

Currency hedging and the Danish pension sector

The ratio of pension assets to GDP in Denmark is the highest among OECD countries. Danish pension funds invest more than half of the country's pension wealth in foreign assets, giving rise to exchange rate risks that are managed using financial instruments. We study the currency hedging behaviour of the Danish pension sector and show that it differs with respect to exposures in dollar and euro, given Denmark's fixed exchange rate against the euro. Additionally, we find a statistically and economically significant relation between US stock price movements and flows of kroner from FX rebalancing.

Written by**Sigurd A. M. Steffensen**
Senior Economistsams@nationalbanken.dk
+45 2370 9818**Birthe Merethe Jensen**
Principal Economistbmj@nationalbanken.dk
+45 3363 6821**Asger Munch Grønlund**
Principal Economistamg@nationalbanken.dk
+45 3363 6816



Adjustments to currency hedge positions give rise to krone flows

Danish pension funds invest more than half of the country's pension wealth in assets that are denominated in foreign currencies, particularly in dollar and euro. The currency risks from these investments are managed using financial instruments. Adjustments to the sector's hedge positions can give rise to significant flows of kroner.



The Danish pension sector's currency hedging is performed in stages

The exchange rate variation of the euro against the krone is very limited due to Denmark's fixed exchange rate policy. Many pension funds therefore hedge non-euro currency exposures to euro. The decision to hedge euro exposures to kroner is impacted by Danmarks Nationalbank's monetary policy interest rate spread to the ECB.



Nowcast of krone flows from rebalancing of dollar hedging

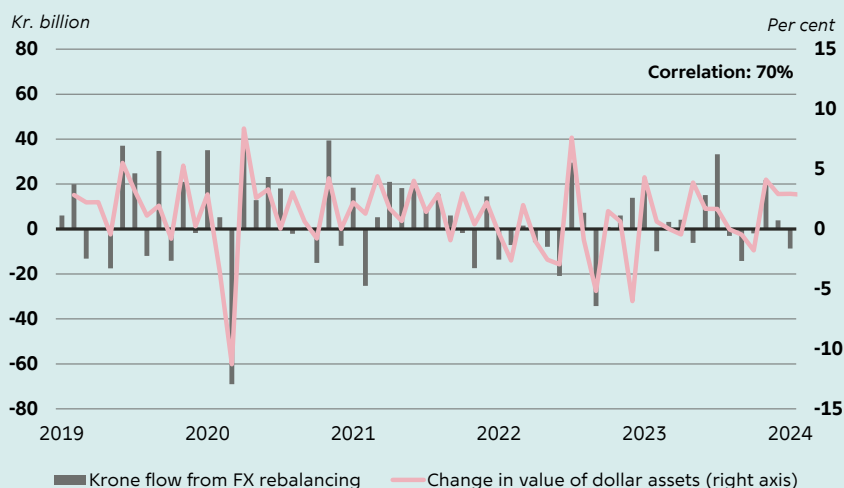
The pension sector hedges a relatively fixed share of the aggregate dollar exposure and adjusts hedge positions as the market value of dollar assets fluctuate. We estimate that a 10 per cent increase (decrease) in US stock prices corresponds to purchasing (selling) kr. 28 billion due to FX rebalancing, holding all else equal.

Why is it important?

Denmark is a small open economy with a fixed exchange rate vis-à-vis the euro. Maintaining the fixed exchange rate regime is one of the main objectives of Danmarks Nationalbank, with monetary policy instruments reserved for this purpose. Danish pension funds are important actors in the market for Danish kroner. Understanding the pension sector's currency hedging improves the understanding of the krone exchange market, which is important in the context of the fixed exchange rate policy in Denmark.

Key chart

Dollar hedge rebalancing leads to a flow of kroner



Note: Krone flow is the monthly buying and selling of Danish kroner against dollar, driven by the rebalancing of dollar hedge positions by pension funds. Change in value of dollar assets is the monthly market-value change in dollar assets, excluding changes from the dollar exchange rate against the Danish krone. The latest observation is February 2024. We estimate that a 10 per cent increase (decrease) in US stock prices corresponds to purchasing (selling) kr. 28 billion due to FX rebalancing, holding all else equal.

Source: Danmarks Nationalbank

Keywords

Denmark's foreign assets

Exchange rates

Fixed exchange-rate policy

Foreign-exchange market

Insurance and pension

01

Pension funds are important actors in the krone market

The ratio of pension assets to GDP in Denmark is the highest among OECD countries and more than half of the country's pension assets are denominated in foreign currencies. Danish pension funds use financial instruments to manage the foreign exchange (FX) risks that arise from these investments.¹ Given the pension sector's large size, even slight adjustments to its currency hedging can give rise to flows of kroner that affect the currency market in Denmark.

In this paper, we study the currency hedging behaviour of the Danish pension sector. As the dollar and the euro constitute the two key currencies in which the sector's foreign assets are denominated, hedging of these two currencies is the main object of study. Crucially, we use unique and granular data on financial transactions reported by the pension funds to Danmarks Nationalbank. In doing so, we show that the sector's hedging behaviour with respect to exposures in dollar and euro is very different, given Denmark's fixed exchange rate against the euro

The euro plays a special role in the pension sector's currency hedging due to Denmark's fixed exchange rate vis-à-vis the euro.² Formally, the exchange rate between the euro and the krone is only allowed to fluctuate by +/- 2.25 per cent around the central parity exchange rate and is in practice kept within a much tighter range. Given the very limited foreign exchange volatility of the euro, Danish pension funds increasingly hedge non-euro currency exposures to euro as a first step in their hedging strategy. The decision to subsequently hedge euro exposure to kroner is *inter alia* dependent on Danmarks Nationalbank's monetary policy interest rate spread to the ECB.

Dollar assets give rise to the largest source of currency risk for pension funds. In aggregate, pension funds hedge a relatively fixed share of their dollar exposure to euro or directly to kroner over time. The goal to maintain a fixed hedge ratio, i.e., a fixed share of hedged dollar to total dollar exposure, means that pension funds actively rebalance their hedge positions when the market value of dollar assets fluctuates. Drawing on our rich dataset, we estimate that a 10 per cent increase (decrease) in US stock prices corresponds to buying (selling) kr. 28 billion due to FX hedge rebalancing, holding all else equal.

The results presented in this paper are related to the emerging literature on currency hedging and foreign exchange rates. Bräuer and Hau (2023) and Sizova and Syrstad (forthcoming) find that FX rebalancing by institutional investors can explain significant amounts of variation in various currency pairs. Our results provide novel insights about the Danish pension sector's currency hedging. This improves the understanding of the krone exchange markets, which is important in the context of the fixed exchange rate policy in Denmark.

¹ In this paper, the insurance and pension sector is referred to as pension funds and the pension sector. The insurance and pension sector consists of life insurance companies, multi-employer occupational pension funds, non-life insurance companies and Arbejdsmarkedets Tillægspension (ATP).

² The currency peg, currently maintained under the framework of EU's Exchange Rate Mechanism (ERM II), is a cornerstone of Danish economic policy and enjoys widespread support and has helped support Danish trade with the euro area member states, see Danmarks Nationalbank (2015). Danmarks Nationalbank has conducted a fixed exchange rate policy since 1982, first against the D-Mark and from 1999 against the euro. Under the ERM II agreement, the central rate is set as 7.46038 kroner per euro.

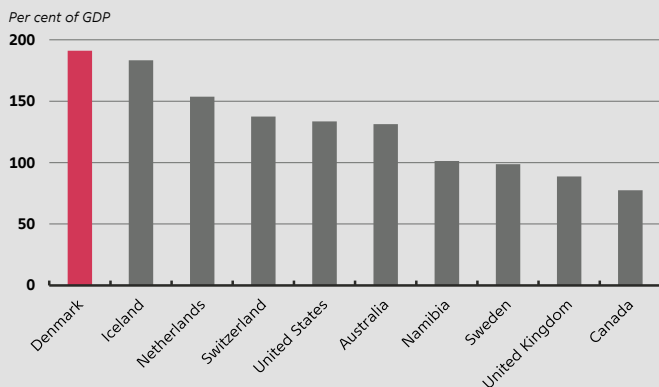
02

The pension sector stands out in terms of its size

The ratio of pension assets to GDP in Denmark is the highest among OECD countries. The Danish pension sector manages household wealth of kr. 5,200 billion, equivalent to 191 per cent of Danish GDP, cf. chart 1.³ The Danish pension sector's growth took off after a tripartite agreement between employer organisations, labour organisations and the government in 1987, which increased the population coverage of compulsory occupational pension schemes. Today, the Danish pension system consists of a combination of tax-financed public pensions and savings-based labour market pensions, with labour market pensions covering around 85 per cent of the employed labour force, see Andersen, Jensen and Rangvid (2022).

CHART 1

The ratio of pension assets to GDP in Denmark is the highest among OECD countries

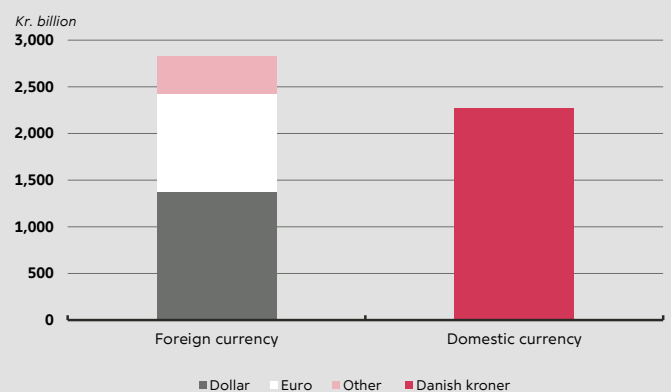


Note: Assets in asset-backed pension schemes at the end of 2022. The numbers are based on GDP values from OECD.Stat and the IMF World Economic Outlook.

Source: OECD.

CHART 2

More than half of Danish pension assets are denominated in foreign currencies – particularly in dollar and euro



Note: The value of total pension assets grouped by the currency in which the assets are denominated. Data are from February 2024. The values shown here are converted to Danish kroner using the exchange rate available at the time of reporting to Danmarks Nationalbank. The category 'Other' primarily includes assets denominated in British pounds, Japanese yen, Swedish krona, and Swiss francs.

Source: Danmarks Nationalbank and own calculations.

The pension sector's liabilities consist of pension provisions to Danish households that are denominated in Danish kroner. However, due to the sector's size, investing all pension wealth in krone-denominated assets would, e.g., incur significant concentration risks. More than half of Danish pension wealth is consequently invested in assets denominated in foreign currencies, primarily in dollar and euro, cf. chart 2.⁴ Dollar assets mainly consist of stocks, while investments denominated in euro are mainly bonds, especially in German government bonds. The remaining part of the pension wealth is invested in krone-

³ This corresponds to around 700 billion euros. Danish pension funds regularly report the value of pension assets and liabilities, as well as their hedge positions, to Danmarks Nationalbank. For more details see [link](#).

⁴ As most pension liabilities are far into the future, the pension sector has a long investment horizon and invests accordingly in long-term assets. Consequently, changes in interest rates have a significant impact on the value of both assets and liabilities of pension funds, see Danmarks Nationalbank (2019).

denominated assets, mostly in Danish government and callable mortgage bonds, see Autrup and Jensen (2021). As the dollar and the euro constitute the two key currencies in which the foreign assets are denominated, the pension sector's hedging of exposures in these two currencies is the main object of study in this paper.

How foreign exchange hedging leads to krone flows

Investing in foreign assets comes with the risk that the currencies in which the assets are denominated may depreciate against the krone when pension liabilities are due. Danish pension funds consequently hedge currency risks using financial instruments such as FX forwards and swaps, as well as cross-currency swaps.⁵ These are instruments that facilitate the exchange of two currencies in the future, at an exchange rate which is fixed at the contract's inception. By entering such contracts, pension funds make sure they can exchange foreign currencies to kroner at a predetermined exchange rate, regardless of the exchange rate's actual development after the contracts' inception.

The key sectors in the krone exchange market are Danish non-financial companies, foreign market participants, and Danish pension funds.⁶ The pension sector's currency hedging can affect the krone exchange market, as counterparties in FX forward contracts are banks that typically buy or sell kroner in the currency spot market following the inception of new contracts.⁷ In most cases, pension funds hedge exchange rate risk in relation to investing in new foreign assets. In these instances, there are counterbalancing flows in the currency market, because pension funds sell kroner and buy the foreign currency needed to acquire the foreign assets, while banks buy the kroner to be exchanged for the foreign currency in the future as specified in FX forward contracts. However, in instances often related to periods of market stress, pension funds rebalance their hedge positions for existing asset portfolios, leading banks to buy or sell kroner without a counterbalancing currency flow from pension funds. Due to the pension sector's large size, even slight adjustments to its currency hedging can lead to significant flows of kroner. The following section highlights two such episodes, specifically pertaining to rebalancing of dollar and euro hedge positions.

Two important cases of FX rebalancing of euro and dollar exposures

The first event dates back to 2015, when the Swiss central bank decided to abandon its limit for how much the Swiss franc could appreciate against the euro. Consequently, foreign investors started buying Danish kroner based on beliefs that the krone would appreciate against the euro and that Denmark could similarly abandon its fixed exchange rate policy, see Danmarks Nationalbank (2015) and Grønlund and Risbjerg (2020).⁸ In light of this, a range of domestic actors, including the pension sector, increased their euro hedging to insure themselves against potentially large losses in case the krone appreciated against the euro.⁹ As increasing the euro hedge ratio entails that kroner are bought by the counterparties in the hedge contracts, see box 1, this decision further added to the appreciation pressure on the krone exchange rate (Danmarks Nationalbank, 2015). As a policy response to safeguard the fixed exchange rate, Danmarks Nationalbank intervened in the currency market and sold kroner against euro in

⁵ Some pension funds also use options to manage currency exposures. These are contracts that gives the buyer the right, but not the obligation, to exchange two currencies at a predetermined exchange rate.

⁶ See Danmarks Nationalbank (2023) and Danmarks Nationalbank (2024). In light of Denmark's persistently high balance of payments surplus, Danish non-financial companies have been net buyers of kroner in the exchange market in recent years, while foreign market participants have been net sellers.

⁷ See, e.g., Jørgensen, Larsen and Risbjerg (2013) and Raffnsøe, Jensen and Larsen (2016). Banks typically do not wish to take on FX risks themselves and therefore buy the currency to be exchanged in the spot market and holds it until the forward contract expires.

⁸ Similar dynamics were also at play during the European sovereign debt crisis. At that time, implicit probabilities in option markets suggested that the krone would break the strong side of the ERM II band, see Jørgensen, Larsen and Risbjerg (2013).

⁹ While the sector increased hedging of euro, there was significant dispersion in the behavior of individual pension funds. Some increased euro hedging, while others reduced it (Abildgren, 2023).

the first months of 2015, while monetary policy rates were lowered and the issuance of government debt was temporarily suspended. The policy response effectively countered the appreciation pressure.

The second event was in relation to the COVID-19 pandemic, where a sharp drop in US stock prices in early 2020 led pension funds to rebalance their dollar hedge positions (Danmarks Nationalbank, 2020). Falling stock prices imply increasing dollar hedge ratios, as the total dollar exposure decreases, see box 1. In order to maintain the same dollar hedge ratios, Danish pension funds responded by actively reducing their stock of dollar hedge contracts. By doing so, the sector maintained roughly the same dollar hedge ratio, but led counterparties to sell significant amounts of kroner in the process. Partly because of this, Danmarks Nationalbank intervened in foreign exchange markets and hiked the policy rate 15 basis points (Grønlund and Risbjerg, 2020).

BOX 1

Stylised examples of FX rebalancing leading to flows of kroner

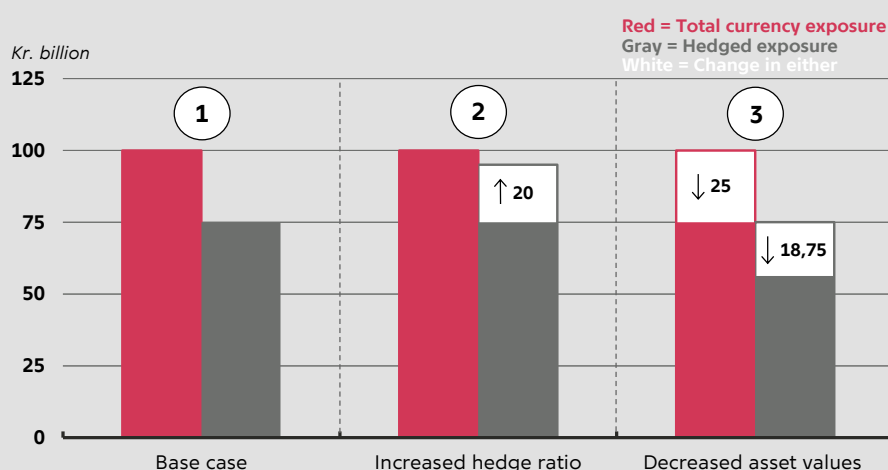
Assume a base case (1), where kr. 100 billion worth of assets denominated in a foreign currency are hedged 75 per cent to kroner by a pension company. The following two cases illustrate how pension funds' currency hedging may give rise to flows of kroner in the currency market.

In the second case (2), kroner are purchased in response to a decision to *increase* the fraction of currency exposure that is hedged, as was the case during the 2015 event. Increasing this hedge ratio by, e.g., 20 percentage points, so that 95 per cent of the FX exposure is hedged, subsequently gives rise to a purchase of $100 \times 0.20 = 20$ billion in the spot market by the counterparties to the hedge contracts. It is important to note that this is symmetrical; if pension funds decide to decrease the hedge ratio in response to, e.g., a higher cost of entering new hedge contracts, this means selling of kroner in the currency market.

In the third case (3), the goal to *maintain* a fixed hedge ratio leads to rebalancing of FX hedging in response to falling asset values as was the case during the COVID-19 event. Assume that the market value of the foreign assets decreased by kr. 25 billion. In the example, the pension company subsequently decreases currency hedging from kr. 75 billion to $75 \times 0.75 = 56.25$ billion to maintain the same hedge ratio. This leads counterparties to sell $75 - 56.25 = 18.75$ billion in the market. Like the previous example, this mechanic is symmetrical, meaning that kroner are bought in the currency market as pension funds increase hedging in response to rising asset values.

Chart A

Changing or maintaining the currency hedge ratio give rise to buying and selling of kroner



Note: Stylised examples of how currency hedging can lead to flows of Danish kroner. Red denotes total currency exposure and grey the hedged exposure. White denotes changes to either total currency exposure or hedged exposure. In the example of the increased hedge ratio, kr. 20 billion are bought. In the case of the decreased asset values, kr. 18.75 billion are sold.

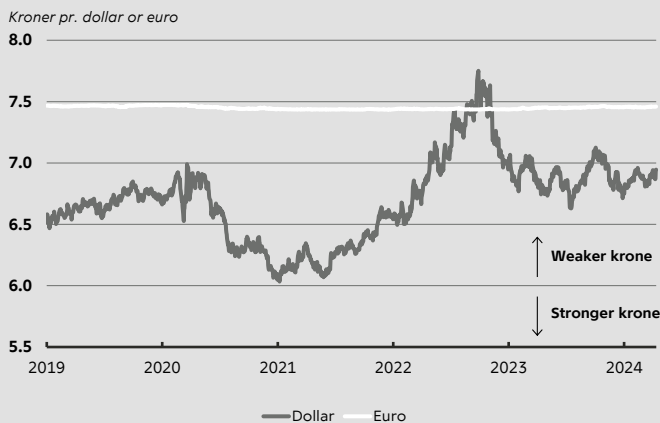
03

Dollar and euro hedging by pension funds

Dollar assets give rise to the largest source of currency risk for pension funds. This is the case both because the pension sector holds many dollar assets and because the dollar exchange rate against the krone varies significantly over time. The euro exchange rate against the krone does not vary much due to Denmark's fixed exchange rate policy, cf. chart 3. Given the very limited exchange rate volatility of the euro, pension funds hedge a share of their non-euro currency exposure to euro. Doing so increases pension funds' total euro exposure, cf. chart 4. The decision to subsequently hedge euro to kroner is *inter alia* affected by Danmarks Nationalbank's policy rate spread to the ECB.

CHART 3

The dollar exchange rate varies against the krone, while the euro exchange rate is stable due to the fixed exchange rate...

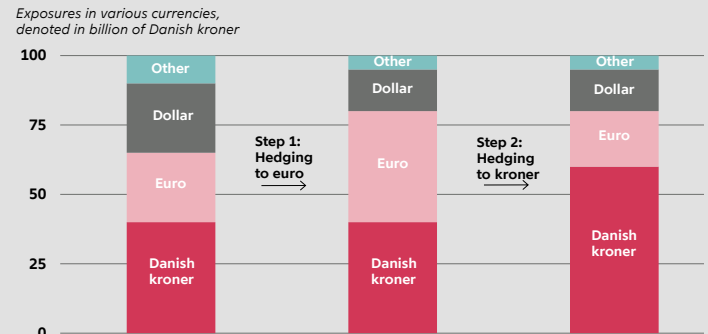


Note: The nominal effective exchange rate between the dollar and the Danish krone, as well as between the euro and the krone. The latest observation is 10 April 2024. The Danish currency peg vis-à-vis the euro is maintained under the framework of the EU's Exchange Rate Mechanism (ERM II), where the central parity rate is set at 7.46038 per euro. For more on Denmark's fixed exchange rate policy, see Spange and Toftdahl (2014).

Source: Refinitiv Eikon.

CHART 4

... leading many pension funds to hedge non-euro currency exposures to euro, as a first step in their hedging strategy



Note: Stylised example of how a pension company with an exposure of kr. 100 billion in various currencies may choose to hedge this exposure first to euro, and then to Danish kroner. In the first step, an amount of dollar and other currencies are hedged to euro. This increases total euro exposure. In the second step, an amount of euro exposure is subsequently hedged to kroner. This final step decreases euro exposure and increases exposure in Danish kroner.

Source: Danmarks Nationalbank.

Dollar hedging ensures the solvency of pension funds and pension savers

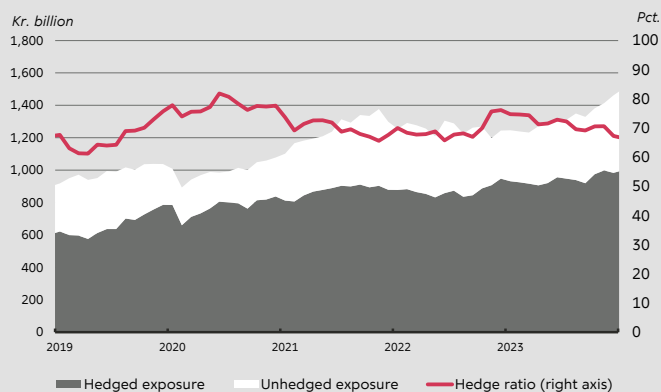
Pension funds seek to hedge dollar exposures in a stable manner and maintain a relatively constant dollar hedge ratio over time. This is evident from chart 5, which shows the aggregate amount of hedged and unhedged dollar exposure in the Danish pension sector, as well as the dollar hedge ratio.¹⁰ The chart reveals that in February 2024, around 70 per cent of the total dollar exposure is hedged to other currencies using financial instruments. Chart 6 shows the currencies to which pension funds hedge dollar exposures. About 30 per cent are hedged directly to

¹⁰ Danmarks Nationalbank has together with this memo published extended statistics on the pension sector's currency exposure and hedging, which now includes their hedging between foreign currencies, see [link](#).

kroner, while 70 per cent are hedged to euro. In addition, the chart shows that the amount hedged to euro has been increasing over time.

CHART 5

Pension funds maintain a stable dollar hedge ratio over time

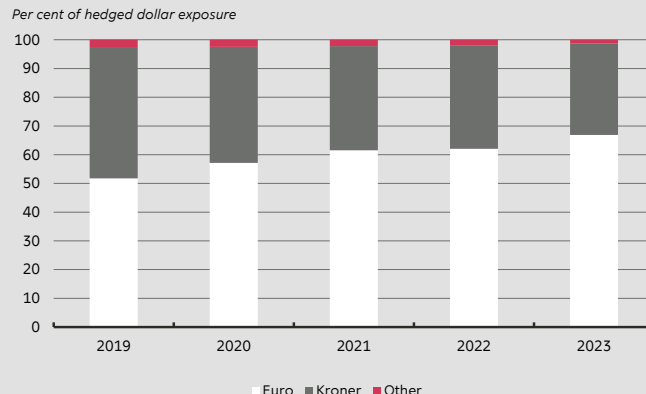


Note: The amount of hedged and unhedged dollar exposure denominated in Danish kroner, as well as the dollar hedge ratio over time. The latest observation is February 2024.

Source: Danmarks Nationalbank.

CHART 6

A growing share of dollar exposures is hedged to euro



Note: The share of hedged dollar exposures ('Hedged exposure' in chart 5) by the currency it is hedged to. Each bar shows the average numbers for each year.

Source: Danmarks Nationalbank.

Pension funds engage in dollar hedging to ensure that pension savers receive their desired combination of risk and return, in accordance with the 'prudent-person principle', see Raffnsøe, Jensen and Larsen, 2016.¹¹ In addition, pension funds are subject to risk-based capital requirements specified under the Solvency II Directive. The directive was adopted in 2009 and stipulates that pension funds must hold regulatory capital for unhedged currency exposures, with a direct capital requirement of 25 per cent for all unhedged non-euro currency exposures. The capital requirement for unhedged euro exposure is much lower at 0.39 per cent. In addition, the capital requirement depends on pension companies' composition of pension liabilities, see box 2.

BOX 2

Composition of pension liabilities impacts currency hedging

Market rate pension plans were introduced to address the challenges faced by pension funds from lower rates of return on financial assets. Prior to the COVID-19 crisis – and the higher interest rates that followed – interest rates had been declining since the 1980's. The lower rates of return were pressuring pension funds' ability to generate the returns necessary to fulfil the promised returns on their pension liabilities, especially in light of longer expected life spans of pension savers. To address this, pension funds introduced market rate products, where the pension saver earns the return that pension funds can achieve in financial markets, rather than being promised a fixed return on pension assets irrespective of market development as with average rate products.

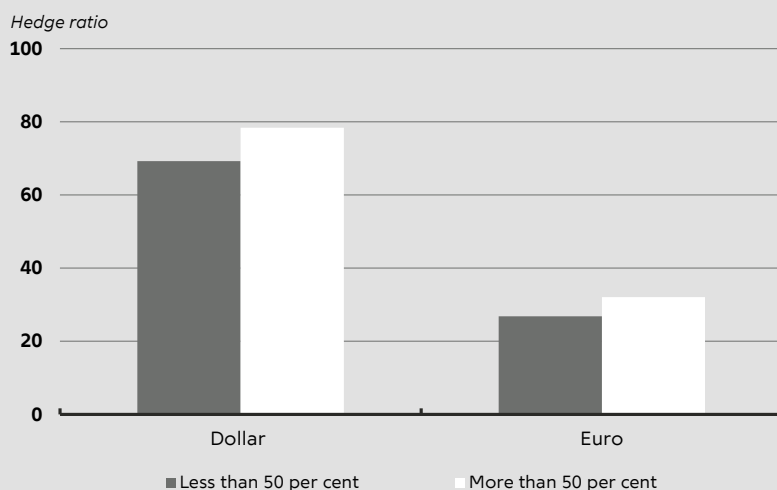
These types of pension liabilities help explain why individual pension funds hedge euro and dollar exposures differently. Individual pension savers carry the investment risk with market rate products, implying a closer match between pension assets and liabilities. As such, authorities do not require pension funds to hold regulatory capital for unhedged currency positions of the investments associated with these pension plans.¹ Funds with a higher share of market rate products consequently have more flexibility in their portfolio allocation and risk management practices. In aggregate, this means that funds with mostly

¹¹ Under the prudent person principle, pension funds are obliged to invest their assets in a manner that best serves the interests of policyholders and beneficiaries. This means that the assets used to cover pension liabilities must be invested in a manner that aligns with the nature and duration of the pension liabilities, ensuring that the investment serves the pension customer's interests as best as possible (Danish Financial Supervisory Authority, 2015).

average rate products tend to hedge currency exposures to a larger extent than funds with mostly market rate products, both for euro and dollar exposures, cf. chart B.²

Chart B

A higher share of average rate products means a somewhat higher currency hedge ratio



Note: Average hedge ratio across individual pension funds for dollar and euro exposures. Pension funds are grouped by whether liabilities consist of less than or more than 50 per cent average rate products. The data presented here are for the 4th quarter of 2023.

Source: Danmarks Nationalbank

¹ See Commission Delegated Regulation (EU) 2015/35 of 10 October 2014 ([link](#)), specifying that the currency risk of assets in pension plans, where the individual pension saver carries the investment risk, are not to be included in capital requirement calculations for currency risks.

² On a similar note, Autrup and Jensen (2021) find that the composition of pension liabilities matters for pension funds' bond holdings. Similarly, Achord et al. (2021) show that pension funds' response to changes in bond duration depends on liabilities composition.

The euro plays a special role in pension funds' currency hedging

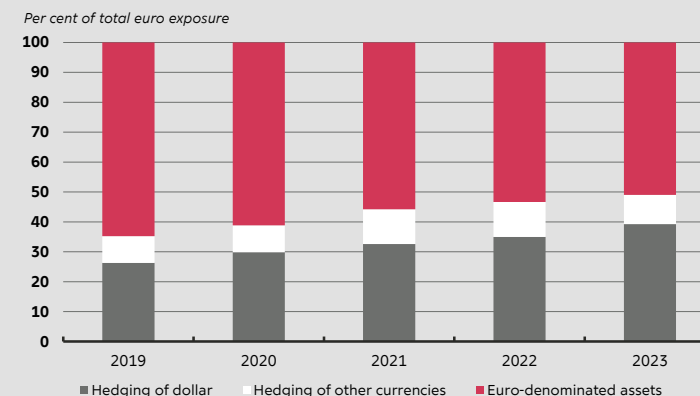
Due to Denmark's fixed exchange rate policy, the exchange rate volatility associated with the euro is very limited. Many pension funds therefore hedge non-euro currency exposures to euro, entailing that their total euro exposure stems both from euro-denominated assets as well as from hedging other currency exposures to euro. As is evident from chart 7, the share of euro exposure stemming from other foreign currencies has been growing steadily over time. The largest contribution comes from dollar hedged to euro, which accounted for around 40 per cent of the sector's total euro exposure in 2023. Meanwhile, only around half of euro exposures stem from investments in euro-denominated assets.

Hedging foreign currencies to euro gives pension funds more flexibility in their overall hedging strategy. For example, hedging dollars to euros, instead of directly to Danish kroner, can be meaningful because the market for exchanging dollars and euros is more liquid than the market for exchanging dollars and kroner. The higher market liquidity means that the price of entering forward contracts in the former market is less affected by liquidity premia (Grønlund and Risbjerg, 2020), making it less costly than to enter forward contracts. In addition, the exchange rate volatility of euro exposures is limited and requires only minimal amounts of regulatory capital, see above. As such, this strategy represents a cost-effective way to reduce currency risks while allowing pension funds to flexibly determine whether to hedge the resulting euro exposure to kroner. Chart 8 shows that in February 2024 around 40 per cent of total euro exposure was hedged to Danish kroner. Part of this originates from exposures in other currencies that are

first hedged to euro and subsequently hedged to Danish kroner as part of pension funds' overall hedging strategy.

CHART 7

A growing share of euro exposures comes from dollar hedging

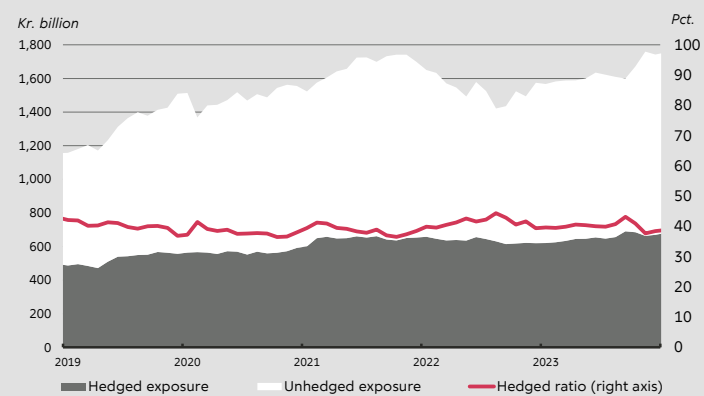


Note: The amount of total exposure in euro divided into contributing sources. Euro assets is the contribution from euro-denominated assets. Hedging of dollar and other currencies capture the euro exposure stemming from hedging of exposures in other currencies to euro. Each bar shows the average numbers for each year.

Source: Danmarks Nationalbank.

CHART 8

Around 40 per cent of euro exposure is hedged back to kroner



Note: The amount of hedged and unhedged euro exposure denominated in Danish kroner, as well as the euro hedge ratio over time. The latest observation is February 2024.

Source: Danmarks Nationalbank.

Denmark's monetary policy interest rate spread to the ECB impacts euro hedging

The decision to hedge euro exposures to Danish kroner depends, in part, on the cost of entering new hedge contracts. This cost is called the FX forward premium and follows Danmarks Nationalbank's monetary policy interest rate spread to the ECB closely, see box 3. Because of this, an independent rate change by Danmarks Nationalbank can affect the price of hedging kroner to euro, being one channel of monetary policy transmission to the exchange rate. Besides this channel, an independent rate change also affects the return from holding short-term money market products denominated in kroner.

The fixed exchange rate policy entails that Danmarks Nationalbank's monetary policy interest rates are reserved for the purpose of keeping the krone close to its central rate. If intervention in the foreign exchange market is not sufficient to stabilise the exchange rate of the krone, Danmarks Nationalbank's will adjust its monetary policy interest rates.¹² As an example of this, Danmarks Nationalbank widened the monetary policy rate spread to the ECB in October 2022 and in February 2023. In two steps, Danish policy rates were set to a level 40 basis points below those of the ECB.¹³ The interest rate differential resulted in lower returns on short-term debt securities in Denmark relative to the euro area. This provided an incentive to borrow kroner and exchange them into euro in order to invest in short-term money market products in the euro area and to reduce existing euro debt (Danmarks Nationalbank, 2023).

In addition, the interest rate differential made it more costly to enter new hedge contracts and gave pension funds an incentive to reduce the overall hedge ratio of euro exposures by around six percentage points between October 2022 and

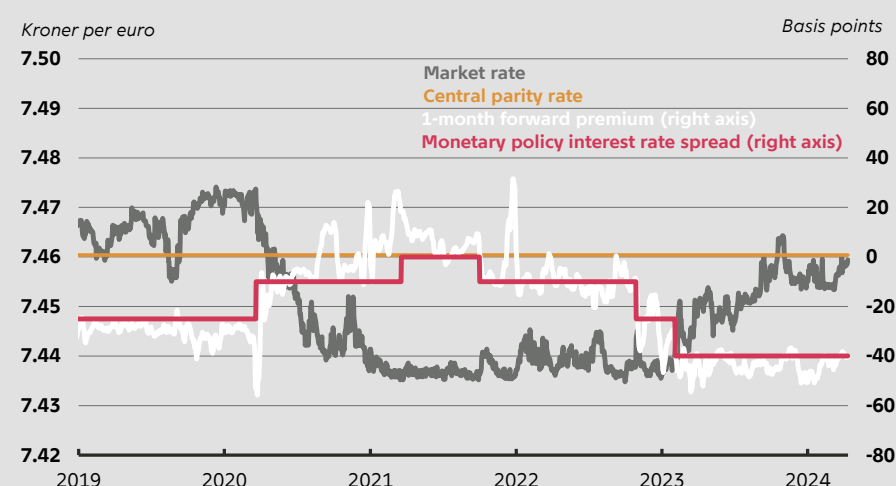
¹² As Danish monetary policy interest rates track euro area interest rates set by the ECB, this is usually done in connection with the ECB's interest rate adjustments, see Spange and Toftdahl (2014).

¹³ The interest rate spread was widened as the krone had been on the strong side of the central parity vis-à-vis the euro for a prolonged period. The widening of the spread occurred in connection with the ECB's monetary policy rate hike and in the wake of a series of interventions in the foreign exchange market by Danmarks Nationalbank (Danmarks Nationalbank, 2023).

February 2024, see Danmarks Nationalbank (2023) and Danmarks Nationalbank (2024). As laid out in box 1, decreasing the hedge ratio of a given currency hedged to kroner implies that counterparties sell kroner in the currency market. As such, the combination of two channels mentioned here led market participants to sell kroner in the currency market and resulted in an intended weakening of the krone exchange rate vis-à-vis the euro, chart 9.

CHART 9

A higher cost of hedging weakens the krone exchange rate against the euro



Note: The monetary policy rate spread of Danmarks Nationalbank against the ECB, the 1-month forward premium for exchange of euros to kroner, as well as the market rate of the Danish krone against the euro and the central parity rate specified under the ERM II agreement. The latest observation is 10 April 2024.

Source: Danmarks Nationalbank.

BOX 3

The cost of euro hedging follows the monetary policy interest rate spread

The cost of entering new FX forward contracts depends on the current (spot) and future (forward) exchange rate between the two currencies in question. Let S_t denote the spot exchange rate between the Danish krone and the euro (kroner pr. euro), and let F_t be the forward exchange rate between these two currencies as observed today, time t . The FX forward premium is calculated as $(F_t - S_t)/S_t$. A positive FX forward premium indicates that the forward exchange rate is higher than the spot exchange rate $F_t > S_t$, signalling a weaker krone against the euro relative to today's spot exchange rate. A negative FX forward premium, on the other hand, signals a stronger krone against the euro, $F_t < S_t$.

The FX premium between the euro and the krone primarily reflects the interest rate differential between the policy rates of Danmarks Nationalbank and the ECB. In other words, the relationship between the spot and forward exchange rate can be explained in terms of the classic covered interest rate parity (CIP), by which the forward premium approximately equals the interest rate differential between the domestic and foreign interest rates,

$$\frac{F_t - S_t}{S_t} = \frac{(1 + i) - (1 + i^*)}{1 + i^*} \approx i - i^*.$$

Here, i and i^* are the domestic and foreign risk-free rates of return. Because of this, the cost of entering new hedge contracts (the FX forward premium) can be said to contain a compensation to the counterparty in the contract, who must accept a lower rate of riskless return over the period in question. See, for example Hansen and Hodrick (1980) and Fama (1984). In practice, this means that for a pension company that hedges, say, euro exposures worth kr. 1 billion, the forward premium translates into an annual expense of kr. 4 million in hedging costs, under the assumption of a 40 basis points forward premium and that the pension fund rolls the hedge contract over the year.

04 Nowcast of krone flows from FX rebalancing

The previous chapter showed that dollar exposures are hedged in a stable manner over time, entailing that pension funds tend to rebalance currency hedge positions when the market value of dollar assets fluctuates.¹⁴ In this section, we empirically estimate the relation between FX rebalancing and krone flows. For dollar hedge rebalancing, we find that a 10 per cent increase (decrease) in US stock prices corresponds to buying (selling) kr. 28 billion. due to FX hedge rebalancing, holding all else equal.

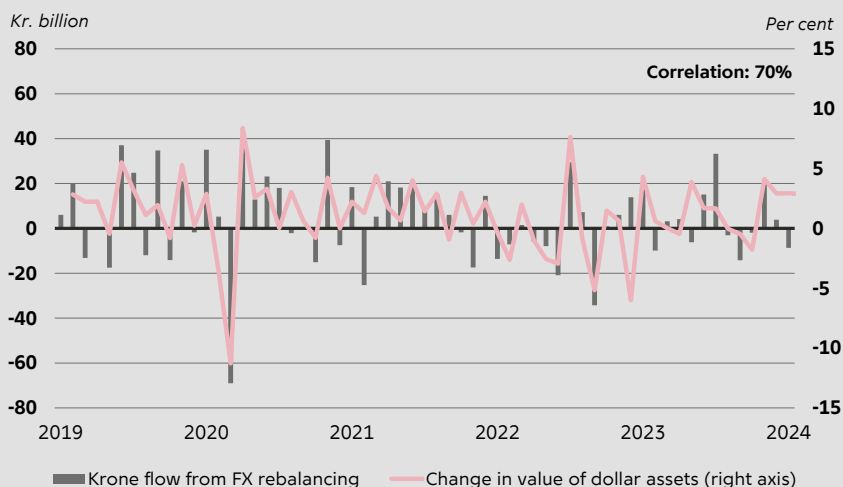
We also test for a similar FX rebalancing effect from euro hedging but do not find statistically significant results. Due to the euro's special role under the fixed exchange rate regime, around half of euro exposures stem from sources other than euro-denominated assets. As such, the hedging of euro exposures to kroner is more complex and rebalancing depends on more factors than fluctuations in the market value of euro assets alone. Due to the absence of significant results, regression evidence for euro rebalancing is omitted from this chapter.

Rebalancing of dollar hedge positions is a significant driver of krone flows

Chart 10 shows the monthly change in the market value of the pension sector's dollar-denominated assets along with the flow of kroner that follows from the sector's rebalancing of dollar hedge positions. As the chart shows, the two series are tightly linked and co-vary significantly over time. For instance, the sharp drop in US stock prices in March 2020 described above, can be seen along with the substantial amount of kroner sold during the month due to FX rebalancing.

CHART 10

Dollar hedge rebalancing leads to a flow of kroner



¹⁴ This is exemplified above by the third case in box 1. For previous evidence on the relation between the value of dollar assets and krone flows, see for example Danmarks Nationalbank (2022a) and Danmarks Nationalbank (2022b).

Note: Krone flow is the monthly buying and selling of Danish kroner against dollar, driven by the rebalancing of dollar hedge positions by pension funds. Change in value of US assets is the monthly market-value change in dollar assets, excluding changes from the dollar exchange rate against the Danish krone. The latest observation is February 2024. We estimate that a 10 per cent increase (decrease) in US stock prices corresponds to purchasing (selling) kr. 28 billion due to FX rebalancing, holding all else equal.

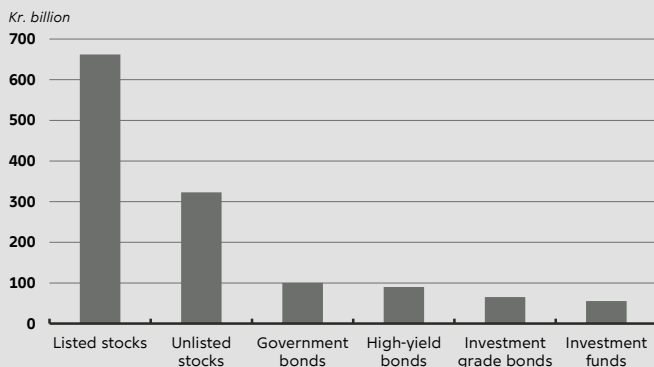
Source: Danmarks Nationalbank and Refinitiv Eikon.

In box 4 we estimate the relation between changing dollar-denominated asset values and FX rebalancing and compute nowcasts of the krone flows that ensue. We find that FX rebalancing is a statistically significant driver of krone flows from the pension sector and estimate that a 10 percent increase (decrease) in the S&P 500 stock market index over a given month will, *ceteris paribus*, lead to a combined krone purchase (sale) of kr. 28 billion, conditional on the current value of the dollar asset portfolios. To put the estimated relation into perspective, a simple variance-decomposition shows that rebalancing of dollar hedging explains around one-third of the total flow of kroner from the pension sector.¹⁵ As such, rebalancing of dollar hedging is both a statistically and economically significant driver in this regard. This channel does not, however, explain the pension sector's total buying and selling of kroner each month, which is driven by many different factors in addition to currency hedging.

The results presented in box 4 reveals that movements in the S&P 500 are the most important driver for the pension sector's krone flows from FX rebalancing. This is not surprising, as US stocks make up 75 per cent of all dollar assets, cf. chart 11. The importance of US stocks is corroborated by chart 12, which shows how movements in the S&P 500 drive most of the variation in dollar hedging over time. Bond portfolios may also give rise to krone flows in response to market movements, albeit of smaller magnitudes compared to the equity portfolio.

CHART 11

Stocks make up three quarters of dollar-denominated assets

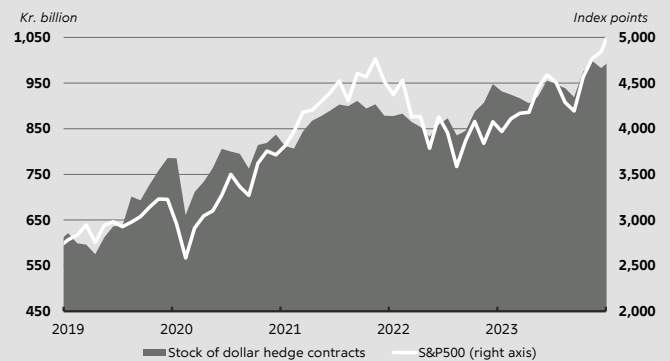


Note: Pension funds' dollar-denominated assets by asset type. Investment funds contain both listed and unlisted funds. All values are denominated in Danish kroner. Data are from February 2024.

Source: Danmarks Nationalbank

CHART 12

US stock prices drive the majority of changes in dollar hedging



Note: Stock of dollar FX forward contracts denominated in Danish kroner, as well as the level of the S&P 500 stock market index. The latest observation is February 2024.

Source: Danmarks Nationalbank and Refinitiv Eikon

¹⁵ The variance-covariance decomposition computes the contribution from FX rebalancing associated with fluctuations in the market value of dollar assets to the pension sector's total krone flow as $cov(\Delta DKK_t^{USD \text{ hedge rebalancing}}, \Delta DKK_t^{Total}) / var(\Delta DKK_t^{Total})$, where ΔDKK_t^{Total} is the pension sector's total buying and selling of kroner within a given month, and $\Delta DKK_t^{USD \text{ hedge rebalancing}}$ is the subset of the pension sector's total krone flow that stems from FX rebalancing.

BOX 4

Nowcast of krone flows from FX rebalancing

We estimate the relation shown in chart 10 through the following regression equation:

$$\Delta DKK_t = \alpha + \beta \Delta MV_t * h_t + \varepsilon_t, \quad (1)$$

where the left-hand side of the equation is the monthly purchase or sale of Danish kroner stemming from pension funds rebalancing dollar hedge positions. In equation (1), ΔMV_t is the monthly change to the market value of dollar assets, expressed as $\Delta MV_t = MV_{t-1} * r_t$. MV_{t-1} denotes the market value at the end of the previous month and r_t is the percentage return on the asset portfolio over month t . We focus only on the local currency return (i.e., changes in dollar market values).¹ Finally, h_t is the hedge ratio. We estimate the regression with the hedge ratio as either a random walk process or a constant and find that results are robust to either specification. Note that changes to longer-term macroeconomic trends could lead to strategic reviews of hedge ratios or rebalancing of the asset portfolio that are not captured in the analysis here. We analyse instead pension funds' response to short-term market movements to maintain a current hedge ratio.

We estimate the above model by simple OLS regression and evaluate the parameters. For $\beta = 0$, the changes in the market value of dollar assets do not lead to a flow of kroner via the adjustment of FX hedge positions. On the contrary, for $\beta = 1$, changes in the market value of the dollar assets are reflected one-to-one in the demand for kroner from the pension sector. The slope coefficient β is estimated to be 0.57 and is significantly different from zero at a t -ratio of 6.86. As such, the change in the market value of dollar assets is a significant driver of krone flows via the FX rebalancing channel. The krone flow from dollar rebalancing comes either from rebalancing of hedge positions exchanging dollars directly to kroner, or from dollars that are first hedged to euro and subsequently hedged to kroner. Unreported regression evidence shows that both channels contribute significantly to the results presented here.

Table 1

Variable		Estimation results			
Dependent	Independent	Beta	Gamma	R ²	Kr. billion
Listed stocks	S&P 500 index	0.95 [61.88]		0.98	23.58
Unlisted stocks	S&P 500 index	0.24 [8.05]	0.13 [4.36]	0.54	3.28
Listed funds	S&P 500 index	0.49 [16.07]		0.81	0.57
Unlisted funds	S&P 500 index	0.37 [7.57]		0.48	0.32
US government bonds	ICE BofA US Treasury Index	0.74 [21.26]		0.88	1.26
Other government bonds	Markit iBoxx USD Liquid Emerging Markets Sovereigns Index	1.08 [34.46]		0.95	2.17
High yield corporate bonds	ICE BofA US High Yield Index	1.05 [33.91]		0.95	3.55
Investment grade corporate bonds	ICE BofA BBB US Corporate Index	0.88 [37.02]		0.96	2.13

Note.: The table shows results from regressing the monthly return on each sub portfolio of assets on the monthly return on the relevant market index. Columns 'beta' and 'gamma' contain coefficient estimates and t -ratios in square brackets. Note that the regression for unlisted stocks uses an additional lagged value of the S&P 500 (gamma coefficient), as the price of unlisted stocks often reacts more slowly to new information, as the price is determined by pension funds' internal models. The column 'Kr. billion' shows the estimated buying or selling of kroner due to FX rebalancing, in response to a 10 per cent move in the relevant market index. The estimation sample consists of monthly data from January 2019 to February 2024.

Source: Own calculations based on Danmarks Nationalbank and Refinitiv Eikon.

Nowcast of krone flows from currency hedge rebalancing

The statistically significant relation presented above means that it is possible to make nowcasts of the pension sector's demand for kroner in response to fluctuations in financial markets. These nowcasts are made using the parameters estimated above, in combination with estimates of the real-time change in the

value of the pension sector's subset portfolios. To find these real-time changes, we estimate the relation between the portfolio value changes and the return on a range of dollar-based financial market indices:

$$r_{i,t} = \alpha_i + \beta_i r_{i,t}^{market} + \varepsilon_t. \quad (2)$$

Here, $r_{i,t}$ is the monthly return on sub portfolio i of dollar assets, such as the portfolio of US stocks, government bonds, corporate bonds etc. (for a total of $i = 1, \dots, n$ subset portfolios).³ Meanwhile, $r_{i,t}^{market}$ is the monthly return on market index j that corresponds most closely to a given portfolio. As an example, the relevant index for listed stocks is the S&P 500. All financial market indices are from Refinitiv Eikon, while the monthly values of dollar asset portfolios are reported by pension funds to Danmarks Nationalbank.

Dollar-denominated stocks drive most of FX rebalancing

Table 1 shows the results from estimating the above regression (2) for each asset portfolio. Most of the estimated slope coefficients are around one, showing that the value of the portfolios closely follows aggregate market developments. Based on these results, a nowcast of krone flows from each asset portfolio is subsequently found as:

$$\Delta DKK_{i,t} = \hat{\beta} \Delta MV_{i,t} * h. \quad (3)$$

Here, $\hat{\beta}$ is the estimated slope coefficient from regression (1), and $\Delta MV_{i,t}$ is the estimated change in the market value of dollar assets based on results from regression (2). The estimated change in asset market values for the current month t is found as:

$$\Delta MV_{i,t} = MV_{i,t-1} * \hat{r}_{i,t} \quad (4)$$

Note that $\hat{r}_{i,t}$ is the estimated change in the value of each subset portfolio from regression (2). Based on this, we can nowcast how value changes in each dollar portfolio lead to krone flows. The last column in table 1 reports the estimated kroner purchased following a 10 per cent change in the relevant market index. We estimate that a 10 per cent increase (decrease) in the S&P 500 over a given month will, ceteris paribus, lead to a combined krone purchase (sale) of kr. 28 billion. We note that this estimate of krone flow also depends on contemporaneous movements in government and corporate bonds. We do, however, refrain from commenting on the likely size of krone flows from bond portfolios when the stock market moves, as the correlation between US bond and stock returns varies significantly over time, see, e.g., BIS (2023) and Campbell et al. (2020).

The estimate presented here is conditional on the current value of the dollar asset portfolios. The estimate is found by inserting the last market values of listed and unlisted stocks, as well as listed and unlisted funds into equation (4), along with the estimated portfolio return in response to a move in the S&P 500, as found in equation (2).⁴ As the value of pension funds' dollar asset portfolios can be expected to increase over time, the flow of kroner from the rebalancing of dollar hedge positions may become stronger. The value of kr. 28 billion corresponds to around 2.7 per cent of the market value of these four portfolios combined. This number can be used to compute an expected krone flow in the face of different values of dollar asset portfolios in the future.

¹ We consequently disregard the change in the DKK-value of the assets stemming from the change in the dollar exchange rate against the krone. Assets that are denominated in foreign currencies are typically hedged with FX forward contracts that are denominated in the same currency as the asset. Changes in the currency exchange rate therefore have the same impact on the asset value and the FX hedging contract, such that exchange rate movements have no impact on the relation between asset values and currency hedging.

³ Due to data limitations, we do not include stock market futures in this analysis.

⁴ In February 2024 the values of listed and unlisted stocks were kr. 662 and 323 billion, respectively, while the values of listed and unlisted funds were kr. 32 and 24 billion. The hedge ratio of dollar exposures was 67 per cent.

Conclusion

We analyse how pension funds manage foreign exchange risks and how their hedging behaviour leads to flows of Danish kroner. Foreign currency exposures denominated in euro and dollar are hedged differently due to Denmark's fixed exchange rate vis-à-vis the euro. The decision to hedge euro exposures to kroner is impacted by Danmarks Nationalbank's monetary policy interest rate spread to the ECB, which affects the cost of hedging in the FX forward market. We show that pension funds' goal to maintain a fixed hedge ratio for dollar exposures makes it possible to nowcast krone flows due to rebalancing of currency hedge positions. We estimate that a 10 per cent increase (decrease) in the S&P 500 corresponds to buying (selling) kr. 28 billion. Understanding the pension sector's currency hedging improves the understanding of the krone exchange markets, which is important in the context of the fixed exchange rate policy in Denmark.

Bibliography

Abildgren, Kim (2023), The Monetary History of Denmark 2005-2020, Danmarks Nationalbank

Achord, Samuel, Søren Lejsgaard Autrup, Nastasija Loncar, Alexander Meldgaard Otto, Lars Risbjerg, Casper Rønde and Johan Emil Westergaard (2021), Domestic bond portfolio adjustments during duration jumps, *Danmarks Nationalbank Economic Memo*, 14. December

Andersen, Torben M., Svend E. Hougaard Jensen, and Jesper Rangvid (2022), The Danish pension system: Design, performance, and challenges. Oxford University Press

Autrup, Søren Lejsgaard and Jakob Roager Jensen (2021), QE in a quasi-preferred habitat: The case of the Danish pension sector and the ECB asset purchase programme, Danmarks Nationalbank Working Paper No. 167, January.

BIS (2023), Quarterly Review – International banking and financial market developments, December 2023

Bräuer, Leonie and Haral Hau (2022), Can time-varying currency risk hedging explain exchange rates?, CESifo Working Paper No. 10065

Campbel, John Y., Carolin Pflueger, and Luis M. Viceira (2020), Macroeconomic drivers of bond and equity risks, *Journal of Political Economy*, 128.8

Danish Financial Supervisory Authority (2015), Markedsudvikling i 2022 for livsforsikringselskaber og tværgående pensionskasser

Danmarks Nationalbank (2024), Monetary policy is tight and dampens inflation, Danmarks Nationalbank Analysis (Monetary and financial trends), No. 3, March

Danmarks Nationalbank (2023), Monetary policy has been tightened further, Danmarks Nationalbank Analysis (Monetary and financial trends), No. 12, September

Danmarks Nationalbank (2022a), Rising inflation and Russian invasion have increased volatility, Danmarks Nationalbank Analysis (Monetary and financial trends), No. 4, March

Danmarks Nationalbank (2022b), Tighter monetary policy has made financing more expensive, Danmarks Nationalbank Analysis (Monetary and financial trends), No. 10, September

Danmarks Nationalbank (2020), Stabilisation of financial markets after COVID-19 turmoil, Danmarks Nationalbank Analysis (Monetary and financial trends), No. 11, June

Danmarks Nationalbank (2019), Pensionsselskaberne har stort likviditetsbehov ved rentestigninger, Danmarks Nationalbank Analysis, no. 23, November.

Danmarks Nationalbank (2015), The Danish krone under pressure in January-February 2015, *Danmarks Nationalbank Monetary Review*, 1st quarter

Fama, Eugene F. (1984), Forward and spot exchange rates, *Journal of Monetary Economics*, Vol. 14, pp. 319-338.

Grønlund, Asger and Lars Risbjerg (2020), Pressure on the Danish krone in times of crisis, Danmarks Nationalbank Economic Memo, No. 11, July

Hansen, Lars Peter, and Robert J. Hodrick (1980), Forward exchange rates as optimal predictors of future spot rates: An econometric analysis, *Journal of Political Economy*, Vol. 88 (5), pp. 829-853

Jørgensen, Anders, Christoffer Christen Larsen, and Lars Risbjerg (2013), Was the kroner a safe haven during the Sovereign debt crisis? Danmarks Nationalbank Monetary Review Part 1, 2nd quarter

Raffnsøe, Martin Dencker, Jakob Roager Jensen, and Anders Larsen (2016), The pension sector as a foreign exchange market participant, Danmarks Nationalbank Monetary Review, 4th quarter

Sizova, Elizaveta and Olav Syrstad (forthcoming), Rebalancing of currency hedging and the impact on exchange rates, Norwegian Business School BI Working paper

Spange, Morten and Martin Wagner Toftdahl (2014), Fixed exchange rate policy in Denmark, *Danmarks Nationalbank Monetary Review*, 1st quarter

Publications



NEWS

News may be a news article or an appetiser offering quick insight into one of Danmarks Nationalbank's more extensive publications. The series is targeted at people who need an easy overview and like a clear angle.



STATISTICAL NEWS

Statistical news focuses on the latest figures and trends in Danmarks Nationalbank's statistics. Statistical news is targeted at people who want quick insight into current financial data.



REPORT

Reports consist of recurring reports on Danmarks Nationalbank's areas of work and activities. Here you will find Danmarks Nationalbank's annual report, among other documents. Reports are targeted at people who need a status and update on the past period.



ANALYSIS

Analyses focus on current issues of particular relevance to Danmarks Nationalbank's objectives. The analyses may also contain Danmarks Nationalbank's recommendations. They include our projections for the Danish economy and our assessment of financial stability. Analyses are targeted at people with a broad interest in economic and financial matters.



ECONOMIC MEMO

Economic Memos provide insight into the analysis work being performed by Danmarks Nationalbank's employees. For example, Economic Memos contain background analyses and method descriptions. Economic Memos are primarily targeted at people who already have a knowledge of economic and financial analyses.



WORKING PAPER

Working Papers present research work by both Danmarks Nationalbank's employees and our partners. Working Papers are primarily targeted at professionals and people with an interest in central banking research as well as economics and finance in a broader sense.

Danmarks Nationalbank
Langelinie Allé 47
2100 Copenhagen Ø
+45 3363 6363



**DANMARKS
NATIONALBANK**