversification of exposures and the provision of collateral for loans are therefore important factors.

Besides the market and credit risks Danmarks Nationalbank, like other financial institutions, is exposed to legal and operational risks. However, these are not considered in this article.

PRINCIPAL ITEMS OF THE NATIONALBANK'S BALANCE SHEET,
END-1999 (KR. BILLION)

Table 1

Assets		Liabilities	
Domestic bonds	38	Banknotes and coins in circulation	46
Foreign-exchange reserve	161	Central government's account	40
Gold	5	The banks' net position	73
		Other	2
		Net capital	42

Note: The "Other" liabilities item comprises other liabilities less other assets.

KEY ASPECTS OF THE NATIONALBANK'S BALANCE SHEET

As an element of monetary and foreign-exchange policy the Nationalbank is responsible for fixing the official interest rates. The Nationalbank may also steer the krone rate by buying and selling foreign exchange. Sale of foreign exchange by the Nationalbank will strengthen the krone, while purchase of foreign exchange will weaken the krone.

The Nationalbank is the banker to the banks. This role implies that the Nationalbank makes accounts available to the banks and settles inter-bank payments. The banks' total outstanding with the Nationalbank is affected particularly by the Nationalbank's purchase and sale of foreign exchange, while the central government's payments via its account with the Nationalbank lead to temporary fluctuations. The accounts with monetary-policy counterparties are subject to the Nationalbank's official interest rates.

Danmarks Nationalbank is the sole issuer of banknotes. The banks contact the Nationalbank when they need new banknotes, whereby their claims on the Nationalbank are reduced.

As the basis for a discussion of the Nationalbank's risks a useful approach is to consider its balance sheet and the factors affecting the various items thereof. Table 1 presents a simplified balance sheet for the Nationalbank.

The net position is defined as the banks' current-account balances plus placements for up 14 days in certificates of deposit, less loans from the Nationalbank.

$$\boxed{\text{Current-account holdings}} + \boxed{\text{Certificates of deposit}} - \boxed{\text{Loans from the Nationalbank}} = \boxed{\text{Net position}}$$

The Nationalbank's balance sheet is affected by several types of transaction. The most important in terms of risk are purchase and sale in the

SALE OF FOREIGN EXCHANGE FOR KR. 1 BILLION		Table 2	
Kr. billion	Assets	Liabilities	
Foreign-exchange reserve	-1		
The banks' net position		-1	

foreign-exchange market and the central government's foreign-exchange borrowing, which both affect the foreign-exchange exposure.

In order to *support* the krone rate the Nationalbank purchases kroner and sells foreign exchange, thereby reducing the foreign-exchange reserve as well as the banks' net position, cf. Table 2. All in all, the exchange-rate exposure is reduced.

It makes little difference to the Nationalbank's risk exposure how the banks reduce their net position with the Nationalbank since all monetary-policy accounts are subject to the official interest rates, cf. above.

When the central government raises a loan denominated in foreign exchange the Nationalbank purchases the foreign-exchange proceeds, which are then included in the foreign-exchange reserve, cf. Table 3. The central government's krone-denominated proceeds are deposited to the central government's account in kroner. This account is subject to the official interest rates. In an isolated analysis of the Nationalbank's balance sheet the central government's raising of a foreign-exchange loan corresponds to the purchase of foreign exchange from the market – since in both cases the foreign-exchange reserve and loans, which are subject to the official interest rates, will increase.

The balance sheet is also affected by a number of other factors – such as central-government payments and transactions with the International Monetary Fund (IMF), etc. – which are of less importance in terms of risk exposure. In principle the balance sheet is calculated at market value and is therefore also subject to shifts due to fluctuations in interest and exchange rates.

Besides the transactions affecting the balance sheet the Nationalbank has undertaken a number of transactions which do not affect the bal-

CENTRAL-GOVERNMENT BORROWING IN FOREIGN EXCHANGE FOR KR. 1 BILLION		Table 3	
Kr. billion	Assets	Liabilities	
Foreign-exchange reserve	+1		
Central government's account with the Nationalbank		+1	

ance sheet directly. These are primarily forward purchase and sale of foreign exchange as an element of the management of the foreign-exchange reserve, cf. below.

THE NATIONALBANK'S CORE EARNINGS

Just like other enterprises the Nationalbank's risk profile should be viewed in the light of such factors as the bank's earnings. The Nationalbank's earnings are primarily from three core areas:

- *Banknotes and coins*: the circulation of banknotes and coins can be regarded as an interest-free loan to the Nationalbank. The revenue from this "loan" is placed in order to accrue interest. This is called seignorage.
- *Foreign-exchange reserve and financing thereof*: from the Nationalbank's viewpoint the foreign-exchange reserve reflects krone-denominated loans from either the banks or the central government, and placements in foreign exchange. As the interest rate for kroner is higher than the interest rate for euro, and the krone is stable vis-à-vis the euro, in isolated terms the foreign-exchange reserve entails a cost to the Nationalbank. A weakening of the krone implies a gain for the Nationalbank – again viewed in isolated terms – since the value of the foreign-exchange reserve measured in Danish kroner increases.
- *The bank's net capital*: the net capital is set off by assets generating a return.

There are naturally also other core areas, but their contribution to the Nationalbank's earnings is less significant.

The three core areas are closely related to the Nationalbank's role as central bank, and the yield can be termed the bank's core earnings. This represents the bank's earnings if the risk of capital losses due to fluctuations in interest and exchange rates was kept at the lowest possible level, and if the bank were solely to conclude transactions which are a consequence of its role as central bank.

Such an investment strategy would imply that the Nationalbank conducted very short-term borrowing and placements in kroner at the official interest rates, that foreign assets were placed at short-term euro interest rates, and that accounts in foreign exchange were held in euro.

In the case of this strategy the bank's earnings would vary from year to year in step with the short-term interest rate and the short-term interest-rate differential to the euro area, but the Nationalbank would not be exposed to value adjustments due to interest-rate fluctuations.

THE NATIONALBANK'S CORE EARNINGS			Table 4
	Interest ¹ per cent p.a.	Amount ² kr. billion	Result kr. billion
Counterpart of banknotes and coins	4.10	46	1.9
Foreign-exchange reserve and financing thereof.....	-0.35	160	-0.6
Counterpart of net capital	4.10	42	1.7
Total			3.0

¹ For banknotes and coins and net capital the Nationalbank's lending rate at the beginning of May. For the foreign-exchange reserve the difference between the ECB's official interest rate and the Nationalbank's lending rate at the beginning of May.

² End-1999.

At the interest rates prevailing at the beginning of May 2000 and in view of the composition of the balance sheet at end-1999, the Nationalbank's core earnings can be estimated at approximately kr. 3.0 billion per year, cf. Table 4.

An increase in the foreign-exchange reserve entails a decrease in the Nationalbank's core earnings, all other things being equal. This reflects that the Nationalbank borrows at the short-term official Danish interest rate and makes placements at the short-term euro interest rate, which is normally lower than the Danish interest rate.

THE NATIONALBANK'S FINANCIAL RISKS

However, the Nationalbank's actual profit is also affected by a number of risk factors. These are *market-related* factors, primarily interest and exchange rates, and *credit-related* factors, i.e. factors related to the counterparties' ability to fulfil their obligations. Some risks are inevitably linked to the aforementioned core areas, but the Nationalbank is also exposed to risks which are not strictly derived from the bank's role as central bank. The Nationalbank's profit thus in addition to the core earnings also reflects earnings achieved by undertaking additional risks. These risks, which are additional to the inevitable risks, are a consequence of the guidelines for the composition of the Nationalbank's portfolio, which are determined by the Board of Governors.

The Nationalbank's risk of losses is attributable primarily to the interest-rate risk associated with the placement of the foreign-exchange reserve and the domestic portfolio. The Nationalbank's exchange-rate risk is relatively modest since its foreign-exchange exposure is denominated primarily in euro. In contrast to private banks, which seek to achieve earnings by assuming credit risks, the Nationalbank's objective is to avoid credit losses.

Interest-rate risk

The Nationalbank has placed its domestic portfolio and part of its foreign-exchange reserve in bonds at a certain maturity. On the one hand, this entails a risk of capital losses in connection with interest-rate increases, but on the other hand, it will normally lead to higher earnings since long-term interest rates are normally higher than short-term interest rates. The measure of sensitivity to changes in interest rates is the sensitivity of the market value denominated in kroner to an interest-rate change of 1 percentage point (the krone duration).

The total interest-rate sensitivity is distributed on the financial markets in the euro area, the USA, Japan and the UK, cf. Table 5. This is primarily to diversify the risk of capital losses. Experience shows a certain correlation (covariation) between the various financial markets. This correlation is less than perfect, so that the risk of capital losses is reduced by diversifying the interest-rate risk and placements on several markets.

It is relatively simple to assess the interest-rate sensitivity of most of the bonds which the Nationalbank holds. However, this does not apply to Danish mortgage bonds, which entail a prepayment right for the issuer. The complex interest-rate sensitivity of mortgage bonds depends on several factors, such as the current level of interest rates, the interest-rate volatility and the future prepayment behaviour of homeowners. The interest-rate sensitivity of the mortgage bonds is assessed using an option model, and experience is evaluated on an ongoing basis with a view to improving the results from the model. Previously, interest-rate sensitivity was calculated on the basis of factors compiled by the Danish Financial Supervisory Authority for calculation of the banks' sensitivity to changes in interest rates. These factors are updated every quarter, but this interval is too long for an appropriate adjustment of the overall interest-rate risk if there are changes in interest-rate sensitivity arising from interest-rate fluctuations.

INTEREST-RATE SENSITIVITY OF THE NATIONALBANK

Table 5

Capital loss in kr. billion on a general 1 per cent increase in interest rates	End-1998	End-1999
Kroner	1.1	1.1
Euro ¹	1.3	0.9
Pound sterling	0.2	0.2
Swiss franc	0.0	0.0
Dollar	0.6	0.5
Yen	0.2	0.2
Total	3.4	2.8

¹ For 1998 euro comprises ECU and the sum of the national currencies of the euro area member states.

When foreign exchange is bought and sold only very short-term placements are affected. The Nationalbank's total interest-rate sensitivity thus remains unaffected by changes in the foreign-exchange reserve. This can be attributed to two factors. Firstly, changes in the foreign-exchange reserve do not affect the net capital. As stated above, changes in the foreign-exchange reserve are set off by changes in either the banks' net position or the central government's account. Secondly, an increase in the foreign-exchange reserve does not improve the Nationalbank's earnings capacity. In other words: the Nationalbank's ability to absorb losses is not affected by changes in the foreign-exchange reserve.

Exchange-rate risk

The Nationalbank cannot avoid the exchange-rate risk associated with fluctuations in the krone rate. This risk is closely associated with the Nationalbank's foreign-exchange reserve. Since the krone is closely linked to the euro via the ERM II agreement, this unavoidable risk can be seen as the risk of a strengthening of the krone vis-à-vis the euro, which will – in isolated terms – inflict a loss on the Nationalbank.

On the other hand, the Nationalbank can avoid the exchange-rate risk related to the fluctuation of the euro vis-à-vis e.g. the dollar. This is achieved by maintaining a low sensitivity to other currencies than the euro.

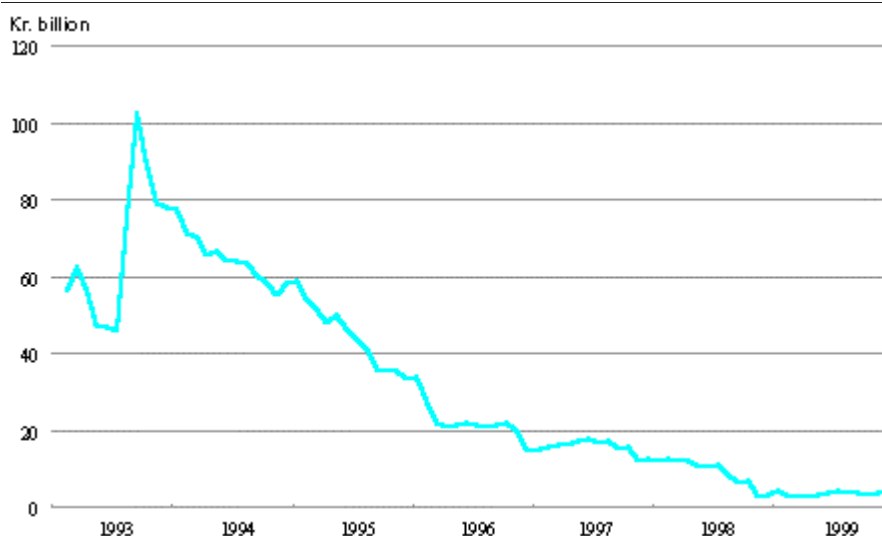
As the central government's foreign-exchange-denominated debt is raised primarily to provide the Nationalbank with an adequate foreign-exchange reserve, and as the Nationalbank's profit is transferred to the central government, since 1992 the currency distribution applied by the Nationalbank and the central government has been subject to coordinated management. This eliminates large-scale fluctuation in the total risk to the central government and the Nationalbank on the central government's raising or repayment of loans. The composition of the total foreign-exchange-denominated placements (or foreign-exchange debt) of the central government and the Nationalbank is determined jointly by the Nationalbank and the Ministry of Finance. The basic principle is that the net placements of the central government and the Nationalbank taken as one shall be subject to a limited exchange-rate risk in addition to the inevitable risk exposure vis-à-vis the euro.

The gross exposure of the Nationalbank and the central government to other currencies than the euro is determined within the framework for net placements.

In step with the repayment of the central government's loans, especially in dollars, throughout the 1990s and in view of the improved placement opportunities on the European markets, the Nationalbank's

THE NATIONALBANK'S EXPOSURE TO NON-EURO CURRENCIES

Chart 1



Note: Before 1999 euro currencies consist of ECU and the national currencies of the euro area member states. The Nationalbank's exposure in these currencies is not included.

exposure in non-euro area currencies has been reduced sharply, cf. Chart 1.

As stated in the section on interest-rate risk, a proportion of the foreign-exchange reserve is placed in the financial markets of the USA, Japan and the UK. To ensure a low exchange-rate risk dollars, yen and pounds sterling are sold forward against euro, so that by far the largest proportion of the foreign-exchange exposure is denominated in euro, cf. Table 6, while the interest-rate sensitivity is spread across several markets.

FOREIGN-EXCHANGE EXPOSURE OF THE NATIONALBANK

Table 6

Market value, kr. billion	End-1998, net	End-1999		
		Placements	Forward contracts	Net
Euro ¹	109	110	55	164
Pound sterling	0	12	-11	1
Swiss franc	-1	0	0	0
Dollar	2	38	-38	0
Yen	-1	11	-9	2
Gold	4	5	0	5
Total	111	174	-3	172

Note: Negative net amounts indicate that the Nationalbank holds liabilities.

¹ For 1998 euro comprises ECU and the sum of the national currencies of the euro area member states.

As a general rule the sole effect of the Nationalbank's sale or purchase of foreign exchange is a change in the euro exposure. This ensures that the "voluntary" exchange-rate risk remains unchanged.

The Nationalbank also holds a stock of gold. The associated risk is not hedged¹.

Liquidity risk

Naturally, the foreign-exchange reserve must be available if there is a need to support the krone. The reserve is therefore placed in securities which can quickly be converted to liquid funds available for intervention. Part of the reserve is held as bank deposits. Placements in bonds are spread across various liquid markets. Certain bonds can thus still be sold, even if there are liquidity problems in individual markets. Finally, investments are also made in bonds with a high credit rating which can be pledged as collateral for loans, cf. below. In this way the bonds can be used to obtain liquid funds, even though they are not sold. The Nationalbank has entered into agreements with several international banks, so that bonds can quickly be provided as collateral for loans. This also ensures that the interest-rate risk is not necessarily affected should bank deposits prove insufficient.

Another element of the liquidity reserve is the central government's Commercial Paper programme which is administered by the Nationalbank. This credit facility can provide credit of up to USD 12 billion at short notice. In accordance with the ERM II agreement, the Nationalbank also holds an automatic borrowing right at the ECB should the krone reach the fluctuation limit vis-à-vis the central rate.

Credit risk

The Nationalbank may suffer losses if a counterparty defaults on its obligations. This is called the credit risk. Unlike commercial financial institutions the Nationalbank does not pursue the objective of gaining a profit by undertaking a credit risk. Commercial financial institutions must expect that some of their customers (counterparties) will default and thereby cause credit losses. By comparison, the objective of the Nationalbank's credit-risk management is to avoid credit losses.

The credit-policy objective is addressed in three ways. Firstly, the Nationalbank uses counterparties with a high credit standing. In the assessment of counterparties' credit standing very great importance is attached to the ratings published by well-reputed international rating agencies. Secondly,

¹ The Nationalbank's gold stock is described in further detail in Ulrik Bie and Astrid Henneberg Pedersen, *The Role of Gold in the Monetary System*, Danmarks Nationalbank, *Monetary Review*, 3rd Quarter 1999.

the placements are spread across various highly-rated counterparties. Thirdly, to a large extent collateral for the Nationalbank's claims is required.

The *foreign-exchange reserve* is placed in bonds and bank deposits. Only bonds issued by highly rated states or by units which are either explicitly or implicitly guaranteed by such states are purchased. Deposits are made only with banks with a suitably high rating at relatively short maturities. To supplement the high rating requirements, agreements on the provision of collateral have been concluded with a number of banks. In recent years the placement pattern has shifted towards a larger proportion of collateralised bank deposits by the Nationalbank, cf. Table 7.

The Nationalbank has accounts with certain international organisations such as the International Monetary Fund (IMF) and the Bank for International Settlements (BIS) which are unrated, but are regarded as counterparties with a very high credit standing. The account with the IMF reflects the Nationalbank's international commitments.

The *domestic portfolio* is placed in Danish central-government bonds as well as mortgage bonds and similar bonds of a high credit quality.

The Nationalbank is also exposed to a credit risk in connection with monetary-policy operations whereby the banks may raise short-term loans, as well as settlement transactions with intraday drawings on the Nationalbank, and the banks' cash depots. This risk is managed via a collateral requirement.

QUANTIFICATION OF FINANCIAL RISKS

Tables 5, 6 and 7 show the Nationalbank's sensitivity to interest-rate, exchange-rate and credit factors, which all contribute to the Nationalbank's financial risk. However, the sensitivity is not the sole indicator of the Nationalbank's risk of losses due to changes in these factors. Evaluating the Nationalbank's risk profile is fairly complicated since besides the sensitivity measures it also requires an assessment of the probability of future changes in respectively interest-rate, exchange-rate and credit factors.

The risk of losses also depends on the future covariation between the various risk factors. A low covariation allows the Nationalbank to reduce the risk of losses by diversifying its placements on various markets. In this situation there is little probability of losses on one market occurring simultaneously with losses on another. On the other hand, a high covariation often implies that losses on one market coincide with losses on another, so that diversifying the portfolio will not significantly reduce the total risk.

TOTAL CREDIT EXPOSURE ON THE FOREIGN-EXCHANGE RESERVE
AND THE DOMESTIC SECURITIES PORTFOLIO, ETC. END-1999

Table 7

Kr. billion	Bonds		Bank accounts		Supra-national institutions	Total
	Governments	Other	Collateralised	Uncollateralised		
Aaa	51.3	15.3	0.0	4.1	2.7	73.4
Aa1	13.5	0.7	-	3.0	-	17.2
Aa2	2.1	1.5	3.4	6.6	-	13.5
Aa3	12.3	12.7	21.1	17.3	-	63.4
A1	-	-	0.9	2.9	-	3.8
A2	-	-	-	3.0	-	3.0
A3	-	-	0.2	-	-	0.2
No rating	-	5.4 ¹	0.9	0.0	22.4 ²	28.8
Total	79.1	35.7	26.6	36.8	25.1	203.3

Note.: Moody's credit rating is used. The scale extends from Aaa to D, where Aaa is the highest credit rating. For more details of ratings reference is made to Kristian Sparre Andersen and Anders Matzen, The Use of Ratings in the European Capital Markets, cf. Danmarks Nationalbank, *Monetary Review*, 3rd Quarter 1998.

¹ Individual Danish mortgage-credit institutes and similar.

² Covers solely BIS and IMF.

During the last 10 years there has been considerable development of methods for quantification of risks. This applies especially to the quantification of market risks, i.e. the risk of losses due to changes in interest and exchange rates. Extensive data is usually available on the historical development of interest rates and exchange rates, which can be applied to statistical analyses. However, extensive data does not guarantee that the future pattern of fluctuation will follow the historical pattern.

There is no unequivocal measure for compilation of the total market risk. Therefore various different market risk measures should be considered in order to gain an impression of the probable losses with the current or other portfolio compositions.

It is far more difficult to quantify credit risk than market risk. The primary reason is that it is more difficult to quantify the probability of credit losses, not least vis-à-vis counterparties of a high credit quality.

Value-at-Risk

The most common measure of market risk is Value-at-Risk (VaR), which shows the maximum loss for a given period, with a given probability.

The Nationalbank calculates two different VaR measures – analytical and historical VaR. The horizon chosen is 1 year, which allows for comparison of the VaR estimates with annual earnings.

The *analytical VaR* is calculated on the basis of estimated correlations between and volatilities of (in principle) all relevant financial variables.

Combined with data on the composition of the Nationalbank's portfolio an estimate of the bank's analytical VaR is achieved.

Analytical VaR presents several methodological problems. A general problem is that a normal distribution of price changes on the financial variables is assumed. Experience shows otherwise since in practice the "tails" are thicker than those of the normal distribution. The risk of large losses thus tends to be underestimated in these calculations.

A more specific problem in relation to the Nationalbank is the horizon for the VaR estimate. The applied correlations and volatilities received from an external supplier are typically calculated on the basis of the immediate past, so that observations which are older than three months are insignificant. However, as stated, for the Nationalbank a risk horizon of 1 year has been chosen. In other words, the risk is evaluated on the basis of a significantly shorter data history than the horizon for the VaR estimate.

The *historical VaR* is calculated on the basis of the actual development in interest and exchange rates over a number of years. Specifically, the change in interest rates (distributed on 1-year maturity segments) and exchange rates is calculated from the end of one period to the end of the following period. On the basis of the Nationalbank's portfolio structure at end-1999 the Nationalbank's value adjustment can then be calculated using these changes in interest and exchange rates. Based on data for the period 1991-2000 110 independent monthly value adjustments are calculated, sorted by size and annualised. The 5-per-cent fractile in the resulting distribution (corresponding to the 6th largest loss) is the historical VaR with a significance level of 95 per cent and a horizon of 1 year.

One weakness of this method is that it does not fully capture structural shifts in volatility or correlations over time. The development in interest and exchange rates 5-10 years ago is considered to be just as representative of the future as the development in the most recent year.

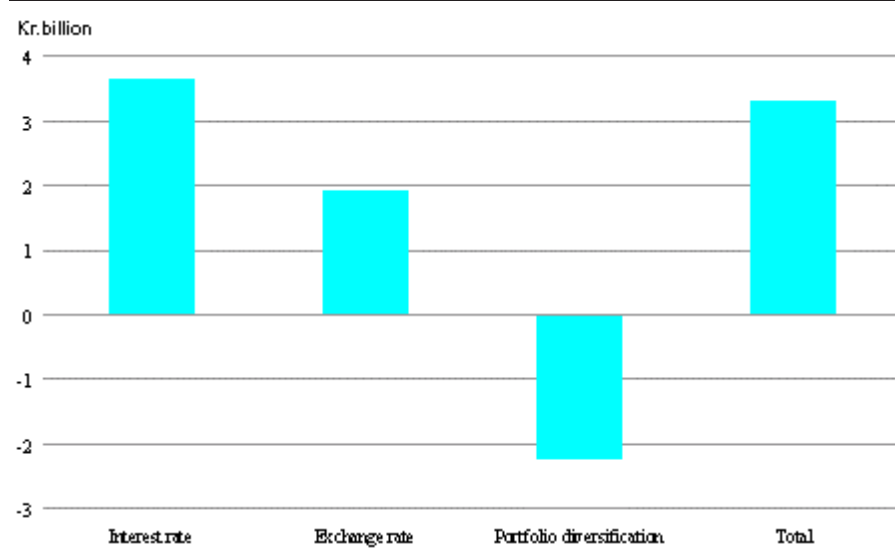
Despite their weaknesses both VaR measures are found to make a significant contribution to the calculation of the Nationalbank's market risks. The key results are shown in Table 8. It appears that, excluding

Level of significance 95 per cent, 1-year horizon Kr. billion	Analytical	Historical	
	Excl. gold ¹	Excl. gold	Incl. gold
Incl. krone/euro risk	3.3	5.2	5.0
Excl. krone/euro risk	3.2	3.3	3.7

¹ At present, it is not possible to include gold in the calculation of analytical VaR.

CONTRIBUTIONS TO ANALYTICAL VALUE-AT-RISK

Chart 2



gold, analytical VaR amounted to kr. 3.3 billion at end-1999. This means that, based on analytical VaR, with a probability of 95 per cent the Nationalbank's maximum capital loss will be kr. 3.3 billion over the coming year. In autumn 1998, when the financial market unrest after the crisis in Russia was at its peak, analytical VaR amounted to kr. 7.2 billion, but has subsequently declined gradually as markets have become more stable.

Most of the analytical VaR can be attributed to the risk associated with the development in interest rates, cf. Chart 2. The chart also shows that the Nationalbank's VaR is reduced significantly by portfolio diversification.

The historical VaR, excluding gold, is at kr. 5.2 billion higher than the analytical VaR. This can be attributed primarily to the considerably greater volatility of the krone/euro risk in the first half of the 1990s than in recent years. Especially the currency unrest in Europe in 1992-93 and again in 1995 plays a role.

In view of the fixed-exchange-rate policy the krone/euro risk is not a traditional market risk. For as long as this policy is pursued the risk in real terms is zero in the longer term – despite small day-to-day fluctuations. Furthermore, unlike almost all other financial entities, the Nationalbank not only has the opportunity, but also the obligation, to influence the course of the krone/euro exchange rate. Only a strengthening of the krone vis-à-vis the euro will entail a loss for the Nationalbank.

The krone/euro risk is thus an inherent risk which it can be advantageous to isolate when calculating the Nationalbank's VaR. This implies only a marginal reduction of the analytical VaR, while the historical VaR

decreases by 30-40 per cent. The VaR estimates for the two methods are thereafter of the same size at kr. 3-3.5 billion.

Gold can be included in the calculation of historical VaR. However, the effect on the result is modest, even though gold is among the assets on the Nationalbank's balance sheet associated with the greatest market risk. Inclusion of gold even reduces VaR slightly in the calculation, which includes the krone/euro risk, cf. Table 8. This result should be interpreted with caution as the effect of gold – due to the limited number of observations – is sensitive to the choice of percentile. In more general terms, however, the calculations reflect a relatively low correlation between the price of gold (in kroner) and the price of the other financial variables. In other words, gold contributes less to the risk than would appear at first sight.

Stress scenarios

The VaR estimates provide information on the general risk of losses, but not about losses in the extreme cases (in the extreme left-hand "tail" of the distribution of value adjustments). Stress scenarios are useful in this respect.

Stress scenarios are calculation examples whereby the consequence of an extreme market development is investigated. Naturally, the results of stress scenarios depend on the degree of stress applied. The scenarios must be extreme, while still appearing realistic.

The approach taken here is to consider the historical development in interest and exchange rates in the period 1991-2000 and to identify particularly unfavourable periods. On the basis of the portfolio composition at end-1999 the estimated loss to the Nationalbank is calculated in the event of an identical development. Three concrete scenarios have been specified.

1. The annual period which would give the greatest total interest-rate and exchange-rate losses.
2. The annual period which would give the greatest total interest-rate loss, combined with the annual period which would give the greatest total exchange-rate loss. The losses do not have to coincide.
3. The annual period which for each 1-year maturity segment in each currency would give the greatest interest-rate loss, combined with the annual period which for each currency would give the greatest exchange-rate loss. The losses do not have to coincide.

The three scenarios result in total capital losses of kr. 11-17 billion, cf. Table 9. The largest loss is the result of a general increase in interest

STRESS SCENARIOS, END-1999 Table 9

Kr. billion	Incl. krone/euro risk			Excl. krone/euro risk		
	Total loss	Interest-rate loss	Exchange-rate loss	Total loss	Interest-rate loss	Exchange-rate loss
Scenario 1	10.8	3.8	7.0	7.4	6.5	0.9
Scenario 2	13.7	6.6	7.0	8.0	6.6	1.4
Scenario 3	16.8	8.4	8.4	10.6	8.4	2.1

rates by 2-3 percentage points, combined with a strengthening of the krone by approximately 4 per cent.

Like the calculations of VaR the stress scenarios are affected by the krone/euro risk, and especially by the gradual strengthening of the krone after its weakening in August 1993. If this factor is disregarded the loss is considerably lower.

Summary

The Nationalbank's net capital was kr. 42 billion at the end of 1999 and the Nationalbank's core earnings are in the range of kr. 3 billion per year. The bank's credit risk can be described as very modest. Against this background a maximum loss on interest and exchange rates (excluding krone/euro movement) of approximately kr. 3.5 billion in 19 out of 20 years is no source of concern.

The stress scenarios result in major losses, but do not pose a serious threat to the bank's net capital. In the most extreme and very unlikely of the scenarios described the loss amounts to approximately 40 per cent of the bank's net capital. For comparison, in 1994, when the Nationalbank's dollar exposure was considerably greater than today, the capital loss amounted to 30 per cent of the net capital.

The overall conclusion is that the Nationalbank is exposed to a fairly moderate market risk and that the total risk profile can be characterised as prudent.

Management of the Interest-Rate Risk on the Foreign-Exchange Reserve (Monetary Review – 1st quarter 2001)

Peter Kjær Jensen, Financial Markets

INTRODUCTION

At the close of 2000 the foreign-exchange reserve was kr. 122 billion. It is thus a significant element of Danmarks Nationalbank's balance sheet. The primary purpose of the foreign-exchange reserve is to make it possible to intervene, i.e. buy or sell foreign exchange against kroner, so as to influence the krone rate in the required direction in the short term.¹ As a consequence of intervention, the foreign-exchange reserve can fluctuate a great deal within short periods.

The foreign-exchange reserve is invested mainly as bank deposits and in bonds. The key factor determining investments is the requirement to keep the liquidity and credit risks low, so as to keep a readily available stockpile of foreign currency that can be used for intervention purposes. Provided that this condition is fulfilled, the objective is to achieve a high return. As a consequence, part of the foreign-exchange reserve is placed in fixed-yield bonds entailing a certain element of interest-rate risk. Although there is a risk of capital losses, in the long run higher earnings are expected.

A key element of the Nationalbank's risk management is the consideration of all balance-sheet items as one.² The level of the Nationalbank's interest-rate risk is thus assessed on an overall basis for all balance-sheet items, and not in isolated terms for e.g. the foreign-exchange reserve. In this article, the management of the interest-rate risk on the foreign-exchange reserve within the overall framework is described.

¹ The role of intervention in monetary and exchange-rate policy is described in *Danish Monetary Policy*, (in Danish) Danmarks Nationalbank, 1999.

² See Ib Hansen and Christian Ølgaard, Danmarks Nationalbank's Risk Management, Danmarks Nationalbank, *Monetary Review*, 2nd Quarter 2000.

OVERALL PRINCIPLES FOR MANAGEMENT OF INTEREST-RATE RISK

Why does the Nationalbank assume an interest-rate risk?

In historical terms, long-term interest rates have been higher on average than short-term interest rates. In other words, during a certain period higher earnings could be obtained from investing in long-term bonds than from placements at variable interest rates, e.g. short-term bank deposits. Moreover, the credit risk can be reduced by making placements in government bonds, rather than as bank deposits.

The Nationalbank has therefore placed a proportion of its assets, including the foreign-exchange reserve, in fixed-yield bonds. This presents the risk of capital losses in certain periods, although over a longer time frame higher earnings are expected. The Nationalbank could avoid this risk by placing the funds solely in assets at variable interest rates. However, the risk is considered to be reasonable compared to the yield premiums that can be achieved.

Interest-rate risk and the size of the foreign-exchange reserve

The level of risk is evaluated in relation to the Nationalbank's ability to absorb losses, i.e. in terms of earnings and the size of the own capital. The basis for evaluation of the risk is therefore the total balance sheet, and not e.g. the foreign-exchange reserve alone. This means that fluctuations in the foreign-exchange reserve as such ought not to affect the level of interest-rate risk. The reason is that changes in the foreign-exchange reserve will typically correspond to an equivalent change in the Nationalbank's liabilities at variable interest rates.¹ The ability to absorb losses is thereby unchanged, so there is no need to increase the total interest-rate risk of the Nationalbank. This is maintained at a constant level since as for liabilities changes in the foreign-exchange reserve take place as movements in instruments with short-term interest rates.

On the other hand, if the amount by which the foreign-exchange reserve is augmented is placed in fixed-yield bonds, the Nationalbank's "gearing" will be higher, since the risk will increase in proportion to the own capital.

Concept of krone duration

The overall target by which the Nationalbank's interest-rate risk is managed is *krone duration*. The krone duration of a portfolio is its duration

¹ See Peter Kjær Jensen, The Foreign-Exchange Reserve, Danmarks Nationalbank, *Monetary Review*, 1st Quarter 1999 for a description of how the Nationalbank's balance sheet is affected by interventions and foreign borrowing by the central government.

multiplied by its market value.¹ The krone duration can be interpreted as the loss measured in kroner if all interest rates were to increase by 1 per cent. This target thus captures parallel shifts in the term structure of interest rates.

When the interest-rate risk is managed by a constant krone-duration target, fluctuations in the foreign-exchange reserve will not affect the interest-rate risk. When the foreign-exchange reserve increases, the krone duration is only held at a constant level if the increase is placed at zero duration, i.e. in the money market. On the other hand, a constant duration of the foreign-exchange reserve would entail that the Nationalbank's interest-rate risk would increase with an augmentation of the foreign-exchange reserve.

The krone duration does not indicate the probability of a given change in interest rates, so it is not a risk measure as such. Instead, the krone duration can be considered as a measure of the Nationalbank's sensitivity to parallel shifts in the term structure of interest rates.

Determining the level of krone duration

At the end of 2000 the Nationalbank's krone-duration target was kr. 3.4 billion, distributed mainly between the foreign-exchange reserve and the Nationalbank's holdings of krone-denominated bonds. At the end of 2000 the krone duration of the foreign-exchange reserve was kr. 1.8 billion.

The krone-duration target is fixed on the basis of an assessment of the overall financial risks to the Nationalbank, and it is ensured that these are at an acceptable level, in order to safeguard the Nationalbank's financial capability. Since krone duration, as previously stated, is a measure of the sensitivity of the Nationalbank to fluctuations in interest rates, it does not in itself indicate the size of the losses that might be incurred. The principal tools to evaluate the latter are Value-at-Risk and stress testing. Value-at-Risk is a measure of the losses which fluctuations in interest and exchange rates impose on the Nationalbank at a given probability. Experience shows that Value-at-Risk does not capture extreme cases. Stress tests are therefore used as a supplement. They entail that the current balance-sheet structure is compared to historic extreme fluctuations in interest and exchange rates.²

Decision-making process

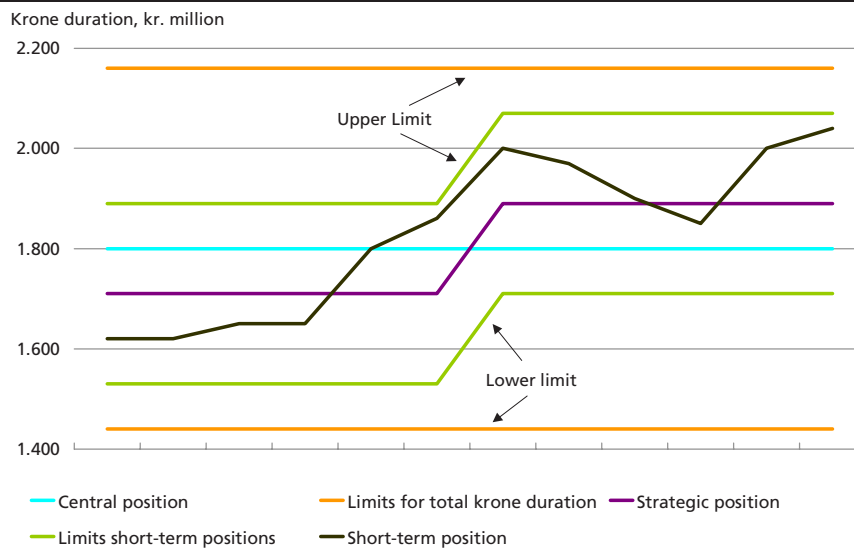
The aforementioned krone-duration target for the foreign-exchange reserve expresses the trade-off between yield and risk in the long term.

¹ The *modified duration* is used. The modified duration of a bond is an approximation to the percentage change in price on a fluctuation in interest rates by 1 per cent.

² The use of Value-at-Risk and stress tests to determine the Nationalbank's sensitivity to fluctuations in interest rates is presented in Ib Hansen and Christian Ølgaard, Danmarks Nationalbank's Risk Management, Danmarks Nationalbank, *Monetary Review*, 2nd Quarter 2000.

FLUCTUATION BANDS FOR KRONE DURATION

Chart 1



Note: The Chart is a theoretical example of krone duration over time.

At least once a year the Board of Governors approves the overall level of the Nationalbank's total krone duration and the distribution thereof on the foreign-exchange reserve and the portfolio of domestic securities.

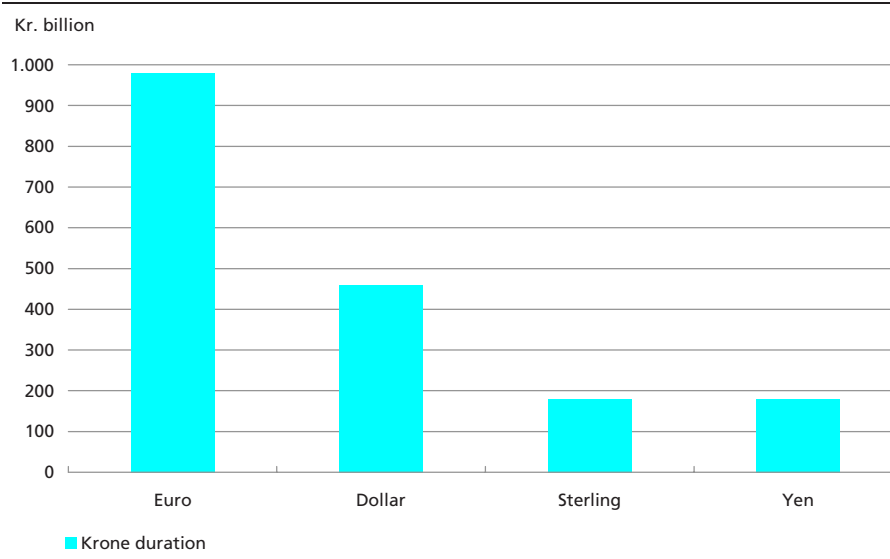
The Nationalbank's actual krone duration may deviate from the central target. This takes place in two stages within a framework which is likewise approved by the Board of Governors, cf. Chart 1. The first stage is a strategic position reflecting expectations of the development in interest rates in the long term. The positions are reviewed on a monthly basis. The second stage reflects short-term positions handled by the portfolio managers responsible for the day-to-day placement of the foreign-exchange reserve. The actual krone duration is thus the sum of the central target and the two positions.

BENCHMARK FOR PLACEMENT OF THE FOREIGN-EXCHANGE RESERVE

For a given krone duration, appropriate risk diversification is required. This entails that the chosen level of krone duration is distributed on currencies and maturities. Diversification of both the interest-rate and liquidity risk is thus ensured. Together these distributions form the overall structure of the benchmark for placement of the foreign-exchange reserve. The actual benchmark is then found by allocating market values to specific bonds and money-market placements in the chosen currencies and maturities, so that the total market value of these securities corresponds to the size of the foreign-exchange reserve.

Krone DURATION BY CURRENCY, END-2000

Chart 2



The Nationalbank has designed its own benchmark for the foreign-exchange reserve. Alternatively, an index from e.g. one of the major investment banks could be chosen. However, they present the disadvantage that they are managed according to the issuers' preferences with regard to e.g. maturity. By constructing its own benchmark the Nationalbank can choose the placement strategy for the foreign-exchange reserve more actively.

Distribution of krone duration by currency

The ratio between yield and risk can be improved by spreading the krone duration into additional currencies, i.e. the expected risk of a given krone duration can be reduced by diversifying the placements. The smaller the degree of co-variation between the interest rates of the currencies in which the reserve is placed, the greater the diversification gain. Distribution on several currencies also spreads the liquidity risk.

The foreign-exchange reserve is placed in four currencies: euro, dollar, sterling and yen.¹ These currencies are chosen because the euro-area member states, and the USA, the UK and Japan have the most liquid bond markets, and are nations with a high credit standing. The four areas comprise the world's largest economies, and they are also the economies with which the Nationalbank is most familiar. Investment management re-

¹ There may be placements in certain other currencies, but these are small compared to the placements in the stated four currencies.

quires knowledge of the trends in the areas' financial markets, but on the other hand also contributes to accumulating this expertise.

More than half of the krone duration is taken in the euro market, cf. Chart 2. Since the krone is linked to the euro as a consequence of the fixed-exchange rate policy, it is natural for a large proportion of the foreign-exchange reserve to be placed in euro. A substantial share of the krone duration is taken in dollars. The US bond market is the most liquid, and intervention in dollars is a possible alternative to euro. The remaining 20 per cent of the krone duration is distributed equally between sterling and yen. These mainly contribute to diversifying the interest-rate and liquidity risk.

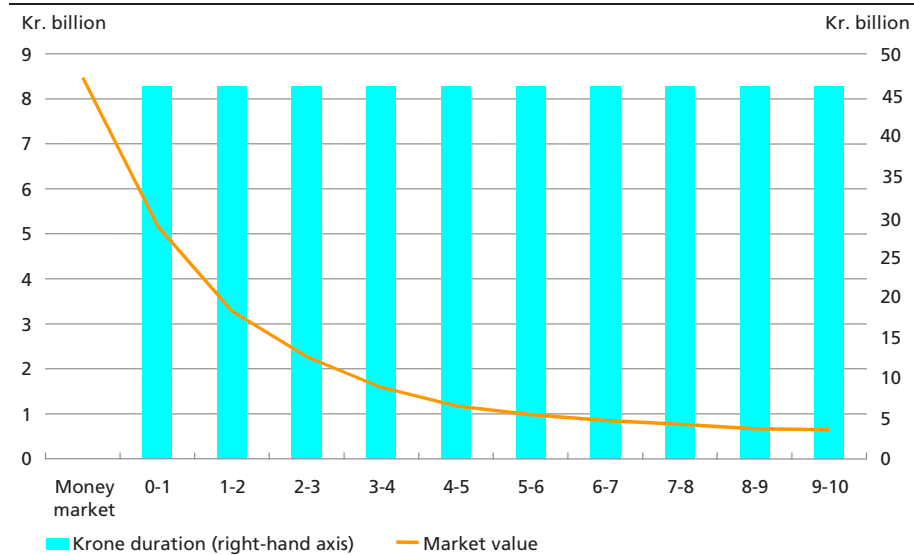
Distribution of krone duration by maturity

For each of the four principal currencies the krone duration is distributed on maturities between 0 and 10 years. The maturities are divided into 1-year ranges and each is allocated a proportion of the total krone duration. The market value in a given range is calculated as the krone duration divided by the duration. The remainder is placed as bank deposits at variable interest rates.

Chart 3 illustrates the correlation between market value and krone duration, using the dollar portfolio as an example. There is equal krone duration in each of the 10 maturity ranges, i.e. kr. 46 million. For larger maturities, all else being equal the duration of a bond will be greater,

EXAMPLE OF THE DISTRIBUTION OF KRONE DURATION AND MARKET VALUE BY MATURITY

Chart 3



and the market value to achieve a given duration will be smaller. Hence, the equal distribution of krone duration entails that market value decreases with maturity. The market value of the money-market placements is determined as the total placements of kr. 26 billion less the placements in bonds at kr. 17 billion, i.e. around kr. 8.5 billion.

In principle, the objective is equal distribution of the interest-rate risk across the yield curve, i.e. analogous to the distribution in Chart 3. One interpretation of this is that the foreign-exchange reserve is equally sensitive to interest-rate fluctuations throughout the yield curve between 0 and 10 years. Even though the concept of krone duration in itself is a measure of sensitivity to parallel shifts in the term structure, the distribution across the curve implies that a choice is made in the benchmark in terms of sensitivity to interest-rate fluctuations at various maturities.

The size of the total investments in a currency is determined so as to achieve a suitable level of money-market placements. For sterling and yen, this means that positions can be taken. An increase in the krone duration in relation to the benchmark can be achieved by increasing the bond portfolio at the expense of the money-market placements. A slightly higher level of money-market placements in dollars is chosen, in view of the dollar's role as an intervention currency.

As an element of the intervention reserve, the money-market placements in euro are at a certain level. Normally, the interventions will exclusively entail movements in these placements. If the money-market placements in euro decline, they can be increased by e.g. changing the maturity distribution of the krone duration. By increasing the krone duration at the long-term end and reducing it at the short-term end, funds are released from the bond market, because a given krone duration is achieved with a smaller market value at the long-term end than at the short-term end, cf. Chart 4.

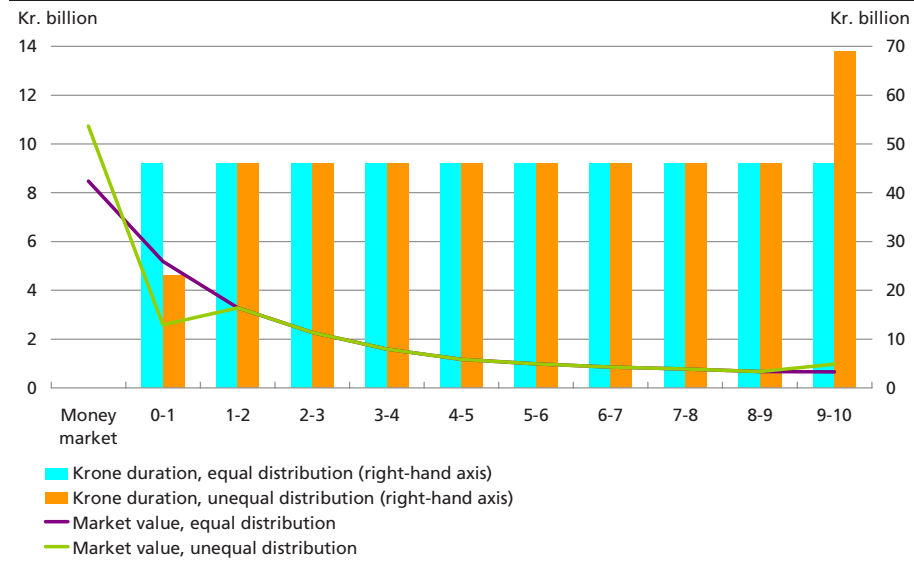
These adjustments of the benchmark have been used from time to time, as required by money-market placements.

The securities in the benchmark

For each currency one or, if appropriate, several papers in each maturity range is chosen. The weight of a given paper in the benchmark is the market value in the maturity range as a ratio of the total market value. The reduction of remaining maturity means that the duration is reduced slowly, so the market value in a paper must be increased gradually, in order to keep the krone duration constant. This re-balancing of the securities' weights takes place on a daily basis. When a paper approaches

EXAMPLE OF THE EFFECT ON THE MATURITY DISTRIBUTION OF MARKET VALUES OF A CHANGE IN THE DISTRIBUTION OF KRONE DURATION

Chart 4



the lower end of the maturity range, a new paper with a remaining maturity at the top end of the range is found.

The benchmark portfolio exclusively comprises government securities. The Nationalbank's credit policy for the foreign-exchange reserve is that placements are made only in bonds issued by central governments, government-guaranteed entities and supranational institutions. Among these issuers, government bonds are the best source of securities in all maturity ranges. This ensures a uniform selection of securities across the range of currencies and maturities.

The euro-denominated portfolio is rather special, since the euro is a currency union between several countries, so that placements denominated in euro can be spread across several countries. The benchmark for the euro currently includes German, French and Italian securities in each maturity range. The number of countries is kept at three in order to maintain a relatively simple benchmark. The three countries were chosen on account of market liquidity, as well as opportunities for favourable yields.

POSITIONS AND CALCULATION OF PERFORMANCE

The benchmark is a portfolio which reflects the overall decisions concerning interest-rate risk. On the other hand, it is not necessarily a precise reflection of the actual placement of the foreign-exchange reserve,

since within a certain framework there can be deviations from the benchmark. So it is possible to take positions of various types vis-à-vis the benchmark.

The positions can be divided into three categories, which are reviewed below. The actual portfolio is usually a combination of the three types of position.

Krone-duration positions

Krone-duration positions are changes in the krone duration from the central target. The strategic positions are taken only by changing the krone duration in the 9 to 10-year maturity range. This ensures simplicity in the implementation of the positions. The strategic positions are thus also taken on the basis of an evaluation of the development in the 10-year yields.

The portfolio managers in charge of the day-to-day positions can take krone-duration positions across the yield curve. There are no limitations to maturity either, i.e. placements can be in bonds with a longer remaining maturity than 10 years.

Curve positions

Since the portfolio managers are to decide where on the yield curve they wish to take a krone-duration position, in reality a curve position is also taken. It is also possible to take curve positions exclusively, whereby the krone duration is increased in one range and reduced in another, while the total krone duration is held constant. A position of this type expresses the expectation of a change in the slope of the yield curve. There are limits for the proportions of krone duration in each range. It is thus not possible to place all of the krone duration in one or two maturity ranges.

Choice of securities

The final opportunity to deviate from the benchmark is by buying other securities than those represented in the benchmark. These might be other government bonds, or bonds issued by government-guaranteed entities or supranational institutions. The opportunities are limited by the credit rules and a list of eligible instruments.

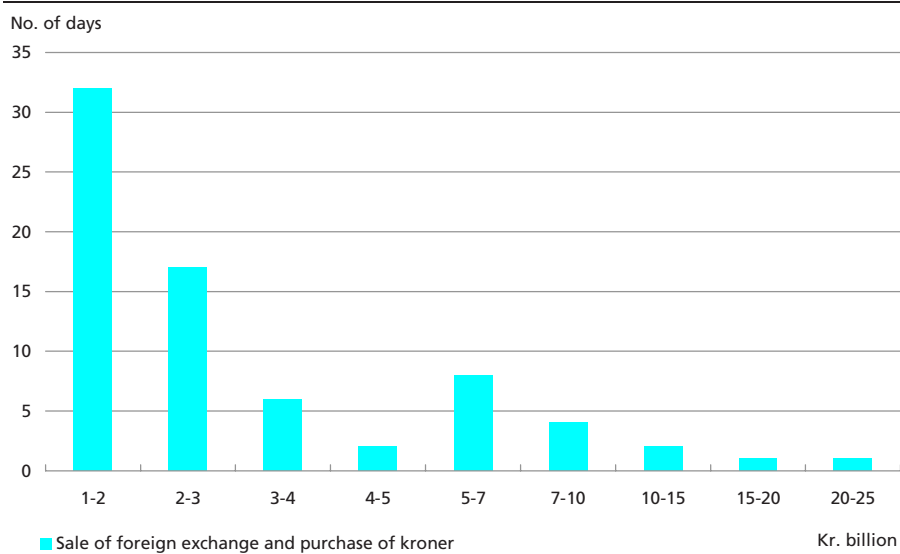
Performance measurement

Performance is the difference between the returns on the benchmark and on the actual placement of the foreign-exchange. This is compiled for each of the four currencies and divided into contributions from the strategic positions and from the individual portfolio managers' positions.

Daily yields are calculated, with due account being taken of changes in the size of the portfolios, e.g. as a consequence of interventions, so that

DAY-TO-DAY INTERVENTION SALES OF FOREIGN EXCHANGE
DISTRIBUTED BY SIZE, 1991-2000

Chart 5



Note: Intervention for less than kr. 1 billion is not included. Such intervention occurs frequently.

they do not affect performance. Performance is reported on a monthly basis.

CONSIDERATION OF OTHER RISKS

The interest-rate risk to the Nationalbank must be considered in the light of other financial risks and the related policies. The interaction with other types of risk is described below.

Liquidity reserve and interest-rate risk

The key factor to be taken into account on the placement of the foreign-exchange reserve is that it must be kept readily available for intervention purposes. To give an impression of the scale of interventions, Chart 5 presents the number of days in the period 1991-2000 on which the Nationalbank intervened on an intra-day basis for amounts in the given ranges. The Chart thus also covers the period of unrest in the EMS system in 1993 when the fluctuation band was increased and the Nationalbank intervened for considerable amounts.

The current level of the foreign-exchange reserve and the structure of the benchmark represent money-market placements for around kr. 40 billion. However, the figure varies a good deal, according to the size of the foreign-exchange reserve and the krone-duration level chosen. So quite extensive pressure on the krone is necessary before the money-market placements become insufficient, and other instruments

have to be used, even if intervention is required on several days within a short period.

If interventions entail a considerable decrease in the money-market placements, as stated it is possible to increase them by adjusting the maturity distribution of the krone duration.

Another instrument by which to procure liquidity for intervention purposes is to borrow against bonds as collateral. When bonds are collateralised, an agreement is concluded whereby the Nationalbank receives liquidity, while the counterparty receives the bonds as security. The Nationalbank assumes the risk of fluctuation in the price of the bond from the agreed re-delivery price during the period of the loan, so that the krone duration is not affected by the transaction.

As a consequence, the liquidity reserve is not a factor which imposes particular limits on the decision concerning the level of krone duration. However, it may limit the maturity distribution of the krone duration.

It should also be stated that the intervention reserve is not limited to the actual foreign-exchange reserve. The central government may increase its foreign borrowing. Among other things, the central government has access to commercial paper programmes whereby up to a total of USD 12 billion can be raised at short notice. Moreover, as part of the ERM II agreement the Nationalbank has access to ECB credit facilities if the fluctuation band of 2.25 per cent from the central rate is reached. The latter facility is perceived as a safety net and has not been used.

Trade-off between credit risk and interest-rate risk

The fixed krone-duration target entails that fluctuations in the foreign-exchange reserve are in short-term placements which mainly comprise accounts with banks. An increase in the foreign-exchange reserve will thus increase the credit risk to the Nationalbank. It can therefore be argued that the Nationalbank would have to increase the bond portfolio in order to reduce the credit risk, if the money-market placements are increased significantly. This can be done either by increasing the total krone duration or by taking a larger proportion of the krone duration at the short-term end of the yield curve.

Separation of exchange-rate risks and interest-rate risks

Holding a foreign-exchange reserve naturally entails exchange-rate risks. As a consequence of the fixed-exchange-rate policy vis-à-vis the euro the Nationalbank can keep the exchange-rate risk at a low level by primarily holding euro-denominated exposures. The Nationalbank will thus only incur exchange-rate losses if the krone strengthens against the euro.

THE FOREIGN-EXCHANGE ACCOUNTS OF THE NATIONALBANK,
END-NOVEMBER 2000

Table 1

Market value, kr. billion	Placements	Forward contracts	Net
Euro	70	57	126
Sterling	9	-7	2
Dollar	38	-40	-1
Yen	10	-9	1
Gold	5	0	5

Note: Negative amounts indicate liabilities. The value of SDR is distributed on the respective currencies.

However, the requirement to spread the interest-rate and liquidity risk also means that placements are made in other currencies than euro. To keep the exchange-rate risk independent of the placement, to a great extent the Nationalbank uses forward contracts to hedge the exchange-rate risks on placements in currencies other than euro, cf. Table 1.

The example below illustrates how the exchange-rate risk is hedged in practice.

At time t the Nationalbank holds a dollar-denominated bond. To hedge the exchange-rate risk on the bond a forward contract is concluded at time t . A forward contract is an agreement to exchange currency with a counterparty whereby the Nationalbank at time $t+1$ receives euro and delivers an amount in dollars equivalent to the value of the bond. The amount in euro received by the Nationalbank for the dollar payment at time $t+1$, i.e. the exchange rate between the euro and the dollar, is agreed at time t . The Nationalbank is therefore not exposed to fluctuations in the dollar/euro exchange rate from the exchange rate agreed with the counterparty.

At time $t+1$ the Nationalbank must pay dollars to the counterparty in the forward contract. However, the Nationalbank still wishes to hold the dollar bond, but without assuming an exchange-rate risk. Therefore, dollars are bought in the spot market to finance the payment under the forward contract, and at the same time a new forward contract equivalent to the first one is arranged, but with expiry at time $t+2$.¹

If the dollar strengthens against the euro between time t and $t+1$, in euro terms it has become more expensive to buy dollars in the spot market in order to fulfil the obligation under the first forward contract. In isolated terms, renewing the forward contract entails a loss, but it is set off by the increase in the value in euro of the dollar-denominated bond.

¹ The spot transaction and the new forward contract correspond to a currency swap.

The ongoing renewal of forward contracts therefore ensures effective hedging of the Nationalbank's exchange-rate risk.¹

In practice, many forward contracts are transacted with various counterparties in order to hedge e.g. the dollar risk. The expiry dates of the forward contracts are spread so that forward contracts are renewed on a more or less daily basis.

CONCLUSION

A proportion of the foreign-exchange reserve is invested in fixed-rate bonds. This increases the Nationalbank's earnings compared to placements exclusively in the money market. The interest-rate risk which investment in bonds entails is relatively small in proportion to the Nationalbank's resilience to losses. Investments are planned so as to keep other risks at an equivalent low level. Credit and liquidity risk are limited by making placements predominantly in bonds issued by central governments or government-guaranteed entities. The capability to intervene in the foreign-exchange market is thus not affected by the fact that a proportion of the foreign-exchange reserve is placed in bonds.

¹ See Ib Hansen and Christian Ølgaard, Danmarks Nationalbank's Risk Management, Danmarks Nationalbank, *Monthly Review*, 2nd Quarter 2000, and Danmarks Nationalbank, *Government Borrowing and Debt, 2000*, Chapter 8, for further discussion of the Nationalbank's management of exchange-rate risks.

The Foreign-Exchange Reserve (Monetary Review – 1st quarter 1999)

Peter Kjær Jensen, Financial Markets Department

INTRODUCTION

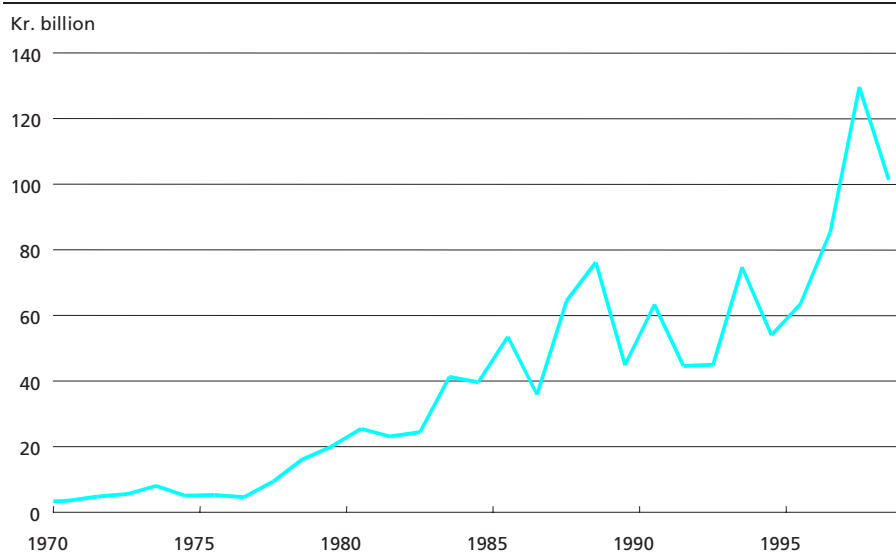
The foreign-exchange reserve consists primarily of the Nationalbank's holdings of foreign bonds and bank deposits. It provides the Nationalbank with a ready available stockpile of foreign currency that can be used for intervention in the foreign-exchange market, i.e. to purchase or sell foreign exchange against kroner in order to influence exchange-rate formation. The foreign-exchange reserve is thus a significant element of Denmark's fixed-exchange-rate policy. Although intervention may affect the krone rate, the most important instrument to maintain the krone rate is the interest-rate policy, and in a wider perspective a credible economic policy.

This article focuses on what the foreign-exchange reserve is (and is not) and the factors determining its size. The following issues are emphasised:

- The foreign-exchange reserve is only one means for the Nationalbank to obtain foreign exchange to support the krone. The central government may quickly borrow foreign exchange either via the short-term Commercial Paper programme or by actual long-term borrowing. Furthermore, the Nationalbank may intervene in the forward foreign-exchange market, which does not require an existing reserve of foreign exchange. Finally, under the ERM II agreement the Nationalbank has access to ECB credit facilities.
- Changes in the foreign-exchange reserve are not unequivocally associated with the development in Denmark's foreign debt. The debt is adjusted in accordance with the current-account balance and changes in the valuation of assets and liabilities.
- It is possible to bring down the central government's foreign debt by reducing the foreign-exchange reserve. However, the extent to which such measures are possible is limited by the requirements made of the balance of the central government's account with the Nationalbank.

The article first considers the development in the foreign-exchange reserve and the components of the foreign-exchange reserve.

 DEVELOPMENT IN THE FOREIGN-EXCHANGE RESERVE, 1970-98 Chart 1



Source: Danmarks Nationalbank, *Report and Accounts, 1970-1998*.

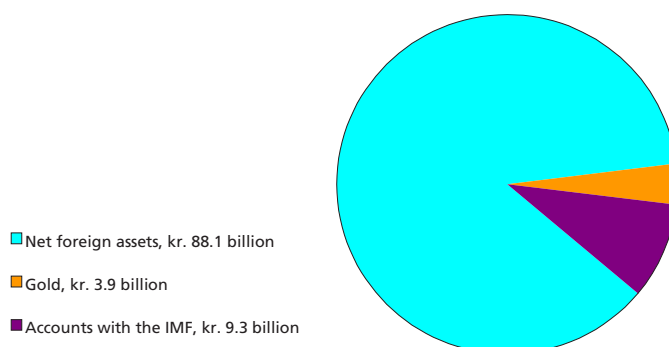
DEVELOPMENT IN THE FOREIGN-EXCHANGE RESERVE

The foreign-exchange reserve has increased strongly during the last 30 years, cf. Chart 1. This is also the case when the rate of inflation in that period is taken into account. At end-1998 the foreign-exchange reserve was kr. 101 billion.

Since the foreign-exchange reserve is the first buffer against fluctuations in the krone rate it varies quite considerably. The required level of the foreign-exchange reserve may also fluctuate broadly in step with market conditions. In periods of unrest there may be a need for a particularly large buffer. It is thus difficult to determine the optimum size of the foreign-exchange reserve.

To a certain extent the foreign borrowing by the central government acts as a buffer against fluctuations in the foreign-exchange reserve. In periods of unrest, when foreign currency is sold, loans in foreign exchange can be raised so as to ensure an adequate foreign-exchange reserve. In calmer periods when the Nationalbank is able to purchase foreign exchange, the central government's foreign debt is reduced as these loans fall due.

The increase in the foreign-exchange reserve in recent years reflects the Nationalbank's purchases of foreign exchange in order to maintain a stable krone rate. At the same time the need for a positive balance on



the central government's account with the Nationalbank has limited the scope to repay the central government's foreign debt, cf. below.

WHAT IS THE FOREIGN-EXCHANGE RESERVE?

The main component of the foreign-exchange reserve is the Nationalbank's deposits with foreign banks and the Nationalbank's holdings of foreign bonds. The reserve furthermore includes the Nationalbank's stock of gold, and its special drawing rights and reserve position with the International Monetary Fund (IMF). The Nationalbank's foreign liabilities, primarily the account of the European Commission and any utilised ECB credit facilities, are subtracted from the foreign assets.

The Nationalbank's forward purchases or sales of kroner, i.e. for future delivery, are *not* included in the compilation of the reserve. Foreign-exchange accounts with residents, which do not affect the Nationalbank's external position, are not included in the reserve either.¹

Chart 2 shows the individual components at end-1998. The item "Net foreign assets" comprises the bond portfolio and bank deposits, less the Nationalbank's foreign liabilities. At end-1998 this item amounted to kr. 88 billion of the total reserve of kr. 101 billion.

In view of the foreign-exchange reserve's function as a buffer in the event of unrest involving the krone, high liquidity is a particular place-

¹ An example of a foreign-exchange account with residents not included in the foreign-exchange reserve is the Nationalbank's lending in foreign exchange to the Danish Export Finance Corporation. Another example is the foreign-exchange swaps transacted between the Nationalbank and the Ship Credit Fund.

ment requirement. Another important criterion is that the credit quality of counterparties is high. Provided that these criteria are met, a high return is naturally also a central element.¹

TRANSACTIONS AFFECTING THE FOREIGN-EXCHANGE RESERVE

The foreign-exchange reserve is affected by the Nationalbank's purchase or sale of foreign exchange, while the foreign-exchange-denominated transactions between the banks and the rest of the private sector do not affect the reserve. There is thus no direct connection between a current-account deficit or surplus and the foreign-exchange reserve. A current-account deficit may very well be offset by capital imports, e.g. non-residents' purchase of krone-denominated bonds, without a need for the Nationalbank to intervene.

Intervention

Intervention denotes the Nationalbank's trading activities on the foreign-exchange market in order to stabilise the krone rate, and thereby includes both purchase and sale of foreign exchange against kroner. The primary purpose of the foreign-exchange reserve is thus to give the Nationalbank the opportunity to use intervention as an instrument to maintain a stable exchange rate between the krone and the euro. Purchases of kroner will thus tend to cause the krone to appreciate, whereas sales of kroner, i.e. purchases of foreign exchange, tend to weaken the krone.

A foreign-exchange reserve of a certain size in itself reinforces the credibility of the fixed-exchange-rate policy. The very fact that the Nationalbank may intervene should the exchange rate deviate excessively from the desired rate already helps to cushion exchange-rate fluctuations.

If there is a more sustained tendency for e.g. a weakening of the krone the Nationalbank's interest-rate policy is the central instrument. By raising short-term interest rates the Nationalbank can make it more attractive to invest in kroner. This will normally cause an inflow of foreign exchange, thereby easing the pressure on the krone.

The Nationalbank will intervene by trading foreign exchange with the banks. If non-residents e.g. resell krone-denominated bonds to Denmark they will usually convert the proceeds to foreign exchange at Danish banks. Unless the banks wish to adjust their foreign-exchange exposure they will then buy foreign exchange and sell kroner in order to restore their positions. Should this lead to a tendency for the krone to weaken,

¹ The guidelines for placement of the foreign-exchange reserve will be described in a later Monetary Review.

the Nationalbank may intervene by buying kroner from the banks against foreign exchange. The result of intervention is a change in the composition of the Nationalbank's balance sheet, whereby currency-denominated assets are reduced and krone-denominated assets increased. Denmark's total foreign debt is not affected, however. The debt is first and foremost determined by the current account's course, but also by value adjustments as a consequence of shifts in exchange rates and securities prices.

In the Nationalbank's accounts, the effect of intervention sale of foreign exchange is that the Nationalbank replaces foreign-exchange-denominated assets (a reduction of the reserve) with krone-denominated assets (an increase in the net position vis-à-vis the banks). Since interest rates in Denmark are higher than in the euro area, in isolated terms the Nationalbank's net income from interest will increase if the foreign-exchange reserve is reduced as a consequence of intervention. On the other hand, the Nationalbank's net income from interest decreases when foreign exchange is purchased and the reserve increases.

Reducing the foreign-exchange reserve is not the only way to obtain foreign exchange for intervention purposes. The central government may increase its foreign borrowing in order to increase the foreign-exchange reserve, cf. the next section on central-government borrowing.

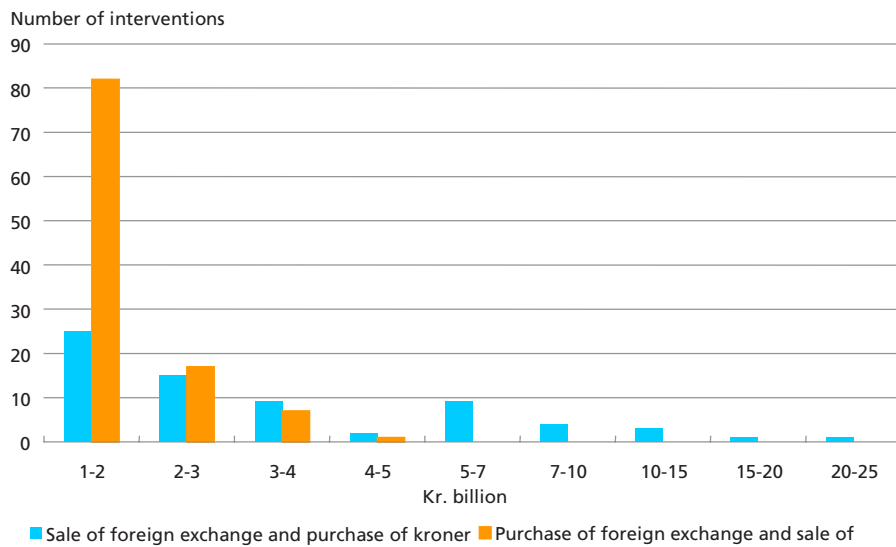
The Nationalbank may also intervene by forward purchases or sales of kroner. Forward intervention by the Nationalbank in the first instance affects neither the banks' net position with the Nationalbank nor the foreign-exchange reserve. This option was last used for a longer period of time in 1990-91, when the Nationalbank conducted forward sales of up to kr. 10 billion. This was to prevent the banks' net position with the Nationalbank from being positive in the banks' favour. With the monetary policy instruments available at that time this would have led to an inappropriate drop in interest rates. Since then the monetary policy instruments have been adjusted and the significance of the banks' net position to monetary policy has been reduced.¹

In principle, forward contracts can also be used to increase the foreign exchange reserve. This is by simultaneous purchase of foreign exchange against kroner for immediate delivery (spot), and sale of foreign exchange for later delivery (forward). However, this is not used by the Nationalbank to increase the foreign-exchange reserve.

¹ See Danmarks Nationalbank, *Report and Accounts for the Year 1992*, for a description of the monetary policy instruments.

INTERVENTIONS DURING ONE DAY BY AMOUNTS, 1986-98

Chart 3



Note: 216 days with intervention sales and 484 days with intervention purchases for less than kr. 1 billion are not included.

Finally, under the ERM II agreement, the ECB and the Nationalbank may intervene to support the weaker currency via intervention credit facilities if the fluctuation margins of +/- 2.25 per cent are reached. If the krone is to be supported the Nationalbank will borrow in euro from the ECB, and therefore the utilisation of the credit facility is offset to the foreign-exchange reserve. The change in the foreign-exchange reserve is therefore the same, regardless of whether intervention is by direct sale from the reserve or by resorting to the intervention credit facility.

The foreign-exchange market normally functions smoothly without intervention by the Nationalbank, and most intervention is for small amounts. However, the Nationalbank has intervened for considerable amounts in a few situations when the krone was under strong pressure. This is illustrated by Chart 3 which shows the number of interventions in the stated amount ranges within one day during the period 1986-98. Interventions for less than kr. 1 billion are not included. For example, there are 25 cases in the period of the Nationalbank selling foreign exchange for between kr. 1 and 2 billion during one day. The greatest intervention in support of the krone took place on 3 February 1993 when foreign exchange for kr. 24 billion was sold.

The Chart also shows that normally purchases of foreign exchange during one day are for relatively small amounts.

BALANCE-SHEET EFFECT OF CENTRAL-GOVERNMENT
FOREIGN BORROWING FOR KR. 1 BILLION

Table 1

	Central government		Nationalbank		Central government and the Nationalbank	
	Kroner	Currency	Kroner	Currency	Kroner	Currency
Foreign-exchange reserve				1		1
The central government's account ..	1		-1			
The central government's currency-denominated debt		-1				-1
Net currency-denominated debt						0

Note: All amounts are stated in kr. billion. Negative figures indicate an increase in a certain liability, while positive figures indicate an increase in a certain asset.

Central-government borrowing and the foreign-exchange reserve

For the last more than 15 years the central government's practice has been to ensure that sales of domestic government securities correspond to the central government's borrowing requirement excluding redemption of the central government's foreign debt. As a result, central-government borrowing in foreign exchange is not used to finance the central government's deficit.

The main purpose of central-government borrowing in foreign exchange is thus to ensure that the foreign-exchange reserve is of an appropriate size. If a larger foreign-exchange reserve is required, the central government may borrow foreign exchange. If the reserve is ample, the central government may refrain from refinancing loan redemptions, cf. below, however.

The central government operates a Commercial Paper programme with a ceiling of 12 billion dollars, or approximately kr. 75 billion. This programme is a very effective means to raise large amounts of foreign currency in a short time and has been used in cases where the krone was under pressure. In a few situations with considerable seasonal fluctuation in the central government's account with the Nationalbank the programme has also been used to prevent an overdraft on the central government's account with the Nationalbank. In these cases the reserve increased equivalently for a short period.

Table 1 shows the relationship between the foreign-exchange reserve, the central government's foreign borrowing and the central government's account with the Nationalbank. When the central government borrows in foreign currency, the Nationalbank purchases the foreign-exchange proceeds, which then become part of the foreign-exchange reserve, and deposits the equivalent kroner amount to the

central government's account. There is thus no change in the net foreign debt of the central government and the Nationalbank as a whole.

When the central government pays instalments on its foreign debt, the same assets and liabilities are reduced correspondingly.

If the above practice for central-government borrowing had always been used, the central government's debt denominated in foreign exchange would in principle be offset by the balance of the central government's account with the Nationalbank, cf. Table 1. However, this is not the case, among other things because loans denominated in foreign exchange contributed to financing the central-government deficit before the present practice for the central-government debt policy was introduced just over 15 years ago. The balance of the central government's account with the Nationalbank is therefore lower than the central government's debt denominated in foreign exchange. The balance of the relevant items at end-1998 is as shown in Table 2.

The central government's foreign debt can be brought down by simultaneously reducing the foreign-exchange reserve. This will also reduce the balance of the central government's account with the Nationalbank. In accordance with the Maastricht Treaty's prohibition of monetary financing of government deficits the central government's account with the Nationalbank may not be overdrawn. The central government's foreign debt can thus only be reduced to the extent that there is still a sufficiently large balance on the central government's account. Since the central government's receipts and disbursements are distributed unevenly over the year, a certain buffer on the central government's account is required, to prevent a negative balance in the event of very large net disbursements by the central government.

The sale of the central government's shares in Tele Danmark in 1998 offered the central government an opportunity to reduce its foreign debt. The shares were sold to a US investor and the foreign-exchange

FOREIGN-EXCHANGE RESERVE, FOREIGN DEBT AND THE
CENTRAL GOVERNMENT'S ACCOUNT, END-1998, KR. BILLION

Table 2

	Central government		Danmarks Nationalbank		Central government and Danmarks Nationalbank	
	Kroner	Currency	Kroner	Currency	Kroner	Currency
Foreign-exchange reserve				100		101
Central government's account	34		-34			
Central government's foreign-denominated debt		-88				-88
Foreign assets, net						-13

Note: All amounts are stated in kr. billion. Positive figures indicate assets, while negative figures indicate liabilities.

proceeds from the sale were used to reduce the central government's foreign debt. Overall, neither the central government's account with the Nationalbank nor the foreign-exchange reserve were affected by the sale.

Customer transactions

The Nationalbank undertakes a number of foreign-exchange transactions on behalf of its customers, primarily the central government.

A number of the central government's current payments are in foreign exchange. These include interest payments on the central government's foreign debt, aid to developing countries, and the central government's purchase and sale of goods and services abroad. For these payments the Nationalbank supplies the foreign exchange, while the central government's account is debited for the equivalent amount in kroner.

Usually customer transactions are handled by selling or buying the relevant amount of foreign currency in the foreign-exchange market. If the central government has a payment in e.g. dollars, the Nationalbank will purchase dollars in the foreign-exchange market, and thus does not use the foreign-exchange reserve. Although the Nationalbank in such case trades in the foreign-exchange market, this is not intervention since the purpose of the transaction is not to influence the exchange rate.

However, the Nationalbank may also take the funds directly from the foreign-exchange reserve. In the above example, this corresponds to the central government's payment being made by drawing on the Nationalbank's dollar holdings, thereby reducing the foreign-exchange reserve.

CONCLUSION

Denmark's fixed-exchange-rate policy requires a certain foreign-exchange reserve. The foreign-exchange reserve functions as a liquidity buffer used for intervention in the foreign-exchange market should it be necessary to stabilise the krone against the euro. The increase in the foreign-exchange reserve in recent years thus reflects that in most years the Nationalbank has made net purchases of foreign exchange in order to maintain a stable krone rate in the European