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Sveriges Riksbank, SE-103 37 Stockholm, Sweden
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Dear readers,

The first edition of Sveriges Riksbank Economic Review for 2021 contains four articles, which all cover subjects related to central bank core activities. The first article discusses why the krona weakened during the period from 2013 to the beginning of 2020. The second and third articles concern liquidity supply: how the Federal Reserve has contributed dollar liquidity to other central banks and how the Riksbank supported the economy during spring and summer 2020. The final article returns to the Riksbank's purchases of government bonds in the period 2015 to 2017, and analyses how the purchases affected financial markets.

- **On the weakness of the Swedish krona**

  Philippe Bacchetta and *Pauline Chikhani* at the University of Lausanne have written an article, commissioned by the Riksbank, analysing the development of the Swedish krona over the past years. From 2013 to the beginning of 2020, the krona weakened continuously against many other currencies, an unexpected development for many, including the Riksbank. Bacchetta and Chikhani go through various explanatory variables, including factors from traditional macroeconomic models and factors that can be linked to the monetary policy conducted. They also discuss how financial frictions and shocks may have contributed to the development of the krona.

- **Dollar liquidity from the Federal Reserve to other central banks**

  Marushia Gislén, *Ida Hansson* and *Ola Melander* describe why the US central bank, the Federal Reserve, has supplied other central banks with liquidity in US dollars, and how this is done in practice. The Riksbank is one of the central banks that has entered into a swap agreement with the Federal Reserve. The authors provide a brief history of the Federal Reserve's swap agreements from the 1960s and onwards, and also discuss how the swap agreements in 2020 contributed to alleviating unease on the dollar market as a result of the coronavirus pandemic.

- **Coronavirus pandemic: The Riksbank's measures and financial developments during spring and summer 2020**

  Peter Gustafsson and *Tommy von Brömsen* describe the measures taken by the Riksbank in spring and summer 2020 to counteract the damaging effects of the pandemic on the Swedish economy. The authors describe the sequence of events on the financial markets during this period, with particular focus on the most acute phase of the crisis in March. They also describe how the banks' lending to companies and households developed, as the purpose of the Riksbank's measures was ultimately to support the supply of credit and prevent the pandemic developing into a financial crisis.

- **Effects on financial markets of the Riksbank's government bond purchases 2015–2017**

  Ola Melander reviews the Riksbank's earlier purchases of government bonds during the period from February 2015 to April 2017. He discusses how such purchases can affect the economy according to economic theory, and analyses how the purchases affected prices on financial markets, that is to say the first stage in the monetary policy transmission to the broader economy. The study is partly based on earlier analysis at the Riksbank, but also contains new results and conclusions regarding the effects on inflation expectations and real interest rates.

Read and enjoy!

Marianne Nessén and Ulf Söderström

Contents

On the weakness of the Swedish krona

Philippe Bacchetta and Pauline Chikhani*

Bacchetta is Swiss Finance Institute Professor of Macroeconomics at the University of Lausanne, and Program Director of the International Macroeconomics and Finance program of the Centre for Economic Policy Research (CEPR, London). Chikhani is a doctoral student at the University of Lausanne.

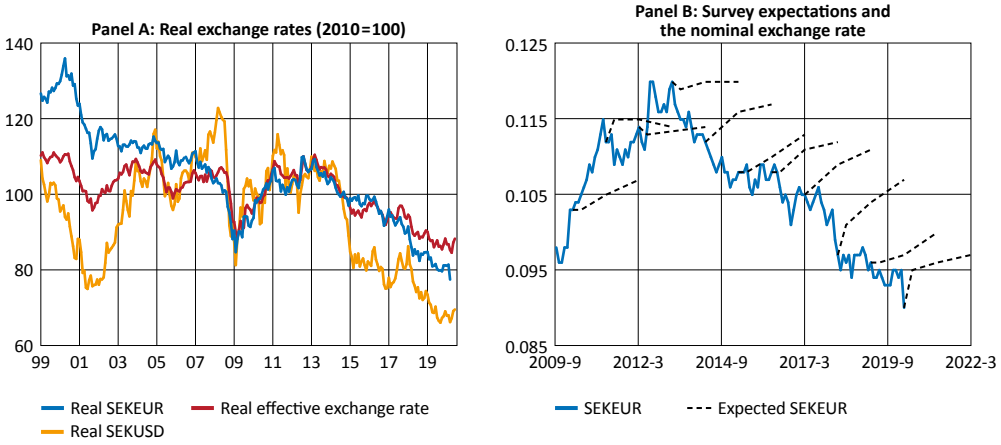
The Swedish krona depreciated sharply between 2013 and early 2020 but standard models are unable to explain this depreciation. This paper reviews the experience of the krona. By estimating an 'equilibrium' value for the real exchange rate, we confirm a growing undervaluation after 2014. The depreciation could initially be explained by a decline in interest rates and then by quantitative easing and the Riksbank communication regarding the krona. However, monetary policy cannot explain the extent of the depreciation nor the long depreciation period of seven years. We then review various complementary explanations proposed in the literature, including imperfect information, financial frictions, the role of financial shocks and the convenience yield. Many of these elements can plausibly explain the weakness of the krona, but cannot be quantified.

1 Introduction

Exchange rates are notably difficult to explain and to predict. An interesting illustration of this is the Swedish krona in recent years. Indeed, the krona has depreciated in real terms over the last decades. Panel A of Figure 1 shows the real value of the krona in terms of the euro, the dollar and a BIS trade-weighted rate for 27 countries (where an increase in the numerical value implies an appreciation). With respect to the euro, the krona has been continuously depreciating from March 2013 to March 2020, with a cumulative real depreciation of about 30 percent. This continuous depreciation has been totally unexpected. Both the central bank and market participants forecasted an appreciation during six years while the currency kept depreciating. Panel B of Figure 1 compares 24-month ahead survey expectations to the actual evolution of the nominal euro-krona exchange rate. From 2013 to 2020, the krona had been expected to appreciate, while it kept depreciating. A recent study on forecasting the krona by the Riksbank writes that over the recent period '... all the relationships and models considered ... underestimate the exchange rate ...' (Askestad et al., 2019).

* This paper was commissioned by Sveriges Riksbank in September 2019. The opinions expressed in this paper are the sole responsibility of the authors and should not be interpreted as reflecting the views of Sveriges Riksbank. We would like to thank seminar participants at the Riksbank as well as Carl-Johan Belfrage, Margaret Davenport, Stefan Gerlach, Philip Lane, Ulf Söderström, Vania Stavrakeva, and Lars E.O. Svensson for discussions and comments on an earlier draft.

Figure 1. The weakening Swedish krona, January 1999–June 2020



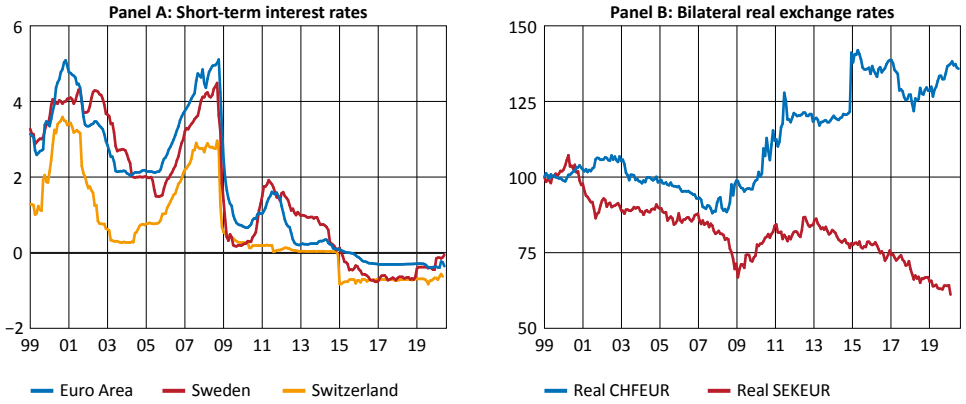
Note. Panel A compares real exchange rate indices. The red line corresponds to the real effective exchange rate for 27 countries given by the BIS, while the light and dark blue lines correspond to bilateral real exchange rates of the Swedish krona against the US dollar and the euro, respectively. Real exchange rates are CPI-adjusted. In Panel B, the blue line shows the nominal value of the Swedish krona in terms of euros. The dashed black lines show Prospera surveys up to 24 months ahead. In both panels, an increase in the exchange rate implies an appreciation.
Sources: BIS and Prospera

These developments complicate the conduct of monetary policy. Overestimating the value of the currency will lead to an underestimation of imported prices and thus of inflation.[1] But it is also a challenge for economic analysis, since standard models seem unable to explain the krona's behaviour. The first objective of this paper is to review the existing evidence and standard explanations for the Swedish krona's weakness. The second objective is to examine alternative explanations recently proposed in the literature.

We confirm the difficulties in explaining the recent evolution of the krona based on standard macroeconomic fundamentals. It is true that the Riksbank has conducted expansionary monetary policy since 2014. But this factor is not a sufficient explanation. As an illustration, it is interesting to compare Sweden to Switzerland, another small open economy with low government debt, a current account surplus, and very low nominal interest rates. Panel A of Figure 2 shows the evolution of nominal interest rates in Sweden and in Switzerland, compared to the Eurozone. Panel B shows the evolution of the exchange rate with respect to the euro, normalized to 100 in 1999. While we notice the same trend in short-term interest rates over time, the gap between the two exchange rates increases substantially, with the well-known strong appreciation for the Swiss franc and the depreciation of the krona. This difference in behavior points towards the role of non-traditional factors in explaining currency behaviour. The continuous depreciation of the currency over a long period of seven years is also puzzling.

1 See Corbo and Di Casola (2020) for a recent study on exchange-rate pass-through in Sweden.

Figure 2. The weak Swedish krona vs the strong Swiss franc



Note. Panel A shows short-term nominal interest rates for the Euro Area, Sweden and Switzerland. Panel B compares the path of the bilateral exchange rate indices of the Swedish krona and the Swiss franc against the euro, normalized to 100 in 1999. Real exchange rates are CPI-adjusted.
Sources: OECD, Global Financial Data and authors' calculations

We start the analysis by attempting to estimate an 'equilibrium' real value for the krona, following the recent literature. We use both quarterly and annual data for Sweden and a panel of ten countries. We find several variables that significantly co-move with real exchange rates: terms of trade, GDP per capita, government consumption and relative traded–non traded sector productivities. Estimates based on country-level regressions turn out to better track real exchange rate movements than those based on panel regressions. Using this methodology, we confirm that the krona has been undervalued since 2014 and that the degree of undervaluation has been growing over time.

We then analyze the potential reasons behind this undervaluation. We start by discussing the role of monetary policy. Beyond a low and mainly negative interest rate, the Riksbank also implemented quantitative easing measures and a communication strategy. The switch to a more expansionary policy in April 2015 clearly contributed to the depreciation. However, the krona kept depreciating when monetary policy stabilized and even after the Riksbank increased its interest rate at the end of 2018. On the other hand, quantitative easing was still active and the Riksbank kept talking down the currency until early 2019.

In the last part of the paper, we review several factors mentioned in the academic literature that could explain the continuing weakness. First, imperfect information has been shown to disconnect exchange rates from fundamentals and, at times, give an excessive role to some factors. This could have played a role in the context of the krona, although this cannot explain by itself the depreciation over so many months. Another perspective is the role of 'financial shocks', which can be seen as changes in desired portfolios by investors that are unrelated to observed fundamentals. While this is conceptually important, it is difficult to find precise measures for financial shocks. At least, global financial shocks do not appear to play a role. One financial factor that could play a role is the liquidity of bonds markets, as measured by the convenience yield. We show that this convenience yield appears to be related to the value of the krona, but that there are both econometric and conceptual issues that make it difficult to interpret this relationship.

There could also be various types of financial frictions that influence the dynamics of exchange rates. In particular, gradual portfolio adjustment could explain a delayed response to fundamental changes. Finally, exchange rate expectations may differ from the standard assumption of rational, forward-looking, investors. Expectations could be influenced by various types of information frictions or deviations from rational expectations. At this stage, however, the impact of this factor on the krona is unclear.

The remainder of the paper is organized as follows. Section 2 estimates an equilibrium value of the krona and documents periods of over- and undervaluation. Section 3 examines

the role of monetary policy. Section 4 discusses the potential impact of financial factors and financial frictions and Section 5 concludes.

2 Estimating the equilibrium real exchange rate

2.1 Analysing real exchange rates

We follow the standard approach of estimating an 'equilibrium' real exchange rate and determining to what extent the actual exchange rate deviates from its equilibrium value. The first step is to choose the price levels to construct the real exchange rate. The most common measure of the aggregate price level is the consumer price index (CPI) and this is the one we will consider: we use the narrow BIS real effective exchange rate index (trade-weighted with 27 economies), which uses CPI. The Riksbank's KIX exchange rate index has 32 countries and uses CPIF for Sweden, which excludes the direct effect of changes in mortgage interest rates.[2] Moreover, it is interesting to notice that the extent of real depreciation of the krona is smaller when using unit labour costs or purchasing power parity measures (see Sveriges Riksbank, 2019).[3]

There is a vast literature attempting to estimate equilibrium exchange rates using panel data over a set of countries. Some recent papers include Ricci et al. (2013), Adler and Grisse (2017), Berka and Steenkamp (2018), or Ca'Zorzi et al. (2020). This literature estimates reduced form regressions relating the real exchange rate to macroeconomic variables. To illustrate this methodology, consider the following equation:

$$(1) \qquad rer_{it} = \alpha_i + \boldsymbol{X}_{it}'\beta + \varepsilon_{it},$$

where rer_{it} is a measure of the log real exchange rate in country i and $\boldsymbol{X}_{it}$ is a set of macroeconomic variables. These are often relative variables, that is, country i compared to an average of other countries. In panel data regressions, α_i allows for country fixed effects. The estimation methodologies differ across studies, but they often use a co-integration method assuming non-stationarity of the real exchange rate and a co-integration relationship with explanatory variables (for example, Adler and Grisse, 2017, Ricci et al., 2013, or Ca'Zorzi et al., 2020). Thus, we estimate the latter relationship using Dynamic Ordinary Least Squares (DOLS). The fitted value of (1) represents the equilibrium real exchange rate and is compared to the actual exchange rate. There are also numerous papers working with country-level data, estimating equation (1) without the i subscript. Papers focusing on the Swedish krona include Nilsson (2004), Lindblad and Sellin (2006), or Lane (2007).

In this section, we follow the literature to estimate an equilibrium real exchange rate for the krona. We consider both panel and country-level regressions with either quarterly or annual data. For panel data, we consider ten countries: Australia, Canada, Finland, Ireland, Japan, Korea, Netherlands, Sweden, United Kingdom, and United States.[4] We first consider regressions with quarterly data and then turn to annual data.

2.2 Quarterly data

We basically follow the methodology described in Ricci et al. (2013) with the same set of advanced economies, even though they consider annual data. In Appendix B, we follow the somewhat different approach of Ca'Zorzi et al. (2020), with a slightly different set of countries. We run the panel data regression (1) with four macroeconomic variables

2 Since 2017 CPIF is the price level measure used by the Riksbank to define its inflation target.

3 Part of the explanation may be that Statistics Sweden makes more quality adjustment in computing the CPI than statistical agencies in other countries. The difference appears substantial for various types of goods. See Tysklind (2020).

4 This list of countries is determined by the availability of productivity data.

available at the quarterly level: GDP per capita, terms of trade, net foreign assets to GDP, and trade balance to GDP. The estimation period is 1975Q1 to 2018Q4. GDP per capita is a relative variable, divided by a weighted average of the countries of interest, the weights corresponding to the share of GDP (in PPP terms) of the ten countries in 2000Q4. Annual population size is interpolated, using cubic splines, in order to deal with quarterly data. It is worth noting that the terms of trade and the net foreign assets to GDP are already relative variables (with respect to the rest of the world), thus we do not take the relative value for these two variables. The terms of trade are defined as a ratio between export and import prices. More details on the construction of these series can be found in Appendix A. We then turn to a Sweden-only estimation of (1) using the same variables and the same time period. In particular, we still use relative variables.

Results for the panel and country-level regressions are shown in Table 1. We first notice that terms of trade are strongly significant with the expected sign, even though the magnitude of coefficients is much smaller with panel data.[5] GDP per capita is also significant and with a positive sign. Net foreign assets and trade balance to GDP are insignificant.[6] Results are similar under slightly different specifications.[7]

However, results differ if we adopt the approach of Ca'Zorzi et al. (2020) with their set of countries, as shown in Table B1 in Appendix B. Terms of trade are still significant and with coefficients of similar magnitude. But the trade balance to GDP becomes significant, while GDP per capita becomes insignificant.[8]

Table 1. Estimating the equilibrium real exchange rate using quarterly data

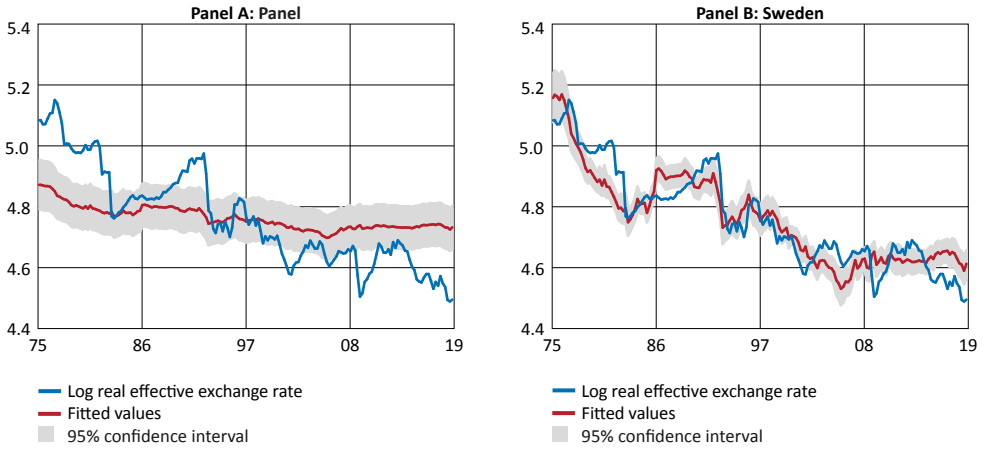
	Panel			Sweden		
	(1)	(2)	(3)	(4)	(5)	(6)
Log terms of trade	0.453*** (0.0966)	0.475*** (0.0988)	0.452*** (0.0968)	1.927*** (0.189)	1.797*** (0.253)	1.719*** (0.279)
Relative GDP per capita	0.255** (0.104)	0.277*** (0.106)	0.272** (0.124)	0.525** (0.262)	0.942 (0.609)	0.305 (0.376)
Net foreign assets to GDP		0.0375 (0.0486)			−0.156 (0.200)	
Trade balance to GDP			−0.0629 (0.235)			−0.775 (0.818)
Observations	1,757	1,757	1,757	173	173	173
R^2	0.598	0.602	0.599	0.843	0.849	0.854

Note. The dependent variable is the log real effective exchange rate. Standard errors in parentheses,
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

While the regression results are not robust to the approach used, the fitted value of these regressions, representing the equilibrium exchange rate, is similar under the various specifications we analyzed. Figure 3 shows the equilibrium exchange rate compared to the actual exchange rate using columns (1) and (4) of Table 1. Panel A of Figure 3 is computed from panel data estimation and Panel B shows the case based on the estimation with Sweden only. Figure B1 in Appendix B shows similar graphs using the methodology of Ca'Zorzi et al. (2020).

5 Notice that there is no claim of causality between these variables and the real exchange, but a co-integrating relationship. For example, terms of trade will naturally be affected by the exchange rate, so it is not surprising to find a strong relationship.
6 The trade balance is significant for the earlier part of the sample, for example until 2005.
7 For example, we used OLS with and without fixed effects or we introduced crisis dummies as in Lindblad and Sellin (2006).
8 GDP per capita has a positive sign if we restrict the data to the earlier sample, for example, until 2005, although it is hardly significant. Ca'Zorzi et al. (2020) also mention this feature. In the case of Sweden, it is not surprising to see a negative relationship in the latest part of the sample as we observe a strong relative growth at a time of real depreciation in the last decade. The Riksbank Monetary Policy Report (Sveriges Riksbank, 2018) discusses this issue. One hypothesis is that GDP growth could have been driven by an increase in productivity in the non-traded good sector, which would lead to a depreciation.

Figure 3. Equilibrium and actual real exchange rate using quarterly data



Note. Panel A displays the fitted values of the equilibrium real exchange rate using a panel of countries, while Panel B shows the fitted values when we estimate for Sweden only. We use the coefficients estimated in columns (1) and (4) of Table 1.
Sources: BIS and authors' calculations

The difference between the two panels of Figure 3 is striking. The equilibrium real exchange rate estimated from panel data, in Panel A, tends to move very little over time. By comparing with the actual exchange rate, we find that the krona has been below its equilibrium real value in the last two decades and that this divergence has been increasing over time. In other terms the estimated panel hardly matches the evolution of the real exchange rate in the last two decades.[9] Using panel data is useful if we can assume cross-sectional similarities. But the assumption of equal coefficients across countries made in the reduced-form equation (1) may not be appropriate. In the context of Table 1, the panel data coefficients could be biased downwards for example if the terms of trade do not matter for some countries. Notice that the issue appears more problematic for Sweden than for other countries in the sample.

In contrast, Panel B of Figure 3 shows a relatively good fit if we only use data for Sweden. The model explains most fluctuations. If we focus on the more recent period, however, we see that the actual value of the krona is below its equilibrium value since 2014. We can also notice the appreciation period 2010–2012 which is above the equilibrium value.

It is interesting to notice that in a Riksbank staff memo, Belfrage et al. (2020), only find an overvaluation since 2018. Their two main variables are also terms of trade and relative GDP per capita.[10] However, they use the Riksbank KIX index and a different methodology. They consider a time-varying autoregressive model with three additional variables for shorter-term fluctuations: the current account, the policy rate differential, and the VIX index (a measure of volatility on the US stock market). These variables turn out to be insignificant in our framework.

While quarterly data provides more data points and more precise fluctuation periods, only a limited set of variables is available across countries. When we turn to annual data we can consider a wider set of variables.

2.3 Annual data

The estimation strategy with annual data is the same as in the previous section, but we can consider more variables in addition to terms of trade, net foreign assets and the trade balance. The sample runs from 1970 to 2018.

9 Notice that Ca'Zorzi et al. (2020) find a similar result for Sweden (see their Figure 3).
10 They use population aged 15–64 to compute GDP per capita, while we use total population. However, our results change very little when we consider working age population.

Theoretically, a key variable determining real exchange rates is relative productivity in traded and non-traded sectors. This data is not available at the quarterly level. Even at the annual level we need to construct imperfect estimates. In this paper, we follow Ricci et al. (2013) and construct a labor productivity measure based on output per worker which distinguishes the productivity in tradables and non-tradables (see Appendix A for details on data construction). In addition to that specificity, we adjust the latter variable using the same method described in Subsection 2.2 dividing by a weighted average of the countries of interest, the weights corresponding to the GDP PPP share of the ten countries in 2000. It is interesting to mention that Berka and Steenkamp (2018) find that measures of total productivity are similar to labor productivity for Sweden.

Another variable that should matter is the fiscal stance.[11] We consider the impact of government consumption per GDP, as in Ricci et al. (2013). We use government consumption to GDP relative to the weighted average of the other countries. Finally, we also consider unit labor cost as suggested by Berka and Steenkamp (2018) and Berka et al. (2018). As the data used by Berka and Steenkamp (2018) is not available after 2012, we use a unit labor cost index based on the number of persons employed (relative to the weighted average of countries).

Table 2 presents the results with panel data and time-series data for Sweden with four variables: terms of trade, (relative) government consumption to GDP, (relative) per capita GDP, (relative) traded minus non-traded productivity differential. We do not show the results with unit labor costs, trade balance to GDP or net foreign assets to GDP as these variables are typically insignificant. Columns (1) and (4) show that terms of trade, government consumption, and GDP per capita are significant with the right sign.

Table 2. Estimating the equilibrium real exchange rate using annual data

	Panel			Sweden		
	(1)	(2)	(3)	(4)	(5)	(6)
Log terms of trade	0.437*** (0.0872)	0.119*** (0.0311)	0.308*** (0.0591)	1.279*** (0.0591)	1.318*** (0.0581)	1.310*** (0.0795)
Government consumption to GDP	1.026*** (0.246)	−0.293*** (0.0644)	0.657*** (0.171)	1.215*** (0.111)	0.331* (0.181)	0.526 (0.646)
Relative GDP per capita	0.790*** (0.149)		0.802*** (0.0941)	0.453*** (0.0632)		0.00526 (0.274)
Log productivity differential traded vs. non-traded sectors		−0.248*** (0.0239)	−0.239*** (0.0422)		−0.254*** (0.0382)	−0.229 (0.164)
Observations	487	487	487	46	46	46
R^2	0.687	0.653	0.727	0.936	0.944	0.948

Note: The dependent variable is the log real effective exchange rate. Standard errors in parentheses,
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

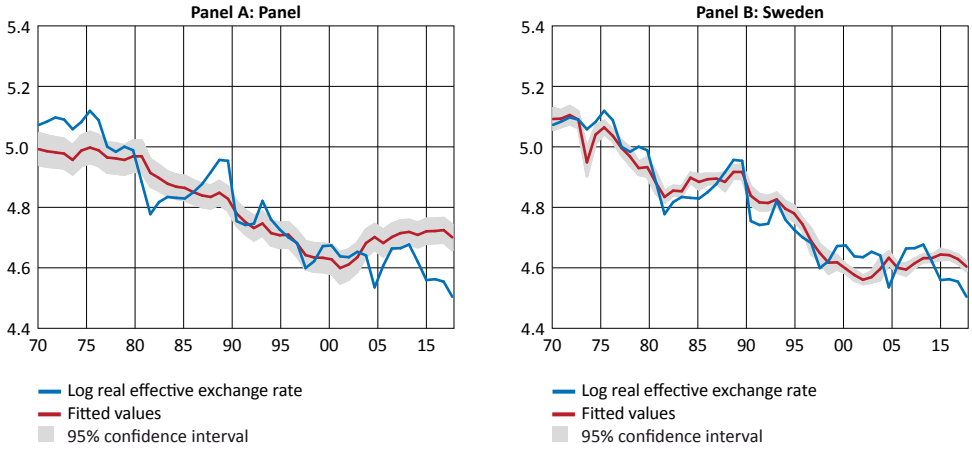
Adding relative productivity between tradables and non-tradables in columns (2), (3), (5) and (6) of Table 2 gives a more complex picture. First, this affects the value of the other coefficients, reducing their significance (columns (5) and (6)) or even changing their sign (column (2)). Moreover, relative productivity is significant, both with panel and Sweden-level data. However, the sign is negative, while the Balassa-Samuelson effect implies a positive impact: an increase in traded sector productivity increases wages and thus prices throughout the economy, which leads to a real appreciation. This negative sign is not specific to Sweden

11 For example, see Ricci et al. (2013), Adler and Grisse (2017), Goldfajn and Valdes (1999), and Lindblad and Sellin (2006).

as it also holds for panel data.[12] A negative sign for developed countries has been found previously in the literature (Ricci et al., 2013, Bordo et al., 2017, Gubler and Sax, 2019). Theoretically, the Balassa-Samuelson effect is positive when tradable goods are identical. However, if export and import goods are different, there may be a terms-of-trade impact that changes the sign of the productivity differential (Benigno and Thoenissen, 2003). There may also be a reverse sign if productivity growth in the traded sector is associated with higher productivity in the distribution sector (Devereux, 1999). Another potential explanation is that our measure of productivity captures demand rather than supply changes. More generally, the Balassa-Samuelson effect is more likely to apply when comparing countries with significant differences in development, while productivity differences across developed countries may be small and our relative TFP measures may capture other factors.

Figure 4 compares the actual real exchange rate with equilibrium values computed from columns (3) and (6) in Table 2. Using panel data, the equilibrium moves closer to the actual rate than with our quarterly data estimates. However, it would imply that the krona has been undervalued since 2008. On the other hand the equilibrium exchange rate estimated with Sweden-only data is close to the actual exchange rate, similarly to the case of quarterly data. The undervaluation only starts in 2014.

Figure 4. Equilibrium and actual real exchange rate using annual data



Note. Panel A displays the fitted values of the equilibrium real exchange rate using a panel of countries, while Panel B shows the fitted values when we estimate for Sweden only. We use the coefficients estimated in columns (3) and (6) of Table 2.
Sources: BIS and authors' calculations

To summarize this section, we find several variables that are significantly related to the real exchange rate: terms-of-trade, per capita GDP, relative productivity and government consumption. Using these variables with country-level data for Sweden, we find an equilibrium exchange rate that broadly moves in line with the actual exchange rate. However, in recent years the actual exchange has been weaker that the estimated equilibrium value. The challenge is to determine the shorter-run factors that have influenced the krona in recent years. One obvious factor is monetary policy and is discussed in the next section. There may be other macroeconomic factors, like increasing trade uncertainty, that are difficult to evaluate. However, our focus in Section 4 will be on alternative explanations for exchange rate behavior.

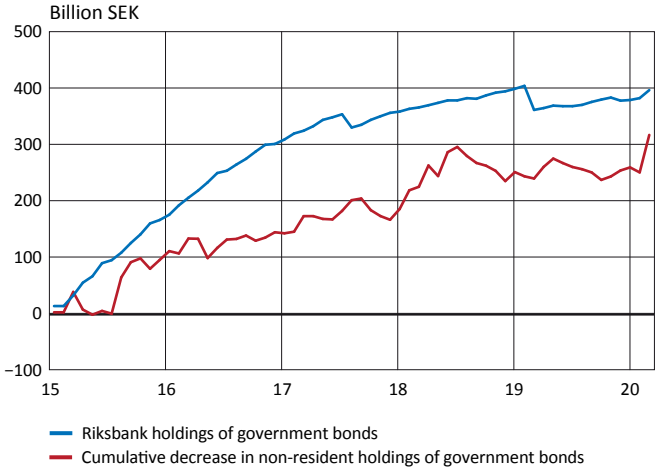
12 We find negative coefficients for eight out of the ten countries in the sample when we run country-level regressions.

3 The role of monetary policy

In the last decade, one can see a direct link between the value of the Swedish krona and the Riksbank policy rate. From Figure 2, one can see that the interest rate hike in 2010–2012 was associated with an appreciation of the krona, while the subsequent interest rate decline in 2015 paralleled the currency depreciation. While we observe a clear positive correlation between the interest rate and exchange rates over the 2010–2012 and 2014–2016 subperiods, no such relationship can be observed in other periods, for example between 2017 and early 2020 when the krona kept depreciating with no decline in the interest rate. Therefore, interest rate differentials alone cannot explain the continuous depreciation.

However, monetary policy is not only measured by current interest rates. The Riksbank engaged in substantial quantitative easing (QE) starting in early 2015, purchasing government bonds for more than 7 percent of GDP until 2019. These purchases implied a portfolio balance effect for the exchange rate, reducing the supply of krona assets to the private sector.[13] The reduction of available government bonds in krona is likely to push investors towards foreign currency bonds. To illustrate this point, Figure 5 shows the increase in central bank holdings of krona securities as well as the cumulative sales of krona government debt by non-resident investors. These non-resident holdings had been steadily increasing until May 2015, but started to decline thereafter.[14] At the same time, one can see an increase in Swedish residents' holdings of foreign currency securities. Overall, there is a net portfolio shift towards foreign currency assets that coincides with QE operations. This QE-induced portfolio shift obviously puts downward pressure on the krona. In a sense QE purchases of domestic currency assets can have effects similar to direct FX interventions.[15]

Figure 5. Riksbank quantitative easing and the decline in non-residents' holdings of government bonds
Billion SEK



Note. The blue line shows the holdings of government bonds from the Riksbank and the red line shows the cumulative decrease in non-resident holdings of government bonds, starting in January 2015.
Source: Sveriges Riksbank

Moreover, expectations of future monetary policy also matter. Central banks can influence these expectations through their communication. In the Swedish case, the central bank started to talk down the currency in 2015 and continued until 2019. The somewhat controversial tightening of Riksbank's policy in 2010–2011 was associated with an appreciation of the krona, as mentioned above (see Svensson, 2018). When the Riksbank

13 The recent literature has re-emphasized the role of these portfolio-balance effects (for example, Gabaix and Maggiori, 2015).
14 Notice, however, that non-residents do not necessarily repatriate all these funds as they could invest in other krona assets, in particular covered bonds.
15 Theoretically, if we consider a standard small open economy model with Ricardian equivalence and perfect asset substitutability, QE purchases can be equivalent to FX intervention.

started to lower its interest rate in April 2015 it also made clear that a stronger krona would not be desirable (see its Monetary Policy Report). Moreover, in January 2016 the central bank announced that it was prepared to use FX intervention to weaken the currency, although it never did. In subsequent years, the Riksbank kept insisting that a stronger krona was not desirable, even though the krona had already been depreciating for several years. This was still mentioned in the Monetary Policy Report of February 2019 (p. 10): 'The krona could be both stronger and weaker than the Riksbank is forecasting, but the effects on inflation of a stronger krona than forecast would be more problematic to manage with the prevailing interest rate levels.' This communication led to an asymmetric framework where the central bank is more likely to intervene when the currency is strong, thus lowering the probability of a strong appreciation. It is obviously difficult to quantify the impact of this communication on exchange rate expectations. Panel B of Figure 1 shows that the krona was always expected to appreciate, but the extent of expected appreciation in 2018–2019 was not so large.

4 The role of financial factors and financial frictions

In this section we examine various potential explanations for the weakness of the krona in recent years. We focus on the nominal exchange rate. Standard models also fail to explain the nominal weakness (for example, see Papahristodoulou, 2019, or Askestad et al., 2019). For example, uncovered interest rate parity (UIP) would imply an appreciation of the krona since Sweden has a negative interest rate differential with most countries. There might be shocks to the perceived riskiness of the currency, for example, a decline in its hedging properties. This would be like an anti-safe-haven effect. One could argue that the krona became less attractive as an alternative to the euro once the Eurozone crisis was resolved after 2012. But it is difficult to see what factors would lead to an increase in this effect in more recent years.

The literature has explored several deviations from standard models, in particular deviations from UIP. It is not the purpose of this paper to provide an exhaustive review of the literature, but we will examine approaches that appear particularly relevant.

4.1 Imperfect information

A strong assumption in standard models is that all market participants have the same information on fundamental variables or on the underlying model. When this is not the case, the exchange rate will deviate from the value implied by fundamental variables. For example, Bacchetta and van Wincoop (2006) develop a simple monetary model with dispersed information about future fundamentals. They show that non-fundamental, or financial, shocks can have large effects leading to a disconnect from fundamentals. The reason is that if market participants observe for example a currency depreciation they might revise their expectations of future fundamentals, assuming other participants have information of fundamental weakness. This disconnect coming from rational confusion should evaporate over time (after several months). Applying these ideas to the krona, it could be that the continuous depreciation has led to expectations of more expansionary monetary policy. While this could be part of the story, it is unlikely to apply over several years.

One should also notice that the model of Bacchetta and van Wincoop (2006) implies a strong relationship between exchange rates and order flow, which is consistent with what is found in the literature initiated by Evans and Lyons (2002). While the evidence on order

flow could be informative about short-term exchange rate dynamics and about the type of investors affecting the exchange rate, it would still beg the question of why investors want to sell the krona for a prolonged period.[16]

Another implication from imperfect information is the scapegoat effect. Bacchetta and van Wincoop (2004) analyze a model where investors have dispersed information about the model parameters. They show that this implies that markets, at times, give too much weight to a specific variable. Bacchetta and van Wincoop (2013) also show that this leads to time-varying coefficients. However, this is also based on rational confusion that should disappear over time.[17] In the case of the krona, it could be that excessive weight has been given to some variable, for example, expansionary monetary policy. However, this is difficult to confirm empirically. And again, it is unlikely that such an effect could last for many years.

4.2 Financial shocks

The recent literature also shows that in order to explain the data on exchange rate fluctuations, one needs to assume large financial shocks (for example, Itskhoki and Mukhin, 2020).[18] These financial shocks may include numerous factors affecting investors' portfolio behaviour and in general cannot be measured directly. So one could argue that investors have shied away from krona assets for reasons that cannot be captured by fundamental variables. But since it is difficult to be more precise, this is not very informative. There are measures of global financial shocks, for example, related to the VIX or to US monetary policy, that can affect the value of emerging market currencies. However, there is no clear relationship with the krona's value in recent years.

One more precise factor associated with financial shocks could be the relative liquidity of domestic currency assets, often referred to as the convenience yield.[19] While the foreign exchange market is liquid, the krona bond market may be less liquid. The question is whether the relative liquidity has declined in recent years. Du et al. (2018a) propose a measure of the convenience yield as the difference in government bond yields adjusted by the forward discount. More precisely, the convenience yield is defined as $\eta_{j,t} = i_t^{*G} - i_t^G + f_t - s_t$, where i_t^G and i_t^{*G} are domestic and foreign government yields, f_t is the forward rate, and s_t is the nominal exchange rate. Jiang et al. (2020) and Engel and Wu (2020) (henceforth EW) relate the value of the convenience yield to the exchange rate, focusing on one-year government yields. Following EW (see their Figure 1), Figure 6 shows the convenience yield and the exchange rate for two countries, Sweden and Switzerland.[20] In Panel A, one can see that the depreciation of the krona coincides with a lower convenience yield. In contrast, in Panel B the strength of the Swiss franc coincides with an increase in the convenience yield. (Note that in Figure 6, an increase in the exchange rate implies a depreciation.)

16 See Bjønnes et al. (2014) for an interesting application to the Swedish krona.

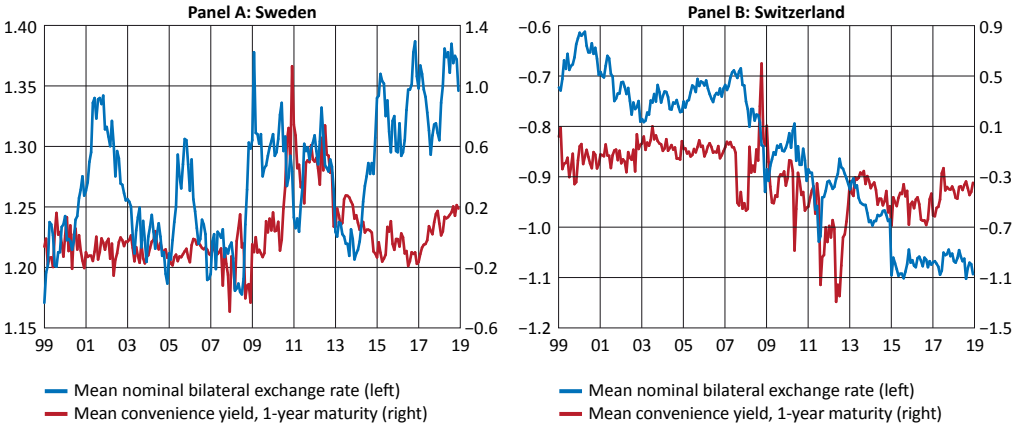
17 Fratzscher et al. (2015) provide support for the scapegoat model using surveys about the perceived role of fundamentals. Unfortunately, these surveys are not available for Sweden.

18 With imperfect information, the financial shocks do not need to be large as there can be an amplification mechanism.

19 See, for example, Engel and Wu (2020), Jiang et al. (2018, 2020), or Valchev (2020).

20 The ten currencies included in the sample are Swedish krona, Swiss franc, Australian dollar, Canadian dollar, euro, Japanese yen, New Zealand dollar, Norwegian krona, British pound and US dollar.

Figure 6. Average convenience yield and the nominal exchange rate



Note. Panel A displays in blue the average log nominal bilateral exchange rate between Sweden and nine different countries. In red, it shows the average of the convenience yield between Sweden and nine other countries. Panel B shows the same variables between Switzerland and the other nine countries. An increase in the exchange rate implies a depreciation.
Sources: Datastream and authors' calculations

To analyse this relationship more precisely, EW consider the following panel regression:

$$(2) \qquad \Delta s_{j,t} = \alpha_j + \beta_1 q_{j,t-1} + \beta_2(\Delta \eta_{j,t}) + \beta_3(\Delta i^R_{j,t}) + \beta_4 \eta_{j,t-1} + \beta_5 i^R_{j,t-1} + u_{j,t}\,,$$

where $i^R_t = i^G_t - i^{*G}_t$. They focus on one-year government yields and find that both the interest differential and the convenience yield are strongly significant. Table 3 presents evidence on equation (2) for Sweden, using the same methodology as in EW, for both one-year and one-month yields.[21] Our results are quite similar to those of EW. Column (1) shows strong significance with both the interest differential and the convenience yield (as in their Table 1A). Column (2) shows significance for the interest differential only, but with a lower R^2 (as in their Table 1B). Column (3) shows significance of the convenience yield without the interest differential. Using one-month yields in column (4) confirms the results of column (1) (as in their Table 1F). The number of observations is smaller in the latter case as one-month yields are not always available.

21 We consider the Swedish krona with respect to nine other currencies, as in Figure 6. We use OLS with country dummies.

Table 3. The exchange rate and the convenience yield

	Convenience yield with 1-year maturity			Convenience yield with 1-month maturity		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged log real exchange rate	−2.556*** (0.412)	−2.494*** (0.398)	−2.237 *** (0.370)	−3.596** (1.089)	−3.571** (1.076)	−4.136*** (0.904)
Change in interest rate differential	−2.691*** (0.453)		−4.396*** (0.541)	−0.894 (0.491)		−19.49*** (4.924)
Lagged interest rate differential	−0.0855 (0.0840)		−0.0955 (0.0696)	−0.0824 (0.0974)		−13.21*** (3.055)
Change in convenience yield		−2.379*** (0.492)	−4.696*** (0.659)		0.736 (0.451)	−19.82*** (4.880)
Lagged convenience yield		−0.654* (0.299)	−0.479 (0.304)		0.0831 (0.107)	−14.38*** (3.366)
Constant	3.392*** (0.518)	3.376*** (0.526)	2.976*** (0.471)	6.327** (1.859)	6.288** (1.837)	7.225*** (1.539)
Observations	2,104	2,104	2,104	1,258	1,258	1,258
Within R-squared	0.0531	0.0332	0.119	0.0223	0.0203	0.0497

Note. The dependent variable is the log change in the nominal exchange rate. Standard errors in parentheses,
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Although Table 3 shows strong significance of the convenience yield, there are various econometric issues with that regression. First, it assumes that the convenience yield is exogenous. But changes in the measured convenience yield could be fully endogenous. For example, imagine that there is a portfolio shift by international investors against krona bonds. This portfolio shift will weaken the currency, but it will also put pressure on krona government yields. Thus, we might observe a reduction in the convenience yield accompanied by a weakening of the currency. To correct for this endogeneity, EW use instrumental variables and still find significant coefficients that are even of a higher magnitude. However, correcting econometrically for endogeneity does not yield causality. If, as in the example above, the exchange rate and the convenience yield are jointly affected by an unobserved financial shock, establishing an econometric link between the two variables does not really inform us about the source of exchange rate fluctuations.

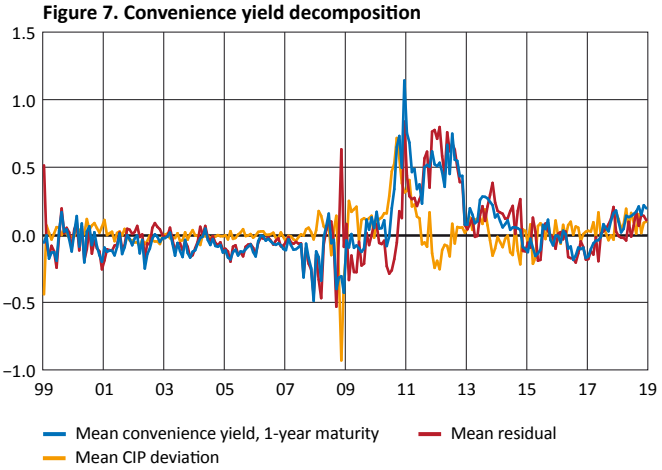
A second econometric problem comes from overlapping data when using one-year yields with monthly data. This problem can be alleviated by adjusting standard errors and parameters remain significant. This is the case, for example, when using Newey-West standard errors or time clusters.

Using one-month yields avoids this overlapping data problem, although it reduces the number of observations. However, the results in columns (4) to (6) of Table 3 point to a third econometric problem: the multicollinearity between the convenience yield and the return differential. Columns (5) and (6) show that neither the interest differential nor the convenience yield are significant. But when they are put together in the regression in column (4) they, somewhat miraculously, become strongly significant with coefficients of very similar magnitude. The explanation for this result is that the correlation between the convenience yield and the interest differential is -0.99. This multi-collinearity fully explains the significance with one-month yields. With one-year yields, the correlation is lower at -0.47.[22] However, it still explains part of the significance and the fact that the coefficients for the convenience yield and the interest differential are very similar for all countries.[23]

22 It also surprising to see that one-month and one-year convenience yields are uncorrelated.
23 The multicollinearity problem is no longer present when we consider 10-year yields.

Fluctuations in the convenience yield may come in part from deviations from covered interest rate parity (CIP). Deviations from CIP are reported by Du et al. (2018b) for Sweden and other countries (see their Figure 2) and show clear deviations from CIP for the Swedish krona since 2008.[24] Following EW, define the deviation from CIP as $\tau_t = f_t - s_t + i_t^* - i_t$, where i_t^* and i_t are Libor rates. We can then decompose the convenience yield as $\eta_t = \tau_t + \lambda_t$, so that λ_t is a relative liquidity measure after adjusting for CIP deviations. Figure 7 shows the evolution of η_t, τ_t, and λ_t averaged over the nine currency pairs for one-year yields.[25] We see that fluctuations in η_t are dominated by fluctuations in λ_t. It is still interesting to examine the differentiated impact of τ_t and λ_t on the krona value, as done in EW (Table 2A). Table 4 shows that both τ_t and λ_t are significant, with a coefficient of similar magnitude.[26] Similar to η_t, the coefficient of λ_t appears overestimated as its value drops when we do not include the interest differential in the regression.

Figure 7. Convenience yield decomposition



Note. The figure represents the decomposition of the convenience yield η_t into the deviation from covered interest rate parity τ_t with one year Libor rates, and its residuals λ_t, such that $\eta_t = \tau_t + \lambda_t$. Each line shows the average between Sweden and nine other countries.
Sources: Datastream and authors' calculations

The econometric issues recommend caution in interpreting the results from convenience yield regressions. More importantly, even if one finds a relationship between the krona and the convenience yield, there still remains the question of what underlying financial shocks influence the convenience yield. Finally, changes in the convenience yield cannot explain the krona depreciation in recent years, as Figure 6 shows an increase in the convenience yield while the krona kept depreciating.

24 Notice that these deviations are similar to several other currencies, in particular the euro and the Swiss franc.
25 Libor rates are only available until 2013 for Sweden. To complete the sample, we use the one-year deposit rate.
26 The regression also includes lagged variables in levels, but the coefficients are not shown in Table 4.

Table 4. The exchange rate and the decomposed convenience yield

	Convenience yield (CY)	Decomposed CY	Decomposed CY
Lagged log real exchange rate	−2.237*** (0.370)	−2.248*** (0.365)	−2.295 *** (0.400)
Change in interest rate differential	−4.396*** (0.541)	−3.987*** (0.504)	
Change in convenience yield	−4.696*** (0.659)		
Change in CIP deviation		−5.710*** (0.983)	−4.747*** (1.017)
Change in residual		−4.153*** (0.664)	−1.719*** (0.493)
Observations	2,104	2,104	2,104
Within R-squared	0.119	0.126	0.0624

Note. The dependent variable is the log change in the nominal exchange rate. Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.3 Other financial frictions

While there can be various explanations for a weak krona, the continuous depreciation is difficult to explain. This means that on average investors wish to keep selling the krona over long periods. One explanation is that many investors change their portfolio gradually. If they expect the return in krona assets to be low, not all investors will immediately adjust their portfolios. The adjustment will be done over time. The hypothesis of gradual adjustment would be consistent, for example, with the gradual increase in purchases of foreign government bonds by Swedish investors. Substantial increases can be observed until mid-2019. Bacchetta and van Wincoop (2010, 2020) show that this gradual portfolio adjustment implies exchange rate dynamics that are consistent with the data.[27] In particular, it is consistent with the exchange rate dynamics considered in the Riksbank DSGE model of the Swedish economy (see Adolfson et al., 2008).

Moreover, investors may not be as forward looking or as rational as standard models assume. Actually, Bacchetta and van Wincoop (2010, 2020) argue that gradual adjustment should be combined with expectations based on limited information to match the dynamic relationship between nominal exchange rates and interest rates. There are obviously numerous reasons why expectations are not fully forward looking and 'rational'. There may be costly information, heterogeneous beliefs, psychological biases, simple trading rules, etc. For example, a simple momentum strategy would keep selling the krona. The fact that survey expectations overpredict the value of the krona for seven years shows a systematic expectational error that is inconsistent with rational expectation models. However, these expectational errors cannot explain the weak value of the krona, as they would encourage krona purchases.

5 Conclusions

The continuing depreciation of the Swedish krona from 2013 to early 2020 is a puzzling phenomenon for an advanced economy. The initial depreciation could easily be rationalized as it was associated with a reduction in interest rates and followed a period of appreciation. But the krona kept depreciating even when the interest differential stabilized. Quantitative

27 Bacchetta et al. (2020) show that this explanation is also consistent with the behavior of international equity portfolios by mutual funds.

easing operations, however, continued and put pressure on the krona through a portfolio balance effect. Moreover, the central bank kept talking down the currency until early 2019. It may appear surprising that the Riksbank was still worried about a strong krona when it had been so weak for many years. Probably its reasoning was that since the krona was undervalued an appreciation was bound to occur. Given that the main focus was inflation, an appreciation was not welcome as it reduces imported inflation. The scenario of an appreciating krona was indeed plausible, as illustrated by the events of 2020. However, given the huge uncertainty regarding the timing of an appreciation, one might wonder whether the focus on relatively short-term inflation prospects was fully optimal.

This paper has also allowed us to revisit empirical methodologies used in exchange rate analysis. Using standard methods to estimate an equilibrium real exchange rate, we found that using pooled cross-country panel data had shortcomings and we preferred the estimates with Swedish time series. We also found that the real exchange rate could not be explained by a Balassa-Samuelson effect, a typical result for advanced economies. On the other hand we found terms of trade, government consumption, and GDP per capita to be significantly associated with the real exchange rate. Moreover, the finding that the krona had been undervalued in recent years is robust across methodologies.

Financial shocks, in the form of desired portfolio shifts by investors, are likely to be a major driving force for exchange rates. Their impact can be amplified by imperfect information. However, these shocks are typically not observable and will impact many financial variables. For example, we have analyzed the relationship between the value of the krona and the convenience yield on krona government bonds. Putting aside the econometric issues with this analysis, finding a relationship between the exchange rate and the convenience yield may simply reflect the impact of financial shocks. This still begs the question of where the shocks come from. The same can be said for the relationship between exchanges rates and order flow. Moreover, financial shocks alone are unlikely to explain the long period of depreciating krona. There may be mechanisms at work such as imperfect information, gradual portfolio adjustment, or biases in expectations.

All in all, part of the krona depreciation is still a puzzle. Exchange rate economists have been humble since Meese and Rogoff (1983). There have been many interesting developments in the field in the last decades. These developments help us understand better the forces that potentially move exchange rates, but, as this paper illustrates, they do not give precise quantitative explanations. Therefore, we have to keep being humble.

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Appendix A – Data

Data description

Table A1. Quarterly data – 1975Q1–2018Q4

Variable	Details	Source
Real exchange rates	Real effective exchange rate BIS27.	BIS
Relative GDP per capita	Real GDP in PPP terms, interpolated population data (cubic spline) relative to a weighted average of all countries (weighted by the share in total GDP PPP of the countries in 2000Q4).	OECD National Accounts, United Nations
Terms of trade	Ratio of export to import goods and services deflators.	OECD Economic Outlook
Net foreign assets to GDP	Balance of payments data (following Lane and Milesi-Ferretti, 2017, definition), complete the database with interpolated data (cubic spline) from the annual database of Lane and Milesi-Ferretti (2018), divided by real GDP in PPP terms.	IMF IFS, External Wealth of Nations database (Lane and Milesi-Ferretti, 2018), OECD National Accounts
Trade balance to GDP	Difference between exports and imports of goods and services.	OECD Economic Outlook

Table A2. Annual data – 1970–2018

Variable	Details	Source
Real exchange rate	Real effective exchange rate BIS27.	BIS
GDP per capita	Real GDP per capita in PPP terms.	OECD National Accounts
Productivity differential	Difference between the log productivity of tradables and non-tradables relative to a weighted average of all countries (weighted by the share in total GDP PPP of the countries in 2000). Productivity is defined as output per worker (in USD). Tradables and non-tradables are separated using the ISIC industry classification (A–E, F–U respectively).	United Nations (output per industry), ILOSTAT (workers per industry), IMF (bilateral exchange rate against USD)
Terms of trade	Ratio of index of export to import prices.	OECD data
Net foreign assets to GDP	Annual database developed by Lane and Milesi-Ferretti (2018), complete missing years with balance of payments data (following Lane and Milesi-Ferretti, 2017, definition), divided by real GDP in PPP terms.	External Wealth of Nations database (Lane and Milesi-Ferretti, 2018), IMF IFS, OECD National Accounts
Trade balance to GDP	Difference between exports and imports of goods and services from the balance of payments.	IMF IFS

Table A3. Monthly data – 1991M1–2018M12

Variable	Details	Source[28]
Exchange rates	Bilateral nominal exchange rate against USD.	Datastream
1-year forward rates	1-year forward rates against USD.	Datastream
1-month forward rates	1-month forward rates against USD.	Datastream
1-year government bond yield	1-year government bond yield, with German government yield for the Euro Area.	Global Financial Data, Datastream
1-month government bond yield	1-month government bond yield, with German government yield for the Euro Area.	Global Financial Data, Datastream
1-month LIBOR	1-month LIBOR.	Datastream
Consumer price index	Consumer price index, interpolated data (linear) when quarterly data only (Australia and New Zealand).	IMF IFS
12-month LIBOR	12-month LIBOR and 12-month deposit rate when former not available.	FRED, Datastream

28 See Engel and Wu (2020) for the exact ticker in Datastream.

Appendix B – Estimation following Ca'Zorzi et al. (2020)

In Subsection 2.2, we estimate the equilibrium real exchange rate using the set of regressors proposed by Ca'Zorzi et al. (2020). Table B1 reproduces their estimation, taking the same regression and set of countries: Australia, Canada, Euro Area, Japan, New Zealand, Norway, Sweden, Switzerland, United Kingdom and United States. GDP per capita is computed relative to foreign values only and the real exchange rate and terms of trade are not in logs. We finally add an estimation with the trade balance as proposed by Lane (2007).

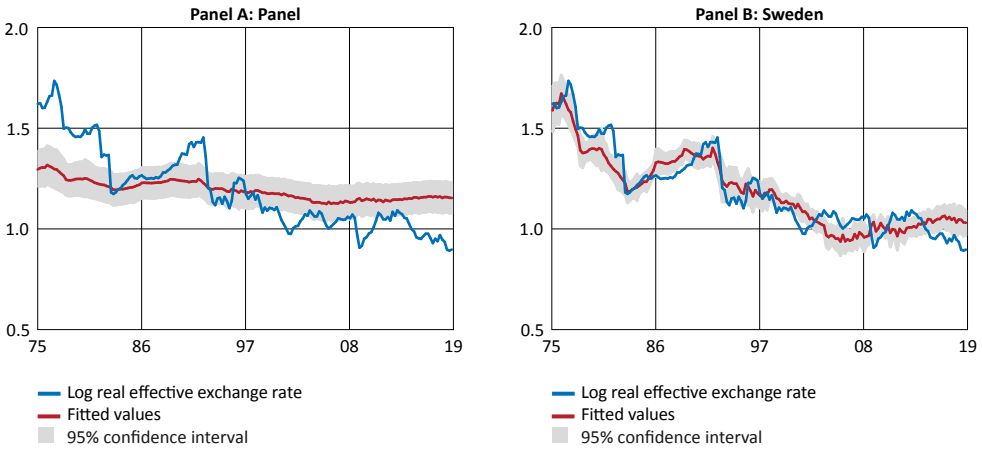
Table B1. Estimating the equilibrium real exchange rate following Ca'Zorzi et al. (2020)

	Panel		Sweden	
	(1)	(2)	(3)	(4)
Relative GDP per capita	−0.174 (1.405)	−0.119 (1.330)	−1.796 (10.26)	−1.465 (6.287)
Terms of trade	0.411*** (0.0998)	0.431*** (0.0992)	2.307*** (0.313)	1.737*** (0.275)
Net foreign assets to GDP	−0.0315 (0.0391)		0.221 (0.224)	
Trade balance to GDP		−0.541 (0.355)		−1.857** (0.906)
Observations	1,757	1,757	173	173
R^2	0.575	0.580	0.847	0.865

Note: The dependent variable is the real effective exchange rate. Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In this setting, relative GDP per capita is insignificant, while the trade balance is significant. Only terms of trade remain consistent with Table 1 in Subsection 2.2. In Figure B1, we show the fitted values of our estimation above for columns (2) and (4).

Figure B1. Equilibrium vs actual real exchange rate following Ca'Zorzi et al. (2020)



Note. Quarterly data estimation with GDP per capita. Panel A displays the fitted values of the equilibrium real exchange rate using a panel of countries, while Panel B shows the fitted values when we estimate for Sweden only. We use the coefficients estimated in columns (2) and (4) of Table B1.
Sources: BIS and authors' calculations

Dollar liquidity from the Federal Reserve to other central banks

Marushia Gislén, Ida Hansson and Ola Melander*

The authors work in the Financial Stability Department of the Riksbank.

A central bank can always increase the volume of money in its domestic currency. However, a central bank might also need access to other currencies, for instance in order to provide liquidity assistance in foreign currency to banks. It is for this reason that central banks hold a foreign currency reserve. Sometimes, central banks can also get access to foreign currency through liquidity swap agreements ('swaps') with other central banks. In this analysis, we focus on dollar liquidity from the Federal Reserve through such swaps because it is important in helping to alleviate stress on global financial markets in a crisis. This paper aims to describe why the Federal Reserve has entered into swap agreements with other central banks, and how such swaps have worked in practice during the global financial crisis and so far during the covid-19 pandemic. Experience shows that liquidity swap agreements have contributed to lower global dollar funding costs and helped alleviate stress on financial markets. However, there is never any guarantee that the Federal Reserve or other central banks will provide foreign currency liquidity in a crisis. Therefore, liquidity swap agreements cannot replace central banks' foreign currency reserves, but rather serve to complement them.

1 Introduction

A central bank essentially has unlimited possibilities of increasing the volume of money in its domestic currency. However, it might also need access to other currencies, for instance to provide liquidity assistance in foreign currencies to banks and other important market participants in a crisis, or to sell foreign currency with the aim of influencing the exchange rate. For this reason, central banks usually hold a foreign currency reserve in the form of securities in foreign currencies. If needed, a central bank can sell these securities to obtain liquid funds in foreign currencies.[1]

In certain conditions, some central banks can also temporarily exchange domestic currency for foreign currency through arrangements known as liquidity swap agreements with other central banks. In the global financial crisis of 2008–2010, the central bank of the United States, the Federal Reserve, entered into swap agreements with a number of select central banks, including the Riksbank, to help provide dollars to the local market. During the covid-19 pandemic as well, the Federal Reserve has entered into swap agreements with

* We wish to thank David Farelius, Joanna Gerwin, Linda Goldberg, Jesper Hansson, Johan Molin, Marianne Nessén, Christina Nordh Berntsson and Olof Sandstedt for valuable comments. We are responsible for any remaining errors. The views expressed in this paper are those of the authors and are not necessarily shared by the Executive Board of Sveriges Riksbank.

1 Central banks usually also hold a reserve in the form of gold. They can use the gold reserve to obtain liquid funds in foreign currencies. The total reserve is called the gold and foreign currency reserve.

these same central banks.[2] Through these agreements, the Federal Reserve can provide dollar liquidity to another central bank in exchange for the currency of the receiving central bank, during a certain predetermined period. The demand for dollar liquidity in auctions held by the receiving central bank determines the amount of liquidity provided by the Federal Reserve within the limits of the agreement. At the end of the period, the central banks swap the currencies back at the same rate that applied at the beginning of the period. The transactions entail currency exchanging owners, which is why they are known as 'swaps', and the foreign central bank pays a fee – a certain interest rate – to the Federal Reserve.

The purpose of this paper is to describe why the Federal Reserve has provided other central banks with dollar liquidity through swap agreements, and how these swaps have worked in practice. We focus on dollar swaps from the Federal Reserve because they are of great significance to the functioning of global dollar funding markets in a crisis. However, it is worth noting that other central banks too, such as the European Central Bank (ECB) and the Riksbank, have entered into swap agreements to provide liquidity to other central banks.[3] In section 2, we provide a number of explanations as to why the Federal Reserve has entered into swap agreements in global crises. In section 3 we provide a brief history of the Federal Reserve's swap agreements from the 1960s and onwards, with a focus on the global financial crisis and the euro crisis. In order to understand the role and effects of the swap agreements, it is important to understand how the dollar funding market works and what happens when the market does not work in a crisis. Therefore, in section 4 we describe how the dollar market works today, its vulnerabilities and risks and how these came to materialise during the covid-19 pandemic. In section 5, we go on to describe how the swap agreements helped alleviate the stress on the dollar market during the covid-19 pandemic with a particular focus on the dollar liquidity provided to the Riksbank and other Scandinavian central banks. In section 6, we explain why the existence of swap agreements does not reduce the need for a central bank to hold a foreign currency reserve to secure foreign currency supply in a crisis. To round off, we present conclusions in section 7.

2 Why does the Federal Reserve collaborate with other central banks to provide dollar liquidity in global crises?

During both the global financial crisis and the covid-19 pandemic, the purpose of the Federal Reserve's swap agreements has been to manage stress on global and domestic dollar funding markets, see Federal Reserve (2020a). Because the US dollar is a central currency on global funding markets, shocks on the international dollar market can spread to the US credit market and affect financial stability. This could in turn lead to a credit crunch for US households and businesses, and hence affect the performance of the real economy in the United States. Through swap agreements, the Federal Reserve can support the provision of dollar liquidity via select central banks. The swap agreements are also important for signalling that central banks are prepared to act jointly to manage a global crisis. Below, we describe the purposes of the Federal Reserve's swap agreements in more detail.

2 Standing swap arrangements with the Bank of Canada, Bank of England, Bank of Japan, the European Central Bank, and the Swiss National Bank. Temporary swap agreements with the Reserve Bank of Australia, Banco Central do Brasil, Danmarks Nationalbank, Bank of Korea, Banco de Mexico, the Reserve Bank of New Zealand, Norges Bank, the Monetary Authority of Singapore, and Sveriges Riksbank.

3 During the global financial crisis, the Riksbank entered into swap agreements with a number of nearby countries and in November 2020 the Scandinavian central banks reached an agreement on a set of principles for liquidity swap agreements in times of crisis.

2.1 Improving liquidity on financial markets and avoiding a credit crunch in the United States

Swap agreements existed already before the global financial crisis, although they often had purposes other than managing stress on global financial markets. According to Goldberg et al. (2011), swaps were used in the past to fund interventions on the foreign exchange market. Humpage and Shenk (2008) describe how the Federal Reserve, in the 1970s, used swaps to obtain foreign currencies, which were then used to buy dollars, thus defending the value of the dollar. The Federal Reserve also used swaps to provide temporary funding for Mexico during the 1982 and 1995 crises.[4] However, McCauley and Schenk (2020) observe that swap agreements, already before the global financial crisis, were not only used for foreign exchange interventions and temporary funding, but also to manage shocks on the dollar market by providing liquidity in dollars.

According to the Federal Reserve, swap agreements today have the purpose of improving liquidity on financial markets by enabling other central banks to offer dollar funding to financial institutions during periods of financial turbulence (Federal Reserve 2020a). Otherwise, shocks on the international dollar market could spread to financial markets in the United States and lead to a credit crunch and hence lower growth. A lack of dollar funding can force banks and other financial institutions to sell assets in dollars, and if many act in the same way, this could in turn lead to plummeting asset prices. By helping to stabilise financial markets and supporting economic development in other countries, the Federal Reserve can thus also contribute to better economic development in the United States. The experience from the covid-19 pandemic shows that swap agreements support the flow of credit to US corporations from US branches of foreign banks providing loans in the US, see Cetorelli et al. (2020a).

2.2 Supplying global liquidity instead of central banks needing to sell assets from their foreign currency reserves

One way for another country's central bank to gain access to liquidity in dollars in a crisis is to sell US government bonds from its foreign currency reserve. In Box 1 below we discuss this and other ways of gaining access to dollar liquidity. If several central banks simultaneously sell US government bonds, there is a risk that this would push down the price and increase the yield on the bonds. This causes an undesirable tightening of financial conditions during a crisis. Swap agreements from the Federal Reserve reduce the need of other central banks to sell assets out of their foreign currency reserves during a crisis to obtain liquidity in foreign currencies.

Bordo et al. (2014) also point out that when central banks sell off dollar assets from their foreign currency reserves, this does not increase available dollar liquidity globally. The buyers of dollar assets pay the central bank in dollars, which initially disappear from the market, to then be lent again from the central bank to the banking sector. By using its foreign currency reserve, the central bank can manage the domestic banking sector's dollar need, but the volume of dollars in circulation is thus unchanged. Only the Federal Reserve can supply new liquidity in dollars. For this reason, dollar reserves held by other central banks can never replace swap agreements when it comes to managing global stress on financial markets in a crisis.

Overall, swap agreements from the Federal Reserve serve an important function in a global crisis, because they can help avoid tightening of financial conditions in the US and globally by supporting the provision of liquidity in dollars. In normal circumstances, there are many other ways for a central bank to gain access to dollars; in a crisis, however, swap agreements from the Federal Reserve play a unique role.

4 See also Toniolo (2005) for a description of swap agreements between the Federal Reserve and other central banks from 1962 to the end of the 1990s.

BOX 1. Other ways for a central bank to gain access to dollar liquidity in a crisis

There are many ways other than liquidity swap agreements for gaining access to dollars in a crisis. A central bank such as the Riksbank can for instance sell assets out of its foreign currency reserve. However, there are also other alternative ways, such as:

i. borrowing dollars once a crisis has struck,
ii. exchanging domestic currency for dollars on the foreign exchange market and
iii. applying for a loan programme from the International Monetary Fund.[5]

Below we discuss these various options for managing a dollar shortage in a crisis from the Riksbank's perspective.[6]

Selling assets out of the foreign currency reserve

Both during the global financial crisis and the covid-19 pandemic, the Riksbank funded dollar lending to banks through the foreign currency reserve. During the financial crisis of 2008–2010, the foreign currency reserve accounted for around SEK 50 billion or approximately one fifth of the Riksbank's total lending in foreign currency to the Swedish banks. The remainder, around SEK 200 billion, was funded using swap agreements. So far during the covid-19 pandemic, the Riksbank has funded lending in dollars to the Swedish banks of USD 2 billion through the foreign currency reserve. It has not been necessary to use the swap agreement with the Federal Reserve because the demand for dollar loans has been low so far.

According to Nyberg (2011) this worked well during the global financial crisis, even though it is somewhat more complicated and time-consuming to sell dollar assets out of the foreign currency reserve than using swap agreements with the Federal Reserve. Assets need to be sold and the proceeds deposited in an appropriate bank account before they can be lent to Swedish banks. The time lag is however relatively small.[7]

Borrowing dollars once a crisis has struck

A pre-funded foreign currency reserve involves an ongoing cost that is similar to an insurance premium. This can be avoided if the Riksbank instead relies on the ability to borrow dollars via the National Debt Office once a crisis has struck. However, depending on the type of crisis, the National Debt Office might have limited possibilities of quickly obtaining loans and thus increasing the sovereign debt without having too much of an impact on interest rates. There are different opinions about how easy it would be to borrow large amounts, in a short space of time and at a reasonable cost, via the National Debt Office in a crisis.

The National Debt Office (2013) and the Riksbank Inquiry (SOU 2019:46) find that the National Debt Office could, without any difficulty, increase borrowings on behalf of the Riksbank with the purpose of restoring a foreign currency reserve that has been used to provide liquidity assistance in foreign currency. The earlier Flam Commission on the Riksbank's financial independence also advocates this option (see SOU 2007:51). Sveriges Riksbank (2017) however finds there is a risk that funding, which is raised once a crisis has struck, will be more expensive, take longer to carry out and affect the transmission of monetary policy. One problem is that large amounts might need to be borrowed within a short space of time. In the 2008 crisis, the Riksbank lent dollars equalling SEK 200 billion in the space of just four weeks. There is a risk of rapid borrowings of such large amounts pushing up state borrowing costs and, at worst, it might be difficult to borrow the amount needed in time.

Exchanging SEK for USD on the foreign exchange market

The Riksbank could create Swedish kronor and exchange them for dollars on the foreign exchange market. An increase to the foreign currency reserve would thus be funded by a greater liability in Swedish kronor. Because the Riksbank would, in that case, have an asset in foreign currency and a liability in Swedish kronor, currency risk on the Riksbank's balance sheet would increase. In a crisis, there is however a risk that large and rapid purchases of foreign currency would be expensive, take time to carry out and affect the exchange rate, and thus come into conflict with monetary policy (see Sveriges Riksbank 2017).

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5 There are also other ways to gain access to dollars: borrowing dollars in a swap transaction secured by gold, selling gold from the gold reserve, selling assets in another currency from the foreign currency reserve in exchange for dollars and entering into swap agreements in dollars with a central bank other than the Federal Reserve.

6 One alternative to increasing the *supply* of dollars in a crisis would be to reduce *demand* for dollars by amending the rules governing the actions of pension and insurance companies on financial markets. More specifically, it would be a case of reducing requirements regarding currency hedging. This would however take time, be complicated and increase the risks in the companies. Another way of attempting to circumvent the need for a foreign currency reserve is to rely on state guarantees for the banks' foreign funding. According to the National Debt Office, this is an effective way of facilitating banks' funding in a crisis. Sveriges Riksbank (2017) however finds that it is uncertain how well a guarantee would work given that the Swedish banking system is currently several times larger than GDP.

7 As already mentioned, the sale of assets in foreign currency reserves cannot however replace swap agreements in a global crisis. There would be a risk of yields on US government bonds rising if many countries simultaneously sold bonds, and also it is only the Federal Reserve that can supply liquidity in dollars (see Bordo et al. 2014).

Applying for a lending programme from the International Monetary Fund (IMF)

For Sweden to qualify for a lending programme with the IMF, the foreign currency reserve would have to be so low that we could not fund our international payments. Also, the IMF imposes certain requirements for economic policy to grant loans. This alternative would therefore put a limitation on freedom of economic policy action during a crisis. Sveriges Riksbank (2017) therefore finds that it is not appropriate to act in such a way that increases the probability of needing to apply for an IMF programme. It is only reasonable to see an IMF programme as a viable alternative once all other options are exhausted.[8]

Moreover, several economists have argued that the IMF should have a role when it comes to currency swap agreements between central banks. Reis (2019) suggests for example that the IMF could bear the responsibility for analysing the risk of a decline in value in the currency of the receiving central bank, which would reduce the value of the lending central bank's collateral in the form of currency. According to the proposal, the IMF would decide which 'haircut' to use when activating a swap agreement. If the receiving central bank does not honour its obligations according to the agreement, the IMF would assume the risk from the liquidity-providing central bank by stepping in with a loan programme, see also Levy Yeyati (2020) for similar suggestions.

Truman (2013) proposed instead that the IMF's role should be to analyse the need for increased global liquidity in the international financial system and, if needed, recommend activation of swap agreements between central banks. The lending central banks would then decide on activating (or not activating) a swap agreement.[9] However, there has not been any support for the proposals for the IMF to have an extended role because the lending central banks have wanted to maintain control over the swap agreements.

8 The Riksbank can also sell its holding of Special Drawing Rights (SDR) to gain access to dollars or euro. However, the volume is limited to just over USD 3 billion (see Gislén and Kangas 2020). A sale of SDR should, at best, be considered a complement to other tools.

9 During the global financial crisis, Truman (2008) suggested instead that the Federal reserve should establish a swap agreement with the IMF to increase the Fund's dollar-lending capacity.

2.3 Signalling that central banks are acting jointly to manage the crisis

Swap agreements clearly signal that the Federal Reserve stands prepared to act together with other central banks to jointly manage a global crisis. Such a signal can in itself help to calm financial markets and hence reduce the need to draw on the swap agreements. The Federal Reserve and the other central banks therefore often coordinate their communication and announce the agreements at the same time (Sheets et al. 2018).

3 The Federal Reserve's swap agreements

Swap agreements were established already in the early 1960s between the Federal Reserve and a number of central banks; mainly European, but also those of Canada and Mexico, see for example McCauley and Schenk (2020), Sheets et al. (2018), and Bordo et al. (2014). During the Bretton Woods system with its prevailing gold standard, the main motive was to reduce the risk of several central banks exchanging dollars for gold at the same time, which could put great pressure on US gold reserves. During this period swap agreements were initiated by both sides in the agreements – that is to say, both European central banks and the Federal Reserve (see Bordo et al. 2014). After leaving the fixed exchange rate system, the Federal Reserve used the swap agreements to defend the value of the dollar by borrowing foreign currencies which were then used to purchase dollar. In the 1970's there was even a debate in the United States regarding the risk of the swap agreements undermining the independence of the Federal Reserve, as the central bank was dependent on the swap transactions, and ultimately the European central banks' willingness to continue lending their currencies against dollars, in order to implement its foreign exchange policy. At the end of the 1980's, the Federal Reserve stopped funding its foreign exchange interventions through swap transactions.

3.1 The 2008 financial crisis – from limited swap agreements to unlimited dollar liquidity

During the global financial crisis, the Federal Reserve gradually assumed the role of an international lender of last resort. This meant that the Federal Reserve acted as a global central bank in the sense that it provided unlimited dollar liquidity to other select central banks to address strains on dollar funding markets and help stabilise financial markets.

Crisis measures are extended through swap agreements to European central banks

Early on in the global financial crisis, the Federal Reserve created a new lending facility – the Term Auction Facility (TAF) – to provide banks located in the US with liquidity. Also, new swap agreements were extended to some central banks in Europe to enable them, if needed, to supply banks located in Europe with dollar liquidity. Within the TAF framework, liquidity was allocated to US banks through an auction procedure in which they placed bids with the Federal Reserve. Similarly, the European central banks held dollar auctions for banks located in Europe. The Federal Reserve's TAF auctions and the European central banks' dollar auctions were coordinated in the sense that the Federal Reserve held its TAF auction first, without communicating the outcome until the dollar auctions of the other central banks had been held a day later, see Goldberg et al. (2011). At the TAF auctions, dollars were allotted to the banks according to the highest interest-rate bid, and with an interest-rate floor that was initially set at the Overnight Index Swap (OIS) rate for the maturity concerned. All bids were allotted at the lowest offered interest rate.

The ECB and the Swiss National Bank (SNB) were first to secure liquidity swap agreements with the Federal Reserve in December 2007. The agreements were to run for six months and the volume was limited to USD 20 billion for the ECB and USD 4 billion for SNB. During this time, the ECB offered dollar loans at the OIS rate for the maturity concerned, while the SNB initially held auctions with OIS as a floor to subsequently also switch to a fixed price (the OIS rate). The fixed price applied in Europe at that time meant that European banks could obtain dollar liquidity at a lower price than the banks in the United States, if the US banks placed the lowest interest-rate bid above the OIS rate. Already after the first auctions in December 2007, both central banks had utilised the entire volumes and in the following months, the maximum amounts were increased several times. Despite these increases, demand was on average more than twice as high as what was offered at the ECB's auctions until the Federal Reserve, in coordination with the ECB, decided to switch to full allotment in October 2008. In that process, the Federal Reserve also adjusted the price to OIS + 100 basis points. In the same month, the Federal Reserve also reduced the price of liquidity via TAF for banks located in the US. Cetorelli et al. (2011) show that foreign banks located in the US drew significant dollar amounts via the TAF funds that were then channelled, via internal lending, to other parts of the bank. Following the expansion of the swap agreements in late 2008, internal lending by these banks decreased significantly while draws on the swaps through national central banks increased.

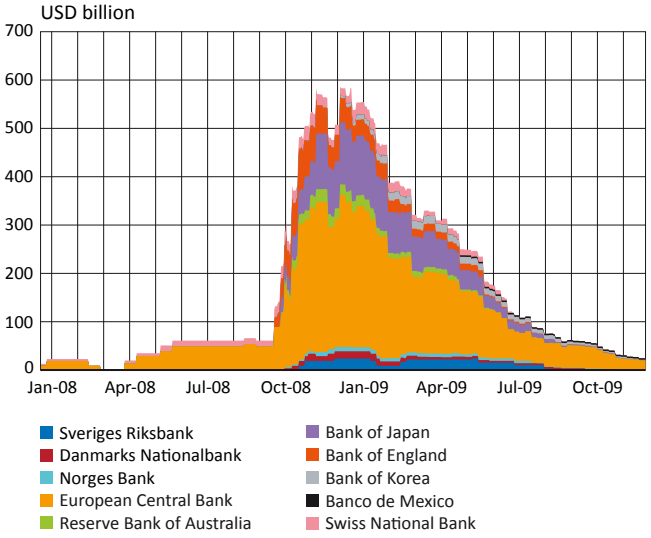
High demand for dollars results in further global expansion of the swap agreements

In September 2008, the Federal Reserve expanded the circle of counterparties for the swap agreements to include the Bank of Canada (BoC), Bank of England (BoE), Bank of Japan (BoJ), Danmarks Nationalbank, Norges Bank, Reserve Bank of Australia (RBA) and the Riksbank. One month later, the circle of counterparties was further expanded to include the central banks of Mexico, South Korea, Brazil and Singapore; their financial sectors were considered to have a sufficiently large need for dollars to influence interest rates on the international dollar market.

When the swap agreements with the ECB, SNB, BoE and BoJ in October 2008 were changed to full allotment at a fixed price (OIS+100 basis points), there was a substantial

increase in the dollar liquidity provided through the swap agreements (see Figure 1). During the financial crisis, the central banks that had full allotment could receive dollar liquidity with terms of one day, one week, one month and three months. The remaining central banks had limited swap agreements with maturities of one and/or three months, with the possibility, in consultation with the Federal Reserve, to decide on pricing and themselves determine the auction procedure. This possibility caused differences in pricing and auction procedures between different central banks, even between the Scandinavian central banks (see Appendix for details on the swap agreements of select central banks).

Figure 1. Outstanding dollar liquidity from the Federal Reserve provided through swap agreements during the global financial crisis
USD billion

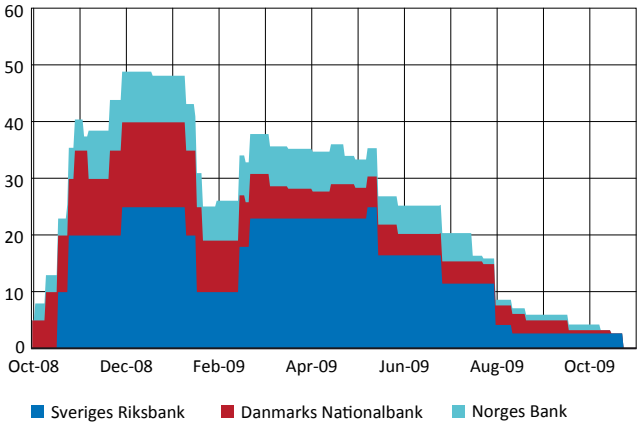


Source: Federal Reserve

Out of the close to USD 600 billion that was provided through swap arrangements from the Federal Reserve during the crisis, the ECB accounted for the majority, followed by BoJ and BoE. The central banks of three countries never utilised their swap agreements with the Federal Reserve: New Zealand, Canada and Brazil. At the time, the price OIS + 100 basis points was applied for swap agreements with full allotment. It might therefore seem odd that the BoC entered a swap agreement with the Federal Reserve, since the Canadian banks could obtain cheaper funding in dollars through their US branches. The fact that BoC nevertheless entered swap agreements with the Federal Reserve could be due to the important signalling aspect of the swap agreements; that is to say, communicating well-functioning cooperation and a coordinated response between the major central banks during a crisis.

The swap agreements of the Scandinavian central banks with the Federal Reserve varied somewhat. For example, Danmarks Nationalbank and Norges Bank offered dollar loans to the banks at maturities of both one and three months, while the Riksbank only offered loans at a three-month maturity. Pricing also varied (see Appendix). At most, the Riksbank utilised USD 25 billion during the financial crisis, and hence not the entire sum of USD 30 billion that was specified in the swap agreement. Danmarks Nationalbank, which had a lower volume specified in its swap agreement (USD 15 billion), utilised the entire amount at the peak of the crisis at the end of 2008, and Norges Bank utilised smaller volumes throughout the entire crisis (Figure 2).

Figure 2. Outstanding dollar liquidity from the Federal Reserve provided to the Scandinavian central banks through swap agreements during the global financial crisis
USD billion



Source: Federal Reserve

It is worth mentioning that swap agreements were also established between other central banks, besides cooperation with the Federal Reserve. For example, the ECB entered into swap agreements with the central banks of Denmark and Sweden after the global financial crisis to secure euro liquidity if needed, as well as temporary agreements with the central banks of Lithuania, Poland and Hungary. Also, the Riksbank entered into swap agreements with the central banks of Iceland, Estonia and Latvia during the global financial crisis and with the central bank of Ukraine in 2015 to support financial stability in the region and, ultimately, in Sweden (read more in Box 2 below).

BOX 2. The Riksbank's swap agreements with nearby countries[10]

The financial crisis of 2008–2010 hit Iceland and the Baltic countries hard. At that time, two of the largest Swedish banks had extensive lending operations in the Baltic countries, which meant that stability in the Swedish financial system was at risk through financial exposures. The Riksbank entered into swap agreements with the central banks of Estonia, Iceland and Latvia to reduce risk by safeguarding macroeconomic and financial stability in these countries.

The Riksbank considered that a financial crisis in Iceland could spread and cause financial instability. This could in turn have negative implications for the ability of Swedish banks to obtain funding and for the Swedish real economy. On 16 May 2008, the Riksbank therefore decided to enter into a swap agreement with the Icelandic central bank, Seðlabanki Íslands, of EUR 500 million in exchange for Icelandic kronor. This was also done at the same time and with the same amounts by the central banks of Denmark and Norway.

In December that year, the Riksbank took a very serious view to the risk of a financial crisis in Latvia potentially spreading. In particular, the large share held by Swedish banking groups of the Latvian lending market could harm the Swedish banking system if extensive credit losses were incurred there, and ultimately also financial stability and the Swedish economy at large. Financial stability in Latvia was thus closely interlinked with stability in Sweden. Therefore, the Riksbank entered into a swap agreement enabling the Latvian central bank, Latvijas Banka, to borrow EUR 500 million from the Riksbank and Danmarks Nationalbank in exchange for Latvian lats. The Riksbank's share was EUR 375 million, while Danmarks Nationalbank's share was EUR 125 million. The agreement had an original term of three months, but was extended twice – in April and September 2009. Throughout the entire period, Latvia had a loan programme with the IMF.

In February 2009, the Riksbank also entered a swap agreement with the Estonian central bank Eesti Pank, enabling the latter to borrow up to SEK 10 billion against Estonian kroon. The swap agreement had a somewhat different purpose because it was given primarily to ensure the ability of the Estonian central bank to provide liquidity assistance to the subsidiaries of Swedish banks. Eesti Pank never utilised the swap agreement however, and it expired on 31 December 2009.

10 For a detailed description of the Riksbank's actions and swap agreements during the financial crisis, see Leung (2020).

Overview of the Riksbank's swap agreements with Nordic-Baltic central banks during the global financial crisis 2008–2010

	Decision date	Currency	Purpose	Swap volume	Notes
Iceland	16 May 2008	Euro	Maintain financial stability in the region	EUR 500m	Coordinated with the central banks of Norway and Denmark and followed by a loan programme with the IMF.
Latvia	16 December 2008	Euro	Maintain financial stability in the region	EUR 375m	Coordinated with the central bank of Denmark and IMF loan programmes were in place during the entire period.
Estonia	26 February 2009	Swedish kronor	Secure liquidity assistance for the subsidiaries of Swedish banks, and ultimately maintain financial stability	SEK 10bn	The swap agreement was never utilised.

In 2015, the Riksbank entered into a swap agreement with the Ukrainian central bank (NBU) for USD 500 million as part of a broader support package together with the IMF. It was judged that support from the international community was crucial for Ukraine to succeed with its economic reform programme. Also, there was a risk that a full-blown crisis in Ukraine would spread to Sweden's neighbouring area and potentially have a negative impact on economic conditions in Sweden. At the same time, the Riksbank initiated technical assistance cooperation with Ukraine, whereby the Riksbank shared with the NBU its knowledge and experience within important central-bank related fields.

3.2 Positive effects of the Federal Reserve's swap agreements during the global financial crisis

Funding costs decreased for both US and non-US banks in connection with the announcement of the swap agreements with the Federal Reserve and the implementation of the dollar auctions by the other central banks, see Goldberg et al. (2011) and Eguren-Martin (2020). When the Federal Reserve communicated full allotment to the largest central banks in October 2008, the Libor-OIS spread narrowed by a full two percentage points (see McCauley and Schenk 2020).[11] A few years after the crisis, the ECB concluded that the transition to full allotment was crucial to reducing stress on the dollar market (see ECB 2014). In order to distinguish the effects of swap agreements from other factors, the effects of the announcements of the extended swap agreements on financial markets need to be examined. Such empirical studies by for instance Baba and Packer (2009) show that the swap agreements contributed to reducing stress on the dollar market in areas where the central banks had full allotment. Aizenman and Pasricha (2010) look specifically at the effects of the swap agreements in emerging markets and find noticeable effects on both spreads and exchange rates in the countries that entered into swap agreements with the Federal Reserve.[12] Barajas et al. (2020) show that stress on national financial markets subsided in countries that entered into agreements with the Federal Reserve due to the coordinated communication surrounding the swap agreements during the global financial crisis and while the agreements were active. The same analysis shows that the banking sector in countries

11 USD Libor is the interest rate for unsecured interbank loans in US dollars and is affected by various risk premiums (for example credit risk). The Overnight Index Swap (OIS) rate is a derivative contract based on the Fed Funds rate, which is a short-term rate, and reflects the average expected short-term rate over a certain period of time, but is not affected by risk premiums. Both Libor and OIS are affected by the market's expectations about future monetary policy and the spread between Libor and OIS thus reflects a risk premium. An increase in the risk premium, or the spread, can thus indicate financial stress.

12 Emerging market economies that entered into swap agreements with the Federal Reserve were Brazil, South Korea, Mexico and Singapore.

with an active swap agreement with the Federal Reserve did not reduce their dollar lending. On the other hand, the banking sector in countries without a swap agreement reduced their dollar lending by just over 5 per cent. According to the authors, the reduction was only half as large if the central bank maintained dollar reserves above 10 per cent of the country's gross domestic product.

3.3 Continued use of swap agreements during the euro crisis

The swap agreements ended temporarily on 1 February 2010. However, already in May that year, they were resumed between the Federal Reserve and BoE, BoJ, ECB, and SNB with full allotment and fixed price (OIS+100 basis points). The Federal Reserve and BoC also signed a swap agreement with the volume limited to USD 30 billion. A difference from before was however that liquidity was now almost exclusively provided with a one-week maturity. The smaller central banks did not obtain extended swap agreements during the euro crisis, however.

To start with, there was little demand for dollar lending and in November 2011 the price was reduced by 50 basis points to OIS+50 basis points. Also, the ECB started once more to offer loans to banks in the euro area with a three-month maturity. Dollar lending in Europe then increased, but was still much lower than during the previous crisis. It is possible that the European banks felt a degree of stigma surrounding utilisation of the dollar facility, out of fear of signalling difficulty to borrow dollars elsewhere. However, Bahaj and Reis (2020) find this is improbable because the ECB does not disclose which banks utilise the dollar facility. Moessner and Allen (2013) find that the swap agreements reduced stress on the dollar market, but that the effect was smaller than during the global financial crisis. This may be a result of banks only drawing on the dollar facility at the end of the euro crisis.

Standing dollar facilities with a number of central banks

After the euro crisis, in October 2013 the temporary swap agreements were turned into standing facilities for the ECB and the central banks of Canada, the United Kingdom, Switzerland and Japan. At this point, the BoC also entered into a swap agreement with full allotment. Once a week, they could receive dollar liquidity with one-week maturity and once a month liquidity with three-month maturity, still at a fixed price. In the communication around the agreements, assurances were given about the availability of the liquidity backstop, while certain other details were kept intentionally unspecified for instance which circumstances would lead to the activation of the agreements (ECB 2014). Other more operational aspects, such as price or collateral requirements, were kept flexible and could be adjusted to specific market developments. This was done to reduce moral hazard, that banks would take on higher risk if they knew the exact rules that would apply in a crisis. After the crisis, the swap agreements were still active and could be used in the event of renewed turbulence, although they were barely utilised between the euro crisis and until March 2020.

4 The dollar market today and stress during the covid-19 pandemic

The next section focuses on how the Federal Reserve's swap agreements have worked during the covid-19 pandemic. However, to understand both the need for them and their role and effects, it is important to understand how the dollar market works today, the vulnerabilities and risks that exist and how these came to materialise during the covid-19 pandemic. This is described in this section.

4.1 The dollar market features complex interlinkages between various participants and markets

The US dollar is the most important currency in the international monetary and financial system. For example, according to BIS (2020), around half of all cross-border loans and international debt instruments today are denominated in dollars, 85 per cent of all foreign exchange transactions involve the dollar, and around half of international trade is invoiced in dollars. The dollar is also the most important reserve currency and accounts for almost two thirds of the official foreign currency reserves.

In the following, we describe how the dollar market, in a complex way and often across borders, links together various participants and markets.

Banks, both US and non-US, play a key role

Banks are the main intermediaries between other participants on the dollar market. US banks account for a substantial share of the dollar transactions, although a significant proportion of the transactions take place directly between non-US banks. BIS (2020) shows that as much as almost half of the banks' cross-border claims in dollars against other countries do not involve a US participant on either side.

The availability of dollar funding for banks differs depending on whether or not they are based in the US. Non-US banks generally do not have access to stable dollar funding because they rarely have sizeable dollar deposits from households and businesses, and neither do they participate on the US interbank market. They must instead use less stable forms of dollar funding. For example, they issue short-term, unsecured debt instruments such as certificates of deposits (CDs) and commercial paper (CP) on securities markets. These instruments are mainly purchased by money market funds that invest in short-term debt instruments issued by banks or non-financial corporations. Such funds are known as 'prime money market funds' (prime MMFs) and are the main lenders of dollars to non-US banks (see for instance Eren et al. 2020b).[13, 14]

Non-US banks are interested in dollar funding for several reasons. The dollar market is attractive because its size and liquidity often make the cost of dollar funding lower than that of other funding sources, particularly for banks with high credit ratings. Also, the broad investor base means that banks can diversify their funding. Additionally, some countries' own money markets are not sufficiently developed or liquid, making the banks more dependent on dollar funding. This is common in emerging market economies, but also applies to the Swedish money market.

Insurance companies demand large volumes of dollars through the foreign exchange swap market

Another important reason why banks are interested in dollar funding is the demand for dollars among their customers. This is particularly common in international industries in which the dollar is the standard currency, such as shipping. Insurance firms and pension funds, named collectively as insurance companies in this paper, also demand large volumes of dollars from the banks (see for instance Avdjiev et al. 2020, BIS 2020, Nilsson et al. 2014 and Sveriges Riksbank 2020a). They often have a large share of their investments in foreign currencies, usually in dollars, to diversify their portfolios to spread the risks and potentially increase their risk-adjusted return. For entities that have considerable assets to invest, some domestic asset markets might also be too small to offer sufficient investment opportunities

13 On the money market funds market, there are also 'government money market funds' which have a lower risk appetite and mainly invest in government securities.

14 The banks can also obtain dollar funding in other ways, such as by entering into repurchase agreements (repos), entering into transactions on the currency market and by issuing bonds (see BIS 2020).

without an excessive impact on pricing. Swedish insurance companies also act this way.[15] BIS (2020) emphasises that insurance companies worldwide have grown in size and significance in recent years. Their exposure to the dollar market has grown sharply, especially for Asian insurance companies.

Insurance companies generally have poorer access to dollars through securities markets or central bank lending facilities than banks have. They can instead fund their purchases of dollar assets by exchanging the domestic currency for dollars on the spot market, when they receive their continuing incoming payments from savers and policyholders. They can also enter foreign exchange swap transactions whereby they 'borrow' dollars in exchange for the domestic currency over a certain period. The insurance companies thus enter foreign exchange swaps with banks as counterparties, and these contracts differ from the swap agreements and swap transactions that take place between central banks described earlier in this paper. Through foreign exchange swaps, the insurance companies gain access to dollars and limit the currency risk that would otherwise arise from them holding assets in dollars and liabilities in domestic currency.[16] In this approach, it is characteristic that the swaps often have relatively short maturities while the underlying dollar assets, which are funded and currency-hedged through the swaps, generally have longer maturities (see Avdjiev et al. 2020, BIS 2020 and Sveriges Riksbank 2020a). This difference in maturity between assets and liabilities implies vulnerabilities for the insurance companies if conditions in the dollar markets change. It also makes the insurance companies dependent on the continuing willingness of the banks to offer dollars through foreign exchange swaps. We describe this in more detail in the next section.[17]

4.2 The characteristics of the dollar market implies vulnerabilities that materialised during the covid-19 pandemic

There are economies of scale and network effects in having the dollar as a funding currency that reduce borrowing costs. However, the financial infrastructure around the dollar also presents vulnerabilities because the global interconnectedness makes it possible for financial stress to spread across the globe. Below, we describe the vulnerabilities and risks in more detail, and how they came to materialise during the covid-19 pandemic.

Non-US banks can experience difficulties in obtaining dollar funding in the event of financial stress

As we have described above, non-US banks have poorer access to stable dollar funding than US banks and rely on the willingness of prime MMFs to buy their short-term debt instruments in dollars. Prime MMFs are sensitive to changes on the financial markets, and, in the event of stress, their possibilities of investing can swiftly decline when investor risk appetite wanes. At the start of the covid-19 pandemic, there were large and rapid outflows from prime MMFs as investors sold their fund units. At the end of March 2020, over USD 150 billion had been withdrawn, equalling 20 per cent of total assets under management in prime MMFs, see Figure 3.[18]

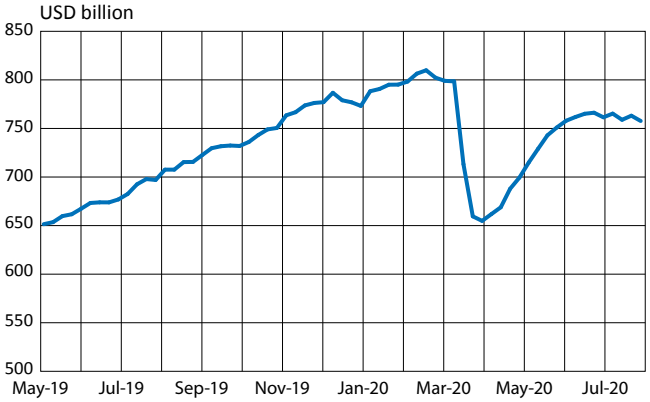
15 Nilsson et al. (2014) argue that capital in the Swedish financial system is flowing out of Sweden because part of the collective pension savings is invested in assets abroad. This might be a reason for why Swedish banks obtain a large share of their funding abroad.

16 Through a foreign exchange swap, the insurance company 'borrows' dollars for a certain period of time, which must be repaid upon maturity of the swap. During the duration of the swap, the insurance company thus has a liability in dollars which matches its assets in dollars, which hence reduces the currency risk.

17 There are also other non-banks besides insurance companies, such as hedge funds and non-financial corporations, that are highly active on the foreign exchange market. However, BIS (2020) shows that, overall, the short and long dollar positions of these entities on the foreign exchange market offset each other, while insurance companies overall have a short position in dollars.

18 At the same time, government MMFs (funds that invest in safer assets) saw major inflows. At the end of March 2020, assets under management in these funds had increased by 30 per cent (see Eren et al. 2020a).

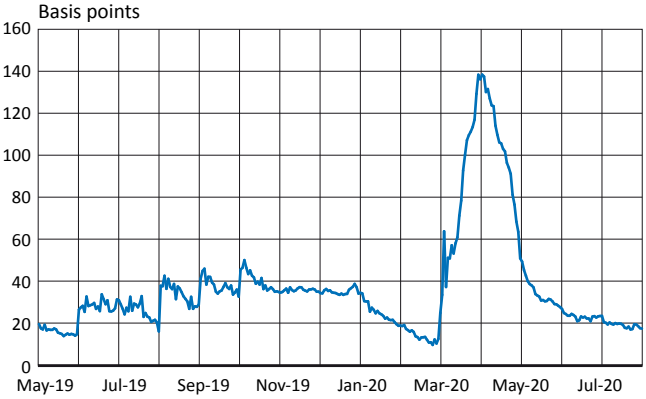
Figure 3. Fund assets for prime money market funds
USD billion



Note. Prime money market funds invest primarily in short-term debt instruments issued by banks and non-financial corporations.
Source: Investment Company Institute (ICI), Macrobond

The major withdrawals from the funds forced fund managers to sell off securities instead of investing in new ones, which brought the CDs and CP markets to a halt. Banks and businesses worldwide therefore had difficulties in renewing their dollar funding, and the cost of unsecured dollar funding increased sharply, even for entities with high credit ratings. Because CD and CP interest rates are of great significance to banks' funding costs, this led to a rise in USD Libor. Stress on the market can thus be illustrated using the USD Libor-OIS spread, which widened sharply in mid-March, see Figure 4.[19]

Figure 4. The difference (spread) between three-month USD Libor and the OIS rate (Libor-OIS spread)
Basis points



Note. OIS stands for Overnight Index Swap and is based on the Fed Funds rate. The rate can be interpreted as the expected Fed Funds rate throughout the duration of the contract, commonly three months. USD Libor is the interest rate for unsecured interbank loans in US dollars.
Source: Bloomberg

The cost of dollar funding via the foreign exchange market can rise sharply in times of stress

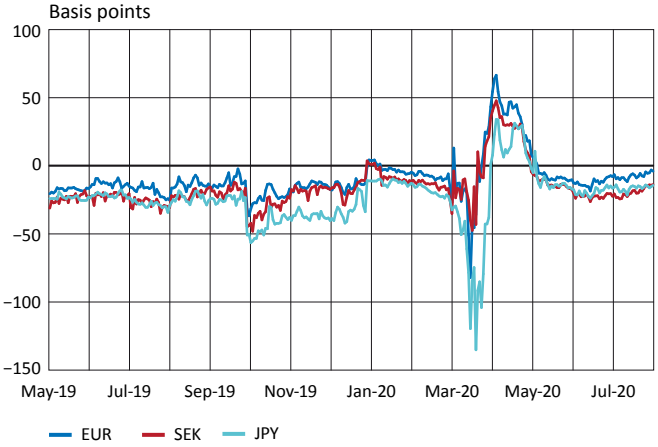
At the same time as banks' access to and possibilities of lending dollars deteriorate in financial stress, demand for dollars among other actors often increases. BIS (2020) describes how many businesses worldwide at the start of the covid-19 pandemic predicted lower revenues and therefore attempted to increase their funding to enable them to pay their

19 USD Libor is the interest rate for unsecured interbank loans in US dollars and is affected by various risk premiums (for example credit risk). The Overnight Index Swap (OIS) rate is a derivative contract based on the Fed Funds rate, which is a short-term rate, and reflects the average expected short-term rate over a certain time period, but is not affected by risk premiums. Both Libor and OIS are affected by the market's expectations about future monetary policy and the spread between Libor and OIS thus reflects a risk premium. An increase in the risk premium, or the spread, can thus indicate financial stress.

costs. Some companies also wanted to increase their liquidity as a precautionary measure due to the large prevailing uncertainty. Demand for dollars became particularly high due to the important role of the dollar as a funding currency and invoicing currency in international trade.[20]

Stress on the dollar market was apparent and clearly noticeable on the foreign exchange swap market, where prices rose sharply and it became more expensive to borrow dollars through foreign exchange swaps than to borrow dollars directly on the market.[21] In this context, foreign exchange swaps refer to swap transactions between market participants, such as between insurance companies and banks. They should not be confused with swap agreements and transactions between central banks. The difference in the cost of borrowing dollars on the market compared with converting another currency into dollars through a foreign exchange swap is usually known as basis spread. A negative basis spread means that it is more expensive to borrow dollars through a swap than directly on the market. A more negative basis spread is often interpreted as a stress indicator of dollar shortage in the same way as, for instance, widened Libor-OIS spreads (see for example Avdjiev et al. 2020 and Cetorelli et al. 2020b). As shown by Figure 5, basis spreads turned sharply negative in mid-March during the covid-19 pandemic.[22]

Figure 5. The difference in cost of borrowing dollars at three-month USD Libor compared with converting other currencies to dollars through foreign exchange swaps (the basis spread)
Basis points



Note. The basis spread (rate difference) between three-month USD Libor and the implicit USD rate, calculated through national interbank rate and cost of foreign exchange swap.
Sources: Bloomberg and Sveriges Riksbank

The cost of borrowing dollars through foreign exchange swaps rose sharply due to the banks' worsened access to dollars, which in turn made them less willing to lend dollars. At the same time, the insurance companies and other actors still needed to obtain dollars through foreign

20 BIS (2020) also finds that some financial institutions during the covid-19 pandemic were forced to make margin payments due to the appreciation of the dollar exchange rate, which might have pushed up the demand for dollars.
21 The implicit cost of dollars an entity has to pay by converting another currency into dollars through a foreign exchange swap is calculated using the covered interest rate parity based on spot and forward rates and the interest rates in the currencies concerned.
22 On a perfect market, such a difference in costs should present opportunities for arbitrage that ought quickly to disappear. Borio et al. (2016) find that new regulations have reduced the banks' possibilities of utilising such opportunities for arbitrage. Avdjiev et al. (2020) highlights that the fact that the swaps of insurance companies are often in one direction is a contributory factor. Avdjiv et al. (2019 and 2020) also find that an appreciation of the dollar exchange rate leads to greater deviations from the interest rate parity as the credit risk of global banks increases when the dollar appreciates, as their borrowers with liabilities in dollars and revenues in domestic currency are adversely affected by a stronger dollar. When the dollar appreciates, the banks are therefore less willing to expose themselves by lending dollars through foreign exchange swaps, the supply of dollar funding through foreign exchange swaps declines and the price of obtaining dollars through this channel increases.

exchange swaps (see for example Avdjiev et al. 2020, BIS 2020 and Sveriges Riksbank 2020a).[23] If insurance companies cannot renew their foreign exchange swaps at maturity, they must pay back large volumes of dollars. Insurance companies could obtain dollars through exchanging domestic currency for dollars on the foreign exchange spot market, but the volumes could be very large in relation to normally traded levels, which could affect exchange rates. BIS (2020) and Sveriges Riksbank (2020a) describe that the companies could be forced to sell off parts of their dollar assets to enable them to repay the dollars they have borrowed through the swaps. If unplanned sales have been preceded by a drop in asset prices, this could cause substantial realised losses for the insurance companies. Such 'fire sales' can cause a negative spiral with further drops in prices, especially on small or illiquid markets, and hence exacerbated financial turmoil.

In April 2020, stress on the foreign exchange swap market subsided. The reduced stress coincided with the Federal Reserve entering into swap agreements with a number of other central banks (including the Riksbank) and after the ECB and others started their comprehensive dollar auctions. We describe this in more detail in the next section.

5 The role and effects of swap agreements during the covid-19 pandemic

The early announcement of the new swap agreements with the smaller central banks, combined with a lower and more uniform interest rate, helped to reduce the initially high stress on the dollar market during the covid-19 pandemic. This was in spite of the fact that the dollar liquidity provided by the Federal Reserve under these agreements was much lower during the spring and summer of 2020 than during the 2008–2010 financial crisis. At that time, it was the ECB's dollar facilities for banks in the euro area that represented the majority of dollar lending globally. In contrast, so far during the covid-19 pandemic the Japanese central bank has had the largest demand for dollar liquidity from the Federal Reserve. Lower demand for dollar loans from European banks is most likely due to higher initial liquidity and capital, and lower dollar exposure than during the global financial crisis. Demand for dollar liquidity has also so far been much lower from the Scandinavian banks, just as in the rest of Europe.

5.1 The Federal Reserve and other central banks acted swiftly to supply liquidity

In response to the rapidly soaring stress on financial markets globally, the Federal Reserve, BoE, BoC, BoJ, ECB and SNB issued a coordinated statement on 15 March 2020, reducing the price of transactions within their existing liquidity swap agreements by 25 basis points to OIS +25 basis points. The Federal Reserve then started to provide dollar liquidity with a three-month maturity once a week, in addition to the existing auctions with one-week maturity.

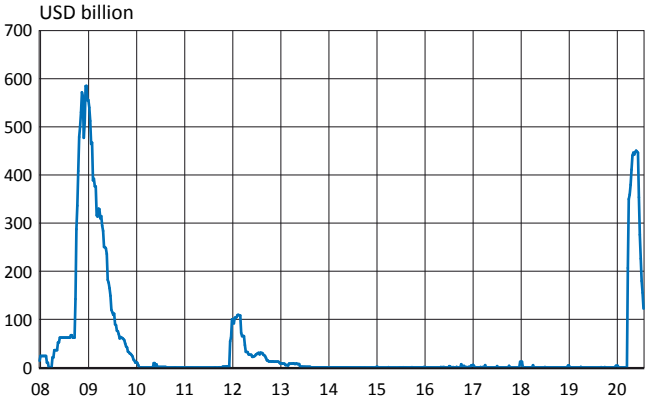
On 19 March, the Federal Reserve also entered into swap agreements with nine additional central banks – the same central banks as during the financial crisis.[24] These agreements now allowed for larger volumes than during the financial crisis, albeit still with limited volumes. Due to high demand for dollar loans early in the crisis, it was decided already on 20 March that the central banks with standing swap agreements would hold daily auctions of loans with one-week maturity. This swift reaction shows a concrete lesson learned from the global financial crisis and the euro crisis: that the impact of swap

23 In Sweden, the stress was noticeable in that the insurance companies traded lower amounts per foreign exchange swap and shortened the maturities during this period, see Sveriges Riksbank (2020a).

24 Australia, Brazil, Mexico, Korea, New Zealand, Singapore, and also Denmark, Norway and Sweden.

agreements can be increased if unlimited liquidity is supplied at an early stage. Figure 6 clearly shows by how much, and how quickly, demand for dollars via the Federal Reserve's swap agreements increased globally in March 2020.[25]

Figure 6. Outstanding dollar liquidity from the Federal Reserve to other central banks provided though swap agreements
USD billion



Source: Federal Reserve

A shift in demand for dollars from Europe to Asia

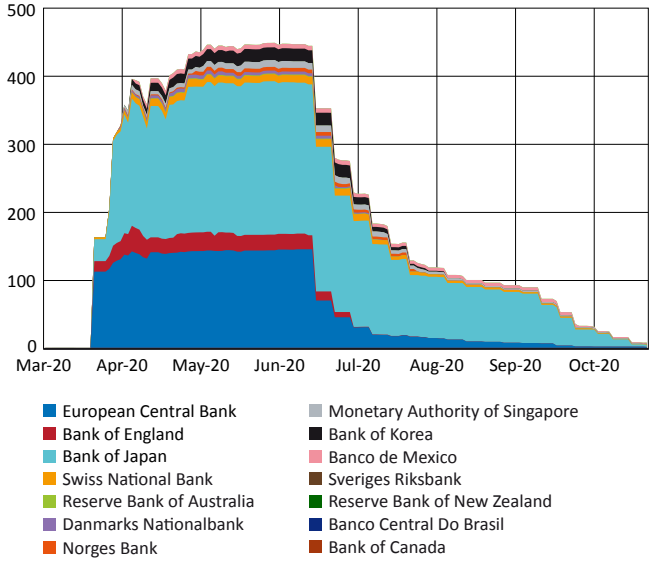
During the global financial crisis, it was European-based banks that, through the ECB's dollar providing facility, had the greatest demand for dollars. During the covid-19 pandemic, on the other hand, Japanese banks have, through the BoJ, demanded the majority of dollars. The ECB has, however, also drawn a significant amount, even if less than during the global financial crisis. Between March and October 2020, BoJ drew USD 225 billion via the Federal Reserve swap arrangement to Japanese banks, compared with USD 144 billion and USD 37 billion by the ECB and BoE respectively. This can be compared with the just over USD 300 billion that was lent to banks in the euro area during the 2008–2010 financial crisis. Figure 7 shows the total outstanding dollar liquidity provided though swaps from the Federal Reserve in 2020. It should however be mentioned that this does not always correspond to the total volume which is then lent to banks by other central banks, because it is also possible to fund dollar lending in other ways (see Box 1).

There may be a number of reasons why Japanese banks in particular has had the largest demand for dollar liquidity during the current crisis, while the demand from European banks has been lower. Japanese banks have increased their dollar exposure significantly since the global financial crisis and Asian life insurers have doubled their dollar assets compared with five years ago (see BIS 2020 and IMF 2019). At the same time, European banks have reduced their dollar exposures. On the other hand, European insurers have increased their dollar exposures, albeit at a slower pace than Asian insurers.[26] Another factor that may have curbed the European banks' demand for dollars so far during the covid-19 pandemic, is the new rules regarding liquidity and capital buffers introduced after the financial crisis have put them in a better initial position than when the global financial began, see ECB (2020) and Sveriges Riksbank (2020b).

25 On March 31 2020, the Federal Reserve also introduced a new repo facility that enabled foreign and international monetary authorities (FIMA) account holders at the Federal Reserve to temporarily exchange US treasury securities for dollars, which could then be lent to banks, see Federal Reserve (2020b).

26 See Sveriges Riksbank (2020a) and Nilsson et al. (2014) for a description of the foreign investments of Swedish pension funds and insurance firms.

Figure 7. Outstanding dollar liquidity provided from the Federal Reserve to other central banks through swap arrangements during the covid-19 pandemic
USD billion



European Central Bank
Bank of England
Bank of Japan
Swiss National Bank
Reserve Bank of Australia
Danmarks Nationalbank
Norges Bank
Monetary Authority of Singapore
Bank of Korea
Banco de Mexico
Sveriges Riksbank
Reserve Bank of New Zealand
Banco Central Do Brasil
Bank of Canada

Source: Federal Reserve

5.2 The swap agreements contributed to reduced stress on the dollar market

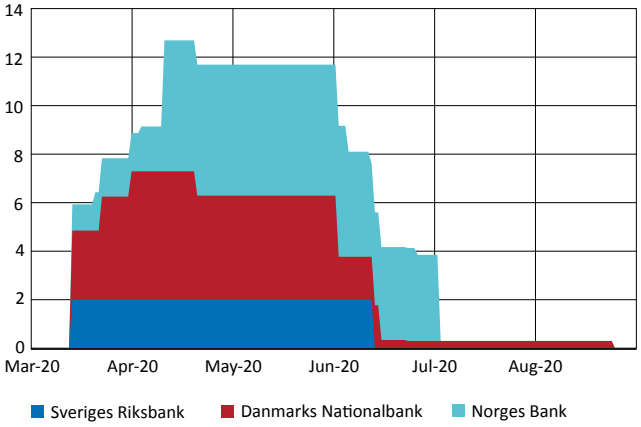
Towards the end of April 2020, the Libor-OIS spread had narrowed and stress on the foreign exchange swap market had subsided. Demand for dollars also levelled off after initial high demand primarily from central banks with standing swap agreements with the Federal Reserve. Several studies show that the swap agreements contributed to curbing financial stress on the dollar market.[27] The foreign exchange swap market in Europe, including Sweden, started to function better particularly once the ECB commenced its extensive dollar auctions. That way, non-US banks had greater possibilities of borrowing dollars directly from the central banks and did not need to rely solely on their possibilities of issuing CDs or CP or borrowing dollars from each other. Dollar liquidity through swap agreements had a clear effect on the cost of market funding, particularly after the interest rate was reduced to OIS+25 basis points (see Bahaj and Reis 2020 and Moessner and Allen 2020). BIS (2020) finds that the reduced stress also coincided with the Federal Reserve entering into swap agreements with smaller central banks in mid-March. The transition to daily auctions for one-week maturity swaps also appears to have had a stabilising effect on the foreign exchange swap market, according to Cetorelli et al. (2020b). Bahaj and Reis (2020) also argue that, even though the announcement itself of swap agreements appears to have helped stabilise interest rates, it was primarily when the central banks drew on the swap agreements that a substantial effect was seen. Cetorelli et al. (2020a) also find that non-US banks whose central banks used the standing swap agreements with the Federal Reserve helped supply liquidity to their US branches and hence supported the US corporate credit market. Because the dollar market is so intertwined and integrated, dollar auctions also benefit banks and the financial systems of countries whose central banks have not taken part in the auctions themselves. For example, Barajas et al. (2020) describe how the cost of dollar funding fell in other countries as well.

27 See Cetorelli et al. (2020a and 2020b), Eren et al. (2020b), Avdjiev et al. (2020), Eguren-Martin (2020), Bahaj and Reis (2020) as well as Moessner and Allen (2020).

5.3 Dollar lending from the Riksbank and other Scandinavian central banks during the covid-19 pandemic

On 26 March, the three Scandinavian central banks held their first dollar auctions. It was also the only time so far during the covid-19 pandemic that Swedish banks utilised the Riksbank's dollar facility.[28] The banks' demand for dollar loans from the Scandinavian central banks has so far been much lower than during the global financial crisis, just like in the rest of Europe. Together, the three Scandinavian central banks lent just over USD 12 billion in the spring of 2020 compared with almost USD 50 billion in the autumn of 2008.

Figure 8. Outstanding dollar loans from the Scandinavian central banks during the covid-19 pandemic
USD billion



Sources: Danmarks Nationalbank, Norges Bank and Sveriges Riksbank

Differences in auction procedure between the Scandinavian central banks

All Scandinavian central banks offered dollar loans with a three-month maturity. Danmarks Nationalbank also offered weekly dollar loans with a one-week maturity. So far during the covid-19 pandemic, Danmarks Nationalbank has lent in total USD 4.9 billion at a three-month maturity and just over USD 3 billion at one-week maturity, with longer maturities predominantly at the beginning of the covid-19 pandemic. Norges Bank has lent USD 5.4 billion in 2020 in total, and the Riksbank USD 2 billion.

28 The Riksbank's dollar auction of 26 March was funded through the foreign currency reserve and not through the swap agreement with the Federal Reserve.

Table 1. Dollar auctions by Scandinavian central banks at the beginning of the covid-19 pandemic
USD million

Auction date	Danmarks Nationalbank		Norges Bank	Sveriges Riksbank
	Maturity			
	1 week	3-month	3-month	3-month
26/03/2020	25	2,825	1,075	2,000
02/04/2020	–	–	500	0
06/04/2020	0	1,425	–	–
15/04/2020	1,000	40	–	–
16/04/2020	–	–	275	0
22/04/2020	1,000	0	–	–
23/04/2020	–	–	3,550	0
29/04/2020	1,000	0	–	–

Note. A dash means that no auction was held on that date. This table shows only auctions between March and April 2020. Since then there has been no demand for dollar loans from the Riksbank or Norges Bank. Danmarks Nationalbank lent smaller volumes between May and December 2020 (USD 650 million in total) at three month maturity.
Sources: Danmarks Nationalbank, Norges Bank and Sveriges Riksbank

In contrast to during the global financial crisis, the three Scandinavian central banks have had the same pricing during the corona pandemic so far, OIS +25 basis points (see Appendix). However, there are certain differences between how the central banks auction off their dollar loans. In Sweden and Denmark, the banks submit bids with an interest supplement. Those with the highest supplement have their bids accepted first, and so on in descending order until the offered volume for the auction has been reached. All bids are however allotted at the lowest accepted interest rate. In contrast, Norway allocates the loans according to the highest interest bid at the rates offered, just like during the global financial crisis. There are also differences when it comes to the lowest permitted volume of bids. While the Riksbank has set its lowest permitted bid at USD 100 million, Danmarks Nationalbank has permitted bids as low as 10 million and Norges Bank 25 million (see Table 2).

Table 2. The Scandinavian central banks' auction procedures during the covid-19 pandemic

	Total offered volume (billion USD)	Maturity	Lowest bid (million USD)	Max number of bids per bank	Max allotment per bank (billion USD)
Danmarks Nationalbank	30	7 and 84 days	10	3	No limit
Norges Bank	30	84 days	25	3	3
Sveriges Riksbank	60	84 days	100	10	4

Sources: Danmarks Nationalbank, Norges Bank and Sveriges Riksbank

The receiving central banks themselves bear the credit risk in their lending. This means that the central banks are responsible for the collateral they accept and the appropriate haircuts. In this respect too, there are certain differences between the rules of the Scandinavian central banks. Danmarks Nationalbank and Norges Bank accept the banks' own covered bonds, while the Riksbank only accepts them temporarily until December 2024. The Riksbank and Danmarks Nationalbank accept collateral with a rating of A–, while in Norway, collateral is accepted with a rating of BBB–. Because Norway lacks a sizeable bond market, Norges Bank also accepts foreign collateral with a rating of A–. In Sweden and Denmark, the domestic bond markets are larger and the Riksbank and Danmarks Nationalbank therefore accept foreign securities to a

lesser extent. It is noteworthy that the ECB accepts securities with a rating equal to BBB– and asset-backed securities (ABS), which for instance the Riksbank does not.

At the end of July 2020, the swap agreements were extended until the end of March 2021 and in December 2020, the Federal Reserve communicated a further extension until the end of September 2021.

BOX 3. Agreement of principle is established between the Scandinavian central banks

In November 2020, the central banks of Sweden, Norway and Denmark entered into an agreement regarding principles for currency swap agreements in times of crisis to support financial stability in the region.

The financial markets in the Scandinavian countries are closely interwoven. While this increases efficiency on the market of each country, it also presents vulnerabilities because a crisis can quickly spread across the borders. The time factor is often crucial in a crisis, and for this reason, in the autumn of 2020, the central banks of Sweden, Norway and Denmark prepared a set of principles according to which currency swap facilities can be established between these three central banks, if needed. In November 2020, principles were adopted that form the basis of bilateral swap agreements between the Scandinavian central banks. Bilateral swap agreements were entered into at the same time between Norges Bank and the Riksbank, and between Danmarks Nationalbank and Norges Bank. An agreement between Danmarks Nationalbank and the Riksbank is being negotiated.

Source: Sveriges Riksbank (2020c)

6 Swap agreements can never replace a central bank's foreign currency reserve

Liquidity swap agreements with other central banks can help to reduce the risk and alleviate the consequences of financial crises, but can never replace a central bank's foreign currency reserves. Central banks therefore also need to hold sufficiently large foreign currency reserves. Theoretically, swap agreements could reduce the need of central banks to hold large foreign currency reserves. If a central bank knew that it always had sound access to foreign currency through swap agreements, there would not be any reason to build up a large foreign currency reserve. That way, swap agreements could theoretically help reduce global imbalances that can arise when countries wish to strengthen their current account in order to increase their foreign currency reserves.[29] In practice however, a central bank cannot be certain of gaining access to foreign currency through swap agreements in a crisis.

Swap agreements cannot replace foreign currency reserves because there is never any guarantee that liquidity will be available in a crisis. Even swap agreements that have not had any limitations on the volume of dollar liquidity from the Federal Reserve have been limited in the sense that the Federal Reserve has always had the possibility of denying a certain transaction (see Sheets et al. 2018). Also, it can take time to negotiate and enter swap agreements, and timing is an important factor in the midst of a crisis. Swap agreements thus do not reduce the need for a foreign currency reserve.

The probability of being able to enter into a swap agreement is also greater if the receiving country has managed its economy prudently and held a sufficiently large foreign currency reserve (see Cecchetti 2014). For example, one of the criteria for a country to obtain a preventive credit line through the IMF's 'Flexible Credit Line' is that the foreign currency reserve must be sufficiently large (see IMF 2020). In that sense, swap agreements and foreign currency reserves complement each other.

29 See Moessner and Allen (2010) for a discussion of the pros and cons of swap agreements and other ways of supplying liquidity to the financial system.

In global crises, the Federal Reserve has on a number of occasions entered into swap agreements with smaller central banks in countries whose financial markets have been deemed sufficiently important for the global dollar funding market. On such occasions, the Federal Reserve has an interest in helping a broader circle of central banks to meet demand for dollars and in signalling that the central banks are prepared to act jointly. If a small country is struck by a domestic crisis that does not affect global financial markets, it is much less probable that the Federal Reserve would grant a swap agreement to that country (see Sveriges Riksbank 2017). In global crises, it might be possible to gain access to dollars through swap agreements, but in domestic crises, the central bank thus needs to rely on its own foreign currency reserve.

For a small country with a large banking sector in particular, it is important to hold a sufficiently large foreign currency reserve for insurance purposes. However, the banks' potential liquidity needs in a crisis, and hence the central bank's contingency need, depend on the size of liquidity risks present in the banking system. In Sweden, the authorities could for instance limit these by obliging the banks to hold greater liquidity buffers in foreign currencies or by restricting the proportion of short-term funding in foreign currency (see Flodén 2017). Cecchetti (2014) argues that the banks' liquidity risks in foreign currency should be regulated and limited, but that such measures do not suffice. Another option, which the Riksbank has suggested on a number of prior occasions, is to let the financial sector contribute to the funding cost for the part of the Riksbank's foreign currency reserve that is in place to provide liquidity assistance to the banks when needed (see for example Sveriges Riksbank 2017). There are thus different measures that could be taken to reduce the potential need for dollars in a crisis or to reduce the Riksbank's cost of holding a foreign currency reserve.

7 Conclusions

Liquidity swap agreements between central banks are important for safeguarding financial stability in global crises. We witnessed this in the global financial crisis, and have done so thus far during the covid-19 pandemic. The Federal Reserve's liquidity swap agreements with other central banks have been key to supplying global liquidity and avoiding a credit crunch. Although European banks have reduced their dollar exposure since the global financial crisis, the global financial system remains reliant on dollar funding. Not least, actors operating in international industries depend on the dollar market. Non-banks such as insurance companies invest a large share of their assets in dollars and thus have an ongoing need for dollar liquidity through the foreign exchange market. The exposure of this sector to the dollar market has also increased in recent years.

Availability of unlimited dollar liquidity from the Federal Reserve to central banks with standing swap agreements has proven to have significant effects through reducing stress on financial markets in a crisis. During the global financial crisis, the price set by the Federal Reserve for dollar liquidity also played an important role. Early during the covid-19 pandemic, the Federal Reserve acted swiftly and in cooperation with other central banks by enhancing provision of dollar liquidity via swap agreements with certain select central banks. This ensued from lessons learned from earlier crises and helped to increase dollar liquidity in the financial system, thus alleviating stress on financial markets.

Liquidity swap agreements can however not replace foreign currency reserves, but rather serve to complement them. A central bank cannot assume that swap agreements from the Federal Reserve will be possible to use in a crisis. With the exception of the standing swap agreements with select central banks, the Federal Reserve has generally only entered into swap agreements in global crises. Individual countries can therefore not count on support in a domestic or regional crisis, but must in that case secure access to dollars through their

foreign currency reserve. Also, the probability of a swap agreement being granted increases if the receiving country has managed its economy prudently and held a sufficiently large foreign currency reserve.

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Appendix A

Table A1. Overview of select central banks' swap agreements with the Federal Reserve, comparison financial crisis 2008–2010 and covid-19 pandemic 2020–.

		Auction procedure		Pricing		Maximum outstanding USDbn	
		Global financial crisis	Covid-19 pandemic	Global financial crisis	Covid-19 pandemic	Global financial crisis	Covid-19 pandemic
Standing agreements	European Central Bank	Fixed price	Fixed price	OIS, later OIS + 100 basis points	OIS + 25 basis points	Initially 20 and unlimited from October 2008	Unlimited
	Swiss National Bank	Auction, switched to fixed price in October 2008	Fixed price	OIS, later OIS + 100 basis points	OIS + 25 basis points	Initially 4 and unlimited from October 2008	Unlimited
	Bank of England	Fixed price	Fixed price	OIS, later OIS + 100 basis points	OIS + 25 basis points	Unlimited	Unlimited
Temporary agreements with Scandinavian central banks	Danmarks Nationalbank	Allotment according to highest bid, whereby the lowest permitted bid is applied as a price for all offers	Allotment according to highest bid, whereby the lowest permitted bid is applied as a price for all offers	Libor + 50 basis points	OIS + 25 basis points	15	30
	Norges Bank	Allotment according to highest bid	Allotment according to highest bid	TAF minimum rate + 50 basis points	OIS + 25 basis points	15	30
	Sveriges Riksbank	Allotment according to highest bid, whereby the lowest permitted bid is applied as a price for all offers	Allotment according to highest bid, whereby the lowest permitted bid is applied as a price for all offers	OIS + 50 basis points	OIS + 25 basis points	30	60

Sources: Goldberg et al. (2011), the central banks' websites and the Federal Reserve

Coronavirus pandemic: The Riksbank's measures and financial developments during spring and summer 2020

Peter Gustafsson and Tommy von Brömsen*

The authors work in the Riksbank's Monetary Policy Department.

The coronavirus pandemic caused a severe and synchronised downturn in economic activity during spring 2020. Many companies were hit hard when societies around the world changed their behaviour and restrictions were introduced to reduce the spread of infection. Investors then rapidly went in search of safer assets, which caused asset prices around the world to fall rapidly. Governments and central banks began to conduct very expansionary economic policy to help households and companies to cope with the decline in economic activity. The Riksbank's measures consisted mainly of providing liquidity support to the banks and purchasing financial assets. In this way it wanted to safeguard the banks' role as supplier of credit, to alleviate frictions in important financial markets and ensure a smooth transmission from policy rate to loan rates for households and companies. The measures taken in Sweden and abroad were sufficiently powerful to turn around developments in the financial markets and avoid an even more severe recession. In this article, we describe the measures taken by the Riksbank to counteract the effects of the pandemic on the economy, the sequence of events on the financial markets during spring and summer 2020 and how lending to households and companies developed.

1 Pandemic creates turmoil in the financial markets

Towards the end of February 2020, it became clear that the novel coronavirus had spread from China to several countries in Europe and to the United States. As it continued to spread rapidly, the WHO declared on March 11 that the illness COVID-19 was a pandemic. This caused unease among many households and companies, and affected their behaviour.[1] The increased spread of infection also meant that governments in many countries introduced different types of restrictions, including travel bans, quarantines, bans on large gatherings and curfews. The restrictions and changes in behaviour affected the real economy in several ways. For example, demand fell substantially when the number of trips and hotel and restaurant visits plummeted. The lower activity in the world economy also led to a decline in world trade, which had a major impact on small open economies like Sweden. Negative effects also arose through a shortage of input goods in production, and considerable sickness

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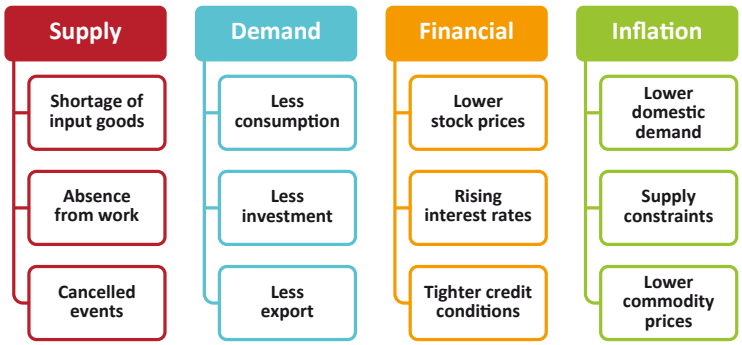
1 For example, people were afraid of being infected and therefore avoided large gatherings of people to a great extent, for instance in shops and restaurants.

absence among employees. Many events were cancelled, partly due to the lack of travel and limits on the size gatherings in public places. A number of companies were hit hard by this, especially those linked to tourism. The most vulnerable were small and medium-sized enterprises, which had less scope to manage the heavy fall in demand. In a very short space of time, a large share of companies' revenue disappeared, at the same time as they also still needed to cover their fixed costs. The situation soon became critical for the companies that lacked the possibility to cover their costs with their own funds, new bank loans or additional market funding.

All in all, this development risked tangibly dampening inflation when, in particular, demand, but also supply, fell heavily.[2] There was also a risk that more long-term effects of the crisis would entail more lasting low inflation. Figure 1 shows how the pandemic affected the global economy through different channels during the more intensive phase of the crisis.

Figure 1. How the coronavirus pandemic affected the economy



When it became clear that a pandemic could not be prevented, unease on the financial markets escalated and investors quickly began to seek safer assets. This led to stock markets plummeting and risk premia on credit instruments rising rapidly. The developments in Sweden is reflected in the Riksbank's index for financial conditions. This shows a rapid shift over the course of around one month, from expansionary financial conditions in February, to clearly tighter conditions in March (see Figure 2).[3] The vulnerable situation for companies during the crisis, and unwillingness among investors to hold risky assets meant that risk premia rose sharply and companies found it much more difficult to finance themselves by issuing commercial paper and corporate bonds. Parallel to this development, both Swedish and foreign banks risked tougher and more expensive funding conditions. Large outflows from certain US money market funds contributed to demand for commercial paper declining substantially.[4] This meant that Swedish banks experienced increasing difficulties securing their short-term funding and meeting their customers' needs of foreign currency. At the same time, there was a decline in demand from investors for the Swedish banks' more long-term debt instruments, which largely consist of bonds with mortgages as collateral; so-called covered bonds.

The Government and the Riksbank took historically extensive measures during spring 2020, as did other governments and central banks around the world. During the most turbulent stage of the crisis, there was a risk that the situation would develop into a financial

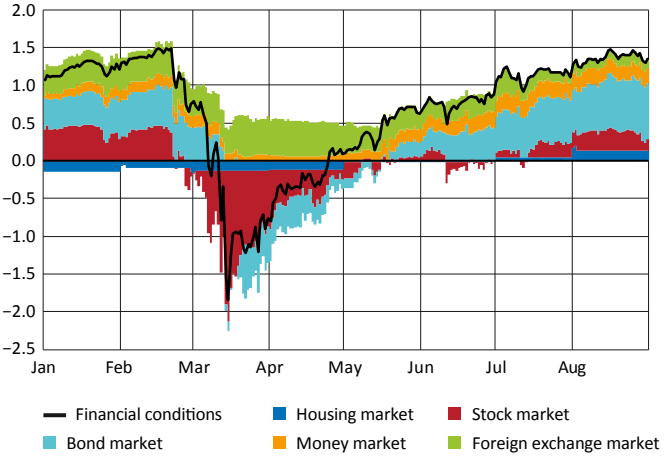
2 Given the assessment that the dampening effects on inflation of a very rapid fall in demand, would outweigh the positive effects on inflation of the lower supply in the economy, inflation in Sweden was expected to be lower in the coming years and it was expected to take longer for inflation to reach the target of 2 per cent more lastingly. See Sveriges Riksbank (2020g).

3 For details regarding the construction of the index, see Alsterlind et al. (2020). The index we show here, unlike the index in Alsterlind et al. (2020), also takes into account the corporate bond market.

4 In the United States, it was the so-called Prime Money Market Funds, which invest in short-term securities issued by banks and companies, that experienced large outflows. The money market funds that primarily invest in government securities instead experienced major inflows over the period.

crisis. If this had happened, the banks could have been forced to substantially tighten credit to households and companies, resulting in an even more severe downturn in economic activity. Such a development could quickly turn into a long-lasting recession, which would have an even greater impact on employees, companies and investors.

Figure 2. Index for financial conditions in Sweden
Standard deviations



Note. A higher value indicates more expansionary financial conditions. The coloured columns show the contributions of the different sub-markets to the index.
Source: The Riksbank

In this article we describe what happened on the financial markets in spring and summer 2020. We focus in particular on the most acute phase of the crisis in March. Further, we describe and discuss the measures taken by the Riksbank and follow up how lending to companies and households developed during the spring and summer. However, we only briefly discuss the measures taken by foreign governments, central banks and the Swedish Government to alleviate the economic consequences of the pandemic. This does not in any way mean that these measures were less important. On the contrary, it is important to have these measures in mind, as in many cases they addressed similar problems. For examples the powerful measures taken by the European Central Bank and the Federal Reserve were most likely crucial in turning around the negative development on the financial markets, and in Sweden the Government took extensive measures to counteract the acute liquidity shortage among many companies. This of course affected the companies' need for loans to survive the crisis.

In the next section we discuss in general terms the problems identified by the Riksbank on the basis of its mandate and the measures taken. In the subsequent section we provide a detailed account of what happened on the financial markets prior to the outbreak of the crisis in February until August. In the fourth section we follow up the development of lending to companies and households, and we conclude with a summary in the fifth section.

2 The Riksbank took many, and far-reaching, measures

The crisis was complex, as the pandemic caused disruptions in both demand and supply. Companies were hit particularly hard and in many cases needed to take out larger loans to survive the crisis.[5] However, the major uncertainty on the financial markets also created problems for the banks. In the middle of March, the Riksbank and many analysts were concerned that the banks would substantially reduce their lending, which would have had

5 Companies refers to non-financial companies throughout this article.

very negative effects on economic activity. In this type of scenario, demand would remain at a lower level for a long time, and ultimately it would have hampered the Riksbank's capacity to meet the inflation target.

The problems the Riksbank identified and considered it could address can be roughly summarised as:

i. many companies suffered substantial liquidity problems, despite being fundamentally robust when demand collapsed
ii. interest rates charged to companies and households risked increasing
iii. companies risked facing more difficulties funding themselves, partly because the markets for commercial paper and corporate bonds were functioning poorly.[6]

The Riksbank therefore took measures to promote the supply of credit and retain the low interest rates on both bank loans and market financing. In Table 1 we summarise the Riksbank's measures during the period from March to the end of August 2020.[7]

6 For a more detailed discussion, see for instance Sveriges Riksbank (2020f).

7 After August 2020 the Riksbank has expanded/extended the measures taken. On 15 September, the Riksbank decided to continue offering loans in USD to the banks up until 30 March 2021. A decision was taken at the monetary policy meeting in November 2020 to extend the Riksbank's asset purchase programme until 31 December 2021 and to expand the envelope for the purchases to SEK 700 billion. The asset purchases were extended to also cover purchases of treasury bills. Moreover, with effect from January 2021, the Riksbank decided with regard to its corporate bonds purchases to only offer to purchase bonds issued by companies deemed to comply with international standards and norms for sustainability, For more information, see Sveriges Riksbank (2020h).

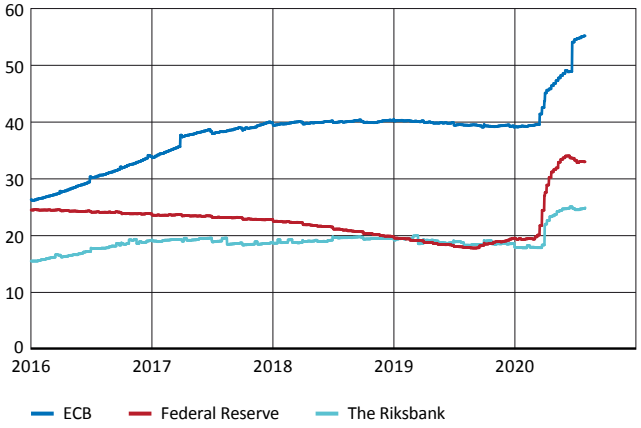
Table 1. The Riksbank's measures during March–August 2020

Measure	Scope	Used up to the end of August	Details
Loans to the banks for onward lending to companies	Up to SEK 500 billion	164.5 billion, of which 145.5 billion in March–April	First decision on 12 March. Initiated 20 March. Initial maturity up to 2 years. Decision on temporary enlargement of eligible counterparties on 26 March. Extended to also cover sole proprietors on 6 April. On 30 June the maturity was extended to up to 4 years, and the interest rate supplement payable if the requirement for onward lending to companies was not met, was cut from 0.20 to 0.10 percentage points above the repo rate.
Envelope for the Riksbank's asset purchases	Up to SEK 500 billion	Purchases: 193 billion, of which 68.4 billion in March–April	First decision on 16 March. Purchase programme extended on 27 March, 27 April, 15 May and 30 June. Programme runs until 30 June 2021. The envelope was expanded from 300 billion to 500 billion on 30 June.
Within the envelope: Purchases of government bonds, municipal bonds and covered bonds		Purchases: 181.5 billion, of which 31.5 billion government bonds, 25 billion municipal bonds and 125 billion covered bonds.	Purchases of government bonds were initiated on 18 March. Purchases of covered bonds began on 25 March. Purchases of municipal bonds were initiated 28 April.
Within the envelope: Purchases of commercial paper	Purchases of commercial paper up to a maximum holding of SEK 32 billion until 31 Dec 2020 and purchases of corporate bonds for SEK 10 billion to 30 June 2021.	Purchases of commercial paper: 11.5 billion and holdings of commercial paper at the end of August: 2.6 billion	First decision on 19 March. Purchases of commercial paper were initiated on 2 April. Decisions to extend the programme on 3 April and 8 May. Purchases of corporate bonds were initiated on 14 September.
Lowered interest rate in lending facility	Cut in two stages from 0.75 to 0.10 percentage points above the repo rate (establishing a symmetric interest rate corridor around the Riksbank's repo rate)		Decisions on 16 March and 30 June.
Weekly market operations at longer maturities in kronor	Unlimited	29 billion, of which 23 billion in March–April	First decision on 16 March. Loans against collateral with a maturity of 3 months. On 30 June the supplement to the repo rate of 0.20 percentage points from these credits was removed and the Riksbank also decided to offer loans with a maturity of 6 months within the same envelope.
Eased collateral requirements when borrowing from the Riksbank	Waive the special limit rules regarding covered bonds up to 30 December 2024.		Decision on 19 March.
Loans to banks in US dollars	Up to USD 60 billion	USD 2 billion, of which USD 2 billion in March–April	Decision on 19 March.

Note. Municipal bonds refers to bonds issued by Swedish municipalities, regions and Kommuninvest i Sverige AB. All of the bases for the decisions on various measures can be found on the Riksbank's website: https://www.riksbank.se/en-gb/press-and-published/updates-on-the-riksbank-and-the-coronavirus-pandemic/the-riksbanks-measures-in-connection-with-the-corona-pandemic/
Source: The Riksbank

In many countries where the policy rate was clearly positive, central banks cut the rate to keep interest rates low and thereby reduce costs for households and companies. In Sweden, however, the repo rate was already at zero, so there was limited scope to cut the rate. A lower policy rate would probably also have been less effective in this situation. Under normal circumstances, a lower interest rate can be expected to stimulate, for instance, household consumption, but during the pandemic the recommendations from authorities and others restricted normal consumption behaviour.[8] Like many other central banks, the Riksbank therefore, in addition to various forms of liquidity support to the banks, began to buy various types of financial asset to a greater extent than before to meet the challenges of the crisis. This made the Riksbank's balance sheet grow significantly during the period February to August, and its balance sheet total increased from around 18 to 27 per cent of GDP (see Figure 3).

Figure 3. The Riksbank's and other central banks' balance sheet totals
Per cent of annual GDP



Note. Annual GDP is calculated as a total of the present quarter and the three previous quarters. For observations after 30 June 2020, annual GDP is the total of GDP for the third quarter of 2019 up to and including the second quarter of 2020.
Sources: Macrobond and the Riksbank

2.1 Liquidity support to the banks to safeguard the supply of credit to companies

An important starting point for the Riksbank's crisis management was to maintain the possibilities for the banks to lend money to households and companies at low interest rates. The banks' capacity to lend money is affected to a large degree by how and at what price they can finance the lending. Since the global financial crisis, various requirements have been tightened with regard to the banks' capital and liquidity and the banks thus were better equipped to manage the disruptions arising during the pandemic. At the same time, developments on the financial markets were very uncertain in March, and there was a clear risk that the banks would tighten their credit terms and reduce their lending. To ensure that the banks had a lasting reliable and cheap source of financing, the Riksbank therefore offered to lend SEK to the banks that they could lend to companies. This measure meant that the banks did not need to rely on market funding and deposits to the same extent during a period of stressed market conditions.

8 There were also arguments against cutting the policy rate below zero again. If negative interest rates were perceived as a more permanent condition, there was a risk that the banks would introduce negative deposit rates for households and that households would react by making substantial withdrawals. This could in turn lead to liquidity problems for the banks, as the deposits are an important part of their funding. See Sveriges Riksbank (2019).

The lending programme to the banks for onward lending to companies could be regarded as an insurance for a smoothly-functioning credit supply. This made it possible to provide support to the banks' lending, but also held down their financing costs and contributed to lower final interest rates to companies.

Moreover, the major Swedish banks are dependent on the international credit markets, partly because their short-term financing is largely in US dollars. During the acute phase of the crisis, global demand for US dollars increased rapidly. This made it more difficult for both Swedish and foreign banks to fund themselves. The Federal Reserve signed swap agreements with several other central banks, including the Riksbank, as a means of increasing liquidity in the dollar market.[9] This agreement meant, in brief, that the Riksbank and the Federal Reserve could swap their respective currencies with one another during a period of time and then swap them back for some interest cost to the Riksbank. The arrangement provided the Riksbank with greater capacity to supply Swedish banks with large volumes of USD if needed. This enabled the banks to continue supplying Swedish agents' demand for USD and that there was good access to dollars in the event the situation were to worsen.[10] At the same time, the Federal Reserve's powerful and more widespread measures calmed the unease on the global dollar markets.

In addition to the lending to the banks, the Riksbank also implemented a number of supplementary measures to facilitate the banks' funding situation (see Table 1). These included weekly market operations at longer maturities, amendments to the overnight interest terms in the lending facility and amendments to regulations to increase the flexibility regarding the collateral the banks could use when borrowing from the Riksbank. The number of counterparties for the Riksbank's transactions was also expanded to broaden the impact of the loan programme to the banks for onward lending to companies.

2.2 Broad and targeted asset purchases to keep interest rates low

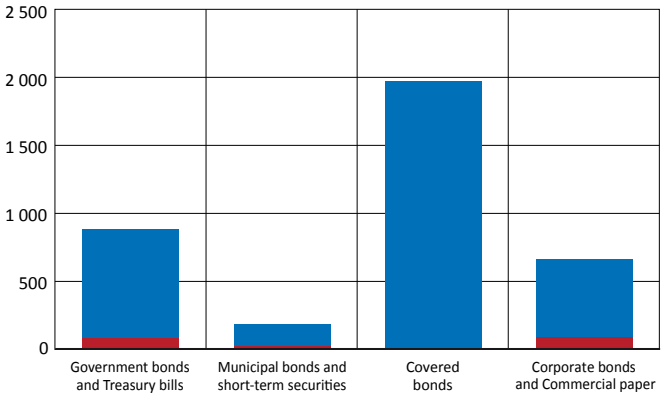
The monetary policy discussion and academic literature usually differentiate between two types of asset purchase made by central banks. They can purchase assets to make monetary policy more expansionary. This is often called quantitative easing. But they can also purchase assets to manage frictions on specific markets. This is called credit easing.[11] We will largely follow this division, but to clarify the purpose of the different purchases, we will instead refer to them as broad or targeted.

By broad purchases we mean asset purchases that are largely aimed at lowering or counteracting increases in the general interest rate level. By targeted purchases we mean primarily purchases aimed at lowering or counteracting upturns in risk premia on a specific market.[12] When many investors on a market want to sell assets, for example because the risk is assessed to have increased, risk premia on these assets will rise. Then the price falls and the interest rate rises. By making purchases on such a market, the Riksbank can hold down risk premia and interest rates and thereby make it easier for issuers on the market to issue new paper. More generally, the targeted purchases are thus aimed at maintaining the transmission from the repo rate to the market rates that the issuers meet on specific markets.

9 For a more detailed discussion of the Riksbank's swap agreement with the Federal Reserve, see Gislén et al. (2021).
10 For a more in-depth discussion of the banks' short-term funding and its interaction with the need for foreign currency among, for instance, insurance companies and pension funds, see the article 'The interconnectedness of insurance firms, National Pension Insurance Funds and banks via the foreign exchange market' in Sveriges Riksbank (2020c).
11 See D'Amico and Kaminska (2019) and Armelius et al. (2020).
12 It is assumed that the risk premiums for a specific bond can be summarised by the spread between the bond in question and a corresponding government bond. In addition, there are forward premiums, which compensate the investors for the risks linked to the bond's maturity.

The Riksbank's asset purchases included both broad and targeted purchases during the spring and summer. The purchases gradually came to include government bonds, municipal bonds, covered bonds, commercial paper and corporate bonds. Figure 4 contains a review of the outstanding volumes of short- and long-term securities denominated in SEK in August 2020.

Figure 4. Outstanding nominal volume of short- and long-term securities denominated in SEK in August 2020
SEK billion



Note. The blue field refers to long-term securities (bonds) and the red field refers to short-term securities (treasury bills, municipal short-term securities and commercial paper).
Sources: Statistics Sweden and the Riksbank

When the asset purchases were announced in March 2020, the financial conditions in the Swedish economy had rapidly tightened (see Figure 2). As inflation was already below the target prior to the pandemic, the Riksbank had clear motives for maintaining an expansionary direction for monetary policy.

Purchases of government bonds and municipal bonds

The Riksbank purchased government bonds primarily to affect the rates on government bonds and in this way lower long-term interest rates in the economy in general – or prevent them from rising.[13] These purchases may thus be characterised as broad. Put simply, they have an impact through two channels. First, they can affect expectations of future short-term rates according to the so-called expectations hypothesis. Second, they can affect the term premium that investors receive as compensation for the risk a longer time to maturity entails: what is known as the term risk.[14] According to the primary channel, the outstanding volume of bonds available for trading in the secondary market declines, and the volume of term risk that can be invested in therefore also declines. This means that the term premium falls, as investors cannot demand the same premium for holding the term risk when the supply has declined. According to the secondary channel, the purchases contribute to reinforcing the signal that the repo rate will be low going forward, which means that the market participants' expectations of future short-term interest rates fall.[15]

13 The Riksbank's purchases of government bonds can also contribute to lowering interest rates with short maturities. In the repo market, government bonds are used as collateral when participants borrow money from one another at short maturities. The Riksbank's purchases mean that the volume of available government bonds, and thereby the volume of collateral, declines. This entails a reduced pressure to borrow money on the repo market, which pushes down interest rates. However, the Swedish National Debt Office's repo facility, where they offer to lend money at the repo rate minus 0.40 percentage points, sets a lower bound for the rates in the repo market. It is also at this level that these interest rates have remained for some years now, just after the Riksbank began its purchases of government bonds in 2015.
14 Term risk refers mainly to the risk that the expected short-term rates will change, and thereby the value of the bond with the longer duration. The longer the maturity of the bond, the more sensitive the bond price is to such changes.
15 See Melander (2021) for a more detailed review of the different channels for the effects of bond purchases and an analysis of the effects of the Riksbank's purchases.

The lower rates on government bonds also contribute to lowering the rates on more risky bonds. To understand how this works, one can similarly decompose the rates on more risky bonds into two parts. One part consists of the rate on a government bond with the same maturity, and the other consists of a risk premium that compensates investors for the extra risk the bond entails in relation to the government bond. The government bond purchases can thus, in addition to lowering rates on government bonds, also contribute to lower rates on more risky bonds. This means they have a broad impact on market rates. How far the rates on risky assets ultimately fall depends on how the risk premium develops.

The announced purchases of municipal bonds can be seen as a complement to the purchases of government bonds to affect longer market rates. Municipal bonds have a different position among investors with regard to risk and liquidity, which is reflected in a somewhat higher interest rate (see Figure 9)**.**

Purchases of covered bonds

During the more acute stage of the crisis, the rate on covered bonds rose clearly, as did the rates on government and municipal bonds. The upturns were at the same time limited in a historical perspective. However, the market for covered bonds is central to ensuring the banks can supply credit, as the major Swedish banks fund most of their lending for housing purchases by issuing covered bonds.[16] If risk premia on this market continued to rise, there was thus a risk that it would lead to the banks reducing their lending volumes and raising interest rates charged to companies and in particular households. The announced purchases of covered bonds can be characterised as targeted, as they were aimed at reducing the risk premia and preventing a further rise in rates on this specific market. If the purchases contribute to reducing the risk premium, they will also directly affect the banks' funding costs. In this way, they ultimately also affect the final interest rates charged to households and companies.

Purchases of commercial paper and corporate bonds

Historically, Swedish companies have primarily obtained funding via bank loans. But in recent years, market funding, that is the issue of corporate bonds and commercial paper, has increased relatively strongly, especially among larger companies. The Riksbank included these assets in its purchases following a period when the risk premium on the market for corporate bonds continued to rise even after the corresponding premia on other bond markets had begun to stabilise. During the third week in March, companies responding to the Riksbank's Business Survey described the primary market for commercial paper as 'dead'. The market participants the Riksbank conducted regular discussions with painted a similar picture. The companies were finding it difficult to issue paper on the primary market, and on the secondary market liquidity and market functioning deteriorated significantly, as many wanted to sell commercial paper at the same as few wanted to buy. Many bond funds also experienced major outflows. To meet these outflows, the funds were forced to sell a disproportionately large amount of their more liquid and easily sold assets, which meant that the pressure to sell even spread to other markets to some extent. Several corporate bond funds also experienced rapidly growing difficulties in valuing individual bonds, and when they could not guarantee fair market pricing, they were temporarily closed for deposits and withdrawals.[17]

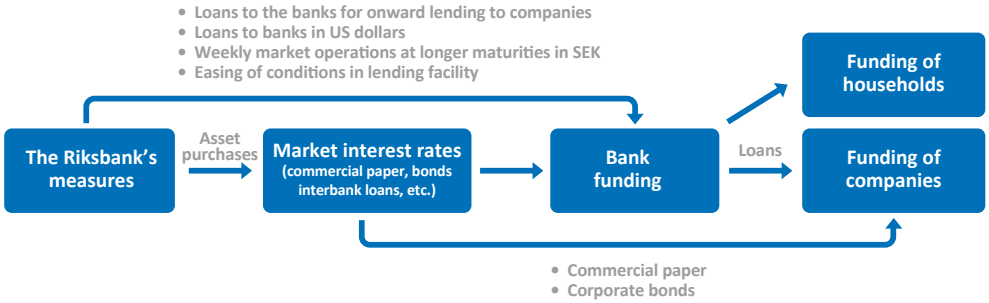
16 The Swedish banks finance mortgages with roughly 70 per cent market financing via covered bonds and the remaining 30 per cent through a mixture of other liabilities and equity capital, see Eidestedt et al. (2020). However, it is difficult to make a corresponding division with regard to the financing of corporate loans.

17 For an in-depth discussion of the development of the Swedish corporate bond market during the turbulent phase of the crisis, see Wollert (2020).

The Riksbank's purchases of commercial paper and corporate bonds can be characterised as targeted measures. The aim was to ensure that the market functioned, and to counteract the risk premium rising. By acting as 'buyer of last resort', that is, acting as buyer on the markets for commercial paper and corporate bonds when most participants wanted to sell, the Riksbank could contribute to companies being able to issue new commercial paper and bonds.[18] Better functioning market funding could also absorb some of the companies' total demand for loans and thereby prevent larger companies with market funding from crowding out small and medium sized enterprises' possibility to obtain bank loans.

Figure 5 outlines how the Riksbank's various measures impacted during the crisis to support the credit supply and prevent a rise in interest rates paid by companies and households.

Figure 5. The Riksbank's measures and their impact on the credit supply



2.3 The Riksbank's various measures have been used to a varying degree

The Riksbank's measures were used to varying degrees by the monetary policy counterparties during the spring and summer (see Table 1). As many of the measures were of an insurance nature in the sense that they were put in place in case developments deteriorated substantially, one cannot measure how effective they were on the basis of how much they were actually used. As an example, only a limited part of the envelope for the Riksbank's loan programme to the banks for onward lending to companies was used. At the same time, some of the banks used the programme to facilitate their financing during the period when alternative sources of financing were relatively expensive (see Figure 13).

The measures with a clear insurance nature, such as the loan programme to the banks, the purchases of commercial paper and several of the supplementary measures aimed at the banks' liquidity supply, were implemented by the bank determining a maximum purchase or lending volume at the same time as setting a price. In this way, the Riksbank wanted to ensure that these measures would only be in demand if the market conditions were 'sufficiently' poor. The demand for them therefore declined apace with the improvement in the financial conditions.

The Riksbank implemented many of the measures described above in a very short space of time. This meant that in several cases both the amounts and the terms and the conditions for the measures needed to be specified and adjusted after the initial announcement. The following section describes the sequence of events during spring and summer 2020 in greater detail, to illustrate the conditions that formed the basis for the Riksbank's actions.

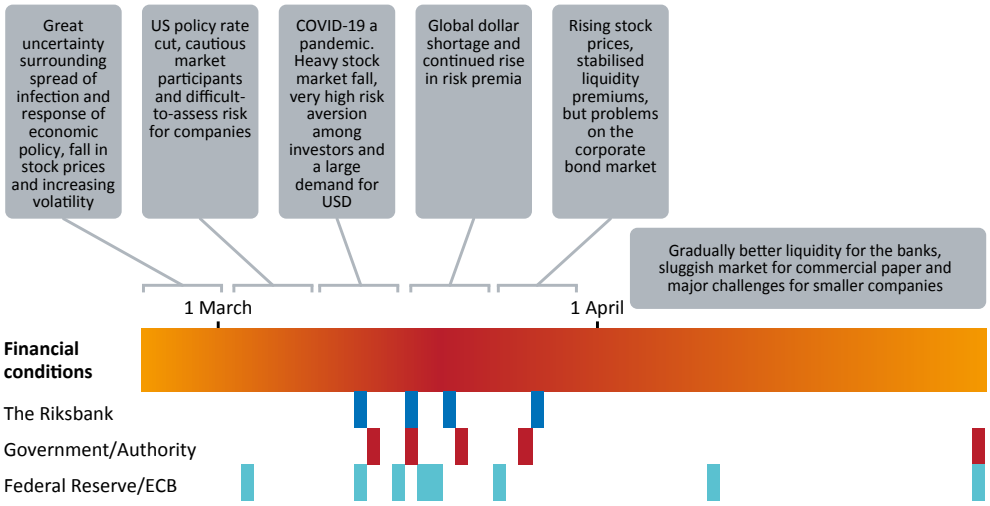
18 The Riksbank's purchases on the secondary market did not affect companies' funding capacity directly, as the terms for the security issued remained unchanged. However, they could be significant when companies needed to refinance securities that matured by issuing new securities. If investors knew that the secondary market was functioning well, they may have been more inclined to purchase securities on the primary market. However, the Riksbank's legal mandate did not allow it to make purchases on the primary market.

3 Development of the crisis on the financial markets

The Riksbank announced many of its measures in March 2020, when the turmoil in the financial markets was at its worst. During the ensuing months, the situation on the markets gradually improved, and after the summer many rates and prices were once again at around their pre-crisis levels. It is still too early to evaluate what effect the measures have had. It is probably also very difficult to determine the causality between individual measures and the ensuing development on the financial markets, as well as for the credit supply. The Riksbank, like governments and central banks in most parts of the world, took many different measures simultaneously over a short period of time, and there are good reasons to believe that this mitigated the course of the crisis.

The Riksbank intensified its contacts with both companies and agents on the financial markets to be able to better understand and follow developments, as the course of events at the beginning of the crisis was so rapid. For instance, the Riksbank carried out business surveys every second week and had regular discussions with banks and other market participants.[19] We provide below a more detailed account of developments on the financial markets in the spring and summer, based on the Riksbank's contacts with companies, banks and market participants and the statistics from the financial markets the Riksbank regularly monitors. The overall development during the more turbulent phase in February to April is summarised in Figure 6.

Figure 6. Financial conditions 24 February to 30 April 2020



Note. The figure reproduces, in addition to weekly summaries, a heat map of the Riksbank's index for financial conditions, where a stronger shade of red implies tighter financial conditions. Blue, red and turquoise fields mark the dates of the measures taken by the respective decision-maker. Dated measures taken by governments or public authorities and the Federal Reserve or the ECB constitute a sample and include the central measures mentioned in this article.
Sources: The ECB, the Federal Reserve, the Swedish Government Offices and the Riksbank

19 The Riksbank regularly interviews the largest companies in industry, construction, trade and parts of the service sector. This normally happens three times a year but, as a result of the pandemic, the Riksbank performed a number of extra interviews by telephone. The surveys referred to in this article took place during the periods 12–28 February, 4–6 March, 16–19 March, 30 March to 2 April, 14–17 April, 6–11 May an 5–9 June, see Sveriges Riksbank (2020b, 2020d and 2020e). Contacts with banks and other market participants intensified, for instance in the regular monitoring of the stability of the financial system, but also through the Riksbank's trading desk that is connected to the banks treasury and market analysis departments.

3.1 February and March: Increasing uncertainty develops into turmoil

At the end of February, it became clear that the coronavirus had spread to Europe. The spread of infection was particularly visible in Italy. The Italian authorities reported around 200 new confirmed cases every day. A week or so later, this figure had soared to more than 1,500 new cases per day. At the same time, the spread of infection in Sweden and most other parts of the world was so far moderate. At the end of February, Sweden had a total of around 10 confirmed cases of COVID-19.[20] However, there was considerable uncertainty as to how the disease would continue to spread, what effects it might have on economic activity and how the Government and central authorities would deal with it.

In the financial markets, investors became less willing to hold risky assets, especially assets with exposures to the corporate sector. Stock market volatility increased (see Figure 7), as reflected in the VIX-index which increased to levels comparable to those that prevailed during the worst periods of the financial crisis. [21] Several stock market indices, including the US S&P500 and the Swedish OMX, fell by around 10 per cent during the last week in February (see Figure 8).[22] The increased demand for safer assets contributed to rates on government bonds falling, which also caused other bond rates to fall (see Figure 9). Risk premia on the Swedish market for corporate bonds rose, however, which was reflected in a larger difference between rates on corporate bonds and government bonds (see Figure 10). This development also marked the financial markets in the rest of Europe and the United States.

During this period the Swedish banks were still facing markets that functioned efficiently with regard to their short-term funding, but they found investors to be rather more hesitant. Additionally, activity on the primary market for covered bonds was low during the winter sports break in Stockholm (end of February/early March). This made it difficult for the banks to assess market conditions with regard to their more long-term funding.

2–8 March: US policy rate cut, cautious market participants and difficult-to-assess risks for companies

During the first week in March, the total number of confirmed Swedish cases of COVID-19 rose to over 200. There was still considerable concern both on the global and Swedish financial markets. However, the price movements were somewhat smaller than during the previous week, with a marginal fall in stock prices and stable spreads on both the corporate bond market and the covered bond market. One reason for this was probably that the Federal Reserve had signalled on 3 March that it was prepared to meet the crisis by cutting its policy rate by 0.5 percentage points between ordinary meetings. The financial markets responded immediately by incorporating expectations of further measures by the Federal Reserve into their pricing.

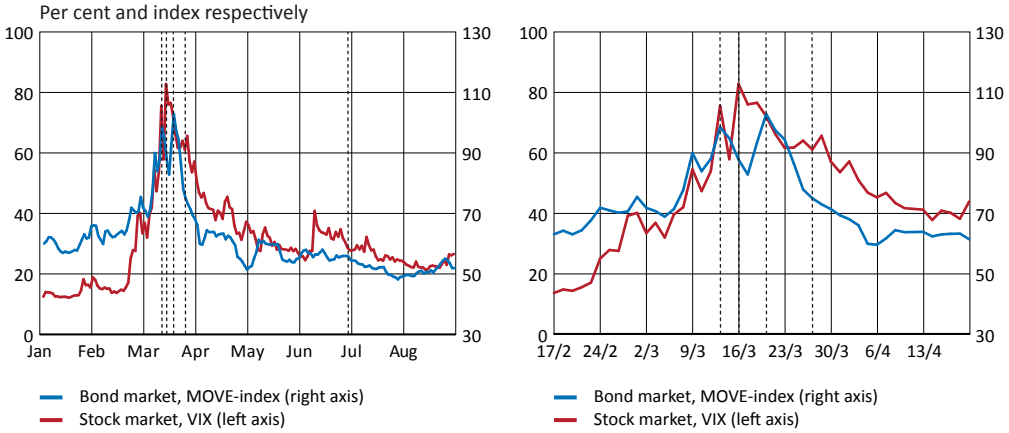
The Swedish banks' long-term funding had gradually become somewhat more expensive, and investors still appeared less willing to hold risky assets. According to the Riksbank's Business Survey in that week, companies were still only experiencing minor effects, and the outbreak of the virus was mainly regarded as a risk that was difficult to assess. At the same time, there was broad concern within the Riksbank and among other economic analysts that the information was not fully capturing the increasing seriousness of the situation. The uncertainty also gave rise to concern that the situation would worsen.

20 For further information, see Public Health Agency of Sweden: https://www.folkhalsomyndigheten.se/the-public-health-agency-of-sweden/communicable-disease-control/covid-19/.

21 The VIX-index is a measure of the expected volatility in the US stock market S&P500, and is computed from option prices.

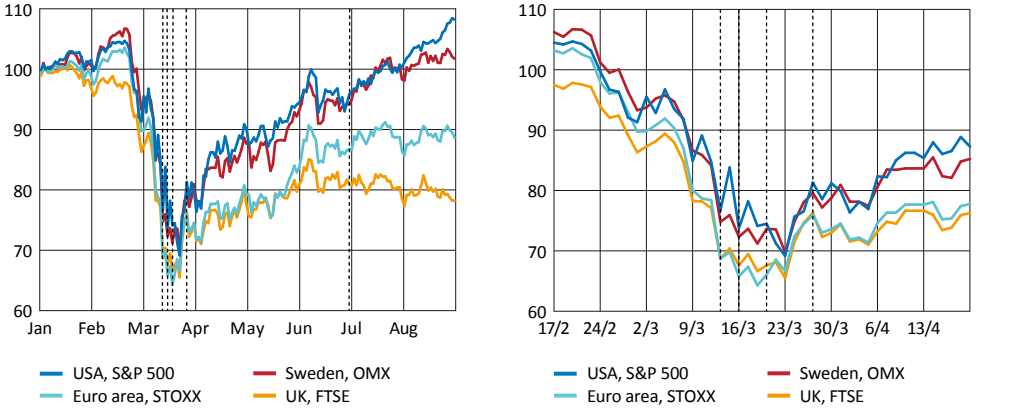
22 OMX refers to OMXSPI (all-share), which includes all companies listed on the OMX Nordic Exchange Stockholm.

Figure 7. Volatility index for US equity and bond markets
Per cent and index respectively



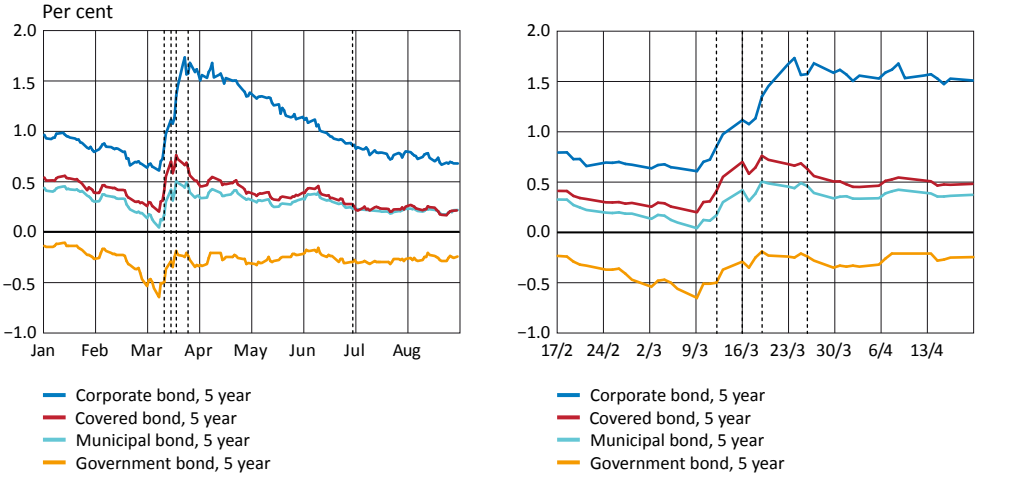
Note. The VIX index shows the expected volatility on the US stock market, based on options prices. The Merrill Lynch Option Volatility Estimate (MOVE) Index is a measure of the expected volatility of US government bonds on the bases of options prices. Broken lines mark the Riksbank's decisions on 12, 16, 19 and 26 March and the decision on 30 June.
Sources: Chicago Board Options Exchange and Merrill Lynch

Figure 8. Stock market movements in domestic currency
Index, 2020-01-03 = 100



Note. Broken lines mark the Riksbank's decisions on 12, 16, 19 and 26 March and the decision on 30 June.
Source: Macrobond

Figure 9. Bond yields, 5 year maturity
Per cent



Note. Covered bonds and corporate bonds are zero coupon rates calculated using the Nelson-Siegel method, bonds for companies with credit ratings equivalent to BBB or better. Municipal bonds are benchmark bonds issued by Kommuninvest i Sverige AB. Broken lines mark the Riksbank's decisions on 12, 16, 19 and 26 March and the decision on 30 June.
Sources: Bloomberg, Macrobond, Refinitiv and the Riksbank

9–15 March: Heavy stock market fall, very high risk aversion among investors and a large demand for USD

In the second week in March, the number of confirmed cases of COVID-19 in Sweden rose substantially. The total number amounted to around 1,000 cases in the middle of the week and the first death in Sweden was confirmed on 11 March. The spread of infection was also tangible in a large number of other countries and on the same day the WHO declared the coronavirus outbreak to be a global pandemic. At the same time, a conflict was escalating between Russia and Saudi Arabia regarding production levels for oil, which caused the oil price to fall more than 20 per cent.

This further aggravated the unease on the financial markets. The flight from risky assets increased again and the OMX fell by almost 20 per cent during the week. This was on a par with the stock market falls in other countries (see Figure 8). Risk aversion increased to such an extent that investors also began selling government bonds with long maturities in favour of government securities with short maturities and other safe assets.[23] This 'dash for cash' contributed to rates on government bonds with longer maturities rising by around 0.3 percentage points (see Figure 9).[24] In connection with this, there were major problems on the market for US government securities, which is normally regarded as one of the world's best functioning markets. Liquidity deteriorated markedly when many of the investors wanted to sell government bonds with longer maturities. One sign of this was that participants in the US market for government bonds reported historically large differences between ask and bid prices.

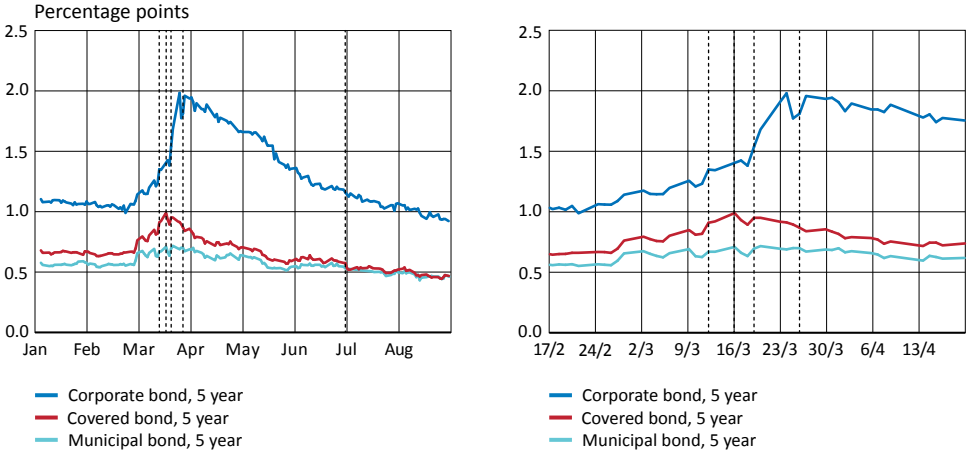
Intermediaries on the bond markets, who normally act as market makers by offering to both buy and sell bonds, had difficulty managing the enormous pressure to sell risky bonds. They rapidly reached the limit as to how much they could offload investors, and hold these bonds on their own balance sheets, both with regard to their internal risk mandate and the regulations. This mainly occurred in the corporate bond market, but also in the covered bond market and to some extent with regard to government bonds.

Rates on covered bonds and corporate bonds rose a few basis points further, compared with the rates on government bonds with equivalent maturities. This meant that the rate spreads which reflect risk premia on these markets, increased (see Figure 10). But despite the companies appearing to be much more exposed to the economic consequences of the pandemic than both banks and households, risk premia for corporate bonds did not increase more than those for covered bonds.

23 In the United States, the flight from government bonds with longer maturities was particularly clear, partly because highly-leveraged investors were forced to sell government bonds to meet their liquidity requirements. For further details, see Schrimpf et al. (2020).

24 There are several economic models that decompose government bond rates in expected future short-term rates and forward premiums. In a model based on Adrian et al. (2013), the rate rise during the second week in March can be largely explained by an increase in the forward premium. This is in line with the impression that risk aversion increased substantially and gave rise to a 'dash-for-cash' behaviour among investors.

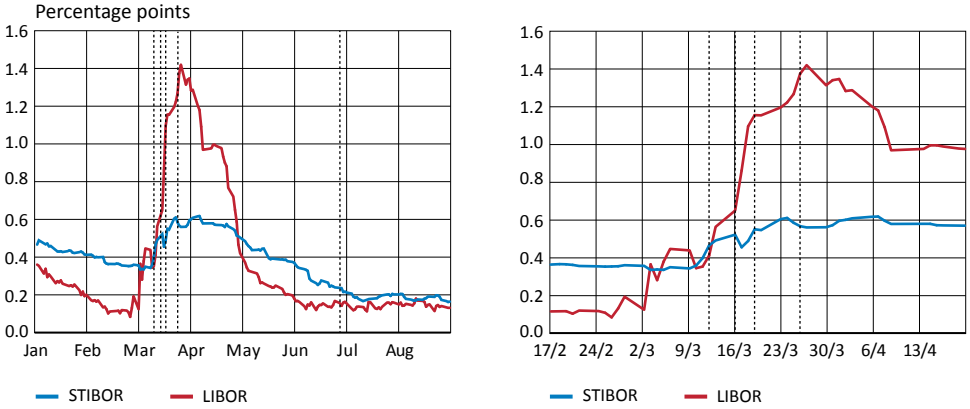
Figure 10. Yield spread between different types of bond and government bonds in Sweden
Percentage points



Note. Covered bonds, corporate and government bonds are zero coupon rates calculated using the Nelson-Siegel method, bonds for companies with credit ratings equivalent to BBB or better. Municipal bonds are benchmark bonds, issued by Kommuninvest i Sverige AB. Broken lines mark the Riksbank's decisions on 12, 16, 19 and 26 March and the decision on 30 June.
Sources: Bloomberg, Macrobond, Refinitiv and the Riksbank

The even lower demand for risky assets had also contributed to large outflows from, in particular, certain US money market funds that invested in riskier, short-term assets. These funds demanded less commercial paper and thus ceased providing the global money markets with dollar funding to the same extent as before.[25] Banks in need of short-term funding in USD had to turn to the interbank market instead. This contributed to the rate on this market, USD LIBOR, rising clearly in relation to the rate on US government securities (see Figure 11).[26]

Figure 11. Rate spread between interbank rates and treasury bills, 3-month maturity
Percentage points



Note. For LIBOR and STIBOR the spreads are calculated in relation to the rates on a US and a Swedish treasury bill respectively. The US treasury bill is a benchmark treasury bill, while the Swedish one is a zero coupon calculated using the Nelson-Siegel method. Broken lines mark the Riksbank's decisions on 12, 16, 19 and 26 March and the decision on 30 June.
Sources: Macrobond and the Riksbank

25 For detailed reasoning on this, see Sveriges Riksbank (2020c), Avdjiev et al. (2020), and Eren et al. (2020).
26 As many non-US agents, such as companies and financial institutions, use US dollars in their day-to-day operations, there is a large market for dollar loans outside of the United States. International banks therefore have both deposits and outstanding loans in USD, and to manage surpluses and deficits, they use the interbank market, where USD Libor is the reported rate. As US banks also have access to this market, USD Libor tends to follow the interbank rates in the United States, such as the federal funds rate. For longer maturities, of a few months, the difference between USD Libor and the rate on US government securities, the so-called TED spread, is usually small and stable. In times of heightened unease, however, it can rise significantly, and then often reflects an increased demand for USD and at the same time a reduced willingness among investors to hold risky assets.

The severe deterioration in market conditions caused both the ECB and the Federal Reserve to launch extensive measures programmes this week.[27] On 12 March, the ECB announced a temporary lending programme to the banks with no total limit and adjusted the terms and conditions in the coming TLTRO programme planned for June.[28] Moreover, they announced an extensive asset purchase programme of up to EUR 120 billion during 2020. Towards the end of the week, on 15 March, the Federal Reserve announced that they were cutting the policy rate by one percentage point to almost zero and intended to purchase government and mortgage bonds for at least USD 700 billion. These very extensive asset purchases were primarily aimed at holding interest rates and risk premia down, and easing the situation for the hard pressed financial intermediaries, thereby improving market functioning.

The major Swedish banks did not experience any problems in meeting their liquidity coverage ratios. On the other hand, they reported that funding at shorter maturities, which is mainly in USD, was increasingly problematic and that liquidity in instruments with a maturity of longer than one day was very low. The market climate for long-term borrowing was also considered to have deteriorated.

The widespread unease on the financial markets and the rapidly deteriorated prospects for Swedish companies made the Riksbank take a number of measures. The first was announced on 12 March, and entailed a loan programme to the banks for onward lending to companies. The Riksbank thereby undertook to lend up to SEK 500 billion to credit institutions that were monetary policy counterparties. The programme had clear similarities to programmes launched earlier by other central banks, such as the Bank of England's Funding for Lending scheme and the ECB's TLTRO programme. The loans were offered at a variable interest rate corresponding to the repo rate with a maturity of two years. If the counterparties wanted to borrow via the programme, but did not at the same time increase their lending to companies, there was an additional cost for the loan.[29]

As a safeguard for smooth functioning of the credit supply, Finansinspektionen (FI, the Swedish Financial Supervisory Authority) reduced the countercyclical capital buffer requirement applied to banks from 2.5 to zero per cent on 13 March. In this way, FI assessed that they could free up to SEK 900 billion for the banks in new bank lending.[30]

16–22 March: Global dollar shortage and continued rise in risk premia

In the third week of March, the coronavirus continued to spread rapidly in Sweden. The number of patients requiring intensive care increased substantially, from around 5 new patients per day at the start of the week to more than 30 new patients per day towards the end of the week. The total number of deceased also increased significantly and amounted to almost 50 people at the end of the week.

This week, too, the larger central banks were very active. The Federal Reserve implemented several measures to improve liquidity, and on 17 March it launched the Commercial Paper Funding Facility (CPFF). As part of this, the Federal Reserve undertook to support the companies' short-term market funding, with the support of state credit guarantees. On the following day, 18 March, they established the Money Market Mutual Fund Liquidity Facility (MMLF), which offered banks funding for up to one year for the purchase of assets from money market funds. This facility was aimed at helping money market funds meet the outflows without having to sell assets at heavily reduced prices. If

27 See https://www.ecb.europa.eu/press/pr/date/2020/html/ecb.mp200312~8d3aec3ff2.en.html and https://www.federalreserve.gov/newsevents/pressreleases/monetary20200315a.htm.

28 Targeted Long Term Refinancing Operations (TLTRO) is a programme first launched in June 2014, where the ECB offers long-term loans to banks and gives them incentives to increase their lending to companies and consumers in the euro area.

29 The Riksbank follows up and evaluates the counterparties' lending to non-financial corporations with the aid of financial market statistics and data the counterparties are encouraged to provide to the Riksbank. If the counterparty's lending to Swedish non-financial corporations has not increased at the time of the valuation by at least one fifth of the amount the counterparties have borrowed from the Riksbank, the cost of the loan increases somewhat (see Table 1 for details).

30 See https://www.fi.se/en/published/press-releases/2020/fi-lowers-the-countercyclical-capital-buffer-to-zero/.

this were to happen, there would have been a risk that the functioning of important funding markets would have deteriorated further. On the same day, the ECB presented new asset purchases via the so-called Pandemic Emergency Purchasing Programme (PEPP) with an envelope equivalent to EUR 750 billion.[31]

The Swedish Government presented proposals for measures aimed at companies on 16 March. In addition to a system for so-called short-term layoffs, the companies were given the opportunity to apply to defer their tax payments. Companies could thereby apply to postpone a maximum of three months' employers social security contributions, preliminary tax on salaries and VAT, for a maximum of 12 months. Short-term layoffs meant that during the remainder of 2020, employees could reduce their working hours while the government provided economic support to the employer. In practice, this meant that the employee could retain a large share of his or her salary, at the same time as the company's payroll costs declined significantly.

As the unease on the financial markets had been so large at the end of the previous week, the Riksbank announced on Monday 16 March a further package of measures to counteract the negative development. This package included, in addition to an extensive asset purchase programme, measures to make it easier for banks to obtain funding. The asset purchases on this occasion included government, municipal and covered bonds. The Riksbank also made it clear that within a total envelope of up to SEK 300 billion it was intending to purchase nominal government bonds to a value of SEK 40 billion and real government bonds equivalent to SEK 5 billion, evenly distributed over the rest of 2020. At this point, the Riksbank did not communicate any amounts relating to how much municipal bonds or covered bonds it intended to buy. To increase the flexibility regarding eligible collateral for banks to borrow from the Riksbank, it also announced that a larger share of covered bonds than before could now be used as collateral. Covered bonds issued by the banks themselves were also accepted as eligible collateral. This measure meant that the banks could borrow more from the Riksbank than they were otherwise able to. The Riksbank also announced that it intended to implement weekly market operations with longer duration to increase the liquidity in the banking system. This would be done by offering the counterparties unlimited loans with three-month maturities at a cost of 0.2 percentage points above the repo rate. Finally, the Riksbank cut the rate on the lending facility from 0.75 to 0.2 percentage points above the repo rate. This meant that the banks could borrow more cheaply from the Riksbank overnight against collateral. All in all, these measures contributed to the banks being given access to very large amounts of liquidity and a ceiling for their funding costs was established at equivalent to 0.2 percentage points above the repo rate. The Riksbank began purchasing government bonds within two days over and above the bond purchases decided on earlier. The same week, the programme for lending to banks and the weekly market operations were also initiated.

Investors on the financial markets were becoming ever less inclined to hold risky assets. Volatility on the stock markets reached its highest level during the crisis on 16 March, according to the VIX, although it declined again during the week. At the same time, the stock market decline came to a halt and stayed at a few per cent. It was now mainly the market for commercial paper that was functioning poorly, when many wanted to sell at the same time as there were few buyers. The sellers included corporate bond funds that were experiencing large outflows and were therefore forced to sell bonds to a corresponding volume. Liquidity on the market thus deteriorated significantly, which was shown in the rapid increase of spreads between the prices that buyers and sellers were offering (see Figure 12). The price uncertainty also contributed to a number of bond funds not considering they could guarantee a correct valuation. They therefore closed temporarily for withdrawals

31 See https://www.federalreserve.gov/newsevents/pressreleases/monetary20200317a.htm and https://www.ecb.europa.eu/press/pr/date/2020/html/ecb.pr200318_1~3949d6f266.en.html.

and deposits, although most funds opened for trade a banking day or two later. Risk premia on the market for corporate bonds rose further and activity on the primary market for commercial paper and corporate bonds was at the same time very low, which further reinforced the picture of the companies' market funding functioning poorly. The rising risk premium probably reflected an increase in both credit and liquidity risk. Credit risk increased because the companies' ability to repay according to the conditions for the bonds became increasingly questioned. At the same time, the liquidity risk increased as investors perceived the functioning of the market to be deteriorating, and difficulties arose in selling bonds at a reasonable market price.

When the Riksbank early this week announced purchases of covered bonds, rates on these bonds stabilised over the course of the week. Banks, whose ability to fulfil their payment obligations is what the rates on covered bonds primarily reflect, were not exposed to the crisis as clearly as companies.

Towards the end of the week, the Riksbank on Thursday 19 March supplemented its earlier announcement of asset purchases, saying it also intended to buy commercial paper and corporate bonds. On the same day, the Riksbank and several other central banks also entered into swap agreements with the Federal Reserve to manage the strained situation on the markets for short-term borrowing in dollars.[32] The Riksbank announced that it would offer the banks loans in USD against collateral. The loans could amount to a total of USD 60 billion during the period from 19 March to 18 September 2020.

The day after, on 20 March, the Government announced it was intending to allocate resources to state-owned Almi Företagspartner, which offers loans and business development to companies. In this way, they wanted to increase lending to small and medium-sized enterprises. The Government also extended the loan scope for the Swedish Export Credit Corporation and the Swedish Export Credits Guarantee Board's ceiling for credit guarantees.[33] On the same day, the Riksbank specified that it intended to purchase covered bonds issued in SEK to a value of 10 billion in the first auction to be held on 25 March.

This week the Riksbank carried out both business surveys and interviews with participants in the financial markets. These confirmed that the situation was more acute. Many companies experienced the main problem to be a shortage of liquidity resulting from reduced income and that the conditions for external funding had deteriorated. As an example, several companies considered market funding to be 'dead', at the same time as they perceived the banks to be overwhelmed with loan applications, that the response times were long and that interest rates were higher. Larger industrial companies considered themselves to be well-equipped, but nevertheless intended to build up buffers to be prepared to manage a potential deterioration in the situation. At the same time, the banks perceived their short-term funding to be functioning poorly, both via the dollar and foreign exchange swap markets. With regard to long-term funding, the banks considered that the Riksbank's measures had had a direct impact on the covered bond market via somewhat lower risk premia and that interest among investors had increased. However, several banks indicated that they were postponing issuing covered bonds.

23–29 March: Rising stock prices, stabilised liquidity premia, but problems on the corporate bond market

Towards the end of March, the spread of infection stabilised at a high level, with around 30–40 new cases that needed intensive care every day. The total number of fatalities was almost five times as high as in the previous week, from 49 to 239.

32 The Riksbank's swap facility was originally established for a six-month period, but in August it was extended until 31 March 2021.

33 Almi received a capital injection of SEK 3 billion. The Swedish Export Credit Corporation's loan scope was extended from SEK 125 to 200 billion and the Swedish Export Credits Guarantee Board's ceiling for credit guarantees was expanded to a total of SEK 500 billion.

Many of the large stock indices, including the Swedish OMX, reached their lowest listing during the crisis on Monday 23 March. On the same day, the Federal Reserve launched a number of new measures.[34] The Federal Reserve declared that it was ready to purchase government bonds and mortgage bonds to the extent needed to ensure the markets functioned properly and monetary policy transmission was effective. Further, they launched two new facilities to support larger companies' market funding: one to supply companies with funding by buying corporate bonds on the primary market and the other to reinforce liquidity on the secondary market for corporate bonds. Moreover, they established a facility to support the funding of smaller companies and households.[35] This also included state guarantees that could cover parts of any losses the Federal Reserve might incur. During the remainder of the week, stock prices rose and the OMX increased by around 10 per cent. However, developments on the Swedish corporate bond market continued to deteriorate. Corporate bond rates continued to rise and the spread against government bonds reached its highest point so far during the crisis (see Figure 10).

The historical covariation between changes in stock prices and in the interest rate spread between corporate and government bonds is low and there are several possible explanations as to why the corporate bond market continued to be weak even after the stock market situation stabilised.[36] The Swedish corporate bond market is characterised, for instance, by low liquidity and relatively few speculative investors, which means it can take longer for prices on the market to reflect the fundamental value of the bonds.[37] Another explanation could be that the bonds reflect the companies' debt-servicing ability up to the maturity of the respective bond, while stock prices reflect how the company will perform over a longer time horizon.[38] Price setting might also have been hampered by several funds being temporarily closed down the previous week.

The rising corporate bond rates also stabilised in connection with the Riksbank announcing at the end of the week that the purchases of commercial paper were being initiated. In a preliminary stage the Riksbank would purchase commercial paper with a remaining maturity of up to three months, that is, companies' more short-term market financing. This was to alleviate the most acute problems for the companies needing to refinance loans maturing in the coming months. The purchases were to begin with an auction the following week, on 2 April, where the Riksbank intended to purchase commercial paper issued in Swedish krona with a credit rating equivalent to at least 'investment grade' for SEK 4 billion.[39]

To reinforce companies' liquidity, the Government presented the corporate loan guarantee on 25 March. This entailed the state guaranteeing, through the Swedish National Debt Office, 70 per cent of the banks' new loans to companies experiencing difficulties as a result of the pandemic, against a risk-based fee. The corporate loan guarantee thus meant that the banks were not exposed to the same extent to the credit risk entailed in providing companies with new loans. The Riksbank's lending programme here filled a complementary function by giving the banks access to cheap financing.

The Riksbank began its purchases of covered bonds and lending in dollars this week. On 27 March, it also extended the scope of these purchases and specified its plans for them.

34 See https://www.federalreserve.gov/newsevents/pressreleases/monetary20200323b.htm.

35 These three facilities were the Primary Market Corporate Credit Facility (PMCCF), the Secondary Market Corporate Credit Facility (SMCCF) and the Term Asset-Backed Securities Loan Facility (TALF).

36 The correlation between the daily, percentage change in stock prices and the change in the interest spread between corporate and government bonds is only −0.15, measured over the period July 2013 to August 2020. The covariation between global stock markets is well-documented, however, and tends to be particularly great in times of market turbulence, see Ang and Bekaert (2002).

37 For a more detailed discussion of why the corporate bond market was so hard hit during the crisis, see Wollert (2020).

38 Chen et al. (2020) show that the substantial recovery in stock prices on the US stock exchange S&P 500 during the spring and summer was largely explained by the explanations of companies' dividend payments on horizons longer than five years, while the expected dividends at shorter horizons were much lower.

39 'Investment grade' refers to issuers/securities with a credit rating equivalent to at least BBB–.

The Riksbank was intending to purchase covered bonds for a total value of SEK 50 billion between 30 March and 30 April, and offered to buy for SEK 20 billion in the following auction on 1 April.[40] To attain a broader impact in the loan programme to the banks, the Riksbank moreover decided during this week to temporarily extend its circle of counterparties. Now a number of smaller savings banks, whose customers largely consist of small and medium-sized enterprises, were also given the opportunity to apply for loans through this programme.[41]

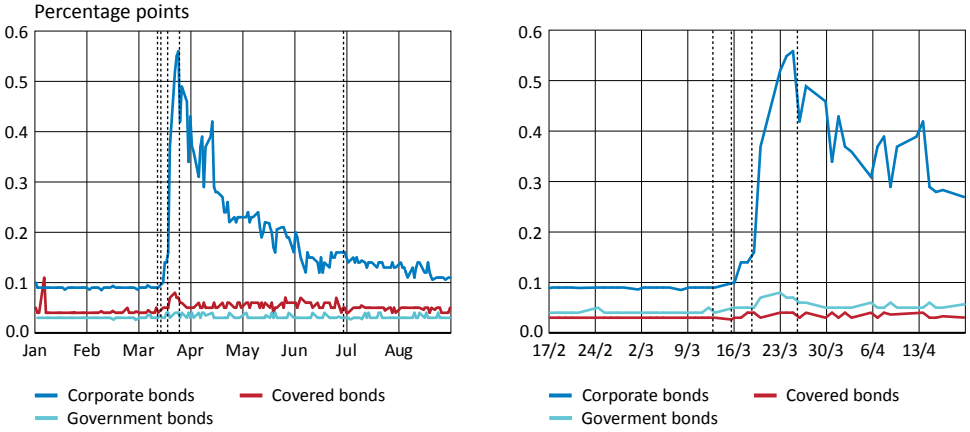
The turnover on the market for FX swaps remained poor, but the banks were able to issue smaller volumes of short-term debt at higher interest rates.

3.2 April: Gradually better liquidity for the banks, sluggish market for commercial paper and major challenges for smaller companies

In the middle of April, the spread of infection was still high but reached its peak during the first wave of the pandemic according to different measures. The number of new cases needing intensive care fell during the month, from almost 40 to around 30 per day. The number of fatalities amounted to around 100 people per day in the middle of April, but declined to around 80 people per day towards the end of the month.

April was marked by some recovery on the financial markets. The Federal Reserve launched new measures on 9 April, including loan programmes aimed at companies (MSLP) and at state and local governments (MLF).[42] The measures taken by the Riksbank and other agents had begun to be implemented, at the same time as investors to some extent became more inclined to take risks. The OMX rose by just over 8 per cent in April, and the rates on covered bonds were already back at the same level as at the start of the year in early April (see Figure 9). However, the spread between rates on covered bonds and government bonds did not fall back to the corresponding levels until the end of the month (see Figure 10). The spread between corporate and government bonds, on the other hand, remained at high levels although it showed a declining trend. The same development could be seen for liquidity on the market for corporate bonds, where the spreads between bid and ask prices were considerable, but declined (see Figure 12).

Figure 12. Spread between ask and bid rates on bonds
Percentage points



Note. Average listed rates, based on all available nominal government bonds, and just over 50 corporate bonds with varying maturities and with credit ratings equivalent to BBB or higher. Broken lines mark the Riksbank's decisions on 12, 16, 19 and 26 March and the decision on 30 June.
Sources: Refinitiv and the Riksbank

40 In August 2020, the outstanding nominal volume of covered bonds amounted to almost SEK 2,000 billion, see further Figure 4.
41 At the end of August the temporary monetary policy counterparties comprised Sparbanken Alingsås AB, Sparbanken Skåne AB (publ), Sparbanken Skaraborg AB (publ), Tjustbygdens Sparbank Bankaktiebolag and Volvofinans Bank AB.
42 See https://www.federalreserve.gov/newsevents/pressreleases/monetary20200409a.htm.

During April, the Riksbank continued to specify details and make minor adjustments to the measures already announced. On 3 April the Riksbank offered to purchase commercial paper for SEK 4 billion in the next auction on 8 April and commercial paper for up to SEK 32 billion between 8 April and 31 May. A few days later, the lending programme to the banks was also extended, to also include onward lending to sole proprietors. Later in the month, on 22 April, the Riksbank announced that it intended to initiate purchases of bonds issued by Swedish municipalities and regions and by Kommuninvest i Sverige AB. These purchases would amount to a nominal total of SEK 15 billion between 27 April and 30 June 2020. On 27 April the Riksbank announced further purchases of covered bonds for SEK 80 billion from May until the end of September.

In April, the Riksbank carried out two business surveys. At the beginning of April, large industrial companies stated that it had become much more expensive to fund their operations than prior to the crisis and that the authorities' measures had not tangibly eased the situation. Moreover, the companies stated that the short-term borrowing via the commercial paper market had ceased at the same time as it was more expensive than before to issue bonds with longer maturities. They could to some extent finance themselves through agreements with banks that had been reached earlier. However, the negotiations with the banks had also become more complicated. In the same survey, trade associations representing the manufacturing sector, the retail sector and the service sectors stated that smaller companies had a more difficult funding situation, as they to a greater extent lacked collateral. The banks were also considered to have had difficulty assessing the debt-servicing ability of companies and managing to process applications in time.

In the Riksbank's business surveys in mid-April, large export companies stated that they had found it easier to fund themselves in recent weeks and that export funding had been secured on reasonable terms thanks to guarantees and loan frameworks from the Export Credit Guarantee Board and the Swedish Export Credit Corporation. These companies at the same time experienced activity on the commercial paper and bond markets to be much lower than prior to the crisis. Instead the companies turned to the banks to obtain new loans and strengthen their liquidity. They stated that the loan conditions were still characterised by short maturities and high costs. The banks' credit assessments were not perceived to have changed significantly, but the negotiations were long and complicated. Property companies and larger manufacturing companies shared the picture of companies using credit lines at the banks as a result of reduced market funding. They also saw a risk that this behaviour pushed out smaller companies with a need to borrow, as they had less access to collateral. Among the property companies there was also some criticism of the Riksbank's purchases of commercial paper not also applying to the primary market. They therefore benefited investors rather than companies, and the banks' credit lines were not considered to suffice to compensate for the loss of market funding.

As a result of the Easter holidays and the fact that banks were publishing their interim reports, there was little market activity. However, the banks considered that the FX swap market was functioning better in USD, EUR and GBP. They also observed that companies were using their credit lines a lot in March, but less in April. Later in the month, conditions for the banks' short-term funding improved in that the dollar market was functioning better, with increased activity on both the primary and secondary market. The banks further observed that a strong development on the stock market reduced investors' need for liquidity and thereby the risk of 'fire sales', and that the conditions for the banks' long-term funding had improved.[43]

43 The expression 'fire sales' is closely linked to so-called liquidity spirals. These arise when many investors want to sell certain assets at the same time. This pushes down prices of assets, which means that balance sheets for the investors holding these assets are weakened, which in turn increases the need to sell the assets. In this way, a spiral is created where pressure to sell leads to increased pressure to sell, and so on. For further details regarding this channels, see Brunnermeier and Pedersen (2009).

At the end of the month, on 30 April, the ECB presented new measures to maintain the supply of credit. In addition to cutting the interest rates in lending to banks within the TLTRO III programme they also intended to extend their loan programme to the banks through seven new long-term market operations market operations, known as Pandemic Emergency Long-Term Refinancing Operations (PELTRO).

On the same day, the Swedish government presented a proposal for reorientation support to companies whose turnover had declined substantially in March and April.[44]

3.3 May – August: Expanded measures and calmer situation on the markets

The downward trend in the spread of infection seen in April continued over the next few months. At the start of May, the number of new cases requiring intensive care was about 30 per day. Towards the end of June, this figure fell to 5 and, two months later, it was down to about 1. The number of fatalities fell in May and June from about 80 to 40 per day, reaching about 2 by the end of August.

The situation on the financial markets continued gradually to improve over the period May to August. Unease over the development of the economy also started to fall slightly as the spread of infection slowed down and the Riksbank and other actors implemented their measures. Uncertainty over companies' future debt-servicing ability thereby decreased. This contributed to yields for corporate bonds returning to the same levels as before the crisis by the end of August (see Figure 9). The yield spread against government bond yields and liquidity on the corporate bond market also returned to earlier levels (see Figure 10 and 12). Investors became more willing to hold high-risk assets and, from the start of May until the end of August, major stock market indices around the world rose, including the OMX index, which rose by about 16 per cent (see Figure 8). However, at the end of August, uncertainty was still greater than before the crisis, which was reflected in the VIX index remaining on slightly elevated levels (see Figure 7).

Over the period May to August, the Riksbank announced further measures and changes to previously announced measures. For example, on 8 May, it announced that purchases of commercial paper would now also include paper with a remaining time to maturity of up to six months, compared with the previous three. Purchases between 1 June and 30 September would take place in such a way that the Riksbank's holdings of commercial paper, acquired under the framework of the current purchase programme running until 30 September 2020, would not exceed a value of SEK 32 billion. On 15 May, the Riksbank also announced that purchases of municipal bonds for the period July to September would amount to SEK 15 billion.

In conjunction with the monetary policy meeting of 30 June, the Riksbank decided to expand the envelope for asset purchases to a maximum of SEK 500 billion until the middle of 2021. At the same time, purchases within this framework to be carried out between 1 October and 31 December 2020 were announced. In addition to the previously announced purchases, the Riksbank intended to purchase:

i. Swedish nominal and real government bonds to a total nominal amount of SEK 20 billion in addition to the previously decided purchases of government bonds over the period July 2019 until December 2020
ii. bonds issued by Swedish municipalities and regions and by Kommuninvest i Sweden AB for a nominal amount of SEK 15 billion
iii. covered bonds issued by Swedish institutions to a nominal amount of SEK 65 billion

44 To receive this support the company was required to have had a turnover of at least SEK 250,000 during the past financial year and a loss of turnover of at least 30 per cent.

iv. commercial paper so that the Riksbank's holdings of commercial paper over the new purchase period would not exceed SEK 32 billion but also so that, upon each purchase, the Riksbank would not own more than 70 per cent of any individual issuer's total outstanding volume of commercial paper in Swedish kronor

v. corporate bonds issued in Swedish kronor from monetary policy counterparties in a nominal amount of SEK 10 billion between 1 September 2020 and 30 June 2021.

At the same time, the Riksbank lowered the banks' cost for borrowing via weekly market operations at longer maturities by removing the mark-up on the repo rate, and also introduced the possibility for the counterparties to take loans at a maturity of six months. The terms of the lending programme to the banks were also modified by an extension of the maturity of the loans from two to four years. In addition, the interest supplement applicable if the bank failed to fulfil the condition on onward lending was cut from 0.20 to 0.10 percentage points above the repo rate.

The Riksbank announced the more specific details of amounts and timings for purchases of corporate bonds after a period of clear recovery on this market. By the end of June, yields were only about 10 basis points above the levels prevailing at the start of the year (see Figure 9), and the yield differential between corporate and government bonds was about 25 basis points higher (see Figure 10). Liquidity had also shown a clear improvement and the bid-ask spread had fallen from just over 50 basis points in mid-March to about 20 basis points (see Figure 12). By this point, there was good reason to believe that market pricing had incorporated the Riksbank's future purchases of corporate bonds. If the Riksbank no longer intended to realise its announced purchases, this could increase uncertainty on the market and risk making future signals on asset purchases less effective. It was also important to fulfil the purchases due to the need to set up operational preparedness to allow purchases to be scaled up rapidly if the situation on the market were to deteriorate.

At the end of April and start of March, the banks considered that the costs for the short-term funding in dollars were continuing to fall but that the corresponding market in euros was still working less efficiently than normal. Concerning their long-term funding, the banks did not consider there to be any problems with issuing covered bonds in Swedish kronor. The Riksbank's measures were cited as a strong contributory cause for this. Furthermore, the banks reported that it was still more expensive for Swedish banks to issue in euros than in Swedish kronor. They also considered that the funding need had decreased due to central bank measures, the deposits that followed withdrawals from funds and increasing household saving. During the rest of May, conditions remained good for the banks' short-term funding and interest rates stabilised. However, it remained relatively expensive to obtain funding in euros, even if interest rates were decreasing. The banks stated that the market for covered bonds was continuing to function well, with falling risk premia.

In June and July, developments continued in the same path, with good liquidity and falling risk premia. Once again, the banks reported that the relatively moderate funding need was contributing to low activity. In August, the banks considered that there was plenty of liquidity on the dollar market for all maturities and that the challenge instead lay in getting rid of their liquidity. The funding need remained low and long-term funding could, in some cases, be secured at a historically low cost.

4 Stable credit supply after massive measures

The rapidly worsened outlook during the spring of 2020 created an acute liquidity crisis for many companies, even those that were fundamentally viable. Revenues fell rapidly at the same time as a significant part of the costs remained. Even if measures such as the Government's short-term layoff scheme, for example, helped companies to reduce their

costs, both small and large companies increased their borrowing very strongly between February and August.

Large companies turned to banks to a greater degree when conditions for market funding deteriorated. In the business surveys over the spring, large companies also stated that they wished to build up liquidity buffers in case the situation was to worsen further. Smaller companies found it more difficult to bear the loss of income and therefore also very heavily increased their short-term borrowing. In contrast to the large companies, the smaller companies reduced their outstanding long-term credits between February and March. This can probably be explained partly by the companies demanding less long-term credit and partly by a certain unwillingness among the banks to lend for longer maturities, which finds some support in the Riksbank's business survey, the Economic Tendency Survey and Almi's loan indicator.

While interest rates on the companies market funding increased slightly, interest rates on the companies' bank loans were not affected to any greater extent for either small or large companies. However, these statistics only include interest rates on granted loans. Consequently, actual interest rates faced by companies may have increased more than the statistics suggest.

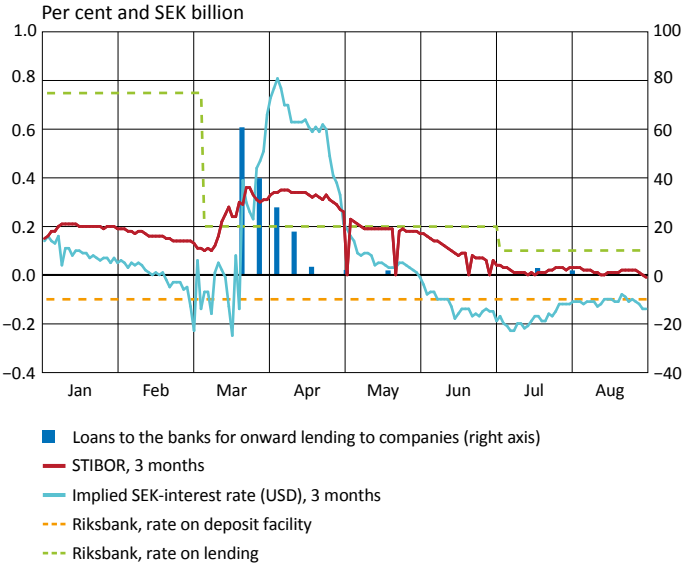
Below, we briefly discuss the banks' funding situation before moving on to review data and indicators for lending to companies and households.

4.1 The banks' funding situation improved gradually

The banks' willingness and ability to issue loans is vital to economic activity. However, the loans that the banks issue must somehow be funded. To some extent, Swedish banks are funded using the deposits made by the general public but the financial markets are also an important source of funding. The banks issue large volumes of bonds, both covered and unsecured, as part of their long-term funding, and are dependent on the global money market for their short-term funding. If the situation on the markets rapidly deteriorates, there may be negative consequences for the banks' ability to issue credit to households and companies. Several of the Riksbank's measures therefore aimed to support the financial markets by purchasing assets but also to offer the banks safe and cheap funding and thereby create good condition for them to continue to grant loans to households and companies, preventing a rise in lending rates. Ultimately, however, it was up to the banks to assess household and corporate credit ratings, as usual, and to determine whether they should be granted credit.

The banks experienced a gradual improvement in the financial conditions after the most turbulent period in March and, in August, the funding situation was very good. This was reflected in the development of the banks' funding costs (see Figure 9 and 13).

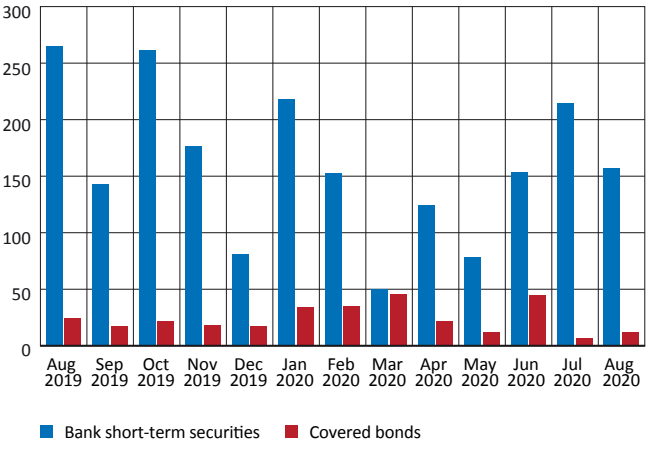
Figure 13. Swedish banks' funding costs and utilisation of the Riksbank's funding-for-lending
Per cent and SEK billion



Note. The implied SEK interest rate is calculated using spot rates and forward exchange rates, as well as the 3-month interest rate USD LIBOR.
Sources: Bloomberg and the Riksbank

The banks' short-term funding largely consists of borrowing in US dollars and euros, and these loans are then converted into Swedish kronor via various financial derivatives. Starting in april, the costs for obtaining funding in this way gradually decreased and can be illustrated using implied SEK interest rates (see Figure 13).[45] The banks also increased their issues of short-term securities (commercial paper and certificates of deposit) compared with March. Issues of covered bonds, however, did not increase to the same extent. One possible explanation of this could be that relatively large issues were made at the start of 2020 and that the banks had a smaller funding requirement after deposits from the general public increased (see Figure 14 and 15). The banks' interest in the Riksbank's liquidity support was also limited after the more turbulent period in March and April (see Table 1 and Figure 13).

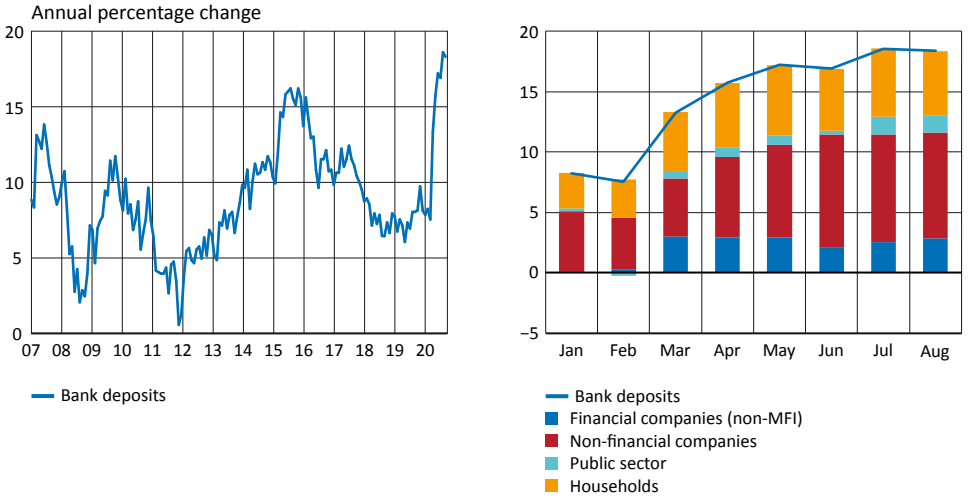
Figure 14. The banks' issuance of short-term securities and covered bonds
SEK billion



Source: The Riksbank

45 When the banks borrow in foreign currency and exchange it for Swedish kronor, they simultaneously wish to enter into a financial derivative contract to insure themselves against the krona depreciating over the maturity of the loan. The final cost for the loan, known as the implied SEK interest rate, thereby consists of two components: both the interest paid on the foreign loan and the cost of this insurance according to the derivative contract.

Figure 15. Bank deposits
Annual percentage change



Note. The public sector refers to municipalities, county councils and the social insurance sector.
Source: Statistics Sweden

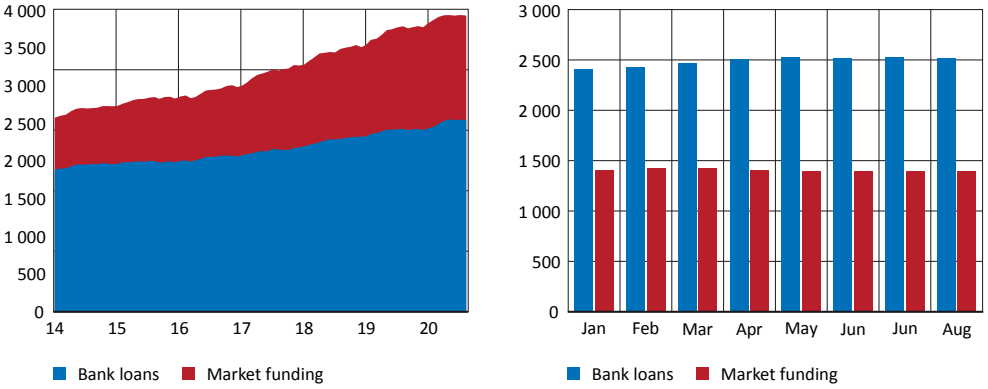
4.2 Companies more dependent on the banks during the pandemic

Companies can fund their operations in different ways. Internal funding is based on companies using equity from profits and shareholders' contributions, while external funding means they take loans from banks and other lending institutions or issue liabilities via commercial paper and bonds. The primary source of most Swedish companies' borrowing is bank loans. However, many companies, above all larger ones, have issued increasingly large volumes on the commercial paper and bond markets in recent years. Consequently, the functioning of these markets and the level of their interest rates are also important to the funding of companies.

When studying the development of lending to companies, alongside the companies' own responses in the business surveys, it is also interesting to study changes in how much the companies have borrowed and how interest rates on these loans have developed. The crisis affected different parts of the corporate sector with varying severity and the business surveys capture a limited sample of companies. At the same time, therefore, it is important to interpret the more aggregated statistics cautiously and, as far as possible, also to study more disaggregated data, both as concerns companies' bank loans and their market funding.

In February 2020, total borrowings within the corporate sector, which is to say bank loans and issued commercial paper, amounted to SEK 3,845 billion or just over 75 per cent of annual GDP. Of this, bank loans made up just under two-thirds (see Figure 16). Credit growth usually slows down when economic activity worsens, among other reasons because companies are investing less and the banks are becoming more restrictive in their lending. However, this typically takes place with some delay. Consequently, it is not that surprising that companies' overall credit growth continued to increase over the spring and summer. Over the period between February and August, companies' total borrowings increased by 1.6 percent. At the same time as bank lending increased by just under 4 per cent, market funding decreased by just over 2 per cent (see Figure 16). This can probably be explained by the strong deterioration in the conditions for market funding over the early part of this period.

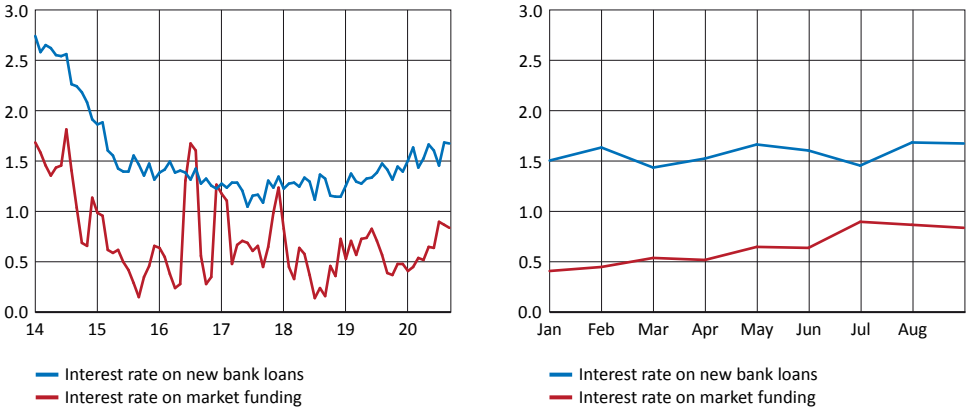
Figure 16. Companies' nominal loan debt, all currencies
SEK billion



Note. Loans from banks refers to MFI lending to non-financial corporations. Market funding refers to non-financial corporations' borrowing via the markets for corporate bonds and commercial paper.
Source: Statistics Sweden

The aggregated statistics suggest that an average companies' cost for taking loans was not affected to any great extent, even if the interest rate on newly-issued commercial paper increased slightly between February and August (see Figure 17). At the same time, it is important to remember that the interest rates we are studying here are based on approved loans and do not necessarily represent the interest rates that the banks offered companies. It is therefore possible that the actual interest rates that companies must take a stance on rose more than the statistics suggest.

Figure 17. Interest rates on corporate borrowing
Per cent



Note. The interest rate on new bank loans refers to the average corporate rate (MFI). The interest rate on market funding refers to a 3-month moving average of the interest expense for amounts issued during the month (commercial paper and corporate bonds, all currencies).
Source: Statistics Sweden

The banks' lending increased, particularly for short maturities and to large companies

Bank loans make up the most common form of funding for companies and the only external source of funding for many small and medium-sized enterprises that do not have access to market funding. In this analysis, we break down the banks' lending by company size and maturity of loans. The maturity of a loan can act as an indicator of the purpose of the loan. Somewhat simplified, it could be said that companies need to borrow money for two reasons:

i. to fund investments
ii. to manage the short-term balance between revenues and expenditure, which is known as *working capital*.

Investment is preferably funded by loans with longer maturities. This is to make it possible to match the repayment of the loan with the streams of future revenues the investment will generate. By matching these cash flows as well as possible, the company can create a long-term balance between revenues and expenditure, and reduce the risk of encountering liquidity problems. However, the short-term balance between revenues and expenditure varies over time for natural reasons, for example due to cyclical patterns or other demand shocks. To manage these short-term fluctuations, companies primarily use bank loans with short maturities and credit lines with the banks.[46, 47]

Breaking down bank loans by company size and maturity shows some clear patterns. Large companies increased both their short-term and more long-term borrowing between February and August. This stands in some contrast with smaller companies, who certainly increased their short-term borrowing very strongly, but, at the same time, slightly decreased their borrowing at longer maturities (see Figure 18).[48]

This development can probably be explained by the interplay of several different factors. Large companies generally have better resilience to demand shocks as they have larger balance sheets that can absorb decreased revenues. The probable explanation for the increase in short-term bank loans by large companies is that they replaced parts of their market funding, which is discussed in the next section. But it may also be due to a wish to build up a liquidity buffer ahead of a possible further deterioration of the situation, in accordance with information extracted from the Riksbank business surveys. Large companies' short-term loans increased by about 30 per cent between February and August (see Figure 18).

For smaller, more exposed companies, it instead became natural, during the pandemic, to rapidly decrease their investments, which are mainly funded using long-term loans. When revenues fell drastically, these companies also faced a great need to reduce their costs and scale back their production of goods and services. This also reduced the need for short-term funding, for example for input goods and labour. In the statistics, we can also see that the utilisation of companies' overdraft facilities with the banks decreased.[49] However, revenues fell more than costs, and the companies instead needed to increase their short-term bank loans to get through the current liquidity situation.[50] Short-term bank borrowing also increased by about 40–50 per cent for these companies over the spring and summer (see Figure 18).

46 As short-term bank loans have lower interest rates than credit lines, companies are likely to prefer to use bank loans to manage predictable fluctuations in working capital, such as seasonal fluctuations. On the other hand, credit lines, whose advantage is that they are immediately available, are used to a greater extent to manage unpredictable shocks in operating capital.

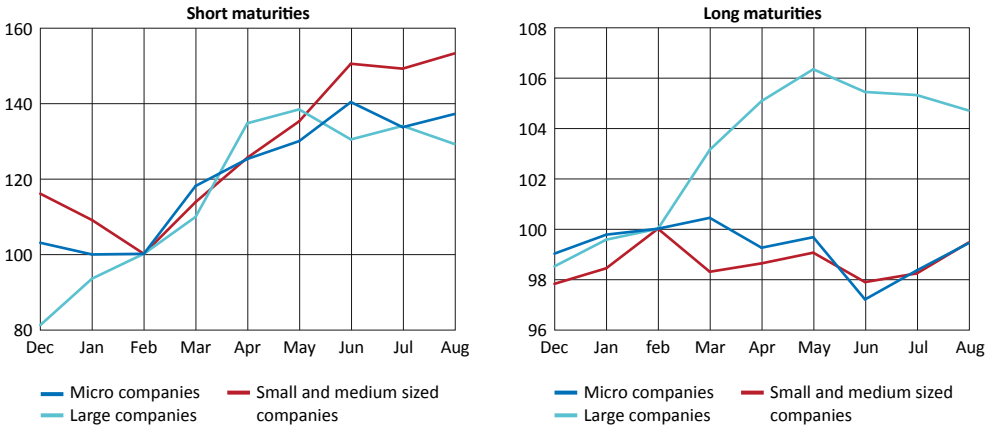
47 About 79 per cent of bank loans are for long maturities (over one year), 14 per cent are for short maturities (less than one year) and the remaining 7 per cent are for unspecified maturities. Source: The Riksbank and Statistics Sweden.

48 In the breakdown of the banks' lending, we use data from the Riksbank's credit database (KRITA) throughout, which includes credit from Monetary Financial Institutions (MFIs) to all sectors except households, loan-for-loan. The first observation for the KRITA statistics is from December 2019, which makes it difficult to identify and consider seasonable variations in the data being analysed. KRITA is a relatively new database and quality assurance of the information is still in progress, meaning that the information should be interpreted with some caution. It is difficult to make a direct comparison of the broken down KRITA statistics reported in the article with the more aggregated MFI statistics for credit growth, as the latter is volume-weighted and, among other things, includes loans to housing cooperatives and loans without specified maturities.

49 See Statistics Sweden's financial markets statistics, https://www.scb.se/hitta-statistik/statistik-efter-amne/finansmarknad/finansmarknadsstatistik/finansmarknadsstatistik/.

50 For example, it was against the background of this need that Almi launched its so-called bridging loans at the end of March. These loans were aimed specifically at meeting funding requirements of small and medium-sized enterprises during the crisis. During a ten week-period following the launch, close to 3000 companies applied for the loan.

Figure 18. The banks' lending to companies by company size and maturity
Index, February = 100

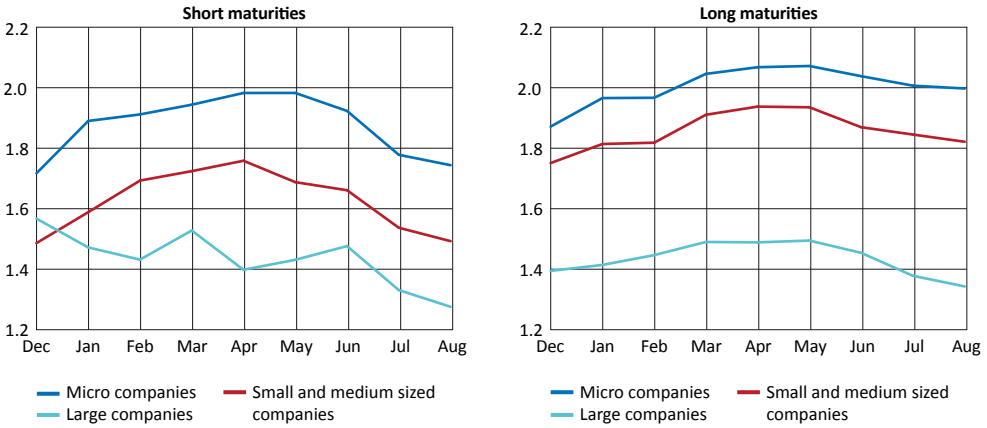


Note. Short and long maturities refer to loan maturities of up to one year and over one year, respectively. The size classification in the KRITA statistics has been made in accordance with European Commission Recommendation (2003/361/EC), and is determined by a combination of the number of employees, turnover and assets.
Source: The Riksbank

Another possible explanation for the increase in short-term bank loans and decrease in long-term ones by smaller companies is that the banks became less wiling to grant more long-term credit when future prospects became more uncertain. They therefore 'forced' smaller companies towards more short-term funding to reduce the credit risk in their own lending. The Riksbank's business surveys provide some support for companies' experiences of such a development (see Figure 20). The greater increase in long-term borrowing by large companies in comparison with smaller ones may also be explained by the larger companies, which usually have a significant proportion of market funding, occasionally finding it difficult to issue bonds on the European market. Instead, they turned to the banks for loans over correspondingly longer maturities.

As regards the interest rates on companies' bank loans, the statistics from the spring and summer do not indicate any larger changes, even when the statistics are divided up by company size and loan maturity. Smaller companies normally have a greater credit risk and lending over the longer term also involves a larger risk that the lender will not receive full payment. This helps explain why different credits cost different amounts for different companies. Interest rates on short-term loans were generally slightly lower in August than in February (see Figure 19). For loans with longer maturities, interest rates were marginally higher than in February for the smallest companies, while larger companies faced marginally lower interest rates in August (see Figure 19).

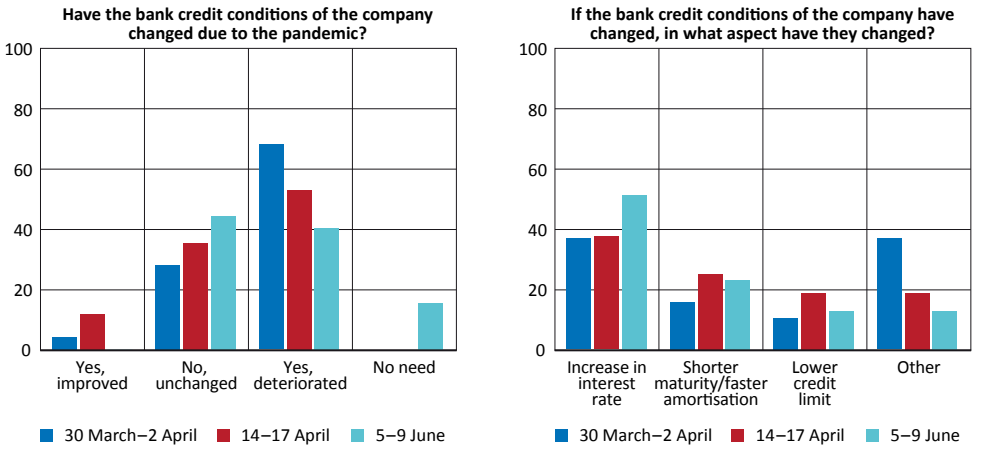
Figure 19. Average interest rate on bank loans to companies by company size and maturity
Per cent



Note. Short and long maturities refer to loan maturities (not interest rates) of up to one year and over one year, respectively. Size breakdown in accordance with European Commission Recommendation (2003/361/EC), in which the combination of number of employees, turnover and assets determines the size classification.
Source: The Riksbank

In the Riksbank's business surveys, almost 70 per cent of companies reported a deterioration of credit terms during the more turbulent phase of the crisis. However, over the spring and summer, this percentage decreased gradually (see Figure 20). In the same survey, those companies that had experienced a change in credit terms reported that, to a significant degree, this was a matter of higher interest rates but also, to some extent, a shift towards shorter maturities for loans and lower limits (see Figure 20).

Figure 20. Have companies' terms for bank loans changed due to the pandemic and, if so, how?
Percentage of responses



Source: The Riksbank's Business Surveys

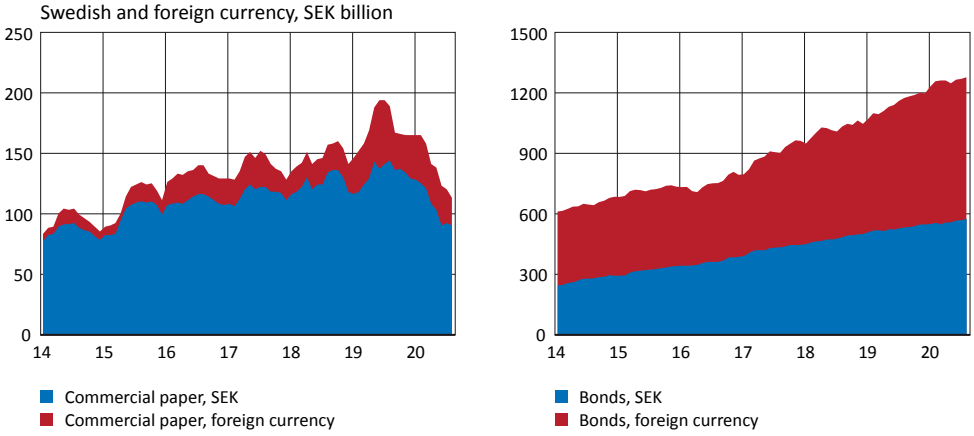
Large companies experienced a rapid worsening of market funding conditions

Relatively few, relatively large companies use market funding as a form of funding.[51] When the Riksbank decided to purchase commercial paper in March, about 70 companies had outstanding paper and slightly fewer than 300 companies had issued bonds.[52] During the more turbulent phase of the crisis, activity on the primary market for corporate debt

51 For a more detailed description of the markets for corporate debt securities, see Wollert (2020) and Sveriges Riksbank (2020a).
52 Of the companies that had issued commercial paper, about 30 companies had commercial paper that fulfilled the criteria announced by the Riksbank for its purchases. In terms of issued volumes, these were dominated by property companies.

securities slowed down significantly, particularly for commercial paper. While the volume of outstanding bonds recovered rapidly, the volume of outstanding commercial paper decreased markedly over the spring and summer (see Figure 21). This meant a clear shift in the trend development and, between January and August, the market for commercial paper shrank by almost one third, from SEK 165 billion to SEK 113 billion in nominal volumes.[53] One possible explanation for this is that maturities for commercial paper are short and many companies were therefore forced to refinance these loans over the spring. When the markets for corporate debt securities were functioning poorly, market funding looked like a relatively difficult and expensive way of covering short-term funding requirements. Many large companies then instead chose to increase their bank loans. At first glance, it is difficult to identify a clear downturn in companies' more long-term market funding. However, the outstanding volume of corporate bonds issued in foreign currency was largely unchanged between February and August after having grown by a yearly average of over 15 per cent between 2017–2019. Growth in the volume of corporate bonds issued in Swedish kronor also slowed down to some extent in the spring and summer (see Figure 21). This stronger development, compared to commercial paper, was probably largely due to there being less of a need to replace funding that had fallen due.

Figure 21. Outstanding nominal volumes of commercial paper and corporate bonds
Swedish and foreign currency, SEK billion

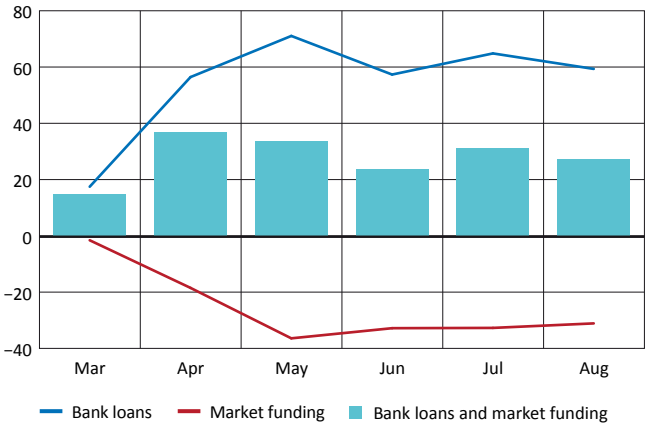


Source: The Riksbank

To investigate in more detail the behaviour of companies using market funding at the start of the crisis, we match the microdata material in the Riksbank's credit database (KRITA) with the corresponding material in the Swedish Securities Database (SVDB). This makes it possible to study how bank lending and the total credit volumes developed more specifically for these companies. This analysis suggests that these companies chose, to a greater extent, bank loans ahead of market funding during the crisis, as their increased bank borrowing more than compensated for the reduced market funding between February and August (see Figure 22). At the same time, borrowing in foreign currency decreased for these companies. Market funding in foreign currency decreased and bank loans in foreign currency were almost unchanged.

53 The percentage downturn was slightly smaller for certificates issued in Swedish kronor, which made up close to 80 per cent of outstanding volumes in August.

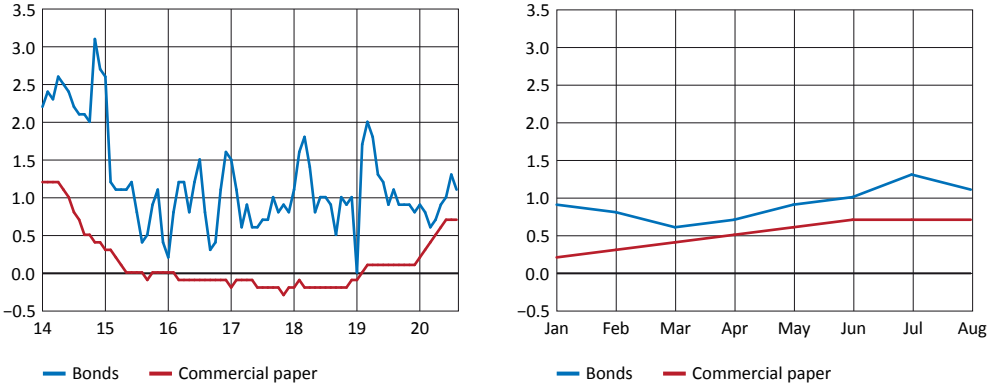
Figure 22. Accumulated change in lending to companies with market funding, all currencies
SEK billion



Note. Companies with access to market funding refers to companies that, by themselves or through a corporate group, have issued commercial paper or corporate bonds since December 2019.
Source: The Riksbank

The rates that companies could issue at increased slightly for both commercial paper and bonds and, in August, they were still slightly higher than before the outbreak of the crisis (see Figure 23). However, it is worth noting that an increase of 30–40 basis points is not particularly large from a historical perspective. In addition, Statistics Sweden's volume-weighted statistics for these interest rates are volatile and should be interpreted with some caution. Compared with the interest rates companies had to pay on bank loans, interest rates on market funding generally seem to have increased slightly more for both shorter and longer maturities (see Figure 19 and 23). To some extent, this might explain the shift in larger companies' form of funding, from market funding to bank loans.

Figure 23. Yields for newly-issued commercial paper and corporate bonds issued in Swedish kronor
Per cent



Note. The yields refer to a 3-month moving average of the interest expenses for amounts issued during the month.
Source: Statistics Sweden

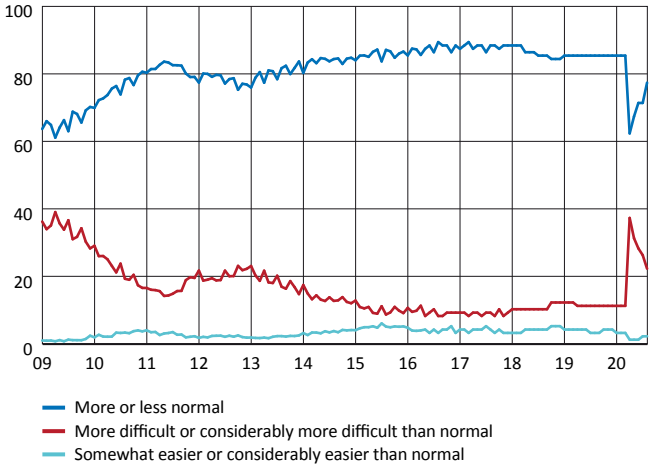
Between February and August, the overall volume of corporate funding via commercial paper and bonds decreased slightly. The interest rates on newly issued corporate paper in Swedish kronor had also increased slightly, both in absolute terms and in relation to interest rates on bank loans. This picture is largely compatible with companies' testimonies in the Riksbank's business surveys. At the start of June, companies were asked how their market funding had changed as a result of the pandemic. As relatively few companies are active on that market, it is natural that many companies responded that they were unaffected. However, of the companies that had experienced a change in conditions for market funding,

half stated that funding was now taking place at a higher interest rate. Approximately one-quarter of these companies experienced difficulties in issuing the desired volumes. Some companies also found that they now needed to issue paper with shorter maturities.

Other indicators suggest a poorer funding situation for companies

Other surveys also suggested that companies' funding situation had deteriorated. In the National Institute of Economic Research's Economic Tendency Survey, the percentage of respondents experiencing their funding situation as more difficult or much more difficult than normal increased rapidly in April in the wake of turbulence in the financial markets.[54] The percentage then gradually decreased slightly but, in August, was still higher than prior to the crisis (see Figure 24).

Figure 24. Funding your company's operations is currently …
Percentage of responses



Source: National Institute of Economic Research

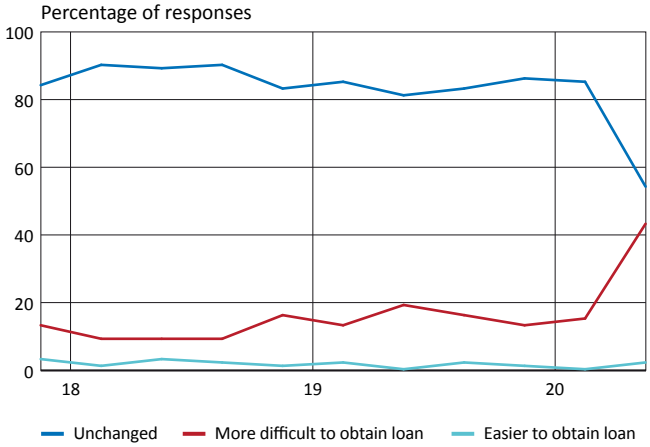
Furthermore, the survey can be broken down by both sector and company size. The breakdown by sector confirms the prevalent view that it was primarily the service sector and trade sector that were impacted severely. Companies with fewer employees also stated to a greater extent than companies with more employees that their funding situation was more difficult. At the same time, a larger proportion of companies in all sectors and size groups experienced a more difficult funding situation in August than prior to the crisis.

Almi also conducts regular surveys of bank managers to monitor the development of the banks' lending to households and companies in its lending indicator.[55] Like the Economic Tendency Survey, Almi's survey indicated that companies found it more difficult to obtain funding in the second quarter of 2020 and that the service industry and retail trade were worst affected. The proportion of managers assessing that companies were finding it harder to raise loans increased strongly and amounted to 43 per cent, compared with 15 per cent in the first quarter (see Figure 25). A larger proportion of managers also deemed that bank lending to companies had decreased and that more loan applications were being rejected.

54 Over the period February 2018 to April 2020, these questions were asked on a quarterly basis. The survey focuses on approximately 5,500 companies of various sizes in the manufacturing, construction, trade and service sectors. The response rate is 70 per cent for the manufacturing sector and construction and civil engineering, and approximately 60 per cent for the trade and service sectors.

55 Almi's lending indicator is based on telephone interviews with 150 bank managers and Almi managing directors in the regional companies within corporate partners across the entire country. Bank branches' lending to the corporate sector mainly goes to small and medium-sized enterprises. Almi's lending goes to small and medium-sized enterprises across the entire country. The survey covering the second quarter is based on telephone interviews held over the period 26 May to 10 June 2020.

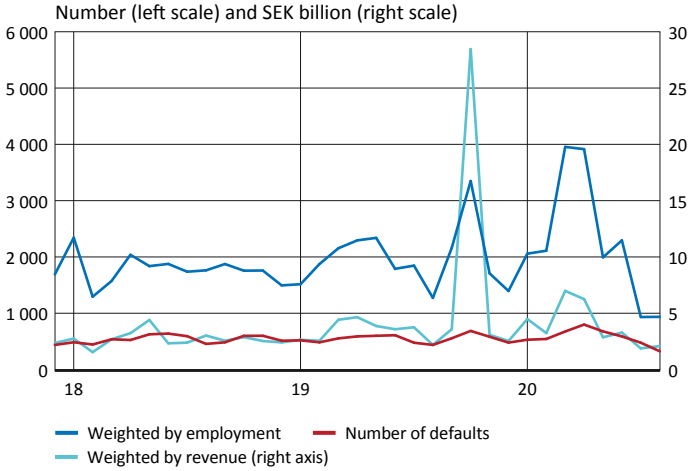
Figure 25. Do you consider it to be easier, more difficult or the same for banks' corporate customers to raise a loan, in comparison with previous quarters?
Percentage of responses



Source: Almi

One further indicator of problems with companies' credit supply could be the number of bankruptcies. The number of bankruptcies increased clearly towards the end of March and was also significant in April and May, before falling back over the summer months (see Figure 26). It is, of course, difficult to use aggregated data to identify whether the tightening of the credit supply has played a significant part in this development or whether companies were already struggling with problems before the outbreak of the crisis. However, in a study of bankruptcies taking place between March and June, Cella (2020) finds, among other conclusions, that the companies affected were highly indebted, unprofitable and relatively illiquid compared with their competitors. It is therefore at least not clear-cut that more comprehensive measures to support the credit supply would have played a decisive role for the survival of these companies.

Figure 26. Bankruptcies, limited liability companies
Number (left scale) and SEK billion (right scale)



Note. Bankruptcy statistics in October 2019 are largely impacted by the bankruptcies of Thomas Cook Northern Europe and Ving Sverige (these companies had almost 800 employees and turnover was almost SEK 18.5 billion). However, all operations and staff were transferred into a newly-formed group with new owners.
Source: Creditsafe

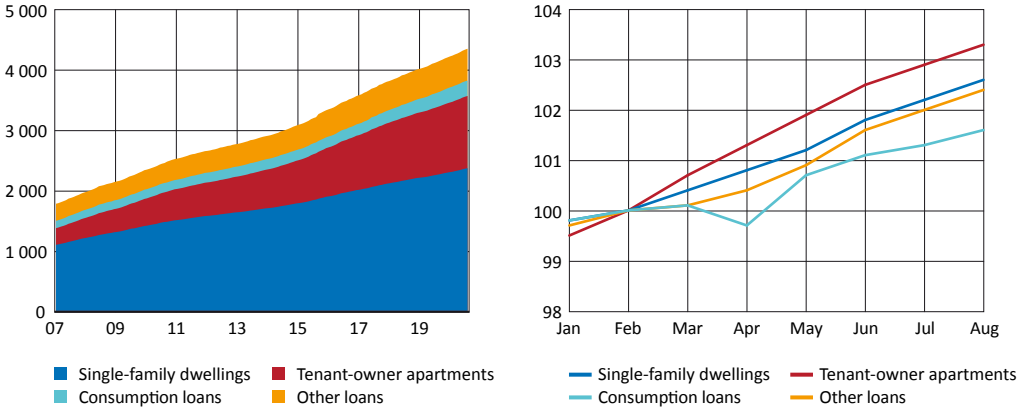
4.3 Minor effects on the housing market and household credit supply

Overall, there are few signs that demand for housing and mortgages fell over the spring and summer. Neither are there any clear indications that the banks tightened the terms for mortgages. Nevertheless, Finansinspektionen made it possible for households to obtain temporary exemption from the amortisation requirement. The continuing good demand for housing means that total household debt continued to increase at approximately the same rate as prior to the crisis (see Figure 27). The interest rates households paid for their loans were also largely unchanged (see Figure 28).[56] In addition, the banks' costs for funding their mortgages were again at very low levels in August (see Figure 9).

The unease in March was primarily a matter of weaker demand in the wake of the pandemic, but there was also concern that unemployment would increase and make the banks less inclined to grant loans to households. As Swedish banks largely use market funding to fund their mortgages to households, there was a risk that household mortgage rates could rise when conditions on the financial markets deteriorated and the banks' funding became more expensive. As 80 per cent of household debt is made up of loans with housing as collateral, the household sector may be particularly sensitive for changes in mortgage rates. Normally, such a rise in interest rates can be counteracted by a lower repo rate. However, as we discussed earlier, cutting the interest rate could be less effective due to restrictions and changed behaviour. Consequently, the Riksbank instead announced purchases of covered bonds, partly to counteract rising interest rates, partly to ensure the market for covered bonds was continuing to work well.

Even though unemployment was rising, housing prices only decreased slightly in April, according to the HOX housing price index. After this, prices recovered and, in August, they were about 3 per cent higher than in February. One important explanation for this was probably that the crisis had had the greatest impact on parts of the service industry. This sector employs many young and low-paid workers, who belong to groups that make up only a small part of the mortgage market. Another possible explanation is that the pandemic led households to value their housing and living spaces more than previously.

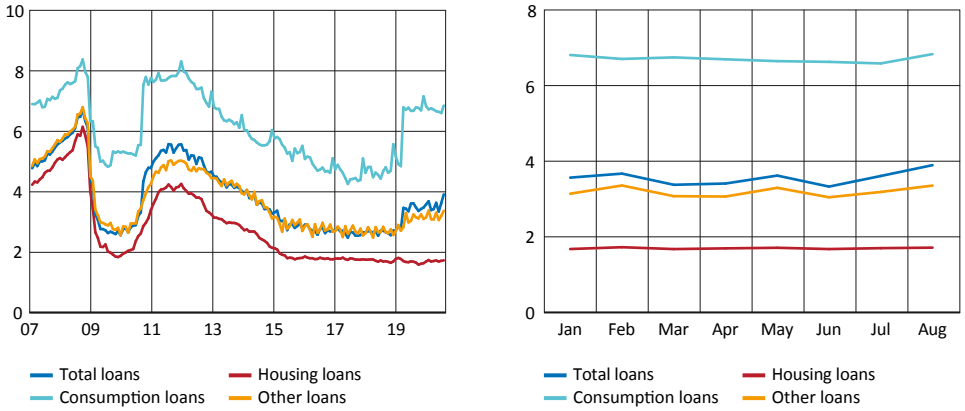
Figure 27. The banks' lending to households by collateral
SEK billion and index, February 2020 = 100



Source: The Riksbank

56 The change was very small for mortgages of all maturities.

Diagram 28. Lending rates to households by purpose
Per cent



Source: The Riksbank

5 No comprehensive credit crunch but many companies faced major challenges

In the beginning of 2021, the infection is continuing to spread across the globe and it is too early to evaluate in more depth whether the measures adopted by the Riksbank and other actors were sufficient to counter the coronavirus pandemic and avoid more long-term economic damage. However, the synchronised economic policy response from both Swedish and foreign governments and central banks at least seems to have prevented a deep and probably more prolonged recession during the first wave of the pandemic.

The pandemic brought about an enormous and synchronous strain on the global economy in the spring of 2020, with a dramatic global decline in demand and production. Production capacity decreased and demand for certain goods and services collapsed, quickly pushing many companies into a liquidity crisis. This development immediately had an impact on the global financial markets. The threat of a severe financial crisis and a deeper and more prolonged recession resulted in massive measures from governments and central banks around the world. Many measures were aimed at helping companies and also, to a certain extent, households get through the period of spreading infection and lower demand. For example, the Riksbank adopted a number of measures to ensure that banks, companies and households could obtain funding but also to ensure that the Riksbank's low repo rate would have full impact on the interest rates paid by companies and households on their loans. The measures involved different forms of liquidity support to the banking sector, but also comprehensive asset purchases. This was primarily because the repo rate was already very low and the Riksbank deemed that it would not be effective to cut it further under the prevailing circumstances. Several of the measures were designed as insurance against a worse scenario, considering the nature of the crisis and the great uncertainty over how the spread of infection would develop. As an example, the banks used the Riksbank's lending programme to a relatively minor extent, but they did so primarily during a period when alternative sources of funding were relatively expensive. It was probably reassuring for the banks to know that the lending programme was in place if the situation should deteriorate, which in itself may have contributed to banks' being able to maintain the credit supply. The Riksbank's liquidity assistance measures gave the banks access to very large amounts of liquidity in Swedish kronor and US dollars at an interest rate that was only slightly higher than the repo rate. In several cases, the Riksbank also purchased assets to restrain or prevent risk premia on strained markets from rising further and thereby risking a further increase in corporate and household interest expenses.

In this article, we have primarily discussed the measures the Riksbank adopted to ensure an efficient credit supply at a low cost but, of course, these measures worked in close interaction with fiscal policy decisions and the comprehensive measures taken by foreign governments and central banks. Together, they helped the financial conditions turn more expansionary. In August, yields on the Swedish bond markets had fallen to about the same levels as before the crisis. Swedish banks also report that the Riksbank's measures had had an effect, on certain markets in particular. It is significantly more difficult to identify the effects of the Riksbank's measures in the corporate sector. At the same time, it should be remembered that, to a significant degree, these aimed to prevent a worse scenario in which companies' borrowing rates could have risen steeply. But companies' costs for bank loans and market funding were largely unaffected in the spring and summer of 2020. Neither were mortgage rates, which are important for households' cash flows, affected appreciably.

Even though it is difficult to estimate how the underlying need for credit evolved over the crisis, at least loan volumes did not decrease to any greater extent. However, it would be unwise to draw any far-reaching conclusions yet, as tighter credit terms usually lead to lower credit growth with some delay. It is also very important to bear in mind that there was a great difference in how companies were affected. Companies in certain sectors lost a very large proportion of their incomes, such as companies with close links to tourism. Such losses of income may also be significantly more difficult to manage for smaller companies with small balance sheets and limited loan collateral. It is, of course difficult to identify how much changes in demand and supply meant for the development of credit volumes in the spring and summer of 2020. At the same time as companies can be expected to demand short-term credit to a greater degree to meet falling incomes and, to a certain extent, to replace funding through commercial paper, willingness to invest has probably decreased. Demand for more long-term funding has thereby been restrained, which has some support in more disaggregated data. Over the summer and spring, it was constantly reported, in surveys by the Riksbank, the National Institute of Economic Research and Almi, that companies faced tighter terms and higher borrowing costs than before the crisis. Even if it is not as clear in the available statistics, this suggests a certain tightening of credit on behalf of the banks.

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Effects on financial markets of the Riksbank's government bond purchases 2015–2017

Ola Melander*

The author works in the Financial Stability Department of the Riksbank but was working in the Monetary Policy Department of the Riksbank at the time of writing.

To ensure that Swedish interest rates would remain low and thus stimulate the economy and support the return of inflation to the target, the Riksbank started to purchase government bonds in February 2015. The scope for cutting the repo rate had started to become increasingly restricted and several other central banks had already used complementary measures such as purchases of government bonds. The Riksbank then expanded its purchases on several occasions. In this article, I describe how such purchases of government bonds work according to economic theory and which effects the Riksbank's purchases have had on financial markets. To analyse the effects of the purchases, I study announcement effects on interest rates and other financial prices. I focus on announcements in the period from February 2015 to April 2017, as it is difficult to identify the effects of later announcements. The empirical analysis shows that the Riksbank's purchases of government bonds have made monetary policy more expansionary by contributing to lower interest rates and a weaker exchange rate via various channels. In this way, the bond purchases have formed a complement to cutting the repo rate. In conjunction with announcements of purchases, real interest rates have fallen more than nominal interest rates, which indicates that inflation expectations have risen. One important conclusion is thus that the effect of the Riksbank's bond purchases is greater than a more limited analysis of its effects on nominal interest rates indicates.

1 Introduction

By autumn 2014, inflation in Sweden had been below the target of 2 per cent for several years. To ensure that inflation would rise towards the target rapidly enough and that inflation expectations would remain anchored, the Riksbank cut the repo rate to zero in October 2014. The Riksbank also announced that it could use other monetary policy tools than the repo rate if necessary. Several other central banks had already used such complementary measures, such as purchases of government bonds, in a situation where the scope for cutting the policy rate had started to become increasingly limited. In January 2015, the European Central Bank (ECB) announced bond purchases aimed at making monetary policy more expansionary.[1] In the short term, the ECB's measures risked leading to a weaker euro and thereby a stronger krona, which, in turn, would lead to lower import prices and even lower

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1 Other central banks that have bought government bonds for monetary policy purposes include the Federal Reserve (the US central bank), the Bank of England (the UK central bank) and the central banks of Japan and Switzerland.

inflation in Sweden. To ensure that Swedish interest rates would remain low and thus stimulate the economy and support the return of inflation to the target, the Riksbank chose to make monetary policy more expansionary. In February 2015, the Riksbank decided to cut the repo rate and initiate purchases of government bonds. The Riksbank then expanded its purchases of government bonds on several different occasions.

In this article, I describe how purchases of government bonds work according to economic theory and which effects the Riksbank's purchases have had on financial markets.[2] Through which channels can bond purchases make monetary policy more expansionary? What effects have the Riksbank's purchases had on different financial prices? I analyse announcement effects on interest rates and other financial prices, as has been done in many earlier studies of the effects of central bank bond purchases. While earlier analyses of the Riksbank's bond purchases have primarily focused on effects on nominal interest rates, I also study effects on real interest rates and inflation expectations.[3] I analyse the effects of net purchases of government bonds announced in the period February 2015–April 2017, as it is difficult to identify the effects of later announcements.

In section 2, I first give an overall description of the Riksbank's purchases of government bonds. In section 3, I then describe the channels through which bond purchases can make monetary policy more expansionary. In section 4, I analyse the announcement effects the Riksbank's bond purchases have had on interest rates and other financial prices. In section 5, I compare the total announcement effects for a number of important variables with the total changes in each variable over the entire period January 2015–June 2017 to gain a perspective on how large the announcement effects have been. I finish by presenting a few conclusions in section 6.

2 The Riksbank's purchases of government bonds

The Riksbank started purchasing government bonds in a situation where the Executive Board deemed that the lower bound of the repo rate had not been reached. The Riksbank also came to cut the repo rate further. However, negative interest rates were untested and could potentially lead to negative side effects on the financial system and economy. By starting to purchase government bonds despite the lower bound for the repo rate not yet having been deemed to have been reached, the Riksbank could later evaluate the effects of gradual cuts of the repo rate at the same time as bond purchases could start to be implemented and have an effect.

In conjunction with the monetary policy decision in February 2015, the Riksbank announced that it would be buying government bonds for SEK 10 billion, with the aim of making monetary policy more expansionary. When making the announcement, the Riksbank also announced that purchases could be expanded if necessary.[4] This happened on several different occasions in 2015, 2016 and 2017, and, by the end of June 2017, the Riksbank's total decided net purchases of government bonds amounted to a nominal amount of SEK 290 billion; see Figure 1.[5] From April 2016, purchases were broadened from nominal government bonds to also include real government bonds. Figure 1 shows the Riksbank's decided net purchases, both at specific monetary policy decisions and cumulatively. In addition, the Riksbank started to reinvest principal and coupon payments in the government bond portfolio in February 2016. Without reinvestments, the Riksbank's holdings of government bonds would gradually have decreased in relation to the decided purchases.

2 For analyses of the effects of negative interest rates, see, for example, Erikson and Vestin (2019) and Sveriges Riksbank (2017a). For a discussion of the side effects of the Riksbank's expansionary monetary policy, see, for example, Sveriges Riksbank (2017b).

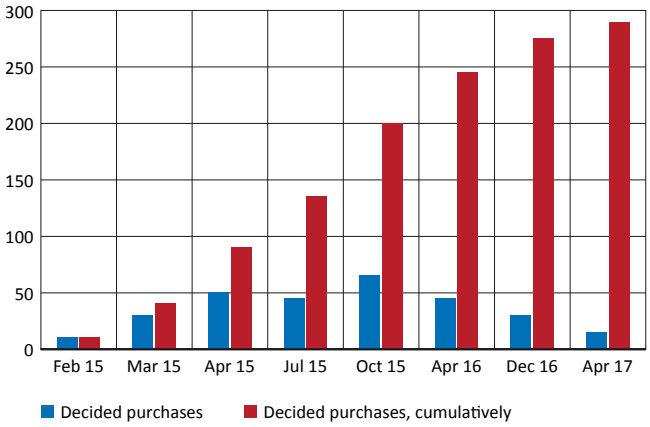
3 De Graeve and Lindé (2015) argue that the effect on real rates is even more important to analyse than the effect on nominal rates.

4 At the same time, the Riksbank also cut the repo rate to −0.10 per cent. See Sveriges Riksbank (2015).

5 This amount excludes reinvestments of principal and coupon payments in the government bond portfolio.

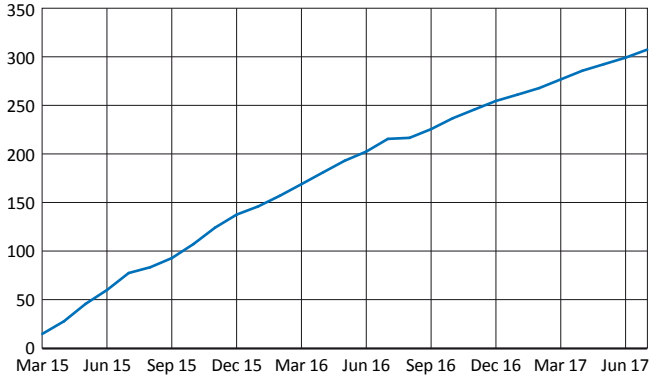
Other central banks that have purchased bonds have similarly reinvested principal payments on bonds. Figure 2 shows how the Riksbank's bond holdings, including reinvestments, have developed over time. The reinvestments meant that the holding of just over SEK 300 billion at the end of June 2017 was greater than the decided net purchases of SEK 290 billion; see Figure 2.

Figure 1. Net purchases of government bonds decided by the Riksbank, February 2015–April 2017
SEK billion



Note. Decided purchases of nominal and real government bonds, excluding reinvestments. Nominal amount.
Source: The Riksbank

Figure 2. The Riksbank's bond holdings in the period February 2015–June 2017
SEK billion



Note. Holdings of nominal and real government bonds. Nominal amount. Reinvestments of principal and coupon payments mean that the holding at the end of the period is larger than the decided purchases. Note that the Riksbank already in early February 2015 had a bond holding of SEK 10 billion. In 2012, the Executive Board decided to set up a bond portfolio to ensure that the Riksbank would have the necessary systems, agreements and knowledge on hand to be able to implement bond purchases rapidly if needed in the future.
Source: The Riksbank

In addition, the Riksbank also announced reinvestments of principal and coupon payments in December 2017, and purchases of government bonds to maintain its holding in April 2019. In conjunction with the monetary policy decision in April 2019, the Riksbank started to communicate in terms of total purchases over a certain period, instead of in terms of reinvestments. The announcements in December 2017 and April 2019 are therefore not completely comparable with earlier announcements. In addition, the Riksbank announced purchases of government, municipal, housing and corporate bonds in March 2020. Expanded purchases were announced in November 2020 when the Riksbank also communicated that

securities purchases would also include treasury bills and green government and municipal bonds.[6] The distribution between different bonds was not communicated in conjunction with the decisions. As part of a package of measures in March 2020, the Riksbank also announced expanded loans to the banks on favourable terms. This makes it difficult to separate the effects of purchases of government bonds from the effects of other measures in this period.[7]

In Sweden, there are only about ten issues of nominal government bonds and these mature at an interval of about 18 months. When the Riksbank purchases bonds at an even rate, it can be difficult to separate reinvestments from decided net purchases that increase the long-term holdings. In conjunction with the monetary policy decision in April 2019, the Riksbank therefore started to report total purchases over a certain period instead of reinvestments. Since then, the Riksbank has also communicated how the decided purchases and principal payments will affect the Riksbank's holdings of government bonds over the period to which the decision refers.[8]

Having presented the Riksbank's purchases of government bonds in this section, I describe, in the next section, how purchases of government bonds through different channels can make monetary policy more expansionary.

3 Effects of the purchase of government bonds according to economic theory

Monetary policy mainly affects the economy through the effects it has on interest rates in the financial markets. The repo rate has a direct effect on short government rates. Expectations of future monetary policy affect yields on government bonds and other bonds with longer maturities. According to what is known as the expectations hypothesis, the yield on a government bond with a long maturity is determined by the average expected short-term yield over the bond's maturity period. This is because investors can choose between purchasing a bond with a long maturity and ongoing investments at a short maturity. For investors to want to own bonds with different maturities, they must expect to receive the same expected return over the period as a whole.

But the expectations hypothesis cannot fully describe rate-setting. This is because, in practice, the yield on a government bond with long maturity also includes a term premium that, among other things, provides compensation for interest rate risk and also can be affected by investors' preferences for bonds with different maturities. The term premium means that the expected return may differ between investments with different maturities. All in all, the expectations hypothesis and term premiums mean that the yield on a bond with a long maturity can be described as:

(1) *Long rate = average expected short rate + term premium*

Normally, the term premium is greater than zero. The price of a bond with a long maturity falls when long-term interest rates rise, which affects any investor who is unwilling to hold the bond until it matures. Investing at a long maturity thus entails a greater risk than investing at a short maturity. Investors therefore normally demand compensation for investing in a bond with a long maturity. This compensation is made up of the term premium.

6 The green bonds issued by the Swedish state only differ from other government bonds with regard to the investor's opportunity to follow the government expenditures to which the bond is linked and what environmental and climate effects they help attain. The same difference applies to green municipal bonds in relation to other municipal bonds.

7 See Gustafsson and von Brömsen (2021) for a description of the Riksbank's measures and developments on the financial markets in the spring and summer of 2020.

8 See Sveriges riksbank (2021) for a more detailed description and a current assessment of how the Riksbank's securities holdings will develop.

However, there are also factors that contribute to lower premiums and sometimes the term premium can even fall below zero. There are several reasons why investors may be prepared to accept a lower return for owning certain government bonds; see Alsterlind et al. (2015). One important explanation is that insurance companies with long-term commitments may wish to hold assets with longer maturities and low credit risk, even if they have a lower expected return. Investors may also want to own government bonds to be able to lend them on the repo market and thereby convert bonds to liquidity. Banks can also use government bonds as collateral when making transactions with each other and with the Riksbank.

The Riksbank's purchases of government bonds can have an effect on financial prices via several channels. The purchases can affect long-term interest rates through their effects on the expected short-term interest rate (the signalling channel) and through their effects on the term premium (the premium channel). Bond purchases can also affect other market rates (the portfolio balance channel), the exchange rate (the exchange rate channel) and liquidity in the banking system (the liquidity channel).[9] Below, I describe how these channels function according to economic theory.[10]

In addition to these five channels, there is one more channel that could be more relevant in Sweden compared with other countries, namely the effect on short-term interest rates. In Sweden, most mortgages are at variable interest rates and short-term interest rates therefore have a greater impact on the economy in Sweden than in many other countries. Since the Riksbank started purchasing government bonds in February 2015, short-term market rates have usually been significantly lower than the repo rate. When the outstanding stock of government bonds decreases due to the Riksbank's purchases, the value of government bonds as collateral in various transactions rises. This contributes to market rates for short-term loans with government bonds as collateral falling. Lenders become prepared to accept a lower yield as the government bonds have a greater value as collateral. This effect can also be seen for other yields with short maturities, such as the yield on treasury bills for example; see Figure 3.[11]

Figure 3. A short-term market rate and the repo rate
Per cent

Note. Dashed lines show announcements of the Riksbank's government bond purchases.
Sources: Macrobond and the Riksbank

9 The channels are usually presented as isolated and separate, but there can also be interactions between the different channels.
10 Alsterlind et al. (2015) describe in a similar manner how the channels function in theory.
11 See also 'Government bond purchases push down long- and short-term rates' in Sveriges Riksbank (2016).

3.1 The signalling channel: signal of a low repo rate for a longer period

Through the *signalling channel*, bond purchases can affect market participants' expectations of the level of repo rate that the Riksbank will set in the future. The market participants may interpret the Riksbank's purchases as a signal that the repo rate will be held low for longer, as the Riksbank will probably not raise the policy rate as long as it is carrying out net purchases of bonds.

In addition, purchases of bonds affect the Riksbank's balance sheet in the longer term and can be interpreted as a more long-term commitment to an expansionary monetary policy than cutting the repo rate. The repo rate can, of course, rapidly be raised again if the economic situation changes, but it is unlikely that the Riksbank would sell bonds rapidly.

If market participants deem that the central bank wants to avoid losses, a larger holding of bonds may lead them to expect the policy rate to be held low for a longer period. When a central bank purchases government bonds, new money is created in the banks' accounts in the central bank, which increases the banking system's surplus against the central bank. As the central bank pays interest on the surplus, a higher policy rate leads to increased funding costs for the bond holding. If the policy rate is raised enough over the maturity of the bonds, this may even give rise to losses in the central bank's profit and loss account. The larger the bond holding is, the greater the effect of a raised policy rate will be on the central bank's financial result.

The signalling channel is a complement to the other ways for the Riksbank to communicate its future monetary policy. Other central banks have sometimes communicated that interest rates will be held low, at least until a certain point in time or until certain conditions have been fulfilled, for example unemployment falling below a certain level. Such communication is sometimes called forward guidance. The Riksbank normally uses the repo rate path to provide guidance for how the repo rate can be expected to develop. Through the signalling channel, the repo rate can strengthen expectations of a low policy rate going forward and thereby increase the credibility of a low repo rate path.[12]

3.2 The premium channel: lower term premium on government bonds

Through the *premium channel*, bond purchases can lead to higher prices and lower term premiums on government bonds. Bond purchases can thus lead to long-term interest rates becoming lower, given the expected short-term interest rate. Normally, the term premium is greater than zero for bonds with longer maturities to compensate investors for the price of such bonds being more sensitive to interest rate adjustments than the price of bonds with short maturities. The premium channel works because different assets vary in terms of credit risk and liquidity, for example, thus being what are known as imperfect substitutes.[13] Some investors prefer to own bonds with specific maturities, while others invest in bonds with many different maturities; see, for example, Andres et al. (2004), Vayanos and Vila (2009), Chen et al. (2012) and Harrison (2012). Hence some investors' demand for bonds with a specific maturity is less price sensitive. When the Riksbank purchases government bonds with a certain maturity, the price for these rises as there are investors who wish to avoid having to sell bonds with this specific maturity and instead having to invest in other assets. When the price of the bonds rises, the term premium falls, pushing down the yields. If the Riksbank purchases government bonds with different maturities, the term premiums and yields can thereby be pushed down for many different maturities.

12 See Söderström and Westermark (2009) and De Graeve and Lindé (2015) for a more detailed discussion.
13 The idea that assets are imperfect substitutes originates with James Tobin. See, for example, Tobin (1969).

3.3 The portfolio balance channel: spillover effects give lower market rates

Through the *portfolio balance channel*, bond purchases can also lead to higher prices and lower interest rates for other assets than government bonds. Like the premium channel, the portfolio balance channel is based on different assets being imperfect substitutes. When the Riksbank purchases government bonds, the sellers receive money that they can use to invest in other assets, such as mortgage bonds or corporate bonds. If the investors did not purchase any other bonds after having sold their government bonds, their portfolios would no longer be balanced. They would have too large a proportion of money and too small a proportion of securities. When demand for other bonds increases, the price of these rises and yields fall.

3.4 The exchange rate channel: lower interest rates lead to a weaker exchange rate

If the Riksbank's purchases of government bonds lead to lower short-term and long-term interest rates, through the channels I have described above, the purchases should also lead to a weaker krona through the *exchange rate channel*. According to the theory of interest rate parity, investments in bonds in different currencies are to have the same expected return; see, for example, Engel (1996). Government bond purchases that cause interest rates to fall in Sweden mean that investors can expect lower returns on bonds in Swedish kronor. If investments in Swedish and foreign bonds are to continue to have the same expected yield, investors need to expect the krona to develop more strongly in the future in comparison with earlier expectations. An expected krona appreciation would then compensate for the lower expected yield on the Swedish bond. If the krona is to be expected to appreciate in the period ahead, it must depreciate when the purchases of government bonds are announced and yields fall, for a given level of the expected future exchange rate.

3.5 The liquidity channel: increased liquidity in the banking system can lead to increased lending

Unlike the channels I have described above, the *liquidity channel* acts through the amount of money or liquidity in the banking system, rather than through effects on interest rates and financial prices. When the Riksbank purchases a bond, new money is created in the account with the Riksbank for the bank selling the bond. This increases the banks' total surplus against the Riksbank, which is to say the liquidity in the banking system. To a certain extent, this can reduce the risk of individual banks encountering liquidity problems, which may lead the banks to increase their lending to households and companies.[14] However, how an increase in the amount of liquidity in the banking system affects lending by the banks also depends on other factors such as demand for credit in the economy.[15]

It cannot be ruled out that the liquidity channel has contributed towards making monetary policy even more expansionary than the effects via the channels above indicate. But the liquidity channel is significantly more difficult to analyse than other channels, as effects on the banks' willingness to lend money to households and companies cannot be observed in the same way as effects on prices in financial markets.

The liquidity channel is closely related to other channels that also act through the liquidity in the banking system. When the central bank increases the liquidity in the banking system, the average maturity for the banks' assets decreases, as the banks' reserves with the

14 A related channel is the bank lending channel, according to which the central bank's policy rate adjustments can affect the banks' lending through their effects on the amount of liquidity in the banking system (see Bernanke and Blinder 1988). The bank lending channel is based on the central bank implementing policy rate adjustments through securities transactions with the banks, which is not the case in Sweden.

15 See Armelius, Claussen and Vestin (2020) for a review of how government bond purchases affect different definitions of money.

central bank have very short maturities. To restore the average maturity of their assets, the banks then need to purchase other assets with longer maturities, which in turn contributes to higher prices and lower yields for bonds with long maturities.[16] Empirically, however, it is not possible to distinguish such an effect, which is a result of increased liquidity in the banking system, from the effect through the normal portfolio balance channel, which is a result of the central bank buying government bonds. In practice, the liquidity in the banking system increases at the same time as the central bank purchases government bonds.[17]

As the liquidity channel acts through the banks' lending, rather than through effects on financial prices, we cannot analyse it by studying announcement effects. However, in an earlier study, Hallsten (1999) finds that companies' bank loans decrease more than other financing after monetary policy tightening, which, in turn, contributes to further decreases in GDP growth apart from the direct effect of the policy rate increase. This is consistent with channels that act through the liquidity in the banking system. Another possible explanation is that smaller companies, which largely obtain funding through bank loans, are affected more by monetary policy tightening than larger companies and that smaller companies therefore find it more difficult to obtain both bank loans and other external funding. In such cases, bank loans fall more than other funding does as a result of funding to smaller companies decreasing more than funding to larger companies. However, this is a result of a broader credit channel with different effects on different companies and is not due to general credit tightening from the banks; see Bernanke and Gertler (1995) and Bernanke et al. (1996). Melander et al. (2017) find support for such a broader credit channel in Sweden.

3.6 More expansionary financial conditions lead to higher growth and inflation

The channels I have described above all contribute to conditions on the financial markets becoming more expansionary when the central bank purchases government bonds. In this section, I briefly describe how monetary policy measures such as policy rate adjustments and bond purchases affect the economy through their effects on financial markets.[18]

Expansionary monetary policy measures lead to falling interest rates and a weakened exchange rate. Lower market rates and a weaker exchange rate mean more expansionary conditions on the financial markets.[19] Lower bond yields result in lower funding costs for banks and mortgage institutions and ultimately lead to lower borrowing costs for households and companies. In addition, higher asset prices lead to an increase in the value of investors' bond holdings.

As prices are sluggish, lower nominal interest rates lead to lower real interest rates, and a weaker nominal exchange rate leads to a weaker real exchange rate. When real interest rates fall, economic growth increases and employment rises due to households and companies increasing consumption and investment. When the real exchange rate depreciates, Swedish goods become cheaper compared to foreign goods, meaning that demand for Swedish products increases. A weaker krona also leads to higher inflation as import prices rise.

Ultimately, it is the effects on growth and inflation that are key, although, as monetary policy acts through the financial markets, investigating how bond purchases affect financial prices is also of great interest. In the next section, I study the effects of the Riksbank's announcements of bond purchases on the financial markets.

16 See Christensen and Krogstrup (2016a) for a more detailed description of this channel, which the authors call the reserve-induced portfolio balance channel.
17 However, in 2011, the Swiss National Bank took measures that increased the liquidity in the banking system without purchasing government bonds. Christensen and Krogstrup (2016b) studied the effects and found that the increased liquidity contributed to lower yields for bonds with long maturities.
18 See Hopkins et al. (2009) for a description of how monetary policy, via adjustments to the repo rate, affects the economy and De Graeve and Lindé (2015) for a discussion of the effects various monetary policy measures have in a small, open economy.
19 See Alsterlind et al. (2020) and Fransson and Tysklind (2017) for examples of methods of measuring the degree of expansiveness in the financial conditions in Sweden.

4 Effects of the Riksbank's government bond purchases on financial prices

In this section, I study the announcement effects of the Riksbank's bond purchases via the signalling channel, the premium channel, the portfolio balance channel and the exchange rate channel.[20] Effects via the liquidity channel are significantly more difficult to measure for the reasons I have discussed in the section above. I therefore focus on channels that can be studied by measuring the announcement effects of bond purchases on financial prices, like earlier studies of the effects of central bank bond purchases.[21] I study not just the effects on nominal interest rates but also effects on inflation expectations and real interest rates, as has been done in earlier studies of experiences in other countries; see, for example, Williams (2014) and Haldane et al. (2016). Earlier studies of the Riksbank's bond purchases have primarily focused on the effects on nominal interest rates.[22]

When studying announcement effects, it is important to control for expected announcements. As financial prices are based on all available information, including expectations of future announcements of bond purchases, an announcement that is completely expected should not have any effects on financial prices at the actual time of announcement. Instead, prices should have been adjusted at an earlier stage, when the market participants raised their expectations of future bond purchases by the central bank. In contrast, announcements of unexpected purchases should affect financial prices as the prices need to be adjusted to take account of the new information.

If we do not control for such expected announcements, we risk underestimating the effects of bond purchases. For example, let us assume that market participants expect the central bank to announce bond purchases of SEK 50 billion in conjunction with a monetary policy decision. Instead, however, the central bank announces significantly larger purchases of SEK 100 billion. The change in financial prices upon announcement will then be a result of the unexpected part of the announcement. But if we do not control for the expected part of SEK 50 billion, we will interpret the change in financial prices as a result of the total announcement of SEK 100 billion. This would mean that the actual effect of these bond purchases is twice as large as the effect we can measure without controlling for expected purchases.

One way of controlling for expected announcements is to use expectations according to the market newsletters published ahead of the Riksbank's monetary policy decisions as a starting point. Table 1 shows how the total announcement in conjunction with a specific monetary policy decision can be divided into the expected announcement according to the market newsletter and the unexpected announcement, see De Rezende and Ristiniemi (2018). For example, according to this measure, the announcement in February 2015 was completely unexpected, while the announcement in December 2016 was completely expected. In total, the unexpected announcements only amount to SEK 130 billion, which is to say less than half of the total announced purchases of SEK 290 billion.

As the announcement of expected bond purchases should not affect financial prices, it is reasonable to interpret the price effects upon announcement as a result of the unexpected

20 In this article, I focus on the effects of net purchases of government bonds announced over the period February 2015 to April 2017. In addition to this, the Riksbank also announced reinvestments in December 2017, purchases of government bonds in April 2019, purchases of government, municipal, housing and corporate bonds in March 2020 and expanded purchases of securities in November 2020.

21 However, this article does not analyse the effects of the Riksbank's bond purchases on macroeconomic variables such as inflation and unemployment. De Rezende and Ristiniemi (2018) measure how expansive the Riksbank's monetary policy is by using a 'shadow interest rate' that includes the effects of bond purchases. According to their analysis, the purchases have contributed to inflation being about 0.5 percentage points higher in October 2017 than it would otherwise have been. The corresponding effect on unemployment in October 2017 was about 0.75 percentage points. See also Di Casola (2021) for an overview of empirical research on the macroeconomic effects of bond purchases in the euro area, the United States and the United Kingdom.

22 For example, De Rezende et al. (2015) study the announcement effects of the bond purchases decided in the period February–July 2015. While they discuss effects on inflation expectations, they mainly study effects on nominal interest rates.

bond purchases. Less than half of the announcements were unexpected, so participants on the financial markets had already adjusted their expectations of future bond purchases, and so the financial prices should have been adjusted at an earlier stage. If we assume that adjusted expectations affect financial prices in the same way as the unexpected announcements of purchases, the total effects of the Riksbank's bond purchases on financial prices may be slightly more than twice as large as the effects according to the analysis in this section.

Table 1. Expected and unexpected announcements of the Riksbank's government bond purchases

Date	Total announcement	Nominal bonds	Real bonds	Expected announcement	Unexpected announcement
12-02-2015	10	10	0	0	10
18-03-2015	30	30	0	0	30
29-04-2015	50	50	0	30–40	10–20
02-07-2015	45	45	0	0	45
28-10-2015	65	65	0	35	30
21-04-2016	45	30	15	60	−15
21-12-2016	30	15	15	30	0
27-04-2017	15	7.5	7.5	0	15

Note. The measure of unexpected announcements has been constructed by subtracting the expected announcement (according to market newsletters) from the announced purchases ('total announcement').
Source: De Rezende and Ristiniemi (2018)

Before moving on to studying the effects of the Riksbank's announcements, it is worth noting that we may not capture effects that arise gradually as previously announced purchases are being implemented. In particular, yields for high-risk assets may be gradually affected via the portfolio balance channel if portfolio rebalancing occurs gradually. Hence we may to some extent underestimate the effects of purchases of government bonds on more risky assets, such as mortgage and corporate bonds.

At the same time, effects of unexpected repo rate cuts could mistakenly be interpreted as effects of bond purchases. In conjunction with several of the announcements, the repo rate was also cut and some of the changes in financial prices are due to the repo rate cut instead of the announcement of bond purchases. However, De Rezende (2017) shows that both interest rate cuts and bond purchases had effects on yields.

4.1 The signalling and premium channels

I start by studying how the Riksbank's announcements affected yields on government bonds. This can take place both via effects on the expected short-term interest rate through the signalling channel and through effects on term premiums through the premium channel.

Government bond yields fell by 30–50 basis points

With a few isolated exceptions, yields fell when the Riksbank announced further purchases of government bonds. Table 2 shows how yields on government bonds with different maturities developed, both at different announcement dates and in total over all announcement dates. The columns show changes in different yields at a specific announcement date, measured as the difference between the closing figure on announcement day and the closing figure on the previous day, while the final column shows the total change in each yield for all announcement dates. In total, the nominal yields fell by approximately 30–50 basis points (hundredths of a percentage point), depending on maturity. The difference between yields for Swedish and German government bonds also

decreased by 30–50 basis points, which indicates that the lower yields in Sweden were not the result of lower international yields. Figure 4 shows how Swedish government bond yields developed over the period from January 2015 to June 2017. For example, the 10-year yield fell by about 10 basis points and the 2-year yield fell by about 60 basis points over the entire period. The changes on the announcement dates are thus significant in relation to the total changes over the period.

Table 2. Changes in government bond yields upon announcement of government bond purchases
Basis points

	12-02-2015	18-03-2015	29-04-2015	02-07-2015	28-10-2015	21-04-2016	21-12-2016	27-04-2017	Total
Government bond, 2 years	−12	−10	+5	−11	−2	0	+3	−3	−31
Government bond, 5 years	−16	−12	+7	−13	−8	+4	−1	−7	−45
Government bond, 10 years	−11	−15	+7	−9	−8	+8	−2	−7	−37
Yield differential, Sweden-Germany, 2 years	−12	−9	+3	−10	−1	−2	3	−2	−31
Yield differential, Sweden-Germany, 5 years	−16	−10	+3	−15	−5	−1	0	−6	−49
Yield differential, Sweden-Germany, 10 years	−11	−15	+1	−16	−3	+2	+1	−6	−47

Note. The changes refer to the difference between the closing figure on the announcement day and the closing figure on the previous day. All bond yields are interpolated to fixed maturities and calculated as zero coupon yields.
Sources: Macrobond and the Riksbank

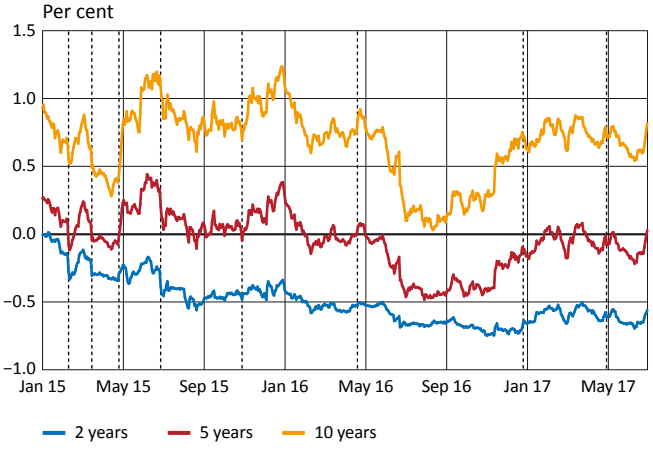
De Rezende (2017) analyses the effects of the Riksbank's government bond purchases in 2015 by studying historical correlations between repo rate changes and government bond yields. Over the period 2003–2014, no purchase of government bonds were announced, so movements in government bond yields upon monetary policy decisions in that period are due to unexpected adjustments to the repo rate, changes to the repo rate path and foreign yield changes. De Rezende then uses these historical correlations to develop a measure of how much of the changes in government bond yields upon monetary policy decisions in 2015 *cannot* be explained by changes in the repo rate, the repo rate path or foreign yields. This unexplained movement in government bond yields can be interpreted as the effect of government bond purchases.

According to this analysis, a significant part of the decrease in government bond yields in conjunction with the monetary policy decisions in 2015 derives from government bond purchases. About half of the decrease in the yield on 2-year government bonds in conjunction with the monetary policy decisions is due to the Riksbank's bond purchases. For 5- and 10-year government bonds, about two-thirds of the decrease in yields is due to bond purchases. In total, bond purchases in 2015 contributed to the 2-year yield falling by 15 basis points, the 5-year yield by 29 basis points and the 10-year yield by 27 basis points.

As Table 2 shows, government bond yields changed significantly more in conjunction with the announcements in 2015 than they did in conjunction with the announcements in 2016 and 2017. The unexpected announcements of bond purchases were also greater in 2015 than in 2016–2017 (see Table 1). Overall, the announcements in 2016 and 2017 were fully expected and it is therefore natural that the changes in financial prices in conjunction with

these announcements were smaller than during 2015 when the announcements were to a larger extent unexpected. Hence it is reasonable to assume that the result of De Rezende's analysis for 2015 also applies to the period 2015–2017 as a whole.

Figure 4. Government bond yields
Per cent



Note. All bond yields are interpolated to fixed maturities and calculated as zero coupon yields. Dashed lines show announcements of the Riksbank's government bond purchases.
Sources: Macrobond och the Riksbank

De Rezende (2017) also studies how bond purchases in 2015 affected estimates of the two different components in the government bond yields – the average expected short-term yield over the bond's maturity and the term premium. The results show that the bond purchases had clear announcement effects on both components. The expected short-term yield was affected for most maturities, while the term premium was primarily affected for longer maturities. The total effect on the expected short-term yield was about 10 basis points for maturities between 2 and 10 years, while the total effect on the term premium was almost 20 basis points for maturities between 5 and 10 years. De Rezende's (2017) results indicate that the Riksbank's bond purchases contributed to lower bond yields through both the signalling channel and the premium channel.[23]

De Rezende and Ristiniemi (2018) construct a 'shadow interest rate' that is intended to measure the degree of expansiveness in the Riksbank's monetary policy, including effects of purchases of government bonds. The difference between the shadow interest rate and the repo rate can be interpreted as the total effect of the Riksbank's bond purchases measured in terms of the repo rate. According to the results, unexpected bond purchases of SEK 10 billion give rise to an expansionary effect corresponding to a repo rate cut of 3.3 basis points. Assuming that the effects are linear, this means that the Riksbank's total bond purchases of SEK 290 billion would correspond to a repo rate cut of just over 95 basis points, which is to say almost one percentage point.

4.2 The portfolio balance channel

To analyse how the Riksbank's announcements of government bond purchases have affected financial prices via the portfolio balance channel, we now study how yields on mortgage and corporate bonds and share prices have developed following the Riksbank's announcements.

23 De Rezende (2017) only studies the effects of announcements in 2015. However, as the changes to government bond yields upon announcements in 2016 and 2017 were significantly smaller than the changes upon announcements in 2015, it is nevertheless possible to draw conclusions for the period 2015–2017 as a whole.

Mortgage and corporate bond yields fell by 25–30 basis points

We start by studying yields on mortgage and corporate bonds. Table 3 shows how yields on mortgage and corporate bonds changed, both at different announcement dates and in total over all announcement dates.

Table 3. Changes in mortgage and corporate bond yields following announcements of government bond purchases
Basis points

	12-02-2015	18-03-2015	29-04-2015	02-07-2015	28-10-2015	21-04-2016	21-12-2016	27-04-2017	Total
Mortgage bond, 2 years	−9	−10	+3	−11	−1	+1	+1	−3	−30
Mortgage bond, 5 years	−10	−11	+8	−7	−5	+3	0	−10	−33
Corporate bond, 2 years	−7	−11	+5	−9	−2	+2	0	−5	−26
Corporate bond, 5 years	−8	−9	+7	−6	−2	+4	−4	−7	−25

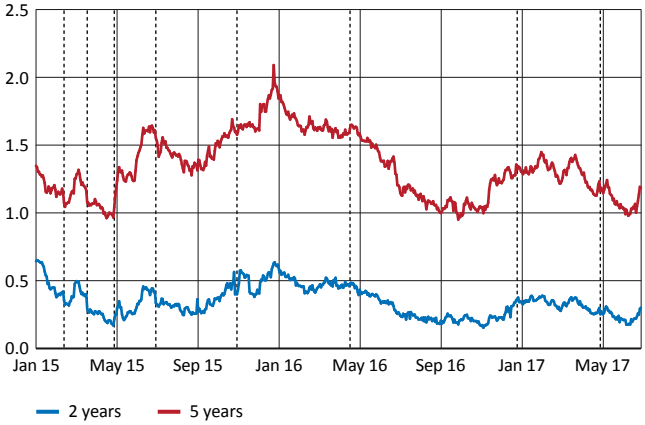
Note. The changes refer to the difference between the closing figure on the announcement day and the closing figure on the previous day. All bond yields are interpolated to fixed maturities and calculated as zero coupon yields.
Sources: Macrobond and the Riksbank

We can see that yields on mortgage bonds moved in line with or slightly less than yields on government bonds, depending on maturity; see Table 2. For mortgage bonds with a 2-year maturity, the total movements were as large as the movements for the equivalent government bond, about 30 basis points. The movements were slightly smaller for mortgage bonds with a 5-year maturity than they were for the equivalent government bond, just over 30 basis points compared with 45 basis points. Yields on corporate bonds fell slightly less than yields for mortgage bonds, in total about 25 basis points. In comparison, yields on mortgage and corporate bonds fell by about 10–50 basis points, depending on the maturity over the period from January 2015 to June 2017. Figures 5 and 6 show how yields on mortgage and corporate bonds respectively developed over the period as a whole.

Figure 5. Mortgage bond yields
Per cent

Note. The changes refer to the difference between the closing figure on the announcement day and the closing figure on the previous day. All bond yields are interpolated to fixed maturities and calculated as zero coupon yields. Dashed lines show announcements of the Riksbank's government bond purchases.
Sources: Macrobond and the Riksbank

Figure 6. Corporate bond yields
Per cent



Note. The changes refer to the difference between the closing figure on the announcement day and the closing figure on the previous day. All bond yields are interpolated to fixed maturities and calculated as zero coupon yields. Dashed lines show announcements of the Riksbank's government bond purchases.
Sources: Macrobond and the Riksbank

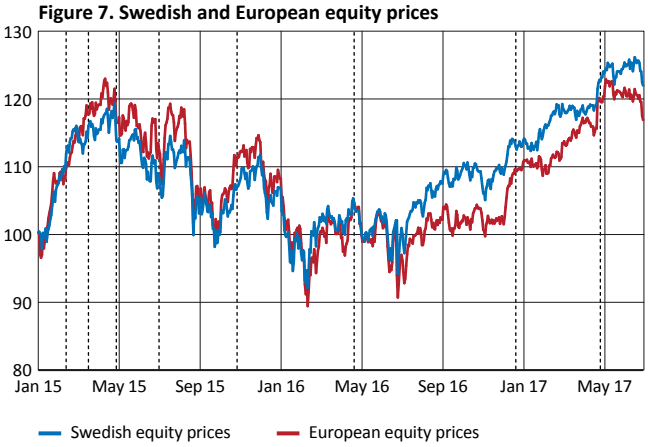
The Riksbank's monetary policy decisions on lower repo rates and further purchases of government bonds have thus contributed to lower yields on mortgage and corporate bonds. However, it is difficult to know how much of the yield changes are due to repo rate cuts and how much are due to bond purchases.[24]

Equity prices rose in line with or more than equity prices in the rest of Europe

In this section, we study how Swedish equity prices developed on announcement days in comparison with European equity prices. The comparison is important if we are to avoid the risk of interpreting a broad, general upswing in Swedish and European equity prices as an effect of the Riksbank's bond purchases. Figure 7 shows how Swedish and European equity prices developed over the period from January 2015 to June 2017. Seen over the entire period, Swedish equity prices rose slightly more than European equity prices. However, as differences in the development of equity prices outside announcement days may be due to a number of different factors, we focus here on changes in equity prices in conjunction with the Riksbank's announcements of bond purchases.

24 One possible way of attempting to distinguish the effects of repo rate adjustments and government bond purchases would be to study historical correlations between repo rate adjustments and other financial prices, as De Rezende (2017) did for yields on government bonds. The historical correlations could then be used to produce a measure of how much of the changes in financial prices in conjunction with announcements of purchases of government bonds that cannot be explained by changes in the repo rate, the repo rate path or foreign yields. The residual could be interpreted as the effect of government bond purchases.

Figure 7. Swedish and European equity prices



Note. OMXS is a broad Swedish share index and EuroSTOXX is a broad European share index. Equity prices are measured in domestic currency. Dashed lines show announcements of the Riksbank's government bond purchases.
Source: Macrobond

Table 4 shows how Swedish and European equity prices changed, both at different announcement dates and in total over all announcement dates. We can see that, on most announcement dates, Swedish equity prices moved in line with other European stock exchanges, but that, on a few occasions, the upswings were greater in Sweden than in other countries. Upon the announcement of bond purchases in February 2015, Swedish equity prices rose by 2.1 per cent, while European equity prices only rose by 1.4 per cent. Upon the announcement in March 2015, Swedish equity prices rose by 1.5 per cent, while European equity prices fell by 0.1 per cent.

Overall, the Riksbank's bond purchases thus seem, to some extent, to have contributed to higher equity prices.

Table 4. Changes in Swedish and European equity prices following announcements of government bond purchases
Percentage change

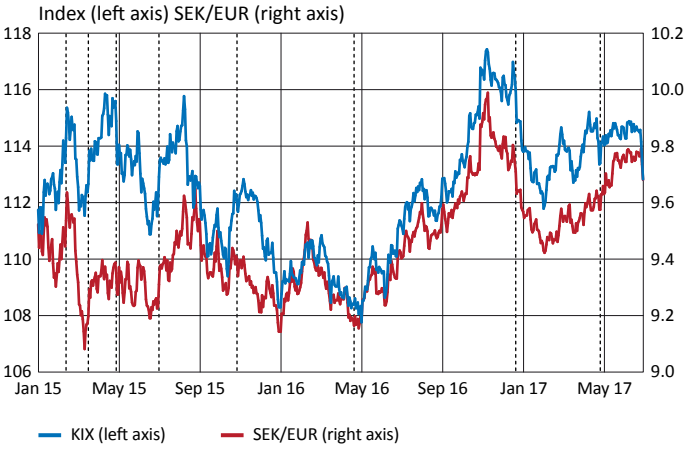
	12-02-2015	18-03-2015	29-04-2015	02-07-2015	28-10-2015	21-04-2016	21-12-2016	27-04-2017	Total
Swedish equity prices	+2.1	+1.5	−2.5	−0.7	+0.5	−0.6	−0.5	−0.2	−0.3
European equity prices	+1.4	−0.1	−2.7	−0.9	+1.1	−0.1	−0.1	−0.4	−1.8

Note. The changes refer to the difference between the closing figure on the announcement day and the closing figure on the previous day. Swedish equity prices are measured using the OMXS index and European equity prices are measured using the EuroSTOXX index.
Sources: Macrobond and the Riksbank

4.3 The exchange rate depreciated

In this section, I analyse the effects of bond purchases through the exchange rate channel by studying how the krona exchange rate developed on announcement days. Seen over the entire period of 2015–2017, the krona weakened slightly, both in trade-weighted terms and against the euro; see Figure 8.

Figure 8. The krona exchange rate
Index (left axis) SEK/EUR (right axis)



Note. The KIX (krona index) is a weighted average of the currencies in 32 countries that are important for Sweden's international trade. A higher value indicates a weaker exchange rate. Dashed lines show announcements of the Riksbank's government bond purchases.
Source: Macrobond

The krona also weakened in conjunction with the Riksbank's announcement of government bond purchases. Table 5 shows how the krona exchange rate changed at different announcement dates and in total over all announcement dates. For example, the krona depreciated in trade-weighted terms by about 1–1.5 per cent after the announcements in February, March and July 2015. On other occasions, the krona appreciated slightly in conjunction with the announcements. Overall, the krona depreciated by about 3 per cent over all announcements.

Table 5. Changes in exchange rates following announcements of government bond purchases
Percentage change

	12-02-2015	18-03-2015	29-04-2015	02-07-2015	28-10-2015	21-04-2016	21-12-2016	27-04-2017	Total
Exchange rate, krona index (KIX)	+1.7	+1.7	−0.7	+0.8	−0.2	−0.3	−0.5	+0.5	+3.0
Exchange rate, SEK per EUR	+1.7	+1.7	−0.7	+0.7	−0.3	−0.3	−0.5	+0.5	+2.9
Exchange rate, SEK per USD	+1.7	+1.9	−0.7	+0.9	−0.2	−0.2	−0.4	+0.5	+3.3
Exchange rate, SEK per GBP	+1.7	+1.9	−0.7	+0.8	−0.2	−0.3	−0.7	+0.6	+3.0

Note. The changes refer to the difference between the exchange rate 30 minutes after announcement and 30 minutes before announcement. Positive exchange rate fluctuations entail a depreciation of the krona. The KIX (krona index) is a weighted average of the currencies in 32 countries that are important for Sweden's international trade. A higher value indicates a weaker exchange rate.
Sources: Macrobond and the Riksbank

De Rezende and Ristiniemi (2018) analyse the effects on exchange rates of unexpected adjustments of the policy rate and other unexpected monetary policy measures, including bond purchases. They study monetary policy measures by the Riksbank, ECB, Federal Reserve and Bank of England. Other monetary policy measures include bond purchases and adjustments of the repo rate path. The measure of the effect of these other measures also includes the effect of other news that affect bond yields in conjunction with monetary policy announcements.

For all the central banks they study, adjustments of the policy rate have a greater effect on the exchange rate than other monetary policy measures. An unexpected cut to the policy

rate of 10 points entails a depreciation of the currency of just over 1 per cent. Other monetary policy measures corresponding to a cut of 10 points in policy rate terms according to the shadow interest rate calculations made by De Rezende and Ristiniemi (2018) lead to a depreciation of 0.35 per cent. According to the authors' analysis, the Riksbank's total bond purchases of SEK 290 billion give rise to an expansionary monetary policy effect corresponding to the effect of a repo rate cut of just over 95 basis points (see section 4.1). If we assume that the effects are linear, the bond purchases according to these estimates should have led to a depreciation of about 3.3 per cent.[25] Such a depreciation is of the same magnitude as the total change in the KIX krona index of 3 per cent, as seen in Table 5. Similarly, the foreign central banks' announcements of bond purchases have also led to depreciations of the respective currency and corresponding appreciations of the Swedish krona.

De Rezende's and Ristiniemi's (2018) results thus indicate that the Riksbank's bond purchases have contributed to weakening the krona, just as other central banks' bond purchases have contributed to weakening other currencies. However, policy rate adjustments seem to have had a greater effect on the exchange rate than bond purchases have. At the same time, it is impossible to know how the krona exchange rate would have developed if the Riksbank had not purchased government bonds. However, in light of the ECB's bond purchases, it is possible that the krona would have strengthened significantly faster than it did. The bond purchases may have had their main effect on the exchange rate by preventing an excessively rapid appreciation of the krona, rather than by actively weakening the krona.

4.4 Real interest rates fell more than nominal ones and inflation expectations rose

In this section, I study how real interest rates and measures of inflation expectations developed in conjunction with announcements of bond purchases. Earlier analyses of the effect of the Riksbank's bond purchases have primarily focused on nominal interest rates. But it is at least as important to study the effects on real interest rates and inflation expectations.

(2) *Nominal interest rate = real interest rate + expected inflation*

According to economic theory, it is primarily real interest rates that affect economic activity and inflation expectations are an important measure of confidence in the inflation target. An analysis of the effects of bond purchases that solely focuses on nominal interest rates may underestimate the effects of the bond purchases.

Real rates fell more than nominal ones

Through the premium channel, bond purchases lead to lower term premiums on government bonds, which means lower nominal yields on government bonds with longer maturities. Lower nominal yields mean that real yields also fall, if prices are assumed to be rigid in the short term. According to economic theory, it is real rates rather than nominal rates that affect household consumption and corporate investment. Lower real interest rates therefore entail higher future economic activity and higher future inflation, which in turn means that the average expected policy rate rises.

As yields on bonds with longer maturities may be divided into term premiums and average expected short-term yield, bond purchases thus have two different effects on yields on government bonds with longer maturities. These effects counteract one another. If the bond purchases have the desired effect, the term premium falls as a *direct* result of the bond

25 Bond purchases corresponding to a rate cut of 10 basis points lead to a depreciation of 0.35 per cent. Bond purchases corresponding to a rate cut of 95 basis points then lead to a depreciation of 3.3 per cent (as 95/10=9.5 multiplied by 0.35 per cent equals 3.3 per cent).

purchases. But the expected short-term yield rises as an *indirect* result of the positive effect of the bond purchase on inflation expectations and the expected policy rate. If, hypothetically, the term premium falls exactly as much as the expected short-term yield rises, the effects offset one another and the nominal yield is unchanged. Hence, an incorrect conclusion of merely studying the effect on nominal yields could be that bond purchases do not have any effect. As pointed out by De Graeve and Lindé (2015), it is therefore important not to study the effect on nominal yields alone – the effect on real yields is more important when the bond purchases are to be evaluated.

The yield on a real government bond is a measure of the risk-free real interest rate for a particular maturity. Figure 9 shows that yields on real government bonds fell from almost 0 in January 2015 to between –1 and –2 per cent in June 2017. As this measure is based on financial prices, it is available day by day and can be used to study the announcement effect on real yields. One possible disadvantage of this individual measure of the real yield is that bond purchases can substantially affect the price of a particular asset, for instance, because of a shortage of liquidity, without any significant contagion effects to other assets, see Altavilla et al. (2015). It could then be problematic to use the yield on a real government bond as a measure of the real yield. Correspondingly, using the yield spread between nominal and real government bonds as a measure of inflation expectations could be problematic. However, other measures of inflation expectations have developed in a similar manner to the measure of inflation expectations that comprises the difference between nominal and real government bonds, see Figures 10 and 11. Different measures of inflation expectations and different measures of real interest rates thus provide a similar picture and the conclusions are not dependent on the specific measure used.

Figure 9. Real government bond yields
Per cent

Note. All bond yields are interpolated to fixed maturities and calculated as zero coupon yields. Dashed lines show announcements of the Riksbank's government bond purchases.
Sources: Macrobond and the Riksbank

Table 6 shows how yields on real government bonds with maturities of 2, 5 and 10 years developed, both at different announcement dates and in total over all announcement dates. In total, real yields fell by 67, 45 and 49 basis points, respectively. This can be compared with the corresponding falls in nominal yields of 31, 45 and 37 basis points. For two of the maturities, real yields thus fell significantly more than the corresponding nominal yields. This indicates that inflation expectations rose in connection with the announcements. Real yields fell in connection with all announcements, with the exception of that in April 2015, when they rose by a few basis points. The bond purchases the Riksbank then announced were largely expected and many market participants had expected that the Riksbank would cut the repo rate. Both nominal and real yields rose when the expected rate cut failed to materialise.

Table 6. Changes in real yields following announcements of government bond purchases
Basis points

	12-02-2015	18-03-2015	29-04-2015	02-07-2015	28-10-2015	21-04-2016	21-12-2016	27-04-2017	Total
Real government bond, 2 years	−24	−15	+2	−11	−3	−9	0	−8	−67
Real government bond, 5 years	−13	−8	+3	−10	−5	−6	−1	−6	−45
Real government bond, 10 years	−16	−10	+4	−7	−6	−3	−2	−8	−49

Note. The changes refer to the difference between the closing figure on announcement day and the closing figure on the previous day. All bond yields are interpolated to fixed maturities and calculated as zero coupon yields.
Sources: Macrobond and the Riksbank

Inflation expectations rose

As the purchases of government bonds are intended to make monetary policy more expansionary, inflation expectations should rise when further purchase are announced. But if market participants believe that the Riksbank has better information on future economic developments than other forecasters, extended government bond purchases may cause analysts to revise down their forecasts for growth and inflation. This will then have a negative effect on inflation expectations, see Campbell et al. (2012). As purchases of government bonds are aimed at ensuring confidence in the inflation target, the effect of announcements on inflation expectations is an important empirical question.

One measure of inflation expectations is the spread between yields on nominal and real government bonds with a particular maturity. This measure is sometimes called 'inflation compensation'. The advantage of this measure is that it is available day by day and can therefore be used to study announcement effects. Figure 10 shows how inflation compensation rose from January 2015 to June 2017.

Figure 10. Inflation compensation
Per cent

Note. Inflation compensation is defined as the difference between yields on nominal and real government bonds with the same maturity. All bond yields are interpolated to fixed maturities and calculated as zero coupon yields. Dashed lines show announcements of the Riksbank's government bond purchases.
Sources: Macrobond and the Riksbank

Following the Riksbank's announcements of further purchases of government bonds, inflation compensation rose for 2- and 10-year maturities, while inflation compensation for 5-year maturities was unchanged. In total, the 2-year inflation compensation rose by 36 basis points, and the 10-year inflation compensation by 12 basis points, see Table 7.

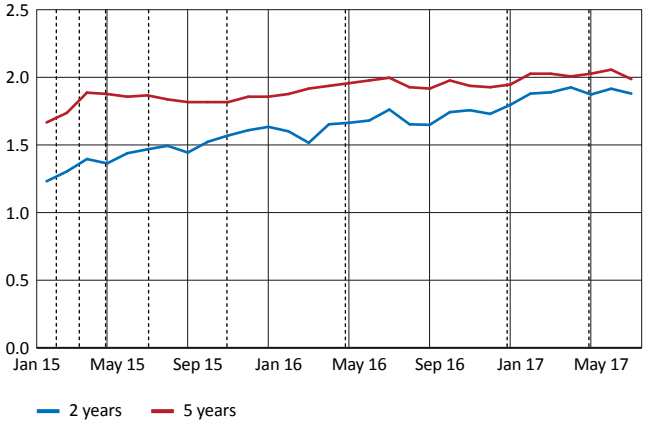
Table 7. Changes in inflation compensation following announcements of government bond purchases
Basis points

	12-02-2015	18-03-2015	29-04-2015	02-07-2015	28-10-2015	21-04-2016	21-12-2016	27-04-2017	Total
Inflation compensation, 2 years	+12	+5	+3	−1	+1	+8	+3	+4	+36
Inflation compensation, 5 years	−3	−4	+4	−3	−3	+9	0	0	0
Inflation compensation, 10 years	+5	−5	+3	−2	−2	+11	0	0	+12

Note. Inflation compensation is defined as the difference between yields on nominal and real government bonds with the same maturity. The changes refer to the difference between the closing figure on the announcement day and the closing figure on the previous day. All bond yields are interpolated to fixed maturities and calculated as zero coupon yields.
Sources: Macrobond and the Riksbank

Inflation expectations according to the Prospera survey show a similar development over time and confirm the picture of rising inflation expectations during the period February 2015 to June 2017, see Figure 11. However, the survey measure is only availably month by month and therefore cannot be used to study the announcement effects.

Figure 11. Inflation expectations according to questionnaire
Per cent



Note. The mean of inflation expectations (CPI) for money market participants according to Prospera's survey. Dashed lines show announcements of the Riksbank's government bond purchases.
Source: Kantar Sifo Prospera

In conjunction with announcements of purchases, real interest rates have fallen more than nominal interest rates have, which indicates that inflation expectations have risen. Different measures of inflation expectations have risen in similar ways, which indicates that this conclusion is general and not dependent on any specific measures of inflation expectations and real interest rates being used. One important conclusion of this analysis is that the effect of the Riksbank's bond purchases is greater than a more limited analysis of its effects on nominal interest rates shows.

5 Perspectives on the announcement effects

The analysis of announcement effects on financial prices shows that the Riksbank's bond purchases have had an effect on interest rates and other financial prices. To put the total announcement effects in perspective, we can compare them with the total changes in financial prices during the period from 1 January 2015 to 30 June 2017. Table 8 below provides such a comparison for a number of important variables. For most of them, the announcement effect comprises a significant part of the total change. This applies in

particular to different nominal interest rates and exchange rates. The announcement effect is often actually larger for these variables than the total change during the period. When it comes to inflation expectations, the announcement effect accounts for around 30 per cent of the total change in inflation expectations 2 years ahead and around 15 per cent of the total change 10 years ahead. With regard to real interest rates, the announcement effect comprises a large share of the total change – just over one third for the maturities 2 and 5 years and just over a half for the maturity 10 years.

Table 8. Total announcement effects in relation to total changes during the period 1 January 2015–30 June 2017
Basis points (*percentage change)

	Total announcement effect	Total change during period
Government bond, 2 years	−31	−56
Government bond, 5 years	−45	−24
Government bond, 10 years	−37	−12
Mortgage bond, 2 years	−30	−54
Mortgage bond, 5 years	−33	−13
Corporate bond, 2 years	−26	−34
Corporate bond, 5 years	−25	−17
Exchange rate, krona index (KIX)*	+3.0	+1.0
Exchange rate, SEK per EUR*	+2.9	+1.6
Exchange rate, SEK per USD*	+3.3	+8.1
Inflation compensation, 2 years	+36	+128
Inflation compensation, 5 years	0	+112
Inflation compensation, 10 years	+12	+79
Real government bond, 2 years	−67	−183
Real government bonds, 5 years	−45	−136
Real government bonds, 10 years	−49	−90

Sources: Macrobond and the Riksbank

6 Conclusions

Many other studies have analysed announcement effects to study the effects of central banks' bond purchases on financial markets. By studying how financial variables move after announcements, it is possible to identify the effects of bond purchases without capturing the effects of other news that also affects financial prices.

But there are factors that mean analyses of announcement effects could potentially overestimate or underestimate the effects of bond purchases. One factor that could lead to overestimation of the effects of the purchases is that the Riksbank on several announcement days also cut the repo rate, which makes it difficult to fully distinguish the effects of extended bond purchases from the effects of a lower repo rate. There are also factors that could lead to underestimation of the effects. The analysis only captures the effects of unexpected purchases, although financial prices should also have been adjusted when market participants changed their expectations of coming bond purchases at an earlier stage. In addition, effects may arise gradually while previously announced purchases are being implemented.

This article shows that the Riksbank's purchases of government bonds have made monetary policy more expansionary by contributing to lower interest rates and a weaker

exchange rate via various channels. The purchases have contributed to lower government bond yields, both by affecting market participants' expectations of the future repo rate (the signalling channel) and by pushing down term premiums on government bonds (the premium channel). Through the portfolio balance channel, the purchases have also contributed to lower yields on other assets, such as mortgage bonds and corporate bonds, and to higher equity prices. In this way, the bond purchases have formed a complement to cutting the repo rate. The bond purchases have also meant that the exchange rate has been weaker than it would otherwise have been. It is not possible to rule out the possibility that monetary policy also became more expansionary through the liquidity in the banking system increasing when the Riksbank purchased bonds, which can have increased the banks' lending. However, such effects are much more difficult to measure.

In conjunction with announcements of bond purchases, real interest rates have fallen more than nominal interest rates have, which indicates that inflation expectations have risen. The effect on the real interest rates is important, as according to economic theory, real interest rates affect consumption and investment. The effect on inflation expectations is also important, as the bond purchases were initiated to anchor inflation expectations and retain confidence in the inflation target. One important conclusion is thus that the effect of the Riksbank's bond purchases is greater than a more limited analysis of its effects on nominal interest rates indicates.

The overall conclusion of this study is that the Riksbank's government bond purchases have contributed to more expansionary conditions on the financial markets. The expansionary effects of the bond purchases on financial markets indicate that the bond purchases have also had expansionary effects on macroeconomic developments in Sweden.

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SVERIGES RIKSBANK
SE-103 37 Stockholm, Sweden
(Brunkebergstorg 11)

Tel 46 8 787 00 00
Fax 46 8 21 05 31
registratorn@riksbank.se
www.riksbank.se