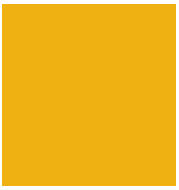
Sveriges Riksbank Economic Review

2015:3

SVERIGES RIKSBANK



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Dear readers,

In this issue, we publish two articles on different monetary policy issues and one on the transformation of the payment market.

- **Why has inflation been so low?**
  Björn Andersson, Vesna Corbo and Mårten Löf analyse the reasons that inflation has been low in Sweden for a long time. They study the development of inflation in more detail and focus on a number of possible explanations. Using a general equilibrium model, they also show how these various explanatory factors may have interacted to keep inflation unusually low over the last five years. The results indicate that weak international economic activity and low commodity prices, particularly for energy, have played a large part. For a period, an appreciation of the krona contributed towards the low inflation. In addition, over the two last years, companies' margins have been lower than normal, particularly as a result of increased competition and uncertainty over the future.
- **The Swedish payment market in transformation**
  Björn Segendorf and Anna-Lena Wretman analyse the structural transformation of the Swedish payment market. They note that payments are increasingly being made electronically and that cash usage is decreasing. The Internet, tablets and smart phones are changing households' purchasing patterns and payment requirements. The banks are also facing competition from new actors. Even if these developments are positive overall, some households, associations and companies perceive them as negative as they create problems for them. Tools for solving, or mitigating, these problems exist but the authors consider that what is needed is cooperation between the market participants and between the market and the government. The government's tasks include ensuring that there is a safety net for those users who risk finding themselves outside the payment market.
- **How can monetary policy take account of uncertainty and risk?**
  Jan Alsterlind describes how monetary policy can more clearly take uncertainty and risks into account. His starting point is that a central bank cannot be certain which description of the economy is correct. This uncertainty may surround which economic relationships and/or which forecast models are appropriate to use when monetary policy decisions must be made. One possibility is to use several forecast models and weigh their respective forecasts together. This will make it possible for monetary policy to be characterised by consideration of risks, which are then defined and quantified. This would also make it easier to monitor and evaluate the account that the central bank has taken of risks and uncertainty in decision making.

Read and enjoy!

Claes Berg, Martin W Johansson, Jesper Lindé and Dilan Ölcer

Contents

Why has inflation been so low?

Björn Andersson, Vesna Corbo and Mårten Löf*

The authors work in the Monetary Policy Department of the Riksbank

Inflation in Sweden has been low for a long period of time. A great deal of the analytical work at the Riksbank has been dedicated to attempting to identify the main drivers underlying the developments. The purpose of this article is to summarise, and to a certain extent update, the findings of that analysis. We start by describing the development of inflation over the past five years, and then study potential explanatory factors, first using simple correlations and then using a model of the Swedish economy. The findings are relatively consistent in that weak international economic activity combined with low commodity prices, particularly for energy, have kept a lid on cost increases, which has been a cause of low domestic price increases in general. The fact that the Swedish krona strengthened for a time also contributed to keeping cost pressures down. In the past two years, companies have in addition squeezed their margins to a greater extent than might be expected from historical patterns.

September 2008 is remembered by many as the month in which US investment bank Lehman Brothers filed for bankruptcy – one of the most critical events of the financial crisis. What is probably less commonly remembered is that September 2008 was also the month when inflation in Sweden hit a record. CPI inflation then reached 4.4 per cent – a level not seen since 1993 when the inflation target was introduced. One reason for the upswing was increasing cost pressures and sharply rising food and energy prices.

As the effects of the financial crisis spread across the globe, and hence to Sweden, in the late autumn of 2008, the momentum of the Swedish economy changed drastically. Inflation came down quickly from its record-highs, but although production declined in 2009 and unemployment rose quickly, inflation was still relatively high. CPI inflation was indeed pushed downwards because market rates fell in line with the Riksbank's sharp cut in the repo rate, which has a direct impact on CPI, but excluding that effect, inflation was back to a level of around 2 per cent at the end of 2009. From 2011 inflation started to decline, however, and has stayed low since.

Periodically low inflation is in itself a natural consequence of the workings of the economy. The economy is constantly affected by changes and shocks, and events occur that sometimes push inflation up, and sometimes bring it down. Depending on what

* This article is based on analysis previously conducted at the Riksbank, and to which many people working in the Monetary Policy Department have contributed. We would like to thank in particular Jesper Johansson, Johan Löf and Peter Nilsson who, besides analysis, also contributed valuable comments during work on this article. Others who have provided valuable input are Carl-Johan Belfrage, Claes Berg, Gabriela Guibourg, Christina Nyman, Ulf Söderström and Anders Vredin. Any errors are naturally our own responsibility. The opinions expressed in this article are the sole responsibility of the authors and should not be interpreted as reflecting the views of Sveriges Riksbank.

happens, and how much the economy is affected, the effect on inflation can also be relatively protracted. While the Riksbank indeed adapts monetary policy so that inflation will return to 2 per cent over time, monetary policy is not so precise that it can ensure that the inflation target will always be met.

The period from 2011 and onwards is however remarkable in many ways. To start with, it is quite simply unusual that inflation is so low for so long. It has systematically turned out lower than the expectations of practically all forecasters, including the Riksbank. Compared with previous years when inflation has been low, the past few years have also been distinctive because the dip in inflation has coincided with long-term inflation expectations trending down to a level below the inflation target. In order to break the trend and buoy inflation, the Riksbank has cut the policy rate to a negative level and has further acted to make policy even more expansionary, for instance by purchasing government bonds.

The reasons for the unexpectedly low inflation have of course been a core issue for the Riksbank in the past few years. A substantial part of the internal analytical work has been dedicated to understanding the drivers behind the developments and why forecasts have overestimated inflation outcomes. Conclusions from that work have previously been presented in, for instance, articles in Monetary Policy Reports, in Economic Commentaries and in the annual Account of Monetary Policy.[1] The purpose of this article is to summarise and update that analysis, and also to present a number of new findings.

We wish to point out that this does not mean that the final word has necessarily been said on the causes of the low inflation of the past few years. To start with, inflation is still low. While it is indeed increasing, there is still great uncertainty about its future development. Also, analytical work is still in progress regarding various aspects of the course of inflation in the past few years. There will thus probably be reason to return to this question in the future. When it comes to monetary policy, we wish to make clear from the beginning that the analysis in this article consists of a comparison of actual monetary policy with that which a simple interest rate rule would have implied in the past five years. Based on that analysis it is not possible to take a stand on whether monetary policy has been well-balanced or not.

The article consists of three core sections. In the first section we describe inflation developments in Sweden since the financial crisis from different perspectives, including an international comparison. In the two subsequent sections, we study potential explanatory factors underlying the developments. There are a number of ways to approach such an analysis. In the second core section, we basically focus on one potential factor at a time, and attempt to explain the way in which and the extent to which it has affected inflation. The statistical analysis consists mainly of simple correlations. The advantage of this approach is that the presentation is relatively simple and clear. The drawback is that it is difficult to grasp how important a certain factor has been to the low inflation compared with other factors. Moreover, correlations do not capture the complex causal links that may

1 See, for example, Apel et al. (2014), Löf (2015) and Sveriges Riksbank (2012, 2013, 2014a,b and 2015a,b).

exist at a macroeconomic level at which it is often difficult to determine underlying drivers and what caused what.

In the third and final core section of the article, we analyse inflation using a model that takes explicit account of the fact that there are interactions between different factors, and that they are determined simultaneously – a general equilibrium analysis, as it is commonly known. The drawback of this approach is that the analysis is technically complex and that the model, by necessity, gives a simplified picture of the complex links prevailing in the economy. The advantage is that this type of model can provide an indication of which factors in the economy have been of particular significance to the weak course of inflation compared to other factors.

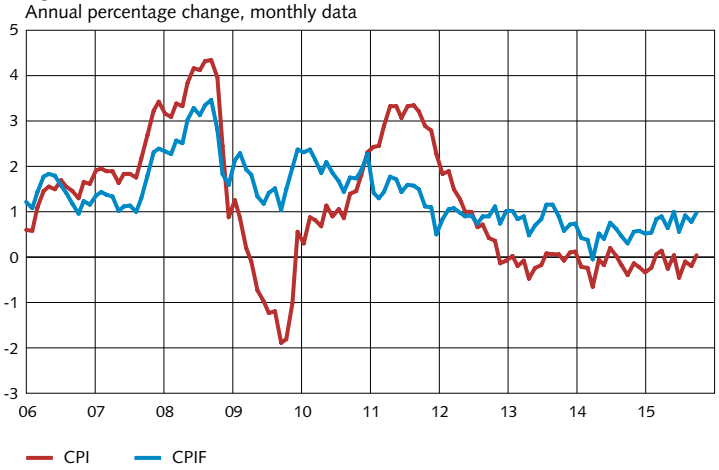
The conclusions of the analysis indicate that the weak economic activity internationally and, linked to that, subdued demand in Sweden, have been particularly important factors in explaining the low inflation of the past five years. The exchange rate has also played a part in pushing down inflation during this period. Furthermore, commodity prices, particularly for electricity and oil, have curbed inflationary pressure, partly due to a direct effect on consumer prices for electricity and oil-related products, and partly by means of an indirect effect through lower production costs for companies. In the past two years, we can also observe that companies appear to have squeezed their margins to a greater extent than might be expected from historical patterns. It is difficult, based on the ensuing analysis, to provide a precise reason for this, although according to the companies themselves it might be related to increased competition and uncertainty about future economic developments.

1. Inflation since the financial crisis

Inflation in Sweden started to drop in 2011 and, measured with CPIF, it has been at a low level ever since. In this chapter we study underlying inflation measures, various subindexes, and Swedish inflation in an international perspective in order to gain a better understanding of the developments of the past five years. The dip in the rate of price increases has generally been broad, even though the price developments in various subgroups of goods and services have affected inflation to a particularly high degree in certain years. Swedish inflation has also been low in an international comparison, particularly in 2011-2013.

In order to gain a better understanding of the causes of the low inflation in the past few years, it might be appropriate to start by taking a closer look at how CPI and its subindexes have developed. In Figure 1 we see, to start with, CPI inflation from the years immediately preceding the financial crisis, and thereafter. As mentioned in the introduction, CPI inflation was over 4 per cent in the summer of 2008. It subsequently dropped drastically and, after having fluctuated sharply, stabilised at around zero at the start of 2013.

Figure 1. CPI and CPIF
Annual percentage change, monthly data



Note. CPIF is the CPI with a fixed mortgage rate.
Source: Statistics Sweden

When studying inflation, it is important to remember the particular effect that changes to the interest rate have on the CPI measure. Changes to household mortgage rates have a direct effect on CPI via the component that measures households' interest expenses for owner-occupied housing. Therefore, when interest rates drop, for example, this will have the effect of pushing down CPI inflation.[2] From a monetary policy communication perspective, this poses quite some difficulty. For example, when the Riksbank cuts the repo rate in order to stimulate the economy and, in time, *increase* inflation, this actually has the direct effect of reducing interest expenses and hence CPI inflation *decreases*. The direct effect of monetary policy on CPI inflation thus heads in the "wrong" direction. This is particularly apparent in periods of major changes in monetary policy, such as in the financial crisis. Then, the Riksbank cut the repo rate by a total of 4.5 percentage points in 2008-2009 in order to underpin the economic recovery – a factor that led to a sharp drop in CPI inflation initially.

Because CPI inflation is affected by mortgage rates in this way, it does not provide a fair picture of inflationary pressure in periods when interest rates change a great deal, such as in the past few years. During such periods, inflation measured as the change in CPIF provides a better picture. The difference between CPI and CPIF is that in the calculation of CPIF, the mortgage rate is kept constant, that is, CPIF inflation does not include the direct effect of interest rate changes.[3] Figure 1 shows that, even excluding the interest rate effect, inflation dropped in connection with the financial crisis. However, the drop was not as drastic and towards the end of 2009 CPIF inflation was at a level of around 2 per cent. It remained

2 This effect on CPI inflation from interest expense is a peculiarity of the Swedish CPI measure. For further details about this and how interest expenses and CPI are measured, see Johansson (2015).
3 In the longer term, when the interest rate has stabilised, CPIF inflation will however coincide with CPI inflation. For further details see Hansson, Johansson and Palmqvist (2008).

there in 2010, but later dropped and stabilised at a level of around 1 per cent. CPIF inflation subsequently fell even further from mid-2013 until the spring of 2014. Since then the trend appears to have been broken and inflation has risen, albeit still being low.

BROAD DOWNTURN IN THE RATE OF PRICE INCREASES FOR GOODS AND SERVICES

A closer look at the developments shows that the low inflation is a result of a broad downturn in the rate of price increases for goods and services. That statement might perhaps seem a tad redundant. Inflation is, after all, the increase in the general price level. So, how can a drop in inflation be anything other than "broad"? The answer is that changes in prices for individual goods and services, particularly those with a high weight in the CPI basket, can temporarily impact and dominate the entire CPI aggregate. This can, at times, affect CPI inflation to a relatively high degree. Actually, we have already seen one example of this in the discussion about the impact of interest expenses on CPI inflation. As we shall see, prices for other groups of goods and services have also kept a lid on inflation to varying degrees in the past five years.

Underlying inflation has been low in the past few years

In order to get an idea of the more enduring trend, which is not affected by the "noise" induced by major price fluctuations for individual goods and services, the Riksbank follows various measures of what is known as underlying inflation. The measures differ slightly in nature and Figure 2 illustrates three of them.

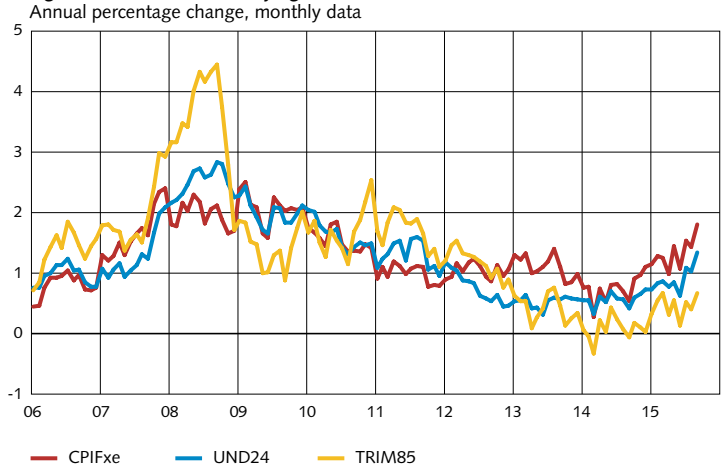
CPIFxe and TRIM85 are measures that strip away price changes that can temporarily affect the picture of the more enduring course of inflation. CPIFxe shows CPIF excluding energy prices, because electricity and oil prices have historically been a source of relatively large fluctuations in CPI(F) inflation. The TRIM85 measure excludes the 7.5 per cent of the prices that have increased the most and the 7.5 per cent of the prices that have increased the least. Then, a weighted mean of the remaining prices is calculated.[4] Finally, UND24 takes as a basis how much individual prices have varied compared to total CPI in the past two years. No prices are excluded; rather, the various prices are weighted together in such a way that greater weight is given to the prices that have remained stable. A change in the price of a product or service that previously has fluctuated a great deal therefore has less of an impact on UND24 than on CPI, in which the weight given to a certain price depends on how much households consume of the product or service.

As can be seen in Figure 2 the underlying inflation measures paint quite a consistent picture of developments since the financial crisis. In fact, inflation measured using CPIFxe and UND24 indicates that the downturn started already in 2010, which implies that energy prices pushed up CPIF inflation that year. In terms of CPIFxe inflation, it can also be noted that it was relatively stable at around 1 per cent from 2011 until the end of 2013

4 To be precise, the calculations are based on 70 CPI subgroups. The product groups that have had the highest and lowest price increases are excluded until 85 per cent of the weight total in the CPI basket remains.

when it dropped slightly. The other two measures of underlying inflation indicate more of a downward trend throughout the entire period until 2013-2014. The conclusion is thus that there has been an underlying, enduring slowdown in inflation in the past few years. This slowdown has not been mainly driven by individual products or services; rather, price increases have been smaller in general.[5]

Figure 2. Measures of underlying inflation
Annual percentage change, monthly data



Note. CPIFxe is CPI with a fixed mortgage rate and excluding energy prices. UND24 and TRIM85 are statistical measures of inflation that are based on CPI broken down into 70 price subgroups. UND24 is a measure in which prices are weighed together such that the weights reflect the historical standard deviation in the various prices. The TRIM85 excludes the 7.5 per cent of the prices that have increased the most and 7.5 per cent of the prices that have increased the least each year.
Sources: Statistics Sweden and the Riksbank

The contributions from different groups of prices have varied quite a lot over the period

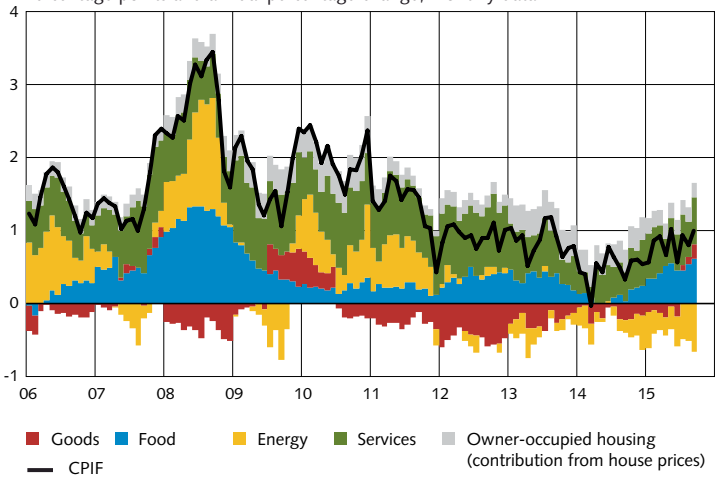
Although it can be said that the decline in the rate of price increases has been broad, the contributions to the low inflation from various groups of goods and services have varied quite a lot over the period. An analysis of various subindexes in CPI or CPIF might therefore be interesting and provide more details about the developments. Here, we have opted to take CPIF inflation as a starting point, since interest rates changed a lot in the period studied.

Exactly how the prices for individual goods and services are grouped into different subindexes can vary slightly depending on the purpose of the study, but a common breakdown is into interest expenses, energy, food, goods (excluding energy and food)

5 To a certain extent, reductions of indirect taxes have been a factor in pushing inflation down during the period. This applies mainly to the reduction in VAT on restaurant and catering services on 1 January 2012. According to calculations of the National Institute of Economic Research, it brought down CPI and CPIF inflation by just over 0.1 percentage point at the start of 2012, see *The Swedish Economy*, July 2012.

and services.[6] The breakdown into goods and services is natural, since these prices are affected differently by, among other things, competitive pressures, cost developments, and exchange rate fluctuations. There is also a point in separating energy and food prices from other goods prices since energy and food prices are highly affected by commodity prices on the global market. Note also that, here, the contribution from interest expenses only consists of the part that is due to changes in house prices, as the direct effects of mortgage rates changing over time do not affect CPIF inflation.

Figure 3. Contribution to CPIF
Percentage points and annual percentage change, monthly data



Note. The bars illustrate the contribution of each price group to the rate of change in CPIF in the past twelve months. The contributions can be interpreted as the annual rate of change in each group, multiplied by the group's weight in CPIF. In 2015 the weights are as follows, in per cent: services (45.0), goods excluding food and energy (24.2), food (17.6), energy (8.3) and owner-occupied housing (contribution from house prices) (4.8).
Sources: Statistics Sweden and own calculations

Figure 3 shows how the contributions from these subgroups to CPIF inflation have varied in the past few years. The contributions show, in simple terms, the annual rate of change in each group of prices multiplied by the group's weight in CPIF. Hence, the sum of the contributions of the different groups is equal to CPIF inflation, that is, the line in Figure 3 is equal to the sum of the bars in the figure. Bars above the zero line indicate a positive contribution to CPIF inflation, while bars beneath the zero line denote a negative contribution.

House prices have pushed up CPIF inflation

As can be seen in Figure 3, the rising prices of owner-occupied housing have contributed to increasing inflation in the period through the part of the interest expenses that is not due

6 This is the breakdown commonly used by the Riksbank. Statistics Sweden's breakdown of CPI into various main groups, available on its website, differs somewhat from this.

to interest rate changes (the grey bars).[7] Prices for owner-occupied housing have risen and households have therefore had to borrow greater amounts, which has led to an increase in interest expenses in CPIF.

Energy prices have made a negative contribution in the past few years

The contribution of energy prices (the yellow bars in Figure 3) has varied a great deal over the period. In 2010 and 2011 the contribution was positive. However, since the outset of 2012, the contribution from energy prices to CPIF inflation has been unusually low, and since 2013 it has, with the odd exception, been negative each month. In a historical perspective, it is unusual for the contribution of energy prices to be below zero several years in a row. An important factor underlying this development is that the spot price for electricity at the northern European trading facility Nord Pool has been at a low level for several years, and electricity prices have basically dropped year-on-year ever since the end of 2011. Adding to that is the fact that the price of crude oil has also been on a weak trend for a number of years, and furthermore dropped sharply in 2014, leading to the price of fuel in CPI declining almost each month on a year-on-year basis since 2013. Besides these direct effects on the prices for household electricity and fuel, the changes of the spot prices for electricity and oil also have indirect, or lagging, effects on the price of other goods and services. We discuss this further in section 2.

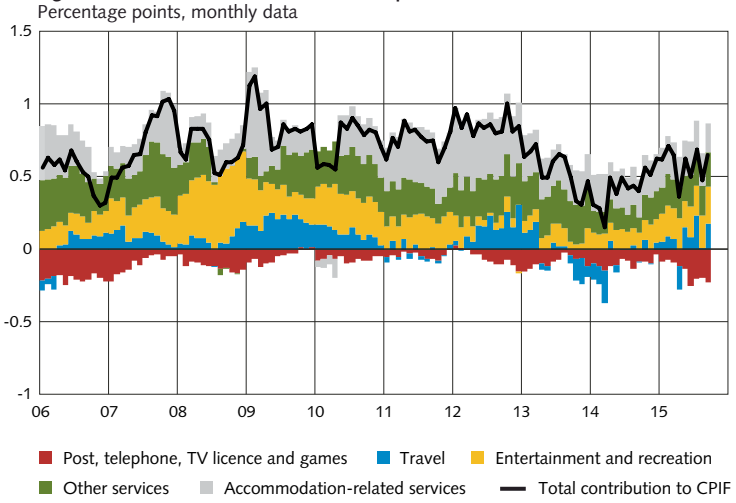
The contribution from prices for services dropped unexpectedly in 2013

Between 2008 and 2012 prices for services increased on average by just shy of 2 per cent annually, which translates to an average contribution to CPIF inflation (the green bars) of approximately 0.8 percentage points. However, as can be seen in Figure 3, the rate of increase of prices for services gradually declined in 2013, and at the outset of 2014 the contribution to CPIF inflation was just above the zero mark. It has subsequently risen again somewhat. Bearing in mind that the rate of increase in prices for services had been stable for a long time, the downturn in 2013 was unexpected. In Figure 4 we see the contribution from prices for services broken down into smaller groups. The figure shows that the downturn in 2013 mainly pertained to rents (included here in accommodation-related services) and travel (primarily air travel) for which the price increases in 2013 were lower than the year before. However, prices for other services also performed weakly in 2013-2014.[8]

7 The interest expenses included in CPI measures households' capital costs for living in an owner-occupied home and those costs are of course affected by changes to mortgage rates, but also by changes to the value of the properties financed by the mortgages. In the calculations of inflation measured with CPIF, mortgage rates are kept constant, but changes to house prices and thus the value of the properties have the same effect on CPIF as on CPI. For more information, see Johansson (2015).

8 For more information, see Nilsson (2014).

Figure 4. Contribution to CPIF from various prices for services
Percentage points, monthly data

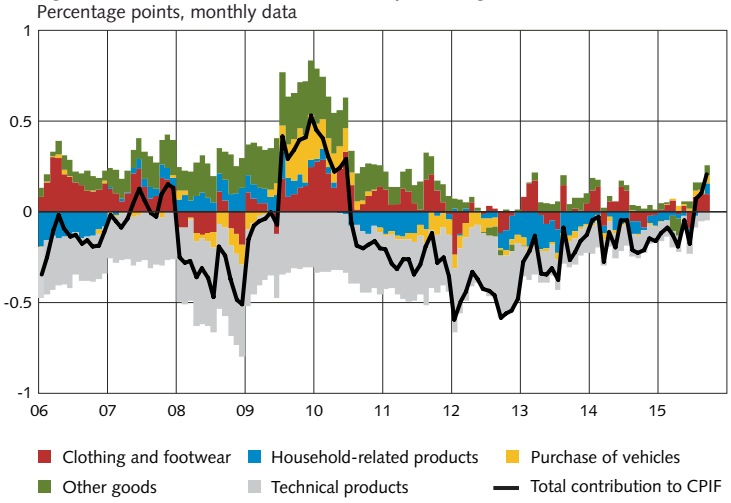


Note. The bars illustrate the contribution of each price group to the rate of change in CPIF in the past twelve months. The contributions can be interpreted as the annual rate of change in each group, multiplied by the group's weight in CPIF.
Sources: Statistics Sweden and own calculations

Goods prices have continued to decline

Goods prices (excluding energy and food) have, for a long time, made a negative contribution to CPIF inflation (the red bars in Figure 3), which reflects the fact that prices for goods have declined on average throughout the entire 2000s. Because a large proportion of the goods are imported, the Swedish krona and prices abroad are important factors for the development of goods prices. The period in 2009 and 2010 in which prices for goods actually helped push up CPI inflation coincided, for example, with a sharp weakening of the exchange rate, which thus led to more expensive imports expressed in Swedish kronor. As for the developments in various subgroups of goods, Figure 5 shows that practically all groups fared weakly after 2010, including household-related products and vehicles. The drop in the price of technical products, which had been occurring for a long time, continued to keep a lid on goods prices, but in the past two years prices for technical products have not contributed to curbing inflation by as much as they did before. The contribution from prices for clothing and footwear has on average been close to zero in the past few years. The contribution from other goods has also been low.

Figure 5. Contribution to CPIF from various prices for goods
Percentage points, monthly data



Note. The bars illustrate the contribution of each price group to the rate of change in CPIF in the past twelve months. The contributions can be interpreted as the annual rate of change in each group, multiplied by the group's weight in CPIF.
Sources: Statistics Sweden and own calculations

The contribution from food prices has been moderate

Food prices, finally, made a positive contribution to CPIF inflation over the studied period (the blue bars in Figure 3). The contribution was relatively stable at around 0.2-0.4 percentage points from mid-2009 until the end of 2013, when it dropped to zero for a couple of months. It subsequently rose relatively quickly again. The moderate development of food prices is slightly surprising considering that the price increases for commodities were relatively high from the end of 2010, pushing up price increases among producers. But this might have been counteracted by the appreciation of the Swedish krona until 2013 (see section 2).

SWEDISH INFLATION HAS ALSO BEEN LOW IN AN INTERNATIONAL COMPARISON

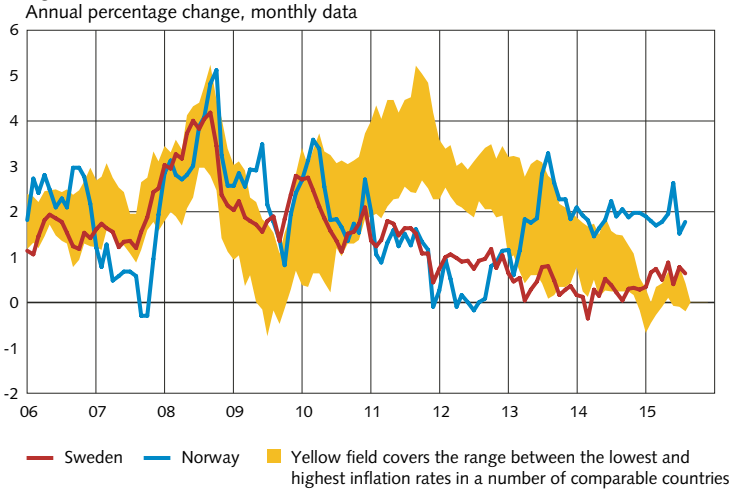
Sweden is a small, open economy and is greatly affected by events abroad. Considering that the factors that have affected Swedish inflation in the past five years have probably affected other countries too, it is interesting to look at how inflation has progressed in Sweden from an international perspective. In Figure 6 we see, to start with, inflation measured as the change in HICP in Sweden and a number of other European countries that are often used for comparisons with Swedish developments.[9] The figure contains two lines. One shows HICP

9 Unlike CPI, whose definition and calculation method may vary from country to country, HICP is a more harmonised index for consumer prices prepared by the EU to facilitate international comparisons. Inflation measured using CPI and HICP may therefore diverge somewhat. A clear difference where Sweden is concerned is that the items that measure the costs of owner-occupied housing are to the most extent not included in HICP. There are also other differences in terms of methodology in how Swedish CPI and HICP are calculated.

inflation in Sweden and the other in Norway. Other countries are included as a range that extends between the lowest and highest inflation rate in the other countries each month.

The figure clearly shows that the low inflation in the past two years is not a uniquely Swedish phenomenon; rather, inflation has been low in other countries too in 2014 and 2015. However, the development in Sweden stands out in prior years and it is clear that what has occurred in recent years is that inflation in other countries has dropped to the level at which inflation in Sweden has stayed for some time.

Figure 6. HICP inflation in different countries and in the euro area
Annual percentage change, monthly data



Note. The countries included in the comparison in the figure are Sweden, Norway, Denmark, Finland, the Netherlands, the UK and Germany. Developments in the euro area as a whole are also included in the comparison.
Sources: Eurostat and own calculations

It is interesting to compare developments in Sweden and Norway in this context. As can be seen in Figure 6, HICP inflation in Norway was similar to that in Sweden until 2013. Just like in Sweden, inflation fell from 2011 instead of rising like it did in other countries. As of 2013, it is however the Norwegian developments that differ from other countries because inflation then started to rise sharply in Norway. This comparison between Sweden, Norway and other countries illustrates, among other things, the significance of the exchange rate for the movements in inflation. After having weakened significantly in 2008-2009, the Swedish and Norwegian currencies were more or less on a strengthening trend until 2013, which coincided with the decline in inflation. The Norwegian krone subsequently started to weaken sharply once again, and inflation rose when imports became more expensive expressed in Norwegian kroner. The Swedish krona has also weakened in the past few years, but not to the same extent as the Norwegian krone. The significance of the exchange rate for inflation developments is further discussed in sections 2 and 3.[10]

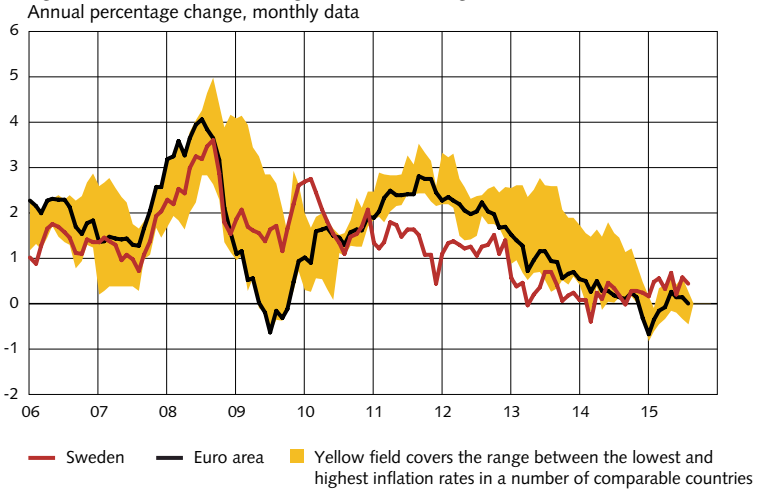
10 It is of course not only the exchange rate that explains the difference between developments in Sweden and Norway in recent years; other factors have also been of importance. See Sveriges Riksbank (2015c) for a more detailed comparison of Sweden and Norway in recent years.

Changes to indirect taxes explain part of the difference between Sweden and other countries

An important reason for the major difference between the developments of inflation in Sweden compared with other countries is the increases to indirect taxes implemented by many other European countries in order to bolster their public finances in the wake of the financial crisis. In countries such as Finland, the Netherlands and the UK, tax increases have been a factor in pushing up inflation by 0.5-0.6 percentage points. In Denmark, and particularly in Germany, this effect is however much smaller and in the euro area as a whole tax changes have on average contributed to raising HICP inflation by 0.2 percentage points.[11] In Sweden, tax cuts have, conversely, pushed inflation down somewhat (see footnote 5).

Figure 7 shows the same information as Figure 6, but with the effect of tax changes excluded (Norway is dropped due to data limitations). If tax changes are taken into account, the difference since 2011 is not entirely as drastic. However, even disregarding tax effects, inflation has clearly been much lower in Sweden in the past five-year period than in many other European countries, particularly in 2011-2013.

Figure 7. HICP inflation excluding effects of tax changes
Annual percentage change, monthly data



Note. The countries included in the comparison in the figure are Sweden, Denmark, Finland, the Netherlands, the UK and Germany. Developments in the euro area as a whole are also included in the comparison.
Sources: Eurostat and own calculations

11 The figures are based on a comparison of the average inflation in 2011-2015 measured with HICP and measured with HICP at constant tax rates.

In general, the contributions from different price groups have been low in Sweden compared to other countries

From Figure 8 we see how contributions from various price groups to HICP inflation have developed excluding effects of changed taxes. The price groups are basically the same as in the previous analysis of the contributions to CPIF inflation, that is, food, energy, goods (excluding energy and food) and services. Like in previous figures, the various ranges indicate the highest and lowest contributions each month among the other countries included in the comparison. Due to data limitations, Norway and the UK are excluded, however.

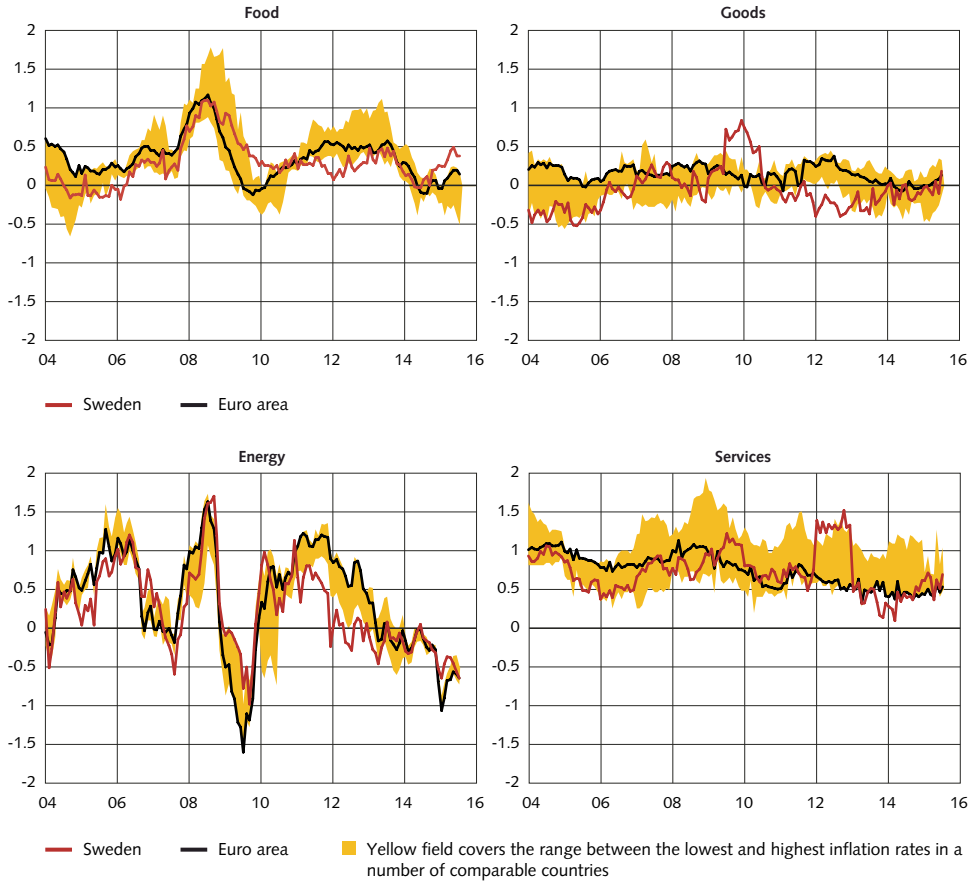
As illustrated by the different panels in Figure 8, the contributions from the various groups have generally been low in Sweden compared with other countries since 2011.[12] However, it is also clear that the price developments in different groups in Sweden have stood out more in certain years. For example, the contributions from food and goods were markedly lower in Sweden in 2011-2013, which is the opposite of the years before that, when contributions from these groups were, conversely, among the highest. It is also interesting to note that the contributions from food, and particularly goods, were comparatively low in Sweden before the crisis. However, the differences compared to other countries were lower and Sweden was not alone in having a negative contribution from goods prices for a relatively long period of time.

In terms of the contribution from energy prices too, developments in Sweden stand out primarily over the period 2011-2013. The downward trend that started in 2011 is also visible in other countries, but prices in Sweden were clearly at a lower level during that period. This differs from previous years when energy prices in Sweden, with the exception of 2005, were in line with other countries. In terms of the contribution from prices for services in Sweden, what is most striking is the drastic increase in 2012 – an effect of the reduction of VAT on restaurant and catering services that started to apply on 1 January that year.[13] Otherwise, the contribution from prices for services in Sweden has been one of the lowest in the past few years, and in 2013 and at the start of 2014, the level was considerably lower than in other countries.

12 A certain degree of caution should be exercised when interpreting the findings from this type of international comparison. To start with, they can be sensitive to which countries are included. Also, HICP statistics are not harmonised in every detail and there may be national differences in the calculations that can affect the results, particularly in the comparison of various subindexes.

13 It may perhaps seem odd that a *reduction* in restaurant VAT and hence restaurant prices leads to an *increase* in the contribution. Because the figure shows contributions excluding tax changes, a tax reduction will be "added back" onto the price, so the effect will be positive and the contribution from service prices thus increases. A partial reason for the effect in 2012 being so large is that in the calculations, a simplified assumption is made that tax changes alter prices immediately and fully.

Figure 8. Contribution to HICP inflation excluding effects of tax changes
Percentage points, monthly data

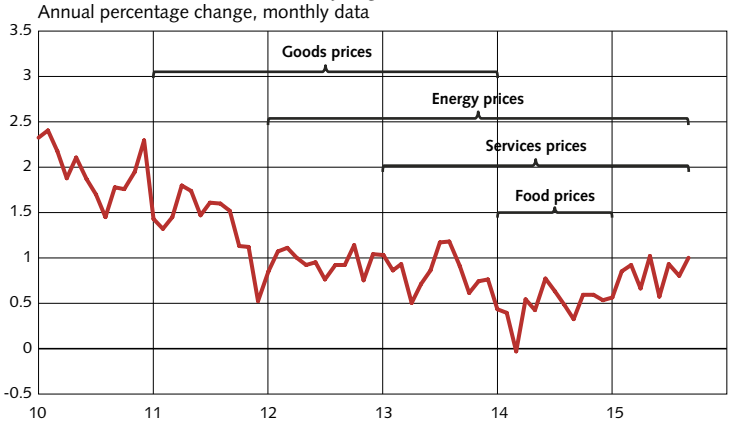


Note. The panels show the contribution of various price groups to the rate of increase in HICP excluding tax effects (HICPct) in Sweden and the euro area, and the highest and lowest contributions among a group of countries including Denmark, Finland (from 2006), the Netherlands and Germany. The euro area as a whole is also included in this group. The contributions can be interpreted as the annual rate of change in each group, multiplied by the group's weight in HICPct.
Sources: Eurostat and own calculations

SUMMARY

In this introductory section, we have described the developments of inflation in Sweden in the past five years from different perspectives. Excluding the effects of changes to interest rates, inflation has been low since 2010-2011. There has been a relatively broad decline in the rate of price increases, although prices in various groups of goods and services have affected CPIF comparatively more in some years, more or less in the way illustrated in Figure 9. The next step is to attempt to explain *why* inflation has taken this turn. Thus far, we have mentioned potential explanatory factors in passing. In the remaining sections, we go into more detail about them.

Figure 9. CPIF and periods in which the contributions from different price groups to the low inflation have been relatively large
Annual percentage change, monthly data



Sources: Statistics Sweden and own calculations

2. Reasons for the low inflation – a partial analysis

In this section we describe how a series of different explanatory factors have correlated with inflation. There are several potential driving forces which, at different points in time, might have caused the low inflation. Demand and resource utilisation have been low, which has affected companies' costs and margins. Energy prices have risen slowly or fallen since 2012, which has also contributed negatively to inflation. As a result of low commodity prices for food, consumer food prices rose very slowly in 2013 and 2014. A strengthening of the exchange rate also contributed to lower inflation, particularly in 2011-2013.

In this section we have chosen to focus on a number of explanatory factors that could be expected to be important, and attempt to describe how and to what extent these factors have affected inflation. Keeping the analysis focused on one or possibly a few factors at a time and looking at them in detail has the advantage of making it relatively simple and clear to explain. The drawback is that it is difficult to grasp how important a particular factor has been to explain the low inflation compared with other factors.

When discussing how individual factors relate to inflation, it is also important to remember that the underlying relationships may be complex – the fact that a certain factor clearly correlates with inflation does not necessarily mean that the factor has been driving inflation developments. Different factors influence each other and at a macroeconomic level it is simply difficult to establish what the underlying reason is and what has affected what.

Over the very long term, we can be relatively certain that inflation will be determined by monetary policy, that is, by the level of the inflation target in the case of Sweden.[14] But over

14 This is sometimes described as inflation being ultimately a "monetary phenomenon".

the short to medium term, the general price level – along with production, employment, unemployment and all other major macroeconomic variables – is determined by the interaction between households and companies, the central bank and government and their foreign equivalents. An overall analysis of the macroeconomy that attempts to capture the fact that all factors essentially affect each other and are determined simultaneously is usually described as a general equilibrium analysis. It is also important to gain this kind of perspective, and we therefore present the results of this type of analysis in section 3.

WHICH FACTORS SHOULD BE EXPECTED TO INFLUENCE INFLATION?

Although inflation developments are ultimately driven by complex interactions, there are a number of factors that can be expected to have a direct impact on price movements. Prices for individual goods and services are, after all, set by companies, so factors that affect companies' pricing will of course be an important factor. The price set by a firm can be broken down into two components: one component that reflects the cost of producing the product or service and a component that reflects the fact that, in addition to covering its production costs, the firm also wants a return on the capital that has been invested, that is, a price mark-up or margin.

The cost of producing a product or service will depend on the firm's costs for items such as wages, its premises and machinery.[15] In addition, there are also costs for the goods and services that the firm uses as inputs in its own production. Some of these input goods are imported, which means that prices on global markets also play a part. The exchange rate then also becomes an important factor as it affects the price in Swedish kronor that the company pays for the imported input goods. The margin, in turn, is influenced by factors such as competition in the business sector in which the firm operates.

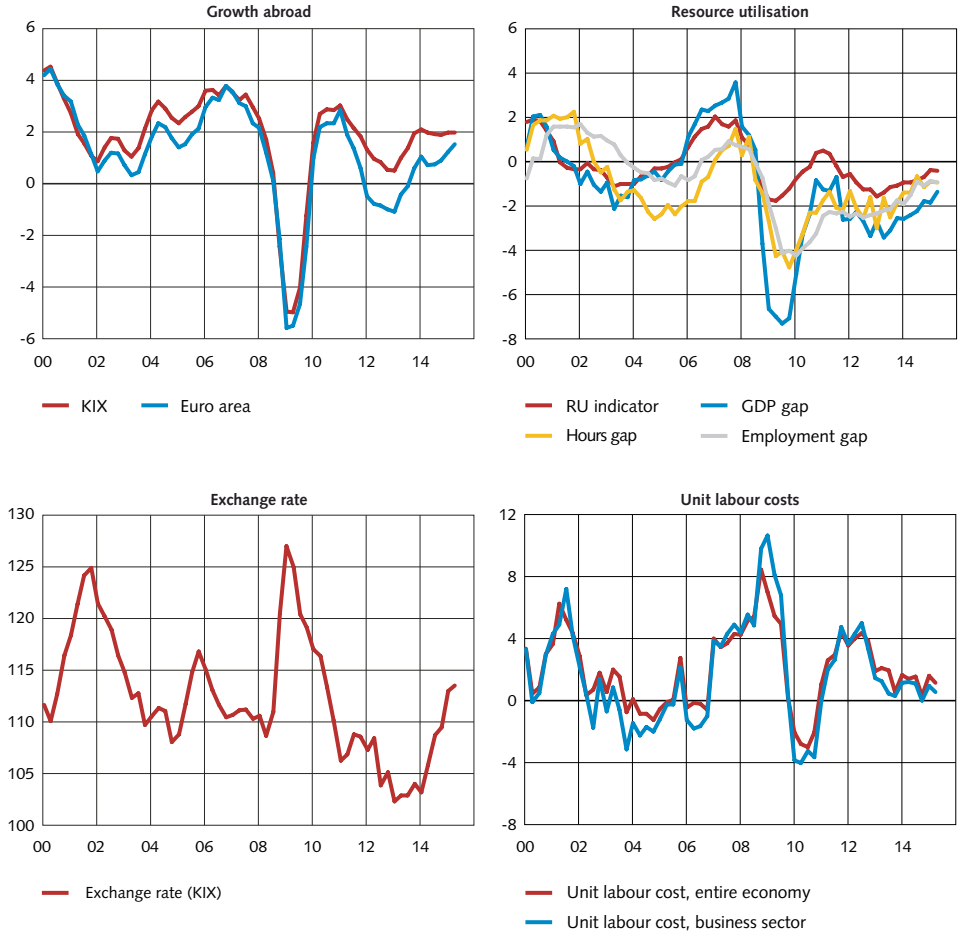
Furthermore, both the firm's costs and margins fluctuate depending on the demand in the economy, both within the country and abroad. For example, global economic conditions influence prices of commodities and other goods that are traded internationally.

Figure 10 below shows a number of factors that, at different points in time, have contributed to the low inflation. The upper-left panel illustrates foreign economic growth, while the upper-right shows various measures of resource utilisation in the Swedish economy.[16] These two figures thus reflect, to some extent, developments in demand abroad and in Sweden. The lower-left panel shows the nominal trade-weighted exchange rate, and the lower-right shows unit labour costs for the entire economy and in the business sector, which are common measures of the part of companies' production costs that are linked to the input of labour.

15 According to economic theory, it is more specifically the marginal cost of companies that is relevant to pricing, the cost of producing one additional unit of the product or service.

16 Here, we show a trade-weighted (KIX-weighted) measure of foreign economic growth. KIX refers to an aggregate of countries that are important for Sweden's international transactions. The euro area has the greatest weight, with 46 per cent.

Figure 10. Factors affecting inflation



Note. Growth abroad and unit labour costs are expressed as annual percentage changes. The GDP gap refers to the GDP devation from trend, calculated using a production function. The hours gap and the employment gap refer to the devation of the number of hours worked and the number of those employed from the Riksbank's assessed trends. The RU indicator can be interpreted as a deviation in per cent from the mean, see p.23. The trade-weighted exchange rate is shown as an index.
Sources: Macrobond, Statistics Sweden and own calculations

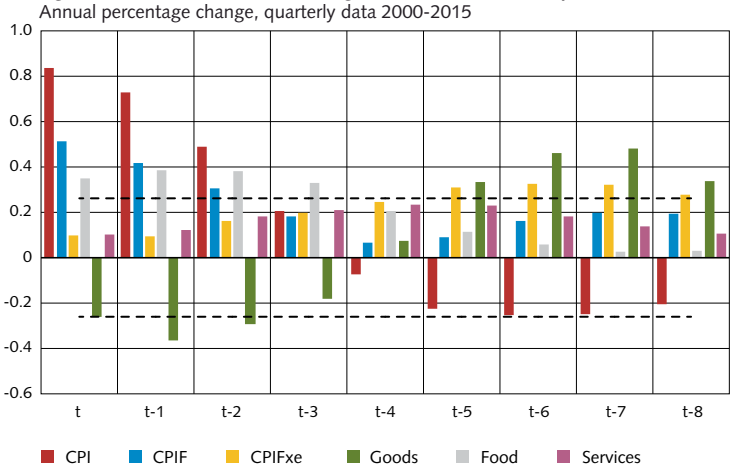
THE INTERNATIONAL ECONOMIC DOWNTURN HAS HELD BACK PRICE INCREASES IN SWEDEN

As already noted, Sweden is a small export-dependent country that is significantly affected by what happens in the rest of the world. This is also reflected in that the correlation between Swedish and foreign GDP growth is over 0.9 for the period 2000-2015. It is therefore quite evident that the weak growth internationally and particularly in the euro zone since the financial crisis has contributed to low inflation in Sweden (see Figure 10). Low demand for Sweden's export products and low price pressure on commodities and imported input goods have also affected domestic price pressure. The same factors have had a negative impact on inflation around the world.

An interesting question is the extent to which inflation in Sweden correlates with inflation abroad, and also on which horizon the correlation is highest. Swedish inflation is likely to be affected by inflation impulses from abroad with a certain lag.

Figure 11 shows correlations between foreign inflation and a number of Swedish CPI subaggregates for the period 2000-2015.[17] The bars to the far left in the figure show the degree of contemporaneous correlation, that is, when Swedish consumer prices in a certain quarter, t, are matched with foreign inflation in the same quarter, t. The bars to the right of them show the co-variation when Swedish consumer prices in quarter t are instead matched with foreign inflation in the previous quarter, t-1, with foreign inflation two quarters ago, t-2, and so on. If the correlation is highest in for example t-4, this means that the co-variation between Swedish consumer prices and foreign inflation is at its highest if foreign inflation lags four quarters. The dotted horizontal line indicates whether the correlation is statistically significant at the 5 per cent level. The positive correlation between CPI in Sweden and foreign inflation (the red bars) is clearest. The relationship is strongest if one compares CPI inflation for a particular quarter with foreign inflation for the same quarter. The contemporaneous correlation between CPIF inflation and foreign inflation is also clear. The fact that the co-variation is highest between these measures and foreign inflation is largely due to the clear link between energy prices in Sweden and the rest of the world.[18] When energy prices are excluded, as in CPIF excluding energy (yellow bars), the contemporaneous correlation between Swedish and foreign inflation disappears and is instead at its strongest six quarters earlier. We also see that this is mainly explained by goods prices (green bars).

Figure 11. Correlations between foreign and Swedish consumer prices
Annual percentage change, quarterly data 2000-2015



Note. Foreign (KIX-weighted) inflation has been lagged 1 to 8 quarters. The dotted black lines in the figure indicate statistical significance at the 5 per cent level.
Sources: Macrobond, Statistics Sweden and own calculations

17 Here, we use a KIX-weighted measure of international inflation.
18 The fact that the contemporaneous correlation is strongest between CPI and international inflation is explained by a clear co-variation between interest expense in CPI and international inflation.

WEAK RESOURCE UTILISATION INDICATES THAT INFLATIONARY PRESSURE HAS BEEN LOW

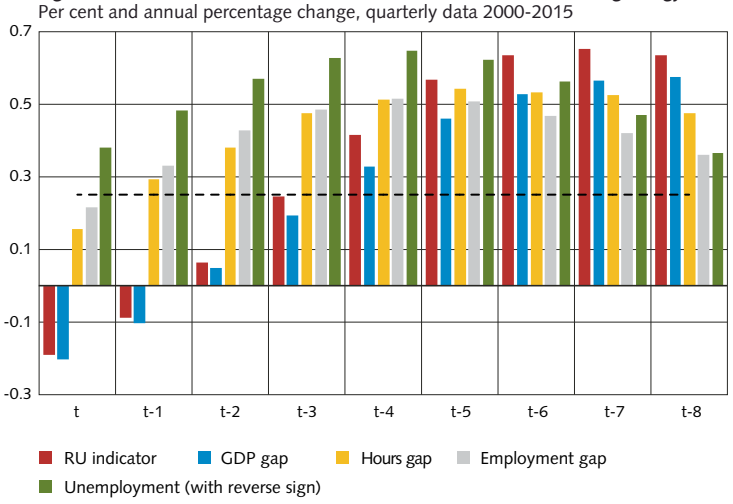
Different measures of resource utilisation are often used to provide an overall view of real economic activity. Resource utilisation is used to try to measure the extent to which the economy's productive resources, that is, labour force and capital, are being used in relation to what is sustainable in the long term. Resource utilisation is of great significance to monetary policy. First, resource utilisation is linked to important economic policy targets such as high GDP growth, high employment and low unemployment. Second, resource utilisation is also a commonly used indicator for how high underlying inflationary pressure is and how high it will be in the future. In somewhat simplified terms, one could say that it reflects economic conditions. One problem is that it is not possible to directly observe actual resource utilisation, unlike other factors such as the unemployment rate. Neither does economic theory offer any obvious definition of resource utilisation. A number of indicators of resource utilisation are therefore usually used to obtain a clearer picture of it. Another difficulty is that the relationship between resource utilisation and inflation is not stable over time. There may be deviations from the average correlation depending on what type of shock the economy is experiencing, and the different indicators of resource utilisation do not always provide a consistent picture as they show different strengths of co-variation with inflation.

GDP in Sweden and many other countries fell rapidly in the 2008-2009 crisis and, based on a number of different indicators, resource utilisation is still lower than normal. This extended period of weak global demand may therefore be viewed as an overarching reason why inflation has been low for a long time, as this has resulted in low domestic resource utilisation (see Figure 10).

Figure 12 shows the correlations between different measures of resource utilisation and the annual percentage change in CPIF, excluding energy for the period 2000-2015. Just as in the previous analysis of inflation abroad, we calculate correlations between Swedish inflation in quarter t and resource utilisation lagged up to eight quarters, that is, t-8. The contemporaneous correlation between inflation and unemployment is statistically significantly different from zero on a quarterly basis, but the relationship is stronger if one compares inflation as it was for a particular quarter with unemployment a few quarters earlier. Compared with unemployment, the hours gap and the employment gap, the GDP gap and the Riksbank's RU indicator seem to be early indicators of inflationary pressure.[19] We get the highest correlation with inflation if we lag these measures seven to eight months. In other words, it seems that for example slowdowns in real economic activity appear to be associated with downturns in inflation around two years later.

19 The RU indicator summarises the information in survey data and labour market data using principal component analysis. In principal component analysis, latent variables (principal components) are used, which explain as much as possible of the total variation of the original variables. The first principal component captures the greatest share of the variation in the dataset, while the second principal component, which is independent of the first, explains the second-largest share of the variation, and so on. The indicator has the advantage of being revised very little when new information arrives, and that it can be updated relatively quickly.

Figure 12. Correlations between resource utilisation and CPIF excluding energy
Per cent and annual percentage change, quarterly data 2000-2015



Note. The different measures of resource utilisation have been lagged 1 to 8 quarters. The dotted black line in the figure indicates statistical significance at the 5 per cent level.
Sources: Statistics Sweden and own calculations

THE TREND IN ENERGY PRICES HAS CONTRIBUTED TO LOWER INFLATION

On average, the market price of electricity was lower between 2012 and 2015 than between 2008 and 2011. There a lots of reasons for the lower electricity price, such as increased subsidies for renewable energy in Europe and the growing use of shale oil in the US. This has led to demand for coal decreasing, which in turn has resulted in the price of emission rights falling and the price of electricity being pushed down. Another reason is the weaker economy globally and in Sweden. This has had a direct effect on the price via lower demand for electricity. In Sweden, electricity prices also fell to a particularly large extent in the spring and summer of 2015. But the trend has been mainly driven by supply-side factors, such as heavy rainfall and high water storage reservoir levels.

From 2011 through the first six months of 2014, the global price of oil was relatively stable, despite the weak global economy. With the exception of a few months, Brent Crude oil continually traded within a narrow price band of between USD 100 and USD 120 per barrel. This price stability was broken in the second half of 2014 when the oil price collapsed. At the start of 2014, the price of oil was around USD 110 per barrel, but then sank to around USD 50 per barrel in early 2015. However, the decrease has not been as severe measured in Swedish kronor because the US dollar has strengthened over this period. Expressed in Swedish kronor, the oil price has fallen by around 30 per cent.

Factors on both the demand and the supply side have contributed to the fall in oil prices. Production of North American shale oil has increased sharply in recent years, and Russia, Iraq and Libya have increased their oil production. Moreover, OPEC has not cut its oil production, as it has done when prices have dropped in the past, in order to buoy prices

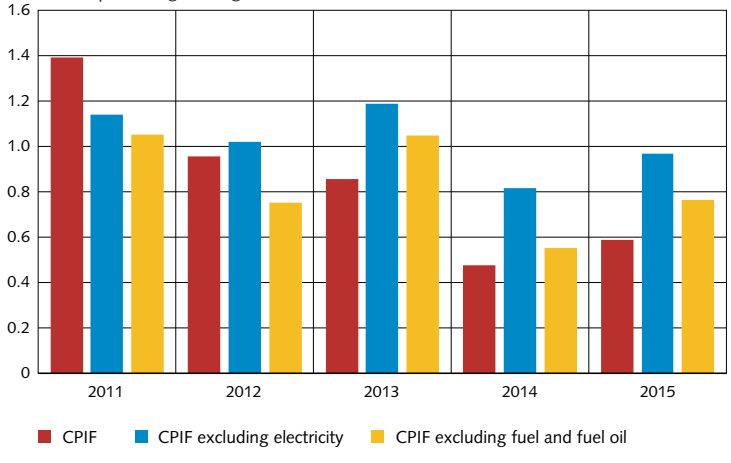
and has instead increased production. Another reason for the fall in prices is that demand for oil has been suppressed by lower expectations regarding global GDP growth.

Both direct and indirect effects of changed energy prices may have affected inflation

A change in energy prices affects inflation in different ways, both directly and indirectly. By direct effects we mean movements in consumer prices for electricity and oil-related products. An example of a direct effect is that the prices of fuel in the consumer price index tend to decline when the oil price drops. The direct effect of lower oil prices is relatively simple to estimate. The direct effect of an altered market price of electricity is often more difficult to forecast, because the link to consumer prices for electricity is not as straight.[20] The measured direct effect from energy prices is shown in Figure 3 in section 1. It can be noted that the contribution of energy prices to inflation has mostly been negative since 2013.

Figure 13 below shows the extent to which CPIF has been affected directly by changes in electricity and oil prices. The red bars show the annual percentage change in CPIF since 2011. The blue bars show developments in CPIF if consumer prices for electricity are excluded, while the yellow bars show the change to CPIF if prices for oil-related products such as fuel and fuel oil are excluded. When the blue or the yellow bar is higher than the red one, electricity and oil-related prices, respectively, contribute to pushing inflation down. As seen in the figure, electricity prices have been a reason for lower inflation since 2012, and oil-related prices since 2013. However, the effect from electricity prices has been greater in the past three-year period.[21]

Figure 13. CPIF excluding energy prices[22]
Annual percentage change, annual data, 2011-2015



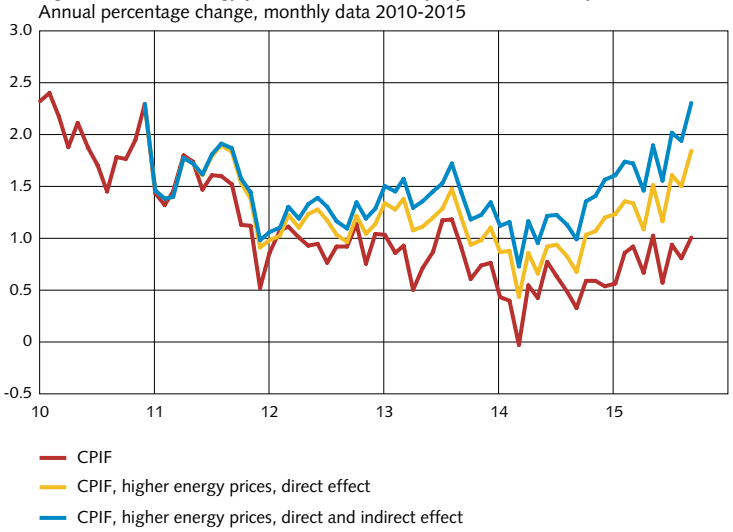
Sources: Statistics Sweden and own calculations

20 The electricity price index in CPI consists of grid fees, continuous prices and contracts with a fixed electricity price for one or several years, which makes the link to the market price of electricity less obvious than to the market price of oil.
21 The figures for 2015 are based on an average until the end of August.
22 In the measure that excludes fuel and oil, prices for district heating and pellets are also excluded.

Changes to energy prices also have indirect effects on the inflation rate in that they affect companies' costs. The indirect effect is much more difficult to estimate than the direct effect because it depends on, for instance, company behaviour. One example is lower fuel costs, which lead to less expensive transport and hence to lower costs for all goods. Declining energy prices can also affect inflation expectations, which can in turn affect inflation through, for example, lower wage demands.

The Riksbank has, on various occasions, attempted to estimate the extent of the indirect effects of changed energy prices using econometric analytical tools. Based on such estimations, Figure 14 shows the development of CPIF inflation if energy prices had risen by 2 per cent on an annual basis on average since 2011, instead of dropping by close to 2 per cent. The total effect is broken down into direct and indirect effects of higher energy prices. The outcomes are highly uncertain but the calculation nevertheless suggests that energy prices and their indirect effects play an important part in explaining the low inflation, since it is shown that inflation would have been between 0.3 and 0.4 percentage points higher on average in 2014 and 2015 if energy prices had risen by 2 per cent annually in the past five years.

Figure 14. CPIF if energy prices had increased by 2 per cent annually
Annual percentage change, monthly data 2010-2015

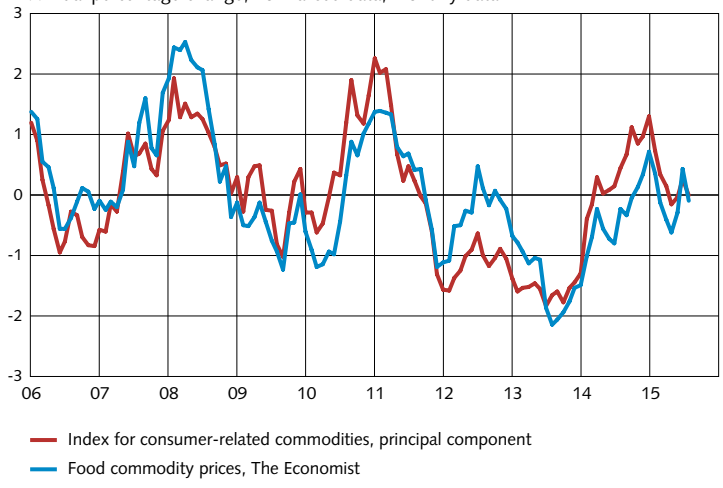


Note. In the above exercise, it is assumed that the energy component in CPIF has risen by a constant monthly percentage change as of January 2011 (see the yellow and blue lines), such that energy prices increase by 2 per cent annually over the period December 2011-September 2015.

LOW PRICE INCREASES FOR OTHER COMMODITIES IN RECENT YEARS

Figure 15 shows the annual percentage change in the Economist's commodity price index for food (the blue line) and a summary index for the development of 29 different commodity prices, mainly in the food category (the red line).[23] Both series show more or less the same progression. The rate of price increase for food commodities was low in 2012 and 2013. Prices subsequently increased, expressed in kronor, in 2014.

Figure 15. Commodity prices, mainly for food, expressed in SEK
Annual percentage change, normalised data, monthly data

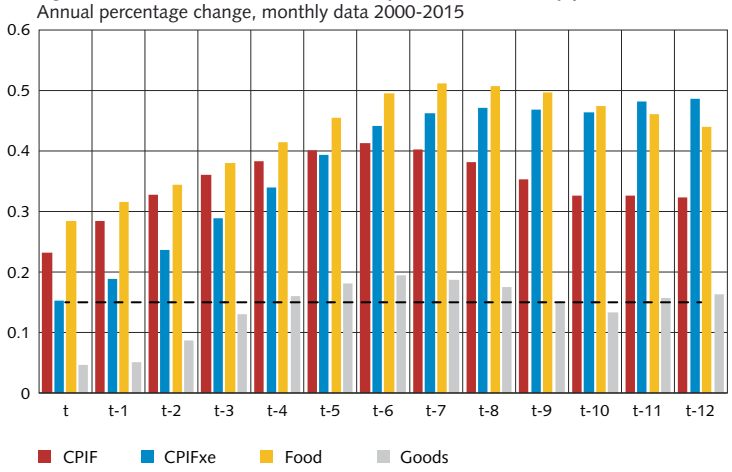


Note. The summary index is calculated based on annual percentage changes. Both series are normalised so that the mean is 0 and the standard deviation is 1.
Sources: Macrobond and own calculations

Figure 16 shows correlations between the summary index and a number of CPI subaggregates for the period 2000-2015. As expected, the correlation is highest between the commodity prices and food prices (the yellow bars). The link is strongest when comparing consumer food prices in a certain month with the commodity price index around seven months earlier. The correlation between CPIF and the commodity index is also statistically significant, as is the correlation between CPIF excluding energy and the summary index. The low commodity prices in 2012-2013 might thus have contributed to curbing consumer food prices in 2013-2014, which also curbed CPIF inflation.

23 In order to calculate the summary index, a principal component analysis has been used.

Figure 16. Correlations between consumer prices and commodity prices
Annual percentage change, monthly data 2000-2015



Note. The commodity price index has been lagged 1 to 12 months. The dotted black line in the figure indicates statistical significance at the 5 per cent level.
Sources: Statistics Sweden, Macrobond and own calculations

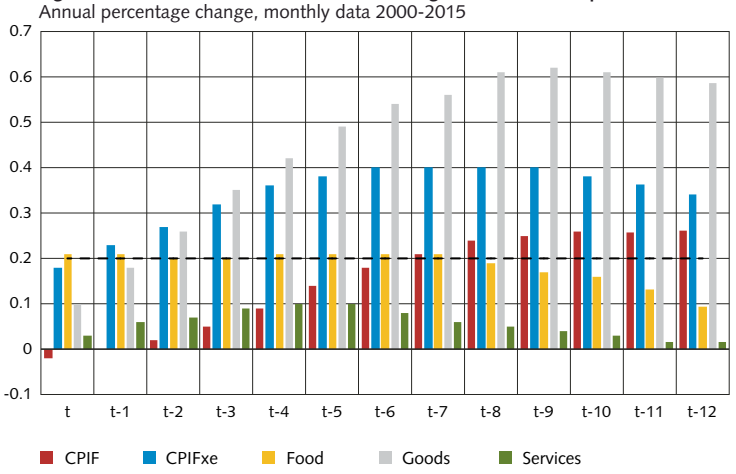
A STRENGTHENING OF THE EXCHANGE RATE KEPT A LID ON INFLATION IN 2011-2013

Another important explanatory factor for inflation developments is the exchange rate, which we touched on already in the first section. The exchange rate is affected by a number of factors, and not least by monetary policy. However, it is often difficult to identify which effect(s) explain most of the exchange rate fluctuations at a certain point in time. In a partial analysis such as this, it is therefore difficult to establish what drives developments and hence pinpoint the underlying factor behind the changes to the exchange rate.

Figure 17 below shows correlations between the trade-weighted exchange rate, KIX, and a number of price indexes for the period 2000-2015. It can be noted that annual price changes for goods are clearly tied to the exchange rate, and that the link is strongest when comparing the change in prices for goods in a certain month with exchange rate fluctuations nine months earlier. The correlation between exchange rate fluctuations and food prices is weaker and barely significantly different from zero, while the correlation with prices for services is never statistically significant.

The Swedish krona depreciated rapidly in 2009-2010, which contributed to a higher level of inflation. After that, a gradually stronger exchange rate probably restrained inflation, particularly in 2011-2013. Since 2014, the exchange rate has weakened again (see Figure 10).

Figure 17. Correlations between the SEK exchange rate and various price indexes
Annual percentage change, monthly data 2000-2015



Note. Nominal competitiveness-weighted exchange rate (KIX). The exchange rate has been lagged 1 to 12 months. The dotted black line in the figure indicates statistical significance at the 5 per cent level.
Sources: Statistics Sweden and own calculations

SUBDUED COST DEVELOPMENTS ARE ANOTHER PIECE OF THE PUZZLE

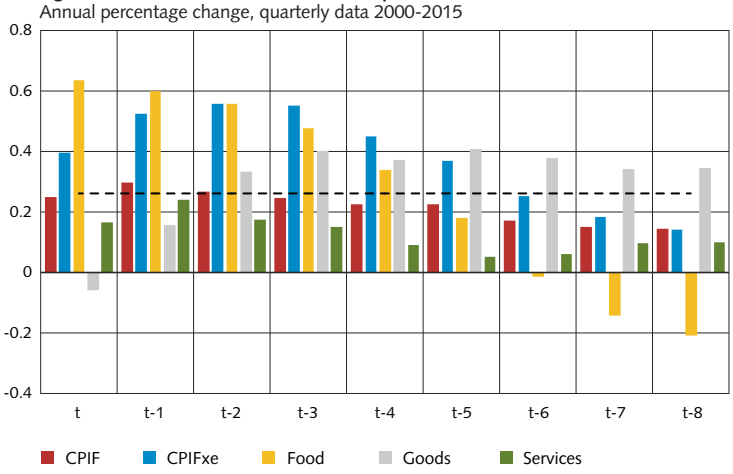
Companies' prices are highly dependent on their costs. At the aggregate level, inflation thus depends on production costs in the economy. A common measure of aggregate costs is unit labour costs. These are determined by both productivity and wages.

Figure 18 shows correlations between the annual percentage changes in unit labour costs and various consumer price indexes.[24] The high contemporaneous correlation between the cost measure and food prices is most evident (the yellow bars).[25] The link is also strong between goods prices met by consumers (the grey bars) in a certain quarter, and labour costs three to five quarters earlier.

After the trough in 2010, costs rose according to this measure for a few years, then fell back again in 2013 (see Figure 10). The average annual percentage change since the first quarter of 2013 is 1.4 per cent for the entire economy. The equivalent figure for unit labour costs in the business sector is 0.8 per cent. These figures are lower than the percentage average rate of increase over the period 2000-2012, which has probably restrained inflation. Interestingly, the figure also shows a strong relationship between unit labour costs and inflation measured with CPIF excluding energy, but not measured with CPIF. Energy prices thus appear to have a pattern that counteracts the positive correlation between inflation and unit labour costs.

24 Here, unit labour costs are used for the entire economy.
25 If the period is extended back in time to 1995, the positive correlation between costs and consumer food prices becomes much weaker.

Figure 18. Correlations between consumer prices and unit labour costs
Annual percentage change, quarterly data 2000-2015



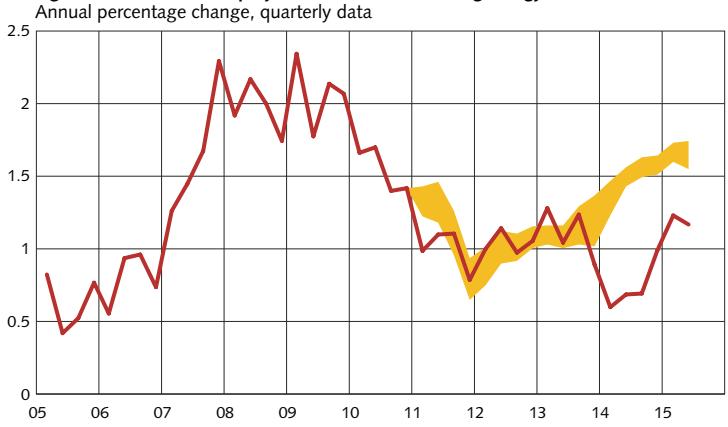
Note. Unit labour costs have been lagged 1 to 8 quarters. The dotted black line in the figure indicates significance at the 5 per cent level.
Sources: Statistics Sweden, Macrobond and own calculations

HISTORICAL PATTERNS DO NOT APPEAR TO FULLY EXPLAIN DEVELOPMENTS

One way of studying more formally whether the inflation developments can be explained by the factors at which we have looked more closely in this section is to estimate an econometric model. This way, we study how large a proportion of the historical inflation variations can be explained using exchange rate fluctuations, unit labour costs, resource utilisation and commodity prices. The inflation measure and the explanatory variables are in this exercise expressed as quarterly percentage changes.[26] Figure 19 shows outcomes and projections for CPIF excluding energy, that is, what inflation according to this measure would have been had it progressed according to the model. Here, quarterly data from 1995 to 2015 is used, and five models are estimated. All specifications include the exchange rate and unit labour costs as explanatory variables. One of these five models only includes these two variables. The other models have one more explanatory variable – unemployment, unemployment gap, employment gap and commodity prices for food, respectively. The models are estimated using data through the fourth quarter of 2010. After that, data for the explanatory variables is used to project inflation through the end of the second quarter of 2015. The projections thus show what inflation would have been if it had followed the historical relationship with the exchange rate, unit labour costs and other variables. The yellow field in Figure 19 indicates the range between the highest and the lowest projection.

26 The exchange rate is the trade-weighted exchange rate, KIX, expressed as four periods' moving average of the quarterly percentage change. For unit labour costs, 12 quarters' moving average of the percentage change is used. For commodity prices, food prices according to The Economist are used.

Figure 19. Outcome and projections for CPIF excluding energy
Annual percentage change, quarterly data



Note. The yellow field refers to projections from the five different models
Sources: Statistics Sweden and own calculations

Developments through the end of the second half of 2013 appear to follow historical patterns relatively well, but in the subsequent period inflation was lower than what it should have been based solely on the historical average relationship.[27] The fact that the explanatory variables do not manage to capture developments since the autumn of 2013 suggests that it is other factors that have kept a lid on companies' price hikes in the past few years.

In order to gain a better understanding of companies' pricing recently, the Riksbank commissioned the Swedish National Institute of Economic Research to conduct a specific survey in the spring and summer of 2014. Many of the companies responded that the price increase rate for their goods and services has been lower than normal recently. The results also showed that companies' margins have been lower than normal. One reason for this is that demand has been weak, and its future development has been uncertain. However, the companies also stated that competition has increased a great deal in recent years, which might be due to the weak demand, but could also indicate that the explanations for the low margins might to some extent be structural. In the climate of weak demand, it thus appears that companies, to a lesser degree than usual, have been able to transfer their cost increases onto customers by increasing their prices and their margins have thus contracted.

In connection with conducting the survey, the Riksbank's own business survey was also extended with more companies in the trade and service industries. Moreover, the questions focused to a greater extent on the companies' prices, costs and margins. That survey showed that cost increases had been lower than normal, which was in turn due to purchasing costs and wages being low. However, this applied mainly to the largest

27 A similar exercise has been performed using an error-correction model, which is used, for example in the Riksbank's forecasting process. In that equation, the quarterly percentage change in CPIF is explained by the unemployment gap and energy prices as explanatory variables in the short-term dynamics. In the long-term dynamics, producer import prices and unit labour costs are included together with CPIF. In this case too, the model has difficulties capturing the low inflation figures in 2013 and 2014.

companies in Sweden, and to a lesser extent to smaller ones. On the whole, the results of the surveys suggest that many companies have been forced to accept a lower margin when demand has been weak and competition fierce.

E-COMMERCE AND INCREASED COMPETITION

One reason for the increased competition that companies state they experience could be growing e-commerce, which has increased its share of the total turnover of retail trade from 1.2 per cent in 2013 to 6.2 per cent in 2014. In many cases, companies are thus now competing not only with other companies in their geographic proximity, but also with companies elsewhere in the world through e-commerce. Compared with regular distribution channels, online stores ought to provide scope for cost cutting, which in turn might increase competition.

New online services have also furthered the possibility of consumers to compare the price and quality of a product. As consumers become more price- and quality-aware, companies might perceive that competition has increased, and that their market power has diminished. In turn, this leads to companies finding it more difficult to increase their prices, but it can also cause them to increase productivity in order to squeeze costs and increase margins that way instead.

However, it is difficult to establish a direct link between such changes, which are more long-term in nature, and the low inflation of very recent years. Increased competition can indeed lead to lower prices in a transitional period, which might be more or less protracted, but the inflation rate should not be affected in the longer term.

THE IMPORTANCE OF INFLATION EXPECTATIONS

A potentially important explanatory factor for the low inflation, perhaps mainly in the past two-year period, is the inflation expectations of households and firms. Short-term inflation expectations have gradually dropped since 2011. The more long-term expectations also show a declining trend, but not at all as steep.

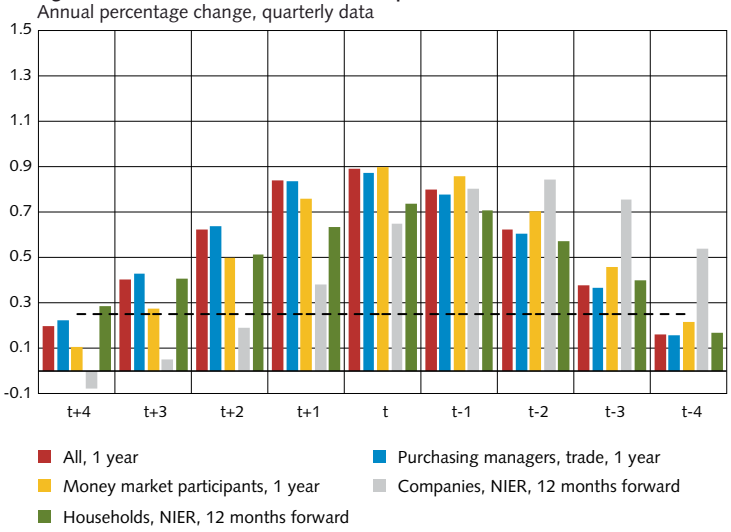
There is a clear link between actual inflation and short-term inflation expectations. In line with inflation falling in the past few years, inflation expectations have also come down. The drop in inflation expectations might have contributed to lower inflation. For example, it might be difficult for companies to hike prices if the general perception of households and other agents in the economy is that the price increase rate will be low ahead. Assessing the extent of the potential impact of lower inflation expectations on inflation is very difficult, however.

As shown in Figure 20, the co-variation is clear between the short-term inflation expectations and the actual inflation according to CPI in the period 2000-2015. With the exception of the inflation expectations of companies, the relationship is strongest when comparing the change to inflation in a certain quarter with expectations in the same quarter. The degree of co-variation then drops. In terms of companies' inflation

expectations (see grey bars), the link is instead strongest when comparing actual inflation in a certain quarter with expectations two quarters ago. The results thus imply that changes in companies' expectations precede changes to actual inflation.[28]

Unlike in previous figures with correlations, we also show in Figure 20 bars to the left of those that indicate contemporaneous correlation. They thus show how expectations in a certain quarter correlate with the measured inflation rate 1 to 4 quarters ago. Here too, the degree of co-variation is relatively high to start with but then gradually drops the further inflation is lagged. The correlations thus show that high inflation expectations in a certain quarter are followed by high inflation a quarter or so later, but also that high inflation in a certain quarter is followed by high expectations a quarter or so later. Hence, both variables tend to move in the same direction at the same time. The same pattern can be observed when studying more long-term inflation expectations.[29] This indicates that inflation expectations, according to all measures except companies' expectations, actually do not precede the movements in inflation. If the movements in inflation were clearly driven by expectations, we ought to observe stronger correlations to the right than to the left of the point in time t, which for most measures does not appear to be the case.

Figure 20. Correlations between inflation expectations and actual inflation (CPI)[30]
Annual percentage change, quarterly data



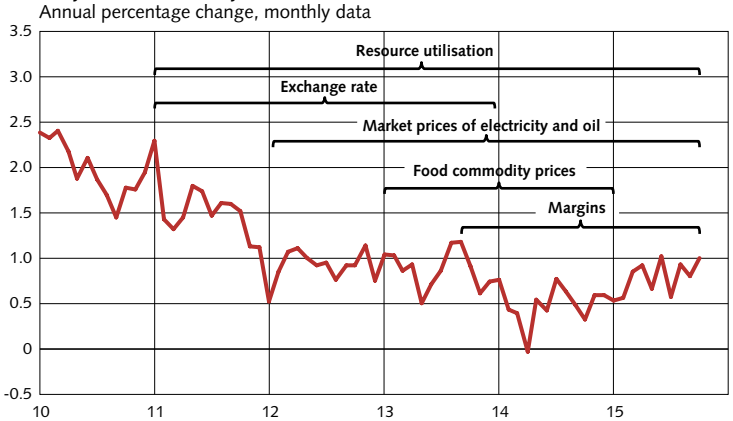
Note. The expectations are lagged 4 quarters back and led 4 quarters forward in time. The dotted black line in the figure indicates statistical significance at the 5 per cent level.
Sources: Statistics Sweden, the National Institute of Economic Research, Prospera and own calculations

28 A simple causality test gives the same conclusion. The test is used to study whether the direction of one variable tends to affect the direction of another variable, or vice versa.
29 This applies to inflation expectations with a two- and five-year horizon.
30 Inflation expectations are usually compared with the CPI inflation, since that is the inflation measure that many of the surveys explicitly take as their basis.

SUMMARY

The low level of inflation over the last few years appears to be due to a series of different factors which we summarise in Figure 21. Demand and resource utilisation have been low, both in Sweden and abroad, which has led to subdued growth in companies' costs and margins. Due to both supply and demand factors, energy prices have risen slowly or dropped since 2012, which has curbed inflation through both direct and indirect effects. The low electricity prices have had the greatest negative direct effect. On top of this, consumer food prices have also been weak, mainly in 2013 and 2014, due to low commodity prices. Finally, a strong exchange rate also contributed to lower inflation in 2011-2013.

Figure 21. CPIF and its most important explanatory factors according to partial analyses of the economy
Annual percentage change, monthly data



Sources: Statistics Sweden and own calculations

3. Reasons for the low inflation – a model explanation

In a general equilibrium model, the economy is driven by exogenous shocks to the model, that is, events both in Sweden and other countries that lead the path of the economy to diverge from historical economic relationships. One way of investigating why inflation has been so low is to study which such shocks, according to the model, have caused the recent course of inflation. Using this type of analysis, we can also compare the extent of the significance the shocks have had in relation to each other. The analysis indicates that it is foreign economic developments and subsequent contagion effects, combined with subdued demand in Sweden, that have had the overall greatest significance in explaining the low inflation since 2011. However, in the past one-and-a-half years, another explanation for the low inflation has gained increasing importance in the model, namely that price mark-ups, and hence the margins, of companies have contracted.

In previous sections, we have discussed the reasons for the development of inflation using partial analyses of the economy. In other words, we have studied how inflation might have been affected by a number of explanatory factors, but without taking account of all factors and their interactions at the same time. In this section, we look instead at the reasons underlying the development of inflation from a macroeconomic perspective, that is, in light of the course of the economy as a whole in the past few years, using the Riksbank's macroeconomic model, Ramses.

THE WORKINGS OF THE GENERAL EQUILIBRIUM MODEL

Ramses is what has been termed as a "dynamic stochastic general equilibrium model".[31] The model being a general equilibrium model means that it is intended to describe how the economy works as a whole – the links between different sectors in the economy are modelled under some specific assumptions about the behaviour of individuals and organisations. The model being dynamic enables us to study the course of the economy over time. The model being stochastic means that we take account of the fact that the economy is affected by random exogenous shocks, in other words events outside of the model that lead the course of the economy to deviate from the historical economic relationships.[32]

The exogenous shocks can reflect events that are uncommon on one hand, such as a decline in production because of an economic crisis. On the other hand, they can also capture more normal variations in, for example, preferences or technology. Such variations can be a case of technology having developed faster or slower than the historical average, making it less or more expensive to produce goods and services, or of household and companies becoming more or less optimistic about future economic developments. It can also be a matter of an increase in competition and a change in companies' pricing behaviour, or monetary policy being conducted in a way that deviates from its historical pattern. Shocks can come both from abroad and from the Swedish economy, as well as from exchange rate fluctuations. Studying the exogenous shocks thus tells us something about why the economy does not fare in line with historical patterns, but also how important each individual explanatory factor has been compared with others, as all the factors are studied within the same model.

All economic models are simplifications of reality. Even the most complex models can only take account of the factors that are considered to be of outmost importance to the questions under study. However, factors that do not fall within the scope of the model of course nevertheless affect the variables included in the model. An example of this is that inflation, which is an important variable in the model, is in practice affected by energy

31 For a more detailed description of the model, see Adolfson et al. (2013).

32 In this context, the historical economic relationships refer to the average patterns over the period covered by the data on which the model is estimated, in Ramses' case Q2 1995 through Q2 2014. We can then analyse also later (or earlier) data, assuming that the parameters governing the model relationships are constant. The assumption is not unreasonable, as most parameters in a DSGE model such as Ramses are intended to capture the underlying preferences and financial motives of the agents in the economy which change very slowly over time.

prices, which are in turn not modelled in Ramses. Because the model does not take explicit account of energy prices, it will instead perceive changes to them as an exogenous shock of some kind, depending on which effects the change to energy prices has on the economy as a whole.

Practically all variables in the model are affected by all the various shocks in the model.[33] Some shocks can be more closely attributed to movements in certain variables, but over time the movements of each variable tend to be explained by a series of different shocks combined. Each shock has a unique general effect on the economy in the model. The precise extent of the contribution of a certain shock is thus determined by how the variables have developed in relation to each other. In a very simple macroeconomic model, a shock that brings down inflation and simultaneously boosts production, for example, is commonly attributed to technological progress, since better technology enables producing more goods at a lower price. However, a shock that increases inflation while boosting production at the same time is instead attributed to increased demand. Production possibilities have not changed, so higher production than normal is due to demand having risen, and prices thus increase. In Ramses the principle is the same, although the variables and shocks are more numerous, and the relationships are therefore far more complex.

THE DEVIATION OF INFLATION FROM THE TARGET CAN BE BROKEN DOWN INTO EXOGENOUS SHOCKS TO THE MODEL

In a way similar to how we broke down inflation developments into contributions from the various subindexes above, we can explain inflation using the various shocks in the model. The number of shocks in the model is too great for all to be shown in one figure, so in order to facilitate the analysis, we present them in different groups. As with the subindexes in CPIF, the grouping can vary depending on what we are interested in studying. Here, we have chosen to form groups of shocks to domestic demand, domestic cost pressure, international factors and price mark-ups (the difference between the prices set by companies and their production costs for a certain product or service). We also look individually at the shocks to monetary policy and to the exchange rate.[34]

Monetary policy in the model is illustrated by a simple interest rate rule, where we assume that the monetary policy authority lets the repo rate respond to movements in inflation and resource utilisation in the Swedish economy.[35] The movements seen by the model on top of that, for example, a lower repo rate than would have been implied by the

33 The exception is international variables, which are not assumed to be affected by shocks to the Swedish economy. Sweden is a small, open economy which, albeit highly reliant on foreign trade, is assumed to be sufficiently small to not appreciably affect the course of the international economy as a whole. Even though individual countries are affected by the state of the Swedish economy, the assumption is reasonable for Sweden's international environment as a whole, and allows a considerable simplification of the model's structure.

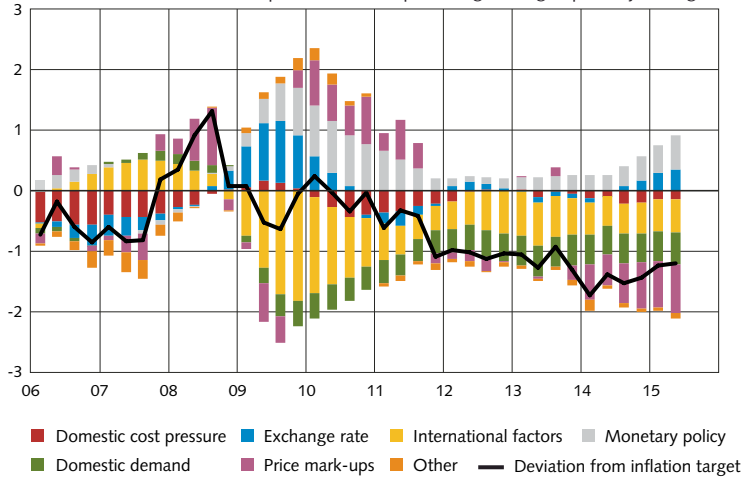
34 The group "Other" contains what the model interprets as measurement errors, that is, inflation movements which are difficult for the model to reconcile with the developments in other model variables. Such contributions are commonly small.

35 More specifically, we assume that the interest rate responds to the deviation of CPIF inflation from 2 per cent in the previous quarter, and the hours gap in the previous quarter. The policy rule of conduct also allows for interest-rate smoothing.

rule, are perceived as exogenous shocks to monetary policy. It is thus only in cases in which monetary policy has been unusually expansionary or contractionary that contributions from it will show up in the analysis. The same reasoning applies to exchange rate movements, which are, in the model, assumed to be determined by an interest rate parity condition. This condition implies, somewhat simplified, that the expected return on an investment in an interest-bearing asset in Sweden and abroad shall be the same after account has been taken of risks, and that this is ensured by the due adaptation of the exchange rate. Exchange rate movements are not in themselves uncommon. The movements often reflect developments in the domestic and foreign economies according to the economic relationships on which the model is based. However, in cases where exchange rate fluctuations deviate from these relationships, this is viewed by the model as the perceived uncertainty on foreign exchange markets having changed. Such deviations are usually called external risk premiums, and these are what we refer to when we speak of shocks to the exchange rate in the breakdown above.

Figure 22 shows how the six shock subgroups' contribution to CPIF inflation has varied in the past few years. The bars show, in simplified terms, the extent to which each shock group has caused inflation to deviate from 2 per cent. A positive bar means that the shock group has helped buoy inflation, while a negative bar means that the shock group has instead contributed to pushing inflation down below 2 per cent.

Figure 22. Contribution to CPIF from exogenous shocks
Deviation of outcome from 2 per cent, annual percentage change, quarterly average



Note. The bars illustrate the contribution of each shock group to the deviation from 2 per cent of CPIF in the past twelve months. The model relationships are estimated on quarterly data for CPIF inflation as well as fourteen other domestic variables and three foreign-economy variables.
Sources: Statistics Sweden and own calculations

FOREIGN ECONOMIC DEVELOPMENTS ARE AN IMPORTANT EXPLANATORY FACTOR

We can see that many of the shock groups have contributed to the developments of CPIF inflation. We can also observe from the figure that some of the patterns that emerge with the outbreak of the financial crisis at the end of 2008 and beginning of 2009 – particularly the factors that keep inflation down – still persist to some extent today.

The overall largest factor since the onset of the financial crisis appears to have been the foreign economic developments, as shown by the yellow bars in the figure. The financial crisis that commenced at the end of 2008 was an internationally triggered crisis from Sweden's point of view. It is thus not unexpected that international factors in the model have been a strong cause in keeping inflation down, particularly in 2009 and 2010. While the contribution from international factors indeed started to shrink after 2009 and was considerably smaller in 2011 in particular, it subsequently rose again in line with the slowdown in the economic recovery in Europe. Along with domestic demand, foreign economic developments are still one of the most important explanatory factors for the low inflation, more than six years after the outbreak of the financial crisis.

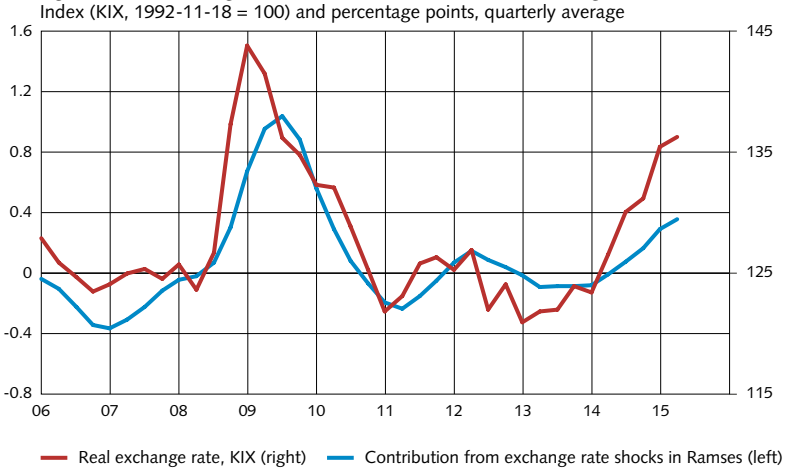
Even though the contributions from international factors were greatest during the early stages of the financial crisis, that was not when inflation in Sweden was at its lowest. According to the model, this is partially explained by the sharp weakening of the Swedish krona in the second half of 2008. The contributions from shocks to the exchange rate, shown as blue bars in Figure 22, play an important role in the developments of inflation from the final quarter of 2008 and about two years onwards. The fluctuations of the Swedish krona are thus not explained particularly well by the interest rate parity condition in this period. Rather, they are perceived by the model as changes in external risk premiums. The model view is thus consistent with the interpretation that investors have tended to prefer large and less volatile currencies in times of economic unease. Swedish assets have thus been perceived as riskier in times of economic crisis, as the market for the Swedish krona is relatively small.[36]

The Swedish krona then strengthened gradually over a long period of time towards levels that are more consistent with the interest parity condition, and so the positive contributions to inflation from the external risk premium shocks also diminished. When the Swedish krona was at its strongest in 2011 and 2013, we could even observe negative contributions to inflation from shocks to the exchange rate. This co-variation can clearly be seen in Figure 23, which shows how the contribution to CPIF inflation from risk premium

36 In 2008-2009, Swedish banks also had substantial exposure to the Baltics, which were associated with high risk. A deepened crisis in the Baltics, with higher credit losses for the Swedish banks, was seen as a risk to Swedish financial markets, which was a factor in the depreciation of the krona. Credit losses subsequently turned out lower than feared, since the recovery of the Baltics was stronger than expected. See, for example, Sveriges Riksbank (2008, 2010).

shocks has evolved in relation to the exchange rate.[37] Not until in the past year has the contribution from shocks to the exchange rate turned positive again. However, while the Swedish krona has indeed weakened relatively sharply since the beginning of 2014, this is only due to a certain extent to developments in external risk premiums. The exchange rate fluctuates, precisely as we have discussed above, also in accordance with the interest rate parity condition. Part of the weakening of the Swedish krona can thus be seen as rather normal given the macroeconomic developments in Sweden compared with those abroad, not least in terms of monetary policy.

Figure 23. Real exchange rate and contribution to CPIF from exchange rate shocks
Index (KIX, 1992-11-18 = 100) and percentage points, quarterly average



Note. The red line illustrates the real exchange rate. KIX refers to an aggregate of countries that are important for Sweden's international transactions. The blue line illustrates the shock group's contribution to CPIF inflation in the past twelve months.
Sources: The Riksbank and own calculations

RESTRAINING EFFECT ON INFLATION FROM DEMAND IN SWEDEN

Domestic demand, shown as green bars in Figure 22, emerges as a negative contributor more or less at the same time as the negative contributions from international factors. The negative green bars are due to consumption and, particularly, investment in Sweden having had a more restraining effect on inflation since the financial crisis than they have historically. In the group of factors that pertain to domestic demand, there are for example confidence factors, such as households' willingness to consume and companies' willingness to invest. The group also encompasses conditions on the Swedish financial market, which

37 The variable that the model takes into account is the real exchange rate gap, which is given by the deviation of the real exchange rate from its long-term level in per cent. Because the long-term level of the exchange rate fluctuates slowly and has changed relatively little during the period studied, the conclusions are more or less the same even if we look at the exchange rate in levels. Furthermore, the real and nominal exchange rates in the studied period have also displayed a high degree of co-variation, such that the same conclusions largely apply for the nominal exchange rate as well.

are reflected in the model by increased financing costs for companies and subdued investment growth ever since the financial crisis.

Weak demand abroad usually subdues demand in Sweden too. We also see from Figure 22 that the negative contributions from shocks to domestic demand, just as the contributions from international factors, never entirely disappeared, but still continue to weigh down inflation today. Part of the explanation for this lies in the fact that there are several different types of contagion effects from the international economy to Swedish markets. A small economy that is dependent on the rest of the world like Sweden is affected by foreign economic developments through more channels than those captured by the foreign-economy shocks in the model.[38] Contagion effects through the channels that are not explicitly modelled will not be perceived as contributions from the international factors by the model; instead they will be attributed to some of the domestic shocks. For example, the model will perceive weaker confidence from households and companies in the economy as a shock to domestic demand, even if it originates from a slowdown in foreign economic activity. The same applies if financing costs for companies deteriorate due to the developments in global financial markets. In light of this, it is not surprising that the shocks to domestic demand have weighed inflation down in the same period as foreign economic developments have been weak.

LOW COST PRESSURE CONTRIBUTES NEGATIVELY AT TIMES

Domestic cost pressure, shown as red bars in Figure 22, has also contributed negatively to the inflation developments at times. If we focus on the period during and after the financial crisis, it is primarily 2010 and 2011 in which shocks to cost pressure have been of significance to Swedish inflation. As of 2014, cost pressure has become unusually weak once more compared to its historical patterns, although the contributions are less pronounced now than they were in previous periods.

The domestic costs group comprises shocks to technological development in Sweden, as well as certain labour market factors. In the model, technology is assumed to constantly improve, both in Sweden and abroad, and this progression is captured as a part of foreign economic developments in our group breakdown insofar that developments in Sweden do not deviate from those of its trading partners. If, however, technological development in Sweden occurs faster or slower than in the rest of the world, this will demonstrate itself as shocks to the Sweden-specific technology and affect cost pressure in Sweden. The economy in Sweden recovered relatively quickly following the deep slump caused by the financial crisis, and in 2010 and 2011 economic growth in Sweden was higher than in its trade-weighted international environment. The model perceives this as technological development having been unusually good, and that Sweden could therefore produce

38 The foreign economic variables included in the model are GDP, inflation and the policy rate, all as aggregates of countries that are important to Sweden's international transactions. It is thus only shocks to these that are included in the yellow bars in Figure 22. The model will attribute other international effects to some of the domestic shocks.

goods and services at a lower cost than usual. Inflation was hence lower too. In addition, in that same period, and also in 2014 and 2015, the labour market situation had a partially restraining effect on inflation. The model perceives that shocks also occurred then to labour supply, which has kept a lid on company costs and ultimately also on inflation.

THE CONTRIBUTION FROM MONETARY POLICY

Ever since the financial crisis, monetary policy has been more expansionary than it would have been had it followed historical behaviour. This can be seen in that the grey bars in Figure 22 have, since 2009, constantly helped buoy inflation. The contributions are high in the initial period following the crisis, before declining from the end of 2011. As of mid-2014 and onwards, the positive contributions from monetary policy shocks increase again. At the same time, inflation turns upwards, after having troughed in the first quarter of 2014.[39]

As discussed above, monetary policy in the model is determined by an interest rate rule based on developments in inflation and resource utilisation. The extent to which monetary policy reacts to changes to inflation and resource utilisation reflects how the Riksbank has actually acted in the past. However, the rule is merely an approximation and does not provide a precise representation of how monetary policy is conducted. The deviations we observe between the actual interest-rate decisions and the interest rate that would have applied had the Riksbank followed the model's interest rate rule exactly is interpreted by the model as a measure of monetary policy shocks – unusually expansionary or contractionary monetary policy. The contributions to the inflation developments that we can observe in Figure 22 thus only reflect the effect of these specific shocks, and not the aggregate effect that monetary policy has on inflation.

UNUSUALLY LOW PRICE MARK-UPS IN 2014 AND 2015

Despite the negative contribution from developments abroad having decreased somewhat and monetary policy having become more expansionary in the past year, this has not been reflected in inflation developments to the extent one might expect. The model explains this by companies' price mark-ups, shown as purple bars in Figure 22, having been unusually low from the beginning of 2014 and onwards.

In the model, the price mark-ups of companies are changed in line with changes to their costs and prices. The price mark-ups reflect the link between demand and the costs of companies on the one hand, and price increases in the economy on the other. The model assumes that the companies set the price of a certain product at the cost of producing it, plus a mark-up.[40] The mark-up is determined by the competition on the

39 It is important to note in this context that the model only takes account of the traditional monetary policy measures or, in other words, the cuts (and previous hikes) to the repo rate that have been made. The additional monetary policy measures carried out since February 2015 in the form of government bond purchases are not given explicit consideration in the model. The contributions made by these to inflation developments will thus be captured by other shocks in the model.

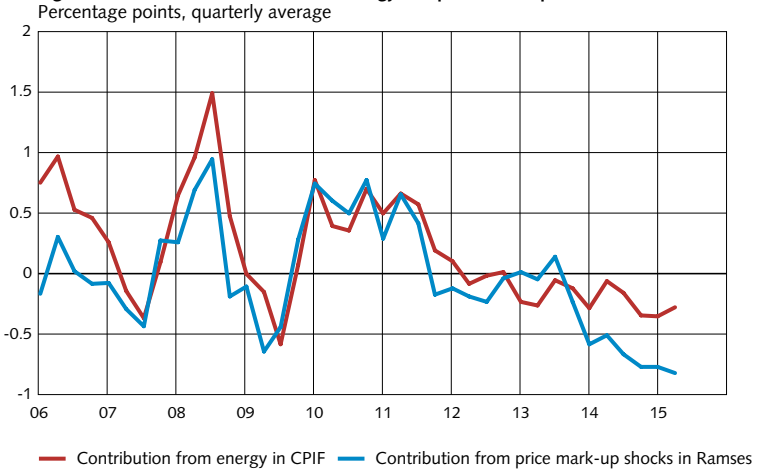
40 The producing companies in the model are assumed to act under monopolistic competition, and are hence able to take out a certain margin on the goods and services they produce.

market in which the company operates, but can also be temporarily affected by demand developments, which make it more or less difficult to transfer the company's cost increases onto consumers. The temporary changes in the price mark-ups that deviate in one way or another from the historical pattern will be perceived by the model as price mark-up shocks, which will affect inflation and many other variables in the model. We note, however, that the model might also perceive a large share of inflation fluctuations that come from variables other than those explicitly modelled in Ramses as shocks to the price mark-ups. This is because the price mark-ups affect pricing directly, while they only affect production indirectly.

One example of inflation fluctuations caused by variables outside of the model, and captured in the price mark-ups, is the direct effects of changes to energy prices, which we have discussed earlier. Energy is indeed used in the production of goods and services, and hence affects production costs. However, energy prices also have a direct impact on CPIF inflation, as seen in sections 1 and 2. It turns out that the contribution to CPIF from the energy component (the yellow bars in Figure 3) correlates closely with the contribution to CPIF that comes from the price mark-ups in Ramses (the purple bars in Figure 22). Figure 24 shows these two contributions in relation to each other. We can, for example, see in the figure that the strong positive contributions from price mark-ups in 2008 and 2010-2011 coincided with high increase rates in energy prices.

Part of the negative contributions from the price mark-ups in the model recently can also be linked to recent falling energy prices. However, this does not appear to be the whole story. The figure below shows that the contribution from price mark-ups in the model in the past year and a half has taken a much more negative direction than the contribution from energy prices. As we discussed in section 2, companies' margins appear to have been under an unusual amount of pressure, and companies appear to have found it difficult to transfer cost increases onto consumer prices. A reason for this could be that international economic unease, with its contagion effects to Sweden, has proven very protracted indeed. As we saw in section 1, inflation has in 2014 and 2015 been suppressed in many countries, which also suggests that the recent very low price mark-up is a broad international phenomenon. However, it is currently difficult to establish with certainty what the underlying driving forces are.

Figure 24. Contribution to CPIF from energy and price mark-up shocks
Percentage points, quarterly average

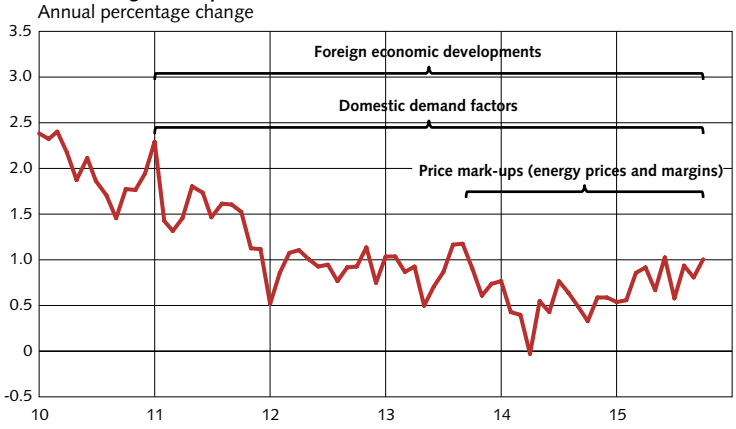


Note. The lines illustrate the contribution of the price and shock groups to CPIF inflation in the past twelve months.
Sources: Statistics Sweden and own calculations

RAMSES' INTERPRETATION OF THE INFLATION DEVELOPMENTS IN BRIEF

Figure 25 largely illustrates what the most important explanatory factors have been behind the progression of CPIF inflation in the past few years, in terms of exogenous shocks to the general equilibrium model. In summary, the model analysis indicates that it is foreign economic developments and contagion effects from those that have been of the greatest significance to the low inflation since 2011, but demand in Sweden has also been low during this period. Furthermore, it appears that inflation in the past year and a half has also been weighed down by squeezed company margins. This might, in turn, have a number of potential explanations that the model unfortunately does not allow us to distinguish, and is a question that deserves further attention.

Figure 25. CPIF and its most important explanatory factors according to the Riksbank's general equilibrium model
Annual percentage change



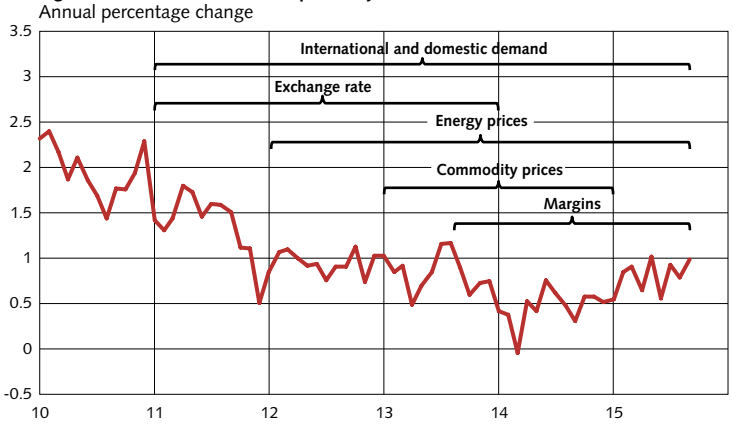
Sources: Statistics Sweden and own calculations

Summary and concluding remarks

The purpose of this article has been to highlight the low inflation and summarise the underlying driving forces. We started by describing how inflation in Sweden has progressed in the past five years, and concluded that there has been a broad downturn in the price increase rate in general, but that prices for different groups of goods and services have contributed to varying degrees to the low inflation in different years. This also becomes obvious when we compare the developments in Sweden with those in other countries.

We then looked more closely at the driving forces underlying the developments. We started by describing how various potential explanatory factors have correlated with inflation, and the extent to which the low inflation can be explained with historical patterns in these correlations. We then analysed the course of events using a general equilibrium model, in which we could identify how much of a certain factor has contributed to keeping inflation down compared with other factors in the model.

Figure 26. CPIF and the main explanatory factors for the low inflation
Annual percentage change



Sources: Statistics Sweden and own calculations

The findings from the various analytical sections are relatively consistent. In Figure 26 we summarise the main explanatory factors and the periods during which they have contributed the most to keeping a lid on inflation. This is of course not an exact illustration of the underlying causes and the time periods in which they have been of significance, but it does provide us with an overarching view of the analysis presented above. The findings indicate that factors that normally affect the rate of price increase, such as demand and the exchange rate, have also contributed to pushing inflation down in the past five years. Not very surprisingly, it appears that the weak economic developments abroad and, linked thereto, subdued demand in Sweden, have been of particular importance. Adding to that, low commodity prices – particularly for electricity and oil, but also for food for a shorter period of time – have suppressed the cost increases of companies and curbed inflationary pressure.

At the same time, it is clear that these factors do not tell the whole story. In the past two years, companies appear to have squeezed their margins to a greater extent than might be expected from historical patterns. The precise cause of this is difficult to pinpoint, but in surveys companies themselves have emphasised perceived uncertainty about the future direction of the economy and increased competition.

We commenced the article by observing that the period from 2011 and onwards is remarkable in many ways. At the same time as inflation has been on a declining trend to a low level, monetary policy has gradually become increasingly expansionary, with the Riksbank's repo rate even coming down to negative levels. Thus far, we have not said much about the role that monetary policy has played in inflation developments in the past five years, but it has of course been of significance.

Monetary policy has little possibility of influencing some of the driving forces behind the low inflation, such as low energy prices – at least their direct effects. However, monetary policy can influence many of the other factors, such as demand and the exchange rate,

in the short term, and through them contribute to inflation rising or falling. Inflation expectations can also be influenced by monetary policy. In the past few years, the policy conducted by the Riksbank has helped buoy inflation. Without it, inflation would have been even lower, as shown by the model analysis presented here. It is important to note in this context that the findings only indicate that monetary policy has been more expansionary than what a historical interest rate rule would imply.[41] The analysis we have presented in this article thus does not take a firm stand on how well-balanced the pursued monetary policy has been.

Monetary policy is based on the forecasts available at the time decisions were made. Inflation has, for a long period of time, been below the target and the Riksbank has, like most other forecasters, overestimated how high inflation will be in its projections. It is possible that the low inflation in the past few years might have been amplified by the fact that inflation expectations have dropped after a long period of low inflation. If the forecasts had been more accurate, the repo rate would probably have been cut down to the current low levels somewhat faster. What is more open to discussion, and what has also been subject to lively debate during the period, is *how much* faster the interest rate might have been cut, the effect that would have had on inflation, and what the implications would have been for the economy at large. These questions are, however, beyond the scope of the analysis in this article.

41 It should also be noted that the parameters in the historical interest rate rule on which the model analysis is based are assumed to be constant over time. If, in actual fact, a downward shift has occurred in the neutral interest rate, while at the same time the model assumes it is constant, the model might perceive monetary policy to be more expansionary than it actually is. There is an ongoing discussion about the extent to which current low interest rates in Sweden and internationally reflect the fact that the neutral interest rate has fallen, or whether the low interest rates are rather due to more temporary effects linked to the weak economic activity. See, for example, Armelius et al. (2014).

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The Swedish payment market in transformation

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Major structural changes are now taking place in the Swedish payment market. Increasing numbers of payments are being made electronically, sometimes with the use of new technology. At the same time, cash usage is declining and it is also becoming more difficult to deposit or obtain cash. The widespread availability of the Internet, tablets and smart phones is changing households' purchasing patterns and payment requirements. The banks, which long dominated the payment market, are now facing competition from new players. Even if the overall development is positive, some households, associations and companies perceive it as negative.

In this article, we first describe how the Swedish payment market looks today and emphasise a couple of its characteristics that are of central importance for understanding current developments. Following this, we describe the most important parts of the structural transformation and the challenges this entails. We discuss the advantages and disadvantages as well as what can and should be done to mitigate the negative effects on certain groups. We also conduct a discussion of the responsibilities of the market and authorities.

In summary, we can observe that the development of the payment market is positive overall and continued development should not be hindered. However, we also note the existence of problems that must be solved or at least eased. Tools for solving these problems exist but require cooperation between market participants and between market and government. Ultimately, however, it is the government that must act as a safety net for users who would otherwise risk finding themselves outside the payment market.

Cash usage is decreasing in Sweden

In an economy, it is important that payments can be made in a safe and efficient manner. Electronic payments such as direct debit, card payments or payments via Internet bank are generally faster and consume fewer resources than paper-based payments such as cheques, cash and paper-based credit transfers and are thereby usually more efficient. The percentage of payments initiated electronically is very high in Sweden. For example, the

* The opinions expressed in this article are the sole responsibility of the authors and should not be interpreted as reflecting the views of Sveriges Riksbank.

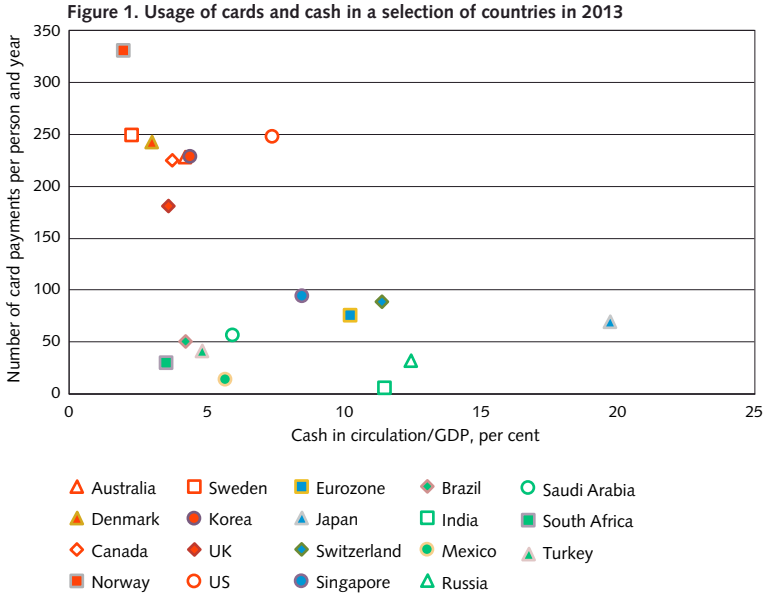
average person in Sweden made 269 card payments in 2014, putting us in a top position worldwide.[1] Sweden thus has one of the most efficient payment markets in the world.

One way of measuring how efficient the payment market is for point-of-sale payments in a country is to investigate how often cards and cash are used for payment at a point of sale. The more frequently cards are used, the more efficient this part of the payment market is considered to be.

Figure 1 shows usage of cards and cash for a selection of countries in 2013. There are no reliable statistics for the number of cash payments. Instead, cash usage is measured by relating the value of cash in circulation to the country's GDP.[2] The further up in the left-hand corner a country is, the more efficient this part of the payment market is considered to be. Correspondingly, this part of the country's payment market is considered to be less effective the further down towards the right-hand corner the country is.

The figure identifies three groups of countries. The red ones are the "card intensive" ones, including Sweden. They are also industrialised. There is also a blue group of industrialised countries characterised by high cash usage and comparatively low card usage. Switzerland and the euro area belong to this group. Finally, there is a green group of emerging market economies with low card usage, including the BRIC countries Brazil, Russia and India.[3]

Figure 1. Usage of cards and cash in a selection of countries in 2013



Sources: CPMI (2014b), ECB Statistical Warehouse and Norges Bank

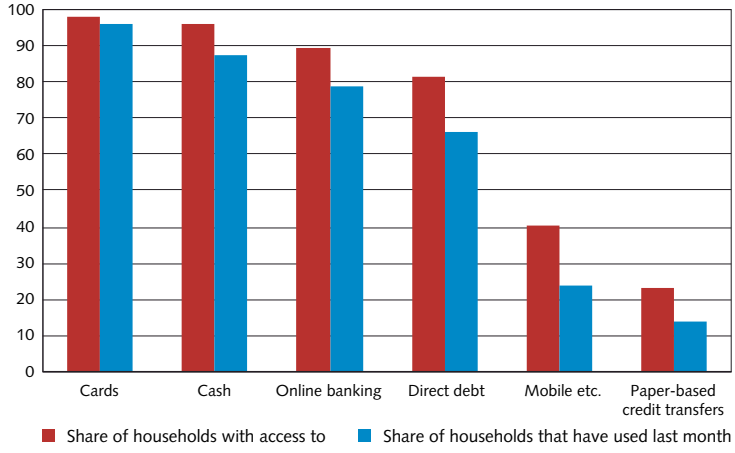
1 The total number of card payments was 2 620 million. See Sveriges Riksbank (2015), Table AB. Statistics Sweden calculates Sweden's population at 9 747 355.

2 Measuring cash in circulation in relation to GDP is a blunt instrument. For the euro area and a number of countries, such as the United States and Switzerland, cash usage is overestimated as some of their cash is held and used beyond their borders.

3 Unfortunately, there are no statistics for China.

In Sweden, cash usage is falling rapidly and, in 2014, about 20 per cent of payments in shops were made in cash – which is a very low figure compared with many other countries.[4] The corresponding figure for 2010 was 39 per cent. Almost 90 per cent of households have access to online banking and make their payments via online or mobile banking services.[5] We also use e-invoices and direct debit. On the other hand, the percentage of payments initiated using various types of paper form (Bankgiro, Plusgiro, cheques and so on) is low. The percentage of households with access to paper-based direct debit is about 23 per cent, while the share of credit transfers initiated on paper amount to 7.3 per cent.[6] The economic costs for payments are therefore low from an international perspective.[7]

Figure 2. Swedish households' access to and use of various payment services 2014
Per cent



Source: The Riksbank

The development of the payment market is proceeding rapidly as new, innovative ways of making payments are launched. These are often based on mobile telephones or require an Internet connection. We can also see increased competition for the banks from new players making an entrance on the payment market thanks to new technology or new processes. Users are quick to adopt new payment services, making cash and paper-based payments decrease rapidly. This structural transformation could give us better, cheaper and more secure payment services in the future but it will also bring challenges for society. Before we discuss the consequences of the structural transformation, it would be helpful to understand the forces driving the structural transformation and why it seems to have progressed so far in Sweden.

4 See Sveriges Riksbank (2013), Chapter 2, for a more detailed comparison between a number of selected countries.
5 Interview survey by Sveriges Riksbank, see http://www.riksbank.se/sv/Statistik/Betalningsvanor/.
6 Sveriges Riksbank (2015), Table AD.
7 Segendorf and Jansson (2012b) and Schmiedel et al. (2012).

What are the characteristics of the payment market?

Payments made by means other than cash are made via services offered by payment service providers, traditionally banks, and consumed by households, companies and the public sector. Examples of such payment services include card payments, credit transfers and direct debits. Suppliers of payment services are commercial enterprises competing with each other on the retail payment market.

A payment service is an information management service in which the information specifies which accounts are to be debited and credited, where these accounts are, the size of the amount, what the payment is for and when it is to be executed. It must also be confirmed that the party initiating the payment has the right to do so, for example via a PIN code for a card purchase, a security authenticator for payments via online banking or eID, and that there is enough money in the sender's account. These accounts are not usually with the same payment intermediary/account operator and so these must exchange information and money.

ECONOMIES OF SCALE, SYNERGIES AND NETWORK EFFECTS

All of this information processing and mediation is conducted using large IT systems/platforms that are expensive to obtain and run but with which the cost of mediating one more payment is very small. This creates *economies of scale* – the more payments that are conducted using the same IT system, the lower the average cost is for managing this information. One way of increasing the volume of payments is to co-locate the processing of different types of payment from several suppliers of payment services (*synergies*).

Network effects are another central concept within payments and, in this case, refer to the benefit of many participants cooperating in a payment system. A payment service is more useful and thereby more valuable for a party making a payment (the payer) if many payment recipients use the same service and vice versa. For example, a card is more useful to a household if it is accepted in many shops and it becomes more valuable to a shopkeeper to accept a card if it is used by many households. For certain types of payment service, the users are both recipient and sender, as is the case with *Swish*.[8] Here, it is the number of connected users that matters. In other cases, the sender and recipient are two clearly separated categories of user, as the card example above illustrates. It is mainly households that use cards to pay and mainly companies and the public sector that receive the payments.

A SWEDISH TRADITION OF COOPERATION

Economies of scale, synergies and network effects give payment intermediaries a strong incentive for cooperation. This cooperation is usually mainly a matter of various standards

8 Swish is a mobile telephone-based payment service for payments between private individuals. In the summer of 2014, it was also opened up to small companies, associations and so on. The service is provided by a number of cooperating banks.

and shared IT systems. Common standards for payment information mean that the various payment intermediaries can exchange payments between their own IT systems. This is called *interoperability*. This cooperation can be taken one step further by collaborating on the large and expensive IT systems that manage payment information. This allows double investments to be avoided and costs to be shared at the same time as economies of scale and synergies can be maximised. Both types of cooperation make it simpler and cheaper for the payment intermediaries' customers – households, companies and the public sector – to send payments to each other, thereby expanding the network.

In Sweden, the banks have a long tradition of cooperation. The creation of Bankgirot, an automated clearinghouse, is a good example of this, as is the cooperation over Swish and the jointly-owned company Bankomat, which has taken over the banks' ATMs.[9] The international card companies Visa and MasterCard are examples of cooperation on a global level within the banking sector. However, even if the banks often cooperate over standards and the payment infrastructure, they compete with each other over selling payment services to users. The banks thus compete with each other as regards fees and conditions of use for cards and card payments, Bankgiro payments, Swish payments and so on.[10]

A CONCENTRATED MARKET AND POSSIBLE LOCK-IN EFFECTS

Economies of scale and network effects tend, however, to create a concentrated market that is dominated by a small number of large players, which is the case with the major banks on the Swedish payment market.[11] Combined with the cooperation between participants, this usually results in there being a small number of large payment services. In Sweden, these are various forms of Bankgiro payments and card payments via Visa and MasterCard.

The cooperating banks have invested heavily in adjusting their internal IT systems and the joint infrastructure to a specific standard. Changing the standard for payment information or the routines for how information is to be processed may entail considerable costs and it could then be least expensive to retain the existing standard. The original choice of software may thus affect future opportunities to choose other software. Similarly, it is expensive to construct a shared infrastructure, so there is reluctance to replace it,

9 Regarding the Bankgiro, the cooperation moved from interoperability to jointly-owned infrastructure. It had been possible to make transfers between current accounts at the commercial banks long before the arrival of Bankgirot in 1959, but the development of office machines and increased costs for handling cheques made it desirable for the commercial banks to create a more easily-administered payment method/routine that could complement cheques and occasionally replace them. This new payment routine was the bank giro system and, in 1950, a joint bank giro form for transfers was developed. It soon became apparent that handling of the forms submitted by the banks' customers should be centralised and, in 1959, Bankgirocentralen was set up. Its main task was sorting bank giro payments and notifying the recipients and their bank accounts. Today, Bankgirot is the central hub through which the majority of payments between different banks pass. For a description of Bankgirot, see Sveriges Riksbank (2013).

10 The Swedish banks' pricing differs for households and companies or the private sector. Households seldom pay transaction charges, which is to say a fee per payment, but this is very common for companies and the public sector. However, both often pay fixed charges such as annual fees. Source: Guibourg and Segendorf (2007).

11 If the economies of scale and synergies are strong enough and full competition prevails, there will only be room for one payment intermediary or infrastructure on the market. The market is then known as a natural monopoly.

even if better hardware has become available. Cooperation over standards and payment infrastructure may thus create lock-in effects making change processes sluggish and today's situation a function of the situation yesterday. Payments between the banks are currently mediated in largely the same way as they were ten years ago.[12]

Households and companies are thus faster to change their way of initiating payments than the banks are to develop new ways of exchanging payment information and money with each other.[13]

SWEDEN IS FAR AHEAD WHEN IT COMES TO USING NEW TECHNOLOGY

New technology often needs to mature and become widely used before it can be used to construct new payment solutions. This is because there would otherwise only be a few potential users, which would prevent network effects and economies of scale from being utilised. For example, a sufficiently large proportion of households must have access to the Internet for it to be worthwhile constructing an Internet bank, and a mobile bank can only be profitable if enough of the bank's customers have smart phones. Exactly how wide the distribution of a technology must be varies from case to case, along with the other business considerations the payment service suppliers must make.

Sweden is a technology-friendly country. The infrastructure for the Internet and telecommunications is extensive and a high proportion of households have access to and use new technology such as home Internet, smart telephones and tablets.[14] The World Economic Forum ranks countries according to how well they are situated with regard to utilising possibilities offered by information and communication technology.[15] In 2015, Sweden was ranked third of 148 countries and has been among the three best countries

12 However, sometimes there are innovations that induce technological shifts. The creation of the mobile payment system M-Pesa in Kenya could provide one such example. See Sveriges Riksbank (2013), page 69. It is also interesting to note that Bitcoin was created partly with the aim of circumventing the banks and the traditional payment system. There is interest, within the financial sector and elsewhere, in attempting to use the same technology as Bitcoin (block chain) for financial services. It is therefore possible that this technology could contribute to reshaping the way in which certain types of payment and securities transaction are made in the future. For a popular science treatment of Bitcoin, see Segendorf (2014).

13 Innovative payment services are often, although not always, a new way of initiating an 'old-fashioned' payment, e.g. linking a card to a payment application in a mobile telephone. The large IT systems for clearing and settlement between the banks form a base platform for an 'ecosystem' of payment services that change over time. In general, this works excellently but occasionally payment requirements arise that cannot be met in this way. The demand for payments to be executed in real time is a clear example. The prevailing system has been constructed to execute payments over a day or the following day. It is difficult to adapt the old IT system for payments to be mediated from account to account in real time, so a new one has to be constructed instead. In Sweden, this system is called BiR (Betalningar i Realtid) and is run by Bankgirot. This is the system that makes the Swish service possible and it may come to serve as the platform for a new ecosystem of payment services.

14 91 per cent of the population over the age of 18 have access to the Internet and computers at home. 76 per cent of those in age groups over 12 use the Internet every day. Source: Findahl (2014), figures 1.3 and 1.7.

15 The ranking is based on an index built up of 53 indicators divided among four components: environment (political/regulatory and business and innovation), readiness (infrastructure and digital content, affordability and skills), usage (individual, business and government), and impacts (economic and social).

since 2006.[16, 17] Naturally, this creates favourable conditions for the development of the payment market.

How does demand for payment services change?

As companies and households gain access to new technology, their demand for payment services is also affected. A household with a computer and Internet access (smart telephone) may demand online banking services (mobile banking services) if this simplifies the management of the household's bills and oversight of the household's economy. Swedish households now use online and mobile banking to an increasing extent instead of paying bills via paper-based credit transfers.

Increased trading via Internet shops (e-commerce) is also giving rise to demand for suitable payment services and auxiliary services.[18] Examples of such services include services in which a third party goes between the customer and the retailer and assists the customer make a payment in a faster and simpler manner. This intermediary can mediate payment information to the customer's online bank, thereby meaning that the customer has to provide less information – this is usually called a *Direct payment* on the Swedish e-commerce companies' websites. It can also manage sensitive information such as card numbers, expiration dates and security codes so that these cannot be seen directly by the retailer. *PayPal* is an example of this type of intermediary. The use of electronic services such as downloads or streaming of music, films, audiobooks and so on may also require the use of specially-adapted payment services. E-commerce increasingly takes place across national borders, meaning that demand for suitable cross-border payment services is increasing.

When paying in a physical shop, households are using cards instead of cash to an increasing extent. The changeover from cash to cards may be speeded up via the recent introduction of contactless smart cards, which is to say cards that only need to be placed near a card terminal by the holder, with no need to enter a PIN code. The increasingly widespread habit of using mobile telephones in many other different contexts has yet to make a clear impact in payment habits, but there seems to be a dawning interest in making payments via mobile telephone.[19]

In much the same way, new technology also gives rise to a demand for new payment services among companies. E-commerce companies are often dependent on it being quick and simple for a customer to make a payment, as the risk of a customer breaking off a

16 For data for 2015, see http://www3.weforum.org/docs/WEF_GITR2015.pdf.

17 In 2014 and 2013, Sweden was ranked 3rd of 148 and 144 countries, respectively (3/144). Corresponding figures for earlier years are 2012: 1/142, 2010–2011: 1/138, 2009-2010: 1/133, 2008-2009: 1/134, 2007-2008: 2/127 and 2006–207: 2/122. Sources: http://www3.weforum.org/docs/WEF_GlobalInformationTechnology_Report_2014.pdf, http://www3.weforum.org/docs/GITR/2013/GITR_OverallRankings_2013.pdf and https://si.se/verksamhetsomraden/sverigebilden-utomlands/internationella-index/the-networked-readiness-index/.

18 Between 2003 and 2014, e-commerce in Sweden grew from SEK 4.4 billion to SEK 42.9 billion. Source: PostNord et al. (2014).

19 Example: 14 per cent of the payments made at Starbucks are implemented using a mobile telephone application. Source: http://www.nyteknik.se/nyheter/it_telekom/mobiltele/article3815524.ece.

purchase increases the more complex the payment process becomes. Payments via mobile telephone in shops may be attractive for retailers if, for example, other information such as additional offers or advertising can be linked to the payment application. No less important is that this makes it easier for companies and/or payment service suppliers to gather and process data concerning their customers and thereby be able to tailor offers and advertising for each individual customer. Such information can also be sold to other companies, thus providing extra income.

In addition to pure payment services, auxiliary services have also arisen, such as those compiling information from online or mobile banking services and thus providing the user with a clearer view of a household's economy.

DEMOGRAPHY ALSO AFFECTS DEMAND

Demand for payment services is affected by demographic factors, with there being two dimensions worth emphasising within the shift towards electronic payment services described above. The first of these is the segregation of demand by age, which is to say the difference in how different generations use payment services seems to be increasing. Older people who are used to using cash and paying via paper-based direct debit continue to use these payment services to a greater extent than younger people.[20] Older people also tend to have less access to the Internet, smart telephones and tablets and, additionally, to use these less.[21] Younger people tend to use cards and online or mobile banking to a greater extent.

The second is geographical segregation. Sweden is a sparsely-populated country. By surface area, Sweden is the third-largest country in the EU but we have the second smallest population per square kilometre. Sweden's population is also concentrated to an increasing degree in the metropolitan regions and, as a rule, the average age is increasing most in the counties with declining populations. This means that it is in the cities that demand for electronic payment services is growing most rapidly, particularly as regards new, innovative payment services. This means that cash and paper-based payment services are demanded to a higher extent in the countryside, although demand for cash is falling in some areas as the population diminishes.

How does the supply of payment services change?[22]

Supply changes in two main ways – through the services supplied and the suppliers. The new technology, consisting primarily of the Internet, tablets and smart telephones, is not just contributing to changing demand but also to the creation of new channels

20 The probability that a person will pay with a card instead of cash decreases with age and increases with income, education and the size of home town. See Segendorf and Jansson (2012a). According to the Riksbank's interview surveys, the same relationship also exists for paper-based credit transfers and online or mobile banking. Younger people and people living in major cities are also more liable to use innovative payment services.

21 Source: Findahl (2014).

22 More information on how the supply of payment services has changed can be found in the reports: Sveriges Riksbank (2013), CPMI (2012) and CPMI (2014).

though which payment intermediaries can provide payment services to their customers. This technology makes it increasingly simple to integrate payment services into purchase situations and a number of payment services aimed at e-commerce in particular have arisen. Card terminals have become portable and increasingly accessible, making it easier to pay by card in different situations. More and more companies are offering their customers the possibility of paying via electronic invoices.

Cash and paper-based payment services are seeing the opposite development, not least as a consequence of changing demand. Declining demand combined with the need to provide these services locally, which is expensive, is leading the banks to look for ways to rationalise their operations. This is primarily noticeable through the banks' reduction of cash services in particular by reducing the number of bank branches and making about half of them cashless so that over-the-counter cash transactions cannot be made. The government previously provided a cash service via Svensk Kassaservice and the rural postal service. This service was discontinued several years ago and replaced by the services offered by banks and payment service providers. In cases in which the market's services are insufficient, the Swedish Post and Telecom Authority (PTS) and county administrative boards have been assigned with ensuring access to basic payment services.[23]

OTHER PARTICIPANTS THAN THE BANKS OFFER PAYMENT SERVICES

The banks have had a dominant position on the payment market for a long time. But rapid technological developments and demand for tailor-made payment services have led to other kinds of company becoming established and starting to offer their services, either in competition or in cooperation with one or more banks. In Sweden, Payex, Klarna, iZettle and Seamless are examples of such companies. In the international arena, PayPal is another example. In other cases, they are companies with other core activities but who provide payment services as a complementary product. This include mobile operators, Internet suppliers and other technology companies. Examples of such companies are FaceBook, Google and Apple.[24]

The Swedish Payment Services Act, which is based on the EU Payment Service Directive, explicitly takes consideration of this development by allowing such activities for companies other than banks. This has taken place by allowing them to apply for registration as *payment institutions* or *institutions for electronic money*. In many rural communities, local shops, petrol stations and so on act as agents for a payment intermediary, in which case it is possible to make certain payments there.

23 Basic payment services means cash withdrawals, the mediation of payments and the handling of daily takings. This assignment means that the government has the possibility of supplying support measures or economic grants to rural communities where the market is not meeting the need for basic payment services. The need for measures is assessed by the county administrative boards. Read more at: http://www.pts.se/betaltjanster.

24 In certain extreme cases, no person or company provides the payment service. This means that there is nobody to be held responsible or regulated. The virtual currency Bitcoin is the best-known example. However, this is used to a very small extent and has not had any impact on the structure of the Swedish payment market. See Segendorf (2014).

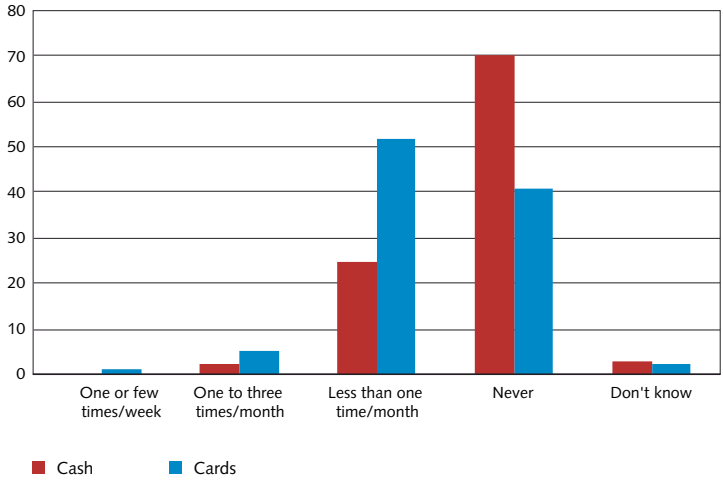
Effects of the structural transformation

In summary, the supply of payment services over the last 10-15 years has shifted towards electronic payment services that are increasingly tailored to and integrated with the purchase situation. These are increasingly provided by companies that are not banks. The diversity of supply has thus increased and has, to a certain extent, fragmented the market. In contrast, the supply of cash services and paper-based payment services has decreased.

This structural transformation is generally positive. New payment services and new operators increase competitiveness and broaden supply, which, in turn, results in simpler, cheaper and, in certain cases, also more secure and user-friendly payment solutions. This increases choice for users and can also lead to higher profitability for associations and smaller companies (for example) in that they have more payment options to offer customers. For instance, there are now new payment services that can, in many situations, replace cash in communities where the customer base or logistical problems make cash payments unprofitable.

It should also be remembered that cash generally works well today. The Riksbank's survey shows that cash seldom fails to work as a means of payment. This can be illustrated by Figure 3 below.

Figure 3. Both cash and cards have high acceptance rates
Per cent



Note. Percentage answering the question: How often have you been unable to pay with cash or card?
Source: The Riksbank's interview survey

Even if the development is positive, it involves challenges and certain households, associations and companies perceive it as negative. The existence of alternatives to cash is of little comfort to those with a strong desire to pay in cash or without access to or ability to use alternative payment services. The development of new services is proceeding very rapidly and a transition to the new payment services entails a cost, either in terms of new

equipment or in terms of devoting time and effort to learning to use the new solutions. Costs may be significant for individuals, associations or companies.

For reasons including the demographic factors discussed above, demand for some (traditional) payment services changes more slowly than supply, both technologically and geographically.[25] This is where the crux of the problem lies: not having access to or an ability or interest in using new electronic payment services is part of a greater digital exclusion and it may thus be difficult to solve this problem by introducing new technology.

THE GREATEST CHALLENGES AND POSSIBLE SOLUTIONS

The payment market is facing challenges of several types. The greatest challenge is, in the long run, achieving a sufficient level of cash service to ensure that it is possible to execute payments in situations where no other appropriate alternative exists. Other challenges are linked to possible solutions to the problems created by the continuing decline of cash services. For example, infrastructural shortcomings must be remedied so that online and mobile payments can function across the entire country. A well-functioning and dynamic market that can continue to develop to ensure the continued future existence of efficient and user-friendly payment services is also needed. Challenges and possible solutions are described below.

Continuing decrease of cash usage is a major challenge

There are no signs at present that the downward trend in cash usage will slacken off. This is due to demographic factors and because incentives for streamlining the way payments are made continue to be high for both companies and households.In certain cases, the cost of accepting cash can be substantial: administrative work, handling of daily takings and cash floats and transportation services. Without cash, the risk of robbery is reduced and it is also sometimes considered that the working environment for personnel is improved. If sales made by an entrepreneur against cash payments become so low that the profits from these sales do not balance out the cost of accepting cash payments, it will probably not be economically rational for the company to continue to accept cash. If a number of companies stop accepting cash, it will be more difficult for households to use cash and they should then react by using less cash and demanding fewer cash services. Banks and others may then, like companies, reduce their costs by reducing the supply of cash services and perhaps also by increasing prices for those companies who wish to continue purchasing cash services. When fewer households pay in cash and the cost of cash increases, more companies will stop accepting cash and the downward spiral will continue.

In the worst case, this negative feedback loop may proceed relatively quickly and be very painful for the companies and households not participating in it. In particular, access to deposit services could be expected to decrease. For the market as a whole, this may not

25 The county administrative boards survey and report access to basic payment services annually. See Länsstyrelserna (2014).

have any major effects as long as the rate of the reduction is manageable. In addition, there are still banks offering cash services in many parts of the country.[26] However, for certain users with poorer opportunities for taking in and using new technology (for example older people and people with some disabilities[27]) and in certain situations, above all when making deposits, reductions in cash services may have serious consequences. The number of geographical areas without cash service, as well, presumably, as other forms of service, will probably also continue to increase.

An efficient, dynamic payment market to solve the problems

Meeting the problems arising when cash usage and cash services decrease will require an efficient and dynamic payment market able to develop long-term, alternative payment services for a reasonable cost. This kind of market is characterised by a fine balance between cooperation and competition. The same applies to regulation, where the challenge lies in setting competition-neutral rules that reduce the risks and uncertainty for the various market participants and users without impeding innovativeness. Transparent and cost-based pricing is also necessary. In addition, a broadly-based infrastructure is a necessity. At present, these areas have shortcomings. Challenges and possible solutions are discussed below.

Balance between cooperation and competition

Above, we pointed out the importance of interoperability, which is to say a special form of cooperation that makes it possible to mediate payments between two participants' technical systems. Shortcomings in interoperability mean that access risks being impaired as fewer payment recipients can then be reached by any given payment service. For example, it becomes less likely that a certain payment service can be used in a specific shop. Payment services become less effective for parties both making and receiving payments as access is needed to a larger number of mutually incompatible payment services, with all the costs and difficulties this entails. In other words, it becomes more difficult for households and companies to find a good alternative to cash.

Cooperation in infrastructure creates possibilities for participants to share costs and also allows them to mediate payments between a larger number of users of linked payment services. This is particularly important when a new payment service requires a new infrastructure. We mentioned above the long tradition of cooperation the Swedish banks have, among other things through the Swedish Bankers' Association, Bankgirot and

26 Swedish Agency for Growth Policy Analysis (2014). The report is only available in Swedish but a summary can be found at http://www.tillvaxtanalys.se/in-english/publications.html.
27 Länsstyrelserna (2014).

Bankomat.[28] However, at present, there is no natural forum for the kind of cooperation between participants that is needed considering the development of the payment market. This means that the market, because of its rapid development and increased diversity, risks becoming fragmented and ineffective giving rise to various related problems.

Another way of cooperating and sharing costs for infrastructure and office networks is by purchasing services from each other. One example is the cash services offered by FOREX Bank to both its own and other banks' customers (for a fee). They also act as agents for certain other banks for deposits and withdrawals. Every bank thus does not need to have a branch in every community. This is a way of maintaining service for a broader circle of customers in a greater number of places for a lower cost.

However, cooperation also has a number of potential disadvantages. Firstly, cooperation may create structures within which a number of participants act to reduce competition on the payment market. For example, they may try to exclude other competitors from participating in their cooperation. Open access to infrastructure on equal terms, combined with effective competition legislation, is necessary to achieve a good balance. Cooperation can also create vulnerabilities by making the market dependent on a single infrastructure or participant (single point of failure). If anything should happen to this, parts of the payment market may be incapacitated.

It is therefore important to have a balance between cooperation and competition that allows high interoperability and continuing innovation. This sets the conditions for efficient and simple payment services. Sweden's tradition of cooperation in payments should therefore be encouraged and broadened to also embrace new services and new participants.

Sufficient regulation without impeding innovation

The potential problems with legislation are partly due to authorities and legislators not having full knowledge of all events on the market or of future developments. Regulations risk being suited to today's situation rather than tomorrow's. The risk of this is particularly great when developments are rapid. For Sweden, as a part of the EU, a further complication can be added to this picture – regulations on the EU level are not particularly suited to the Swedish payment market but are intended to work for the union as a whole. On the other hand, absent or delayed legislation is also problematic as this means that the applicable rules are not clear to market participants.

Consumer protection and integrity form an area in which rapid development could pose problems. There now exist payment and information services in which service providers wish to have access to customers' online or mobile banks and which are based

28 However, in many cases, innovative payment services are only a new way of initiating payments via a pre-existing infrastructure (source: CPMI(2012)). For example, a new mobile payment service, such as Apple Pay, which has yet to be launched in Sweden, may, in practice, be a new way of making a card payment. This reduces the need for investment and benefits from the many customers (cardholders and companies) who can connect to the service with relative ease.

on users supplying their login details. This may give rise to uncertainties over the division of responsibilities between service provider and bank as regards their users. In addition, complicated and unclear chains of participants may make it difficult to determine who is responsible for what and therefore who can be held responsible should something go wrong.

In some areas, the banks' cash services have been replaced by agents, for example retail traders offering payment solutions such as deposits, withdrawals and payment mediation. This involves new and greater demands for competence from the agent, which may increase the risk of deficiencies in handling and in information to customers. These higher demands may also form an obstacle preventing an agent from offering the service.[29]

Legally-secure solutions for people assisting others with their payments, for example home-help personnel, are also absent. In many cases, the user is forced to reveal confidential data to another private individual to obtain assistance. In other cases, the assistant uses his or her own private economy to assist the person or entity who is to pay (associations, school classes, family members).[30]

But poorly-designed regulations can hinder innovation.[31] It is therefore important for authorities to carefully monitor developments so that any regulations contribute towards the development of the payment market rather than impeding it. Regulations should also be aimed at ensuring that solutions are secure and user-friendly.

Transparent pricing

On a market, pricing plays two roles. Firstly, it provides revenue for the producer or seller of a product and covers their costs. Secondly, prices provide information on costs to potential purchasers. Correctly set prices lead to an economically efficient allocation of resources in the economy.

One problem on the Swedish payment market is that households seldom pay transaction charges. For cards and online banking, for example, the banks instead charge a periodical fee and cover other costs via charges from retailers and other banks. Many consumers are of the opinion that payments should be free, which makes it difficult for the retail trade and banks and other payment service providers to apply transaction charges.[32] The resultant problem is that consumers are unaware of the various costs linked to payments,

29 In many cases, the government must balance various targets against each other. The government's justifiable target of countering money laundering and the funding of terrorism stands, to a certain degree, in contrast to its willingness to improve the supply of cash services, primarily as regards deposits. At present, a consumer can often withdraw cash in a shop (cash back) with the use of his or her card. On the other hand, it is difficult to create a corresponding service for deposits, as the shop must then follow the regulations on money laundering and have a strong knowledge of its customers.

30 Länsstyrelserna (2014).

31 One example is the European Commission's E-Money Directive 2000/46/EC), in which the definition of e-money was not technology-neutral and which could thereby have hindered innovation. The Directive was revised in 2009. See CPMI (2012), page 37.

32 There arises what is known as a prisoner's dilemma – a situation in which nobody wants to be first to introduce transaction charges, even though it would benefit all parties. It is also worth noting that the new Interchange Fee Regulation forbids retailers from charging their customers fees for certain types of card payment.

which means that they do not always chose the most cost effective means of payment, from society's point of view.[33] The total costs then become higher than necessary. It can also become more difficult for the payment intermediary to cover its costs, which reduces its incentive to invest in infrastructure and new payment services. This also deprives households of an important means of influencing banks and other payment service providers.

The lack of transaction and withdrawal charges is a special challenge for cash services, particularly in smaller communities. The supplier's cost for cash services is currently perceived as high in relation to the revenues associated services can generate. The banks may then choose to reduce their costs by rationing the supply of cash services. Removing cash from some bank branches is one way of doing this.

A clear price for cash services for households would have two advantages. Firstly, it would give banks and others several strong incentives to provide these services and, secondly, households would have a stronger incentive to go over to alternative payment services when acceptable alternatives exist.

Comprehensive infrastructure

Although the infrastructure for broadband is extensive in Sweden, there are still areas in which the infrastructure is lacking. However, the greatest challenge is formed by shortcomings in capacity in both the fixed and mobile networks. This may be the case in certain geographical areas where capacity is generally lower, but also on certain occasions when more capacity than usual is demanded, for example in certain areas during the tourist season or at certain events that attract many people.[34]

Deficiencies in infrastructure determine which services users have access to and can use. For example, the use of mobile payments is limited in areas in which the capacity of the mobile network is lower than in the country as a whole. There are also areas in which online payments are difficult to make because broadband connections are poor or entirely absent.

Another limitation is formed by users' access to technological equipment. Although many people have access to new technology such as tablets and smart telephones, far from everybody has this and is willing and able to use it. Also increasing heterogeneity contributes to an increased fragmentation of the payment market, which is to say that several types of payment service are needed.

A comprehensive infrastructure is thus necessary to provide everybody with the same opportunity to choose between a greater number of more efficient payment services.

33 Source: Guibourg and Segendorf (2006). One exception is formed by payments made over the counter at a bank or payment services agent. Charges have also started to be applied to services related to coins.

34 Swedish Post and Telecom Authority (2014). Internal surveys by the Riksbank give the same picture.

Who should take responsibility for mitigating these problems?

The development of the payment market is driven by powerful forces on both the demand side and the supply side. Households and companies demand payment services that are adapted to the new forms of purchasing behaviour arising apace with technological developments. Payment intermediaries are striving to provide such services, to rationalise their operations with the use of new technology and to reduce services with low or negative profitability. Overall, this is a beneficial development and should not be impeded but, for some households, companies and associations, the speed of the development is problematic. Responsibility for rectifying shortcomings and mitigating problems is divided between various actors.

BALANCE OF RESPONSIBILITIES BETWEEN GOVERNMENT AND MARKET

In general, it should be the market itself that takes responsibility for managing the challenges arising. The work of the authorities should be focused on making it easier for market participants to provide and demand payment services under competition-neutral forms and with strong consumer protection.[35]

In some communities, demand for certain payment services will be so low that it will not be profitable for the market to provide these services. The authorities should then refrain from forcing payment intermediaries to provide these services via legislation as this could have unexpected consequences. For example, forcing a bank to provide a specific range of payment services at all its branches could lead to the risk of the bank concluding it would be better to close its branches in certain communities rather than to keep the branches but without one or more payment services. Legislating that shops must always accept cash will also lead to increased costs for those shops that would otherwise not have accepted cash. Shops with low profitability could then be forced to close, probably giving rise to even greater problems.

It therefore seems reasonable for the government to ensure a supply of basic payment services in some communities via support or procurements.[36] This task presently lies with the Swedish Post and Telecom Authority and the county administrative boards who are to evaluate and, if necessary, also find ways to provide basic payment services.

However, there is an impending risk that market participants will also withdraw from areas where it should be possible to find a way of providing these services in an economically-justifiable way. This is not a desirable development. Instead, it is necessary for banks and payment service providers to do their utmost to take responsibility for the services they provide today and that their customers demand. This will probably require increased cooperation between market participants.

35 The discussion below takes place on a more general level. For a review of the roles of various authorities on the payment market, see Sveriges Riksbank (2013).

36 Basic payment services means cash withdrawals, the mediation of payments and the handling of daily takings. The task of ensuring equal access to this for a reasonable cost has been given to the Swedish Post and Telecom Authority and the county administrative boards.

COOPERATION

In a number of communities, the costs of providing services must be cut if it is to be economically justifiable to keep them. Payment service providers should cooperate in these cases. A number of ways are imaginable, in concrete terms. Firstly, the market participants could purchase services from each other, as in the example with FOREX, and thus share the costs. Secondly, infrastructure such as service boxes could be shared, for example under the framework of Bankomat. Thirdly, a procurement of payment services in shops, for example via Bankomat, could be made, in which all participating banks' customers would have access to the same service. But this would require a business model in which banks and payment service providers take responsibility for complying with regulations on money laundering, for example. Norway has such a model, where one large bank has opened in-store banks in shops and post offices. Here, it is the bank that takes responsibility for the shop or post office knowing about and complying with the regulations on money laundering. There is nothing to suggest that this could not be done in a cooperative manner in Sweden.

THE PAYMENT ACCOUNTS DIRECTIVE – A CATALYST?

The ongoing work of implementing the EU directive on payment accounts[37] could provide one possible way forward for finding a balance between various participants' responsibilities. The directive is aimed at providing consumers with the far-reaching right to open a payment account with a credit institution. A certain range of basic payment services must be attached to this account, such as deposits and withdrawals of cash. An inquiry is presently underway in the Government Offices into how the directive is to be implemented in Sweden.

Even if we, at present, do not know exactly how the legislation will be formulated in Sweden, one way or another the directive will probably come to affect credit institutions. In addition, the inquiry's instructions[38] say that special attention is to be paid to legislative measures to facilitate deposits and withdrawals. This provides an excellent opportunity for the inquiry and, ultimately, the Government and Riksdag to consider how responsibility between different participants should be divided. The directive could, therefore, be an external event creating conditions for discussions on more cooperation in the payment market.

The Government could also consider taking the opportunity to harmonise the definition of basic payment services in the Swedish Post and Telecom Authority and county administrative boards' assignment with the definition in the Payment Services Directive.

37 Directive 2014/92/EU of the European Parliament and of the Council of 23 July 2014 on the comparability of fees related to payment accounts, payment account switching and access to payment accounts with basic features.
38 Dir 2015:39.

INFRASTRUCTURE FOR FIXED AND MOBILE INTERNET

In its broadband strategy, the Government has determined that at least 90 per cent of all households and companies should have access to at least 100 Mbit/s broadband by 2020. The starting point is that the market should pay for the expansion of electronic communication services and broadband but can also apply for government funding for the expansion in certain areas. The Government has also pointed out a number of action areas to meet the targets, for example functioning competition and nationwide broadband. The evaluation of the broadband strategy for 2014 reveals a number of further areas for improvement.[39]

The Government's initiative is welcome but it is important that this work is speeded up to give users across the entire country the opportunity to choose non-cash payment services. The risk inherent in a market-driven expansion is that the communities that most need access to broadband will be the last to be connected. Consequently, the Government should oversee the expansion in sparsely-populated areas particularly carefully and consider taking measures when necessary. For example, it should be considered whether increased public efforts are required to complement the expansion being conducted by the market. Regional and local public actors such as the county administrative boards are playing an active part here in the identification and prioritisation of geographical areas needing extra measures as well as ensuring that the right measures are adopted.

TRANSACTION CHARGES ARE NEEDED

The introduction of transaction charges based on the cost of providing each payment service is an important condition for an efficient market. Not least, this will provide households themselves with an opportunity to influence their own costs and the supply of payment services. For example, if households demand cash services and are prepared to pay for them, it is more likely that a functioning business model can be identified for the provision of cash services. One important reason for cash services becoming less common is precisely that, in many cases, they are unprofitable for the banks. It also seems both likely and necessary that transaction charges would encourage the payment intermediaries to make greater efforts to facilitate the transition from cash services to electronic payments, for example by more actively informing and educating those who initially need help.

However, transaction charges are problematic. Households are not used to them and, for individual payment service providers, the introduction of these may be linked with high expenses in the customer dissatisfaction. In addition, payment service providers neither can nor should sit down together to discuss pricing. On the other hand, it is difficult to see how a market in which users do not pay for the services they demand can be efficient and meet their long-term needs for payment services. One possible way forward could be to have individual participants introduce charges for the services for which it is obvious that there are costs, for example ATM withdrawals. These charges could then be balanced by a lower

39 Government Offices of Sweden (2014).

annual fee or higher interest on transaction accounts, aimed at compensating households. It is also extremely important that households accept transaction charges and make use of them to influence banks and other payment service providers by making it possible for the banks to provide the services households wish to use.

THE RIKSBANK

The Riksbank has no direct tools to affect the supply of payment services. However, the Riksbank can indirectly affect different participants' costs for cash. Lighter and smaller banknotes and coins in suitable denominations make the physical handling of cash easier and cheaper. This is also one of the points of the banknote and coin changeover that has now been started.[40] The regulatory framework for collection and deposit of cash at the Riksbank also affect the costs for the participants. About ten years ago, the Riksbank introduced what is known as interest compensation to make the collection and deposit of cash at the Riksbank possible via Bankernas Depå AB's depots without any need to physically transport it to the Riksbank's own depot. This reduces the need for transportation and creates the conditions for the market to optimise its cash stocks both geographically and in terms of time.

The Riksbank can also act as a catalyst and provide various discussion forums in which payment intermediaries, infrastructure suppliers, authorities and users of payment services can meet. One example is the retail payments council that the Riksbank initiated in the autumn of 2014.[41] There is also the older Cash Handling Advisory Board, at which market participants meet and discuss issues affecting cash provision.

The Riksbank also carries out special studies and analyses with the aim of contributing towards increasing knowledge of the payment market. For example, regular studies are made of the Swedish people's payment habits and, in 2013, a study was made of the Swedish retail payment market. The annual report the Swedish Financial Market also includes payment statistics and descriptions of the payment market.

Concluding remarks

The restructuring of the payment market is positive on the whole and should not be impeded. The problems faced by certain individuals, companies, associations and so on cannot be completely eliminated. However, increased cooperation on payment services in sparsely-populated areas and an expanded infrastructure for both fixed and mobile Internet could contribute towards mitigating them as far as is possible.

We consider that many of the tools needed to mitigate these problems already exist. The Swedish market has long experience of cooperation but it is now necessary that the next step be taken and cooperation be entered into over service boxes and giro payment

40 Starting on 1 October 2015, the Riksbank is changing all banknotes and coins (except the ten-krona coin). Read more at http://www.riksbank.se/sv/Sedlar--mynt/.

41 http://www.riksbank.se/sv/Finansiell-stabilitet/Betalningar/Betalningsradet/.

and recirculation machines to increase local access to these services. The banking sector in particular has already created joint-owned structures that can be used. The implementation of the payment accounts directive may serve as a catalyst for further cooperation.

Households and companies know a lot about technology and, similarly, there is great knowledge and innovation capacity among new participants on the payment market who, via new specialised payment services, are able to meet part of the payment requirements brought about by the structural transformation. One important precondition for this to work is a well-developed fixed and mobile Internet network – and both the market and the government have responsibility for this.

However, the market will not be able to solve all problems everywhere. The government will therefore continue to play an important role as regards ensuring access to basic payment services in certain communities.

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How can monetary policy take account of uncertainty and risk?

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The academic discussion of monetary policy frequently employs a conceptual framework based on assumptions suggesting that consideration of risks and uncertainty has no effect on the decisions taken. Decision-makers wishing to take such consideration therefore need a new conceptual framework. In this article, we analyse two different versions of an extended conceptual framework in which uncertainty and risks can influence the decisions taken. The common factor for both of these methods is that a central bank is not certain which description of the world is correct. The focus thus lies on an uncertainty over which economic relationships or forecast models are most appropriate to use when a decision is to be taken. These two different methods have theoretical differences but we consider that, in a practical analysis of how monetary policy can be conducted, the differences between these two methods need not be very great. The discussion in this article is based on theoretical reasoning, as illustrated by stylised models, and makes no claim to be a realistic description of how monetary policy functions in practice.

How can monetary policy take account of uncertainty and risk?

In discussions of monetary policy decision-making, it has been pointed out, several times, that risks or consideration of uncertainty influence the decisions taken. One example of this is Greenspan (2005), who states that US monetary policy at the start of the century was characterised by consideration of the risk that inflation would be lower than shown by the forecasts.[1] In the United Kingdom, Ian McCafferty (2014) has discussed the monetary policy decisions taken by the Bank of England in the autumn of 2014, in which he himself participated as a member of the Monetary Policy Committee (MPC). McCafferty has described how his considerations were centred around uncertainty over how the supply side of the economy was functioning at the time of the decision. Poloz (2013), Governor of the Bank of Canada, argues that monetary policy decisions in Canada have focused on balancing the risk of low inflation against increased risks of imbalances in the financial system. In Sweden, Ingves (2014) has argued for attaching particularly great importance

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1 Greenspan considers that the decisions had the nature of risk management and that the monetary policy actually conducted was more expansionary than it would have been had the outcome of inflation been known.

to particularly unfavourable forecast scenarios when decisions are taken. Bernanke (2007) discusses the general principle that monetary policy decisions need to consider that the state of the economy and its functioning are not known. Bernanke considers that actual monetary policy decisions will therefore differ from decisions taken when the conditions are known.

Following the financial crisis, interest in academic circles has increased over how account can be taken of uncertainty and risks in monetary policy decisions. In some cases, the discussion has focused on whether (and how) monetary policy can consider risks and uncertainty associated with financial stability. This problem was also discussed prior to the financial crisis by Moessner (2006), but more recently the issue has been given increased attention, among others by Woodford (2012), Williams (2012), Ajello, Laubach, López-Salido and Nakata (2015) and Svensson (2012). However, this academic discussion of risks and uncertainties is of a general nature and is not specifically tied to risks to financial stability. Brock, Durlauf and West (2003) discuss a general principle for how monetary policy can manage decisions subject to risk and uncertainty. Hansen and Sargent (2008) discuss another type of general principle for decision-making subject to uncertainty, in line with methods developed by engineers.

In this article, we discuss the limitations of the traditional, academic conceptual framework for monetary policy in terms taking account of risks and uncertainty. The traditional framework is characterised by what is known as *certainty equivalence*. The consequence of this is that the decisions taken under uncertainty are the same as the decisions taken under known circumstances. We will describe how this happens in more detail in the next section. Decision makers willing to let consideration of risks and uncertainty influence their decisions may require a different conceptual framework. In this article, we analyse two different versions of an expanded framework that takes account of risk and uncertainty. The common factor for both of these methods is that the decision maker is uncertain which description of the world is correct. The focus lies on an uncertainty over which economic relationships, or forecast models, are most appropriate to use when a decision is to be taken. The two different methods have theoretical differences, but our view is that the differences probably need not be so great in practical application.

A SIMPLE CONCEPTUAL FRAMEWORK FOR MONETARY POLICY

Even if both decision makers and academics sometimes focus on risks and uncertainty, it is not self-evident whether and how monetary policy decisions reflect this. Of course, one reason may be that no particular uncertainty is actually present. But another reason could be that there are methodological problems for how risks and uncertainties impact on decisions. This may mean that a decision maker intends to take account of uncertainty in a decision but that the conceptual framework used is unclear about how this is actually done.

In the analysis of monetary policy, it is not unusual to use a conceptual framework that has its origin in control theory.[2] Using this conceptual framework, it is the decision maker's task to minimise the variation in a number of target variables, under the assumption that the forecasts for the various variables can be described by linear relationships. In this conceptual framework, there is only one source of uncertainty, namely random disturbance terms that additively influence the relationships used to make forecasts. The traditional conceptual framework is based on underlying assumptions that result in *certainty equivalence* and that mean that the same decisions will be taken, regardless of whether it is known with certainty how the target variables will develop over time or whether an uncertain forecast must be made for them.[3] This may sound strange, so the term certainty equivalence therefore deserves a more detailed explanation.

We use a simple example to explain how certainty equivalence functions. We assume that inflation is the target variable and that the central bank wishes to minimise any variation in deviations in inflation (π) from the inflation target (π^*). We use a loss function to describe this:

(1) $$L_t = (\pi_t - \pi^*)^2$$

If inflation is equal to the inflation target, the value of the function is zero and, if inflation deviates from the target, the value will increase as this deviation widens. Large target deviations thus result in very high values in the loss function.[4] We also assume that inflation is only due to resource utilisation (x) in the economy.

(2) $$\pi_t = x_t$$

In turn, the central bank's nominal policy rate (i) affects resource utilisation according to equation (3) below:

(3) $$x_t = ai_t$$

In equation (3), a is a coefficient that is less than zero. By combining equations (2) and (3), we obtain a new equation (4), in which we can see that the central bank has a direct influence on inflation:

(4) $$\pi_t = ai_t$$

2 See, for example, Jacobs (1996) for an introduction.

3 This contradicts the view that decisions taken under conditions of uncertainty differ from decisions taken when the circumstances are understood, as Bernanke (2007) considers.

4 When inflation deviates from the inflation target, large deviations are much worse than small ones, as the deviations are squared. A deviation of two units is therefore not twice as serious as a deviation of one unit, but four times as serious.

The question now is which interest rate level the central bank should maintain to keep the variation in the deviation of inflation from target as small as possible. We can calculate this by using the expression (4) in the loss function (1), and then minimising the rewritten loss function with regards to the policy rate. This calculation shows that the decision leading to the central bank achieving the smallest variation in inflation's deviation from the inflation target is holding the rate in proportion to the inflation target according to the following rule:[5]

(5) $$i_t = \frac{\pi^*}{a}$$

Let us now introduce uncertainty into our reasoning. The uncertainty of the forecasts is illustrated in the usual manner, which is to say by introducing a random disturbance term into equation (4). The disturbance term, ε_t, has the expected value of zero and a given standard deviation. With uncertainty in the inflation forecast, the inflation relationship can now be written as:

(6) $$\pi_t = ai_t + \varepsilon_t$$

With uncertainty in the forecast, it is no longer only resource utilisation that steers inflation, but inflation is also affected by the disturbance term ε_t. The central bank that still wants to minimise the variation of the deviation in inflation from target is no longer certain what inflation will be. The question is whether this changes how the central bank makes its decisions.

As the loss function is quadratic and linear relationships are used to make forecasts, and as the central bank cannot affect the disturbance term ε_t, the answer is that the term does not actually make any difference whatsoever to the decisions taken by the central bank. In the same way as above, the best strategy is to keep the policy rate in proportion to the inflation target in accordance with the rule below:[6]

(7) $$i_t = \frac{\pi^*}{a}$$

The degree of inaccuracy in the forecast, which is to say how large the variation of the disturbance term ε_t is, therefore is of no importance at all to the central bank. When the forecast is unbiased, uncertainty will not have an effect on the actual decision. This is known as *certainty equivalence* and thus means that the decisions taken are the same,

5 Holding the rate in proportion to the inflation target as specified by equation (5) results in the lowest loss possible. In this case, the loss is zero. This can be seen by substituting equation (5) and equation (4) in the loss function (1) and expand it. In this simple model, the optimal rate is negative and resource utilisation is positive when the inflation target is positive as a is negative. But the point of the model is not to be realistic but to be simple and to illustrate the significance of certainty equivalence.

6 Once again, this can be checked by substituting the equations (7) and (6) in the loss function (1) and expand it. The smallest possible loss is now no longer zero but equal to the variance of the disturbance term ε_t.

entirely regardless of whether it is known with certainty how the target variables will develop over time or whether an uncertain forecast must be made for them.

A MODEL FOR FORECASTS AND MONETARY POLICY DECISIONS

In the section above, we saw that forecast uncertainty as represented by additive disturbance terms has no effect on the decisions taken by a central bank in a simple forecast model.[7] Certainty equivalence also applies to more complicated forecast models according to the same assumptions, which is to say that the loss function is quadratic, that the forecasts are based on linear relationships and that the only source of uncertainty is additive disturbance terms with a known variation.

A more complicated forecast model for resource utilisation and for the deviation of inflation from the inflation target ($\pi - \pi^* = \hat{\pi}_t$) is described by Giordani and Söderlind (2004).[8] In this model, the central bank adjusts its nominal interest rate (the policy rate) in relation to the long-term sustainable interest rate ($i - i^* = \hat{\imath}_t$) to minimise the variation in its target variables. The model is written as:

(8) $$x_t = E_t x_{t+1} - \gamma(\hat{\imath}_t - E_t \hat{\pi}_{t+1}) + \xi_t^D$$

(9) $$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \alpha x_t + \xi_t^S$$

(10) $$\xi_t^D = \rho_D \xi_{t-1}^D + \varepsilon_t^D, \quad \text{in which } \varepsilon_t^D \text{ is } N(0,1)$$

(11) $$\xi_t^S = \rho_S \xi_{t-1}^S + \varepsilon_t^S, \quad \text{in which } \varepsilon_t^S \text{ is } N(0,1)$$

Equation (8) describes the resource utilisation that the central bank influences by varying its nominal interest rate. One important component of the forecast model is that resource utilisation is determined by the expectations held for resource utilisation in the next period, $E_t x_{t+1}$. Equation (9) describes the relationship between resource utilisation and how much inflation deviates from the target. Here too, an important component is that current inflation deviations depend on how the deviations are expected to develop in the next period, $E_t \hat{\pi}_{t+1}$. The terms ξ^S and ξ^D are persistent supply and demand shocks respectively. In this case too, the choice of parameters follows Giordani and Söderlind (2004), where $\beta =$ 0.99, $\alpha = 0.64$, $\gamma = 0.5$ and $\rho_S = \rho_D = 0.8$. The parameter β designates a subjective discount factor, γ is the intertemporal substitution elasticity and the parameter α specifies how much resource utilisation influences inflation. The parameters ρ_S and ρ_D specify how persistent

7 Given that decision makers minimise the variation of their target variables and that the forecasts are described by linear relationships.

8 Resource utilisation here means the deviation of demand from long-term sustainable production, $y_t - y^* = x_t$.

the supply and demand shocks are, respectively. The equations (8) to (11) can also be written in a compact form:[9]

(12) $$A_0 w_{t+1} = A_1 w_t + B u_t + C\varepsilon_{t+1}$$

Giordani and Söderlind (2004) assume that the central bank's target variables are inflation's deviation from the inflation target and resource utilisation but that the central bank also wishes to avoid sudden and dramatic changes to monetary policy and therefore includes the deviation of the policy rate from its long-term sustainable level in the loss function. The central bank thereby has the following loss function:

(13) $$E_{t|t_0}\left(\sum_{i=0}^{\infty}\beta^i\left(\hat{\pi}_{t+i}^2+\lambda x_{t+i}^2+\mu\hat{i}_{t+i}^2\right)\right)$$

in which $\lambda = 0.5$ and $\mu = 0.2$.[10] In terms of equation (12), we can instead write the loss function as:[11]

(14) $$E_{t|t_0}\left(\sum_{i=0}^{\infty}\beta^i\left(w_{t+i}'Rw_{t+i}+u_{t+i}'Qu_{t+i}\right)\right)$$

According to the traditional, academic conceptual framework, the central bank's problem concerns finding a decision rule for monetary policy so that the value of the loss function (14) is minimised at the same time as the forecasts for inflation and production develop according to (12). As we saw above, this means that uncertainty does not affect the actual decision. In other words, it makes no difference to the central bank's rate setting that we have forecast uncertainty, $C\varepsilon_{t+1}$, in equation (12).

In the same way as in the simple example in the section above, the solution to the central bank's problem is a rule for how the rate is to be set. A monetary policy decision following this rule or policy is *optimal* in the sense that the central bank achieves the smallest possible variation in the target variables.[12] In Diagram 1 below, we see examples of forecast deviations and monetary policy reaction in the event of a positive demand shock. A demand shock may conceivably arise as the result, for example, of a temporary tax change that allows households and companies to increase consumption and investment for a time.

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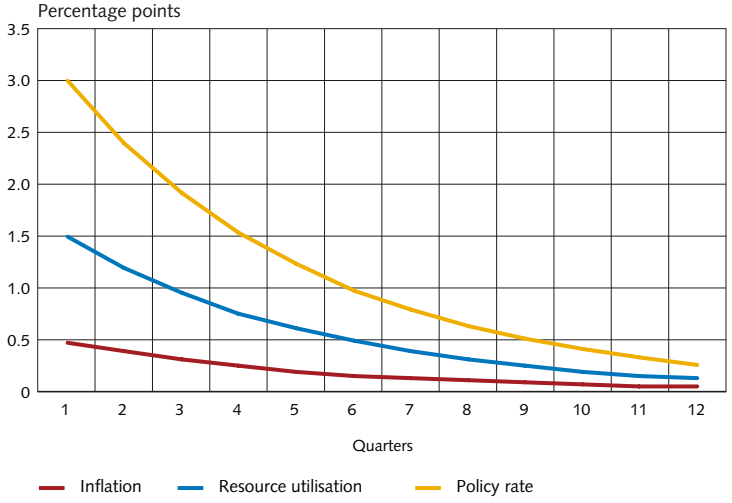
9 $$w_{t+1}=\begin{pmatrix}\xi_{t+1}^D\\ \xi_{t+1}^S\\ E_t x_{t+1}\\ E_t\hat{\pi}_{t+1}\end{pmatrix},\ u_t=\hat{i}_t,\ A_0=\begin{pmatrix}1&0&0&0\\0&1&0&0\\0&0&1&\gamma\\0&0&0&\beta\end{pmatrix},\ A_1=\begin{pmatrix}\rho_D&0&0&0\\0&\rho_S&0&0\\-1&0&1&0\\0&-1&-\alpha&0\end{pmatrix},\ B=\begin{pmatrix}0\\0\\\gamma\\0\end{pmatrix},\ C=\begin{pmatrix}1&0\\0&1\\0&0\\0&0\end{pmatrix},\ \varepsilon_{t+1}=\begin{pmatrix}\varepsilon_{t+1}^D\\ \varepsilon_{t+1}^S\end{pmatrix}$$

10 The numerical values of λ and μ follows Giordani and Söderlind (2004).

11 In which $R=\begin{pmatrix}0&0&0&0\\0&0&0&0\\0&0&1&0\\0&0&0&\lambda\end{pmatrix}$ and $Q=\mu$.

12 Here, we solve the time-consistent (discretionary) problem for the central bank.

Diagram 1. Forecast deviations for inflation and resource utilisation, as well as the monetary policy reaction after a demand shock
Percentage points



Source: Author's own calculations

In Diagram 1, we see that the demand shock leads to resource utilisation initially deviating from forecast by 1.5 percentage points. Higher resource utilisation leads to inflationary pressures arising and, in response to this, the central bank raises its interest rate by about 3 percentage points. Despite this, the forecast deviation for inflation is about 0.5 percentage points after a demand shock. Monetary policy continues to counteract the forecast deviations that have arisen and, after just over 12 quarters, the effects of the shock have abated.

A METHOD FOR MANAGING UNCERTAINTY IN MONETARY POLICY DECISIONS

As we discussed in the introduction, there are several examples in which decision makers at central banks have said they have considered risks and uncertainty. But, in these cases, the usual conceptual framework does not reflect the actual decision-making situation. Neither is the uncertainty a matter of the perceived magnitude of the forecast errors. Rather, the uncertainty is a matter of whether the average relations used to make forecasts are a good description of how the economy is functioning at the time of the decision. A decision-maker may also have misgivings about whether the forecasts consider all important aspects of the economy. It may also be a matter of which basic relationships may be used to make the best possible forecasts of inflation and resource utilisation, for example. This type of uncertainty is usually called model uncertainty.[13] One example of this is if the policy rate, in certain situations, has a stronger effect on resource utilisation and inflation than the

13 The term 'model uncertainty' is used here as a broad designation of the uncertainty that arises over whether a specific dynamic system (that is used to make forecasts) is a satisfactory description of real economic developments. See the introduction in Dulerud and Paganini (2000) for further discussion.

decision maker believes applies on average. In such a situation, the monetary policy, with the average reaction pattern, may result in an exaggerated variation in the central bank's target variables.

The usual conceptual framework is poorly adapted to manage this kind of uncertainty. The fundamental problem is that, in the usual conceptual framework, a small change in the forecast methods can have clear consequences for the decisions taken. This type of problem was already being discussed among control engineers in the 1970s and 1980s. See the discussion in Doyle (1978), for example.[14] To address the way that changes in underlying assumptions effect the forecasts and thereby have consequences for the decisions taken, a branch of control theory was developed which had the management of decisions in an uncertain situation as its primary purpose.[15] This branch of control theory is usually called 'robust control', as it is aimed at managing a situation in which the decision maker wishes to pursue a policy that is robust regarding specification errors.[16] In this type of control theory, it is not unusual for decisions to be aimed at managing the worst conceivable forecasts.[17]

So far in this discussion, we have not made any distinction between the terms 'risk' and 'uncertainty'. However, in discussions of decision-making, it is also common for a distinction to be made between the terms. Hansen and Sargent (2008) present the background to this distinction. Put briefly, 'uncertainty' normally refers to uncertainty that is difficult to quantify or even have an idea of, whereas the term 'risk' is usually reserved for a type of uncertainty that can be identified and quantified, or where it is at least possible to form a subjective idea of the sample space. In the continuing discussion, we will try to maintain this distinction between the terms.

One method for managing decisions taken in conditions of uncertainty has been reported by Hansen and Sargent (2008) and by Giordani and Söderlind (2004). The concept is that a decision maker considers that the forecast model used may have a specification error and that this error, in addition, is unknown. We can illustrate this by suggesting there may be an alternative model that could form the correct description of the relationship between the target variables, and that the forecasts from the main model are consequently being influenced by an unknown disturbance term, ϑ_{t+1}. Forecasts from this alternative model can then be written in terms of the main model:[18]

14 This article is often considered to have one of the best abstracts of any piece of research.

15 See Dulerud and Paganini (2000), Costa, Fragoso and Marques (2010) and Hansen and Sargent (2008) for a discussion of these methods.

16 Specification error means that the dynamic system (which is used to make forecasts) is *not* a satisfactory description of actual economic events.

17 One possible example of this is that safety systems for a nuclear power station are not constructed for a situation in which everything is functioning normally. Instead, the systems are adjusted so that safety can be maintained, even when parts of the safety system have been disabled. The construction of extra safety measures that are not normally used can be seen as insurance. The opposite attitude, only being able to maintain safety systems under normal circumstances, could have catastrophic consequences in the event of an accident that disables the safety systems.

18 See the discussion in chapter 2 of Hansen and Sargent (2008).

(15) $$A_0 w_{t+1} = A_1 w_t + B u_t + C(\varepsilon_{t+1} + \vartheta_{t+1})$$

As earlier, the monetary policy decision is based on minimising the variation in the target variables. At the same time, the decision maker wants monetary policy to be robust if the main model should turn out to have a specification error. This means that the decision maker simultaneously maximises the variation in the target variables that are caused by the disturbance term. This problem can then be described as:

(16) $$\min_{\{u_i\}} \max_{\{\vartheta_{i+1}\}} E_{t|t_0} \Sigma_{i=0}^{\infty} \beta^i \left(w'_{t+i} R w_{t+i} + u'_{t+i} Q u_{t+i} - \theta \vartheta'_{t+i+1} \vartheta_{t+i+1} \right)$$

The decision maker attempts to find a monetary policy that will function in the 'worst case' forecast model, which is unknown.[19] If the worst case model should turn out to be correct, the monetary policy decision will then be appropriate for managing a situation with the target deviations that have been applied. If the economy instead develops in a more positive direction, this robust policy may be far from optimal. The decision maker is thus willing to pay an 'insurance premium' when conditions are normal to be able to manage any problems arising when developments instead become very unfavourable.[20] How much emphasis the decision maker places on managing any specification error is determined by the parameter θ.[21] This approach to decision-making is focused on ensuring that decision are robust in the event that the normal forecast model is wrong about the relationship between the target variables.[22]

In Diagram 2 below, we see forecast deviations and the monetary policy response if a positive demand shock should arise. We see both the case in which the usual conceptual framework is used and also how a decision maker should act when there is uncertainty in order to achieve a robust decision.

19 The reasoning behind the 'worst case' forecast model is that the forecast deviations arising if this model should be correct would be very difficult for the central bank to counteract with monetary policy.

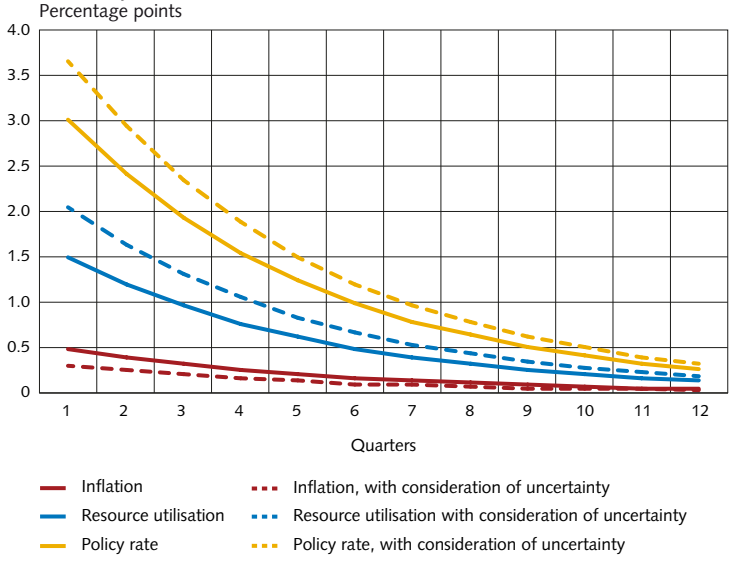
20 See Hansen and Sargent (2008), page 40 onwards, for further discussion.

21 A low value for θ means that the decision-maker has placed great emphasis on a possible specification error in the forecast model. A high value means a fairly low emphasis on specification errors in the model. The numerical example below uses $\theta = 500$.

22 In the numerical simulation that follows, we only solve the time consistent (discretionary) case.

Diagram 2. Forecast deviations for inflation and resource utilisation, as well as the monetary policy reaction after a demand shock, with and without consideration of uncertainty

Percentage points



Source: Author's own calculations

In Diagram 2, we can be seen that the demand shock leads to resource utilisation deviating from the forecast by 1.5 percentage points when the central bank does not take account of uncertainty, while the forecast deviation in the 'worst case' forecast is 2.0 percentage points. We can also see that monetary policy reacts more strongly to the forecast deviations when the decision maker takes account of uncertainty and acts robustly, and the policy rate is now raised a little over 3.5 percentage points. At the same time, the forecast deviation for inflation is slightly less when the central bank considers the uncertainty. The central bank now attaches importance to the demand shock possibly having a greater effect on resource utilisation than in the normal case and therefore reacts more strongly to the shock. The consequence of this is that inflation is slightly lower than would otherwise be the case.

The method thus is a matter of managing forecasts that risk leading to very high losses for the target variables and that the decision makers find particularly difficult to manage. For monetary policy decisions, this means, for example, that decision makers tend to focus on forecasts in which shocks to the economy have greater effects or are more persistent, as opposed to circumstances in which shocks are small and tend to vanish quickly.

However, considering risks and uncertainties in a decision need not always be the same as managing the worst conceivable forecast. In theory, the method may be an attractive principle for monetary policy decisions, but, in practice, this may mean that the central bank risks focusing entirely on highly unlikely forecasts. It cannot be ruled out that this, in turn, may lead to poor average goal fulfilment. Another problem with the method is that,

in practical, decision-making situations, a decision maker may often need to manage and communicate a specific uncertainty (that is, the decision maker rather needs to manage and communicate a risk), while the uncertainty that this method defines may be seen as somewhat theoretical and abstract.

This method works for general uncertainty. With a loss function, the worst case forecast is then made, followed by a robust policy capable of managing the forecast deviations arising in that case. However, there are other methods for managing risks and uncertainty in decision-making that reduce how sensitive a decision is to the analytical assumptions that a decision maker needs to take a stance towards.[23] In the next section, we describe one of these methods.

A METHOD FOR ANALYSING MONETARY POLICY AND RISKS

Unlike the method presented in the section above, there is a method that focuses more on managing and quantifying specific risks in decision-making. This has been described by Costa, Fragoso and Marques (2010). The method is formulated to manage situations in which the decision maker needs to specify in advance which risks are to be considered and how large they are. Svensson and Williams (2008) then expanded the method to also deal with forecast models with forward-looking expectations. The method has the advantage of being fairly simple but simultaneously flexible enough to illustrate a series of different types of risk that may be relevant for a decision maker. See Svensson and Williams (2008) for a discussion.[24]

As with the section above, we can illustrate the risk of using a forecast model with a specification error with this method. The idea is to allow the risk to be represented by the possibility of the economy shifting between these two (or more) different forecast models. This shift is described by a Markov chain with transition probabilities:[25]

$$P = \begin{pmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{pmatrix} \tag{17}$$

In the equation (17), p_{00} describes the probability that the forecasts will be generated by a model in the next period, given that this model has been used as a starting point for forecasts. Reversed, p_{01} then describes the probability that the forecasts will be generated by another model over the coming period. Consequently, at any point in time, the decision maker may realise that the forecast model being used is incorrect and that another model instead provides the correct description of the actual relationship between the

23 See, for example, Onatski and Williams (2003) or Brock, Durlauf and West (2003).

24 The method is not normally subject to certainty equivalence as the degree of risk will influence the optimal policy. There may, however, be special cases in which even this method may lead to decisions that are subject to certainty equivalence.

25 For a discussion of Markov processes (chains), see Stroock (2014). The transition probabilities are here assumed to be unchanged by the state and over time. However, there is nothing to prevent these transition probabilities being functions of the (lagged) state or of time. The appendix shows how both the formation of expectations and monetary policy depend on these transition probabilities.

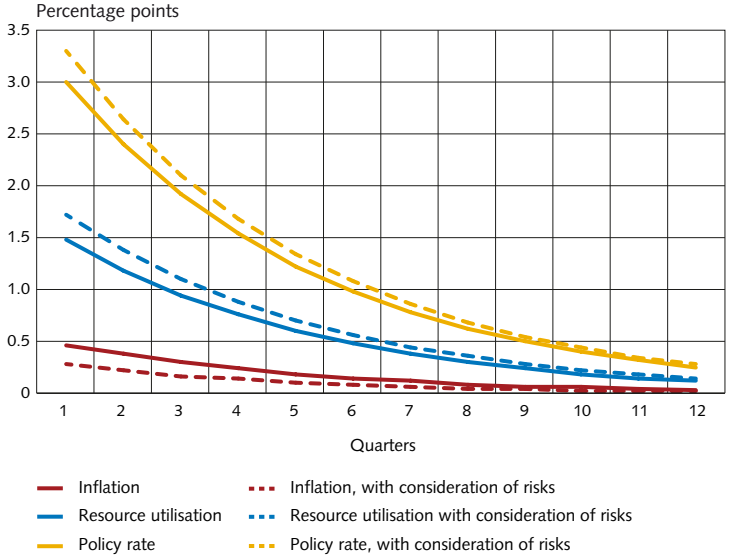
target variables. As p_{00} and p_{01} are probabilities, this means that if p_{00} = 50 per cent, the probability for $p_{01} = 1 - p_{00}$ is also 50 per cent.

In this way, forecasts from different models can represent various mode forecasts, which is to say the most probable forecast given a certain forecast model.[26] A final average forecast is then obtained by weighing the various mode forecasts together with their respective probabilities. The Markov chain means that it can be defined, in a simple manner, how the risk of shifting between the mode forecasts changes over the forecast horizon.

To refer back to the previous example, we can allow a forecast to be generated by the equation (12), which is to say $A_0 w_{t+1} = A_1 w_t + Bu_t + C\varepsilon_{t+1}$, while an alternative forecast model is represented by equation (15), which is to say $A_0 w_{t+1} = A_1 w_t + Bu_t + C(\varepsilon_{t+1} + \vartheta_{t+1})$.

The probability of shifting between the forecast models is set at 50 per cent in all cases. Even if the central bank uses equation (12) to make forecasts, it will react more strongly to shocks than otherwise, as it takes account of the possibility that it is an incorrect forecast model and that the alternative forecast model (15) instead provides the correct description of the relationship between the target variables.

Diagram 3. Forecast deviations for inflation and resource utilisation, as well as the monetary policy reaction after a demand shock, with and without consideration of risks
Percentage points



Source: Author's own calculations

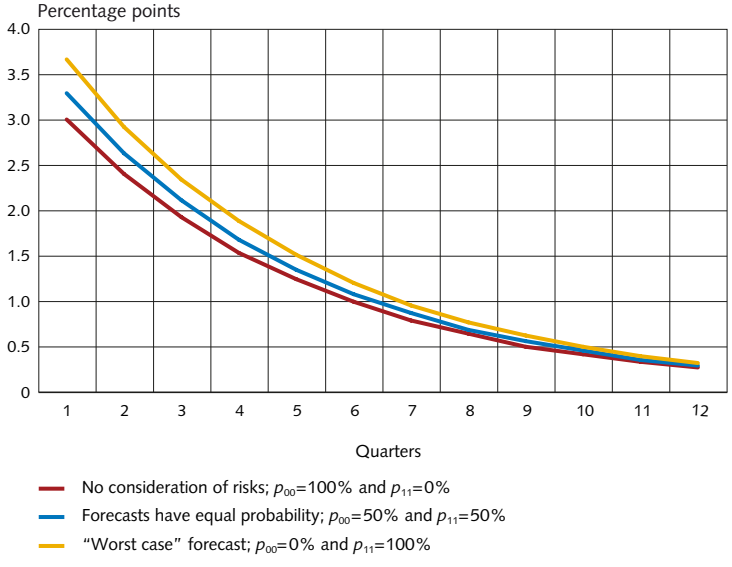
In Diagram 3, we see that a demand shock leads to resource utilisation deviating from forecast by 1.75 percentage points when there is a 50 per cent risk of the worst case forecast being correct. The forecast deviation is thus a little higher than in the case in which the central bank does not take account of risks. The expected forecast deviation for inflation in the case in which the central bank takes account of risks is around 0.25

26 The mode value of a stochastic variable is the most probable outcome.

percentage points and, just as before, the deviation is around 0.5 percentage points when the central bank does not take account of any risks.[27] In Diagram 3, we also see that monetary policy reacts more strongly when the decision maker takes account of the risk of the worst case forecast being correct. In this case, the policy rate is raised by 3.25 percentage points, which is higher than when the central bank does not take this risk into account.

The monetary policy reaction is due to the possibility that the central bank will have to change its forecast model.[28] This means that the monetary policy decision no longer has to be subject to certainty equivalence but depends on risks, here in the form of a future change of forecast model. This is illustrated in Diagram 4 below.

Diagram 4. Monetary policy reaction after a demand shock, with different probabilities for the forecasts
Percentage points



Source: Author's own calculations

The difference between the different monetary policy reactions to a demand shock is thus a matter of differing probabilities. In the diagram, we can see that, when the probability is 100 per cent that the worst case forecast is correct, the monetary policy response becomes the same as when the central bank is acting under genuine uncertainty, according to the method presented in the previous section.[29] With this method, we can thus replicate the monetary policy subject to uncertainty via the probabilities in the Markov chain. However,

27 Precisely as in Diagram 2, the central bank takes into account that the demand shock may have a greater effect on resource utilisation than in the normal case and therefore reacts more strongly to the shock. The consequence of this is that inflation is slightly lower than it would otherwise be.

28 That is to say, change forecast model because the alternative model is the correct description of the relationship between the target variables.

29 The 100 per cent probability of the worst case forecast model corresponds to transition probabilities p_{00} = of 0 and p_{11} = 100 per cent.

this requires that the worst case model is known in advance. If this method is to be used as a tool to manage risks in decisions, a decision must thus be taken as to which risks are present and their extent. The probabilities may be empirically founded, but may also be entirely subjective. Blake and Zampolli (2006) discuss the possibility of letting both the central bank and the market participants have subjective perceptions of the risks that, in addition, may differ from the actual, objective risks.

WHAT CAN HAPPEN WHEN MONETARY POLICY INFLUENCES RISKS?

So far, we have assumed that the probability of the risks can be taken as given. For a small, open economy, there are many international risks that the central bank must manage and that, with good reason, may be considered as given. On the other hand, it cannot always be assumed that all risks are always independent of monetary policy. This is an important issue as the conditions for monetary policy can change rapidly if it influences the risks itself. Such an influence could have consequences for variations in inflation and resource utilisation if the central bank adjusts its policy rate. Among other things, this can affect the scope of the central bank's reaction via the policy rate when various shocks occur in the economy.

As an illustrative example, we allow the demand shock to be affected by the policy rate, so that monetary policy has an impact on the actual shock in a case in which the alternative model is correct:[30]

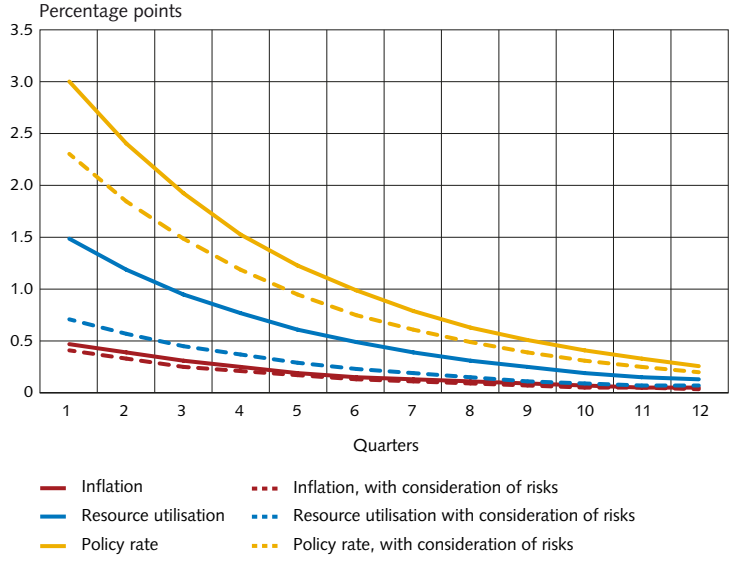
$$\xi_{t+1}^{D} = \rho_D \xi_t^D + \psi(s_t)\hat{\imath}_t + \varepsilon_{t+1}^{D} \tag{18}$$

in which $\psi(s_t = main\ model) = 0$ and $\psi(s_t = \text{“}worst\ case\text{”}\ model) = -0.1$. This parameter is aimed at illustrating that monetary policy in itself can have a direct impact on the shocks the economy is exposed to. In Diagram 5 below, we see that, when ψ could be negative, the central bank instead reacts slightly less to a demand shock than would otherwise be the case, when account is not taken of risks.

30 This reasoning is based on the discussion in Svensson, Lars E. O. (2003), section 7. Another way in which monetary policy can affect risks is through the direct or indirect influence of the central bank's policy rate on the transition probabilities in the Markov chain.

Diagram 5. Forecast deviations for inflation and resource utilisation, as well as the monetary policy response after a demand shock, with and without taking risks into account

Percentage points



Source: Author's own calculations

Just as previously, the central bank raises the policy rate by 3 percentage points when risks are not taken into account. As there is a 50 per cent risk that the worst case forecast is correct, the policy rate is now raised to a lesser extent, by about 2.4 percentage points. The reason for this is that, according to equation (18), when a demand shock occurs, an interest rate higher than the equilibrium rate will lead to the shock being smaller than it would if the alternative model is correct. The tendency of the worst case forecast to give a greater forecast deviation is more than compensated for by monetary policy, at the same time, counteracting the demand shock more powerfully. We can see this in Diagram 5, where the forecast deviation for resource utilisation now becomes slightly lower, around 0.75 percentage points, compared with the case in which risks are not taken into account.

THERE ARE NO EASY ANSWERS FOR HOW RISKS SHOULD BE MANAGED

The influence of risks on monetary policy is basically a matter of the forecast relationship assumed by the central bank.[31] Neither need taking account of risks in monetary policy be reduced to a question of the extent of the central bank's reaction to the shocks affecting the economy. There are cases in which consideration of risks is instead expressed by weighing into a decision factors that would be of little significance to the central bank's target variables under normal circumstances (in this case, inflation and resource utilisation).

31 Leitemo and Söderström (2008) show that, for a small, open economy, taking account of uncertainty can mean that the central bank occasionally reacts more aggressively to shocks but that the result can occasionally be the reverse. It all depends on which shocks occur and on how the links the forecasts are based on are constructed.

A forecast model that makes good forecasts of resource utilisation and inflation under normal circumstances can make very poor forecasts in special situations, such as, for example, if financial frictions are deemed to be influencing the economy in a way that the simple model does not take into account. Another, possibly more complicated model with links between the financial and real economies could then provide better forecasts. In such a case, taking account of risks in a monetary policy decision could involve factors that, under normal circumstances, play a minor role being weighed in, as these play an important role in particular situations.

By analysing various forecast models, account can be taken of a series of different risks in a decision. For example, we can analyse risks linked to the persistence of inflation shocks, an increased variability for inflation shocks or the relationship between demand pressure and inflation by allowing different forecast models to represent it.[32] In the same way, we can also analyse the consequences for monetary policy decisions when there is a risk that the effects of monetary policy will be weaker or stronger than normal. The risk of entering a crisis situation can also be examined by varying the magnitude of the shocks in different forecast models. Risks associated with financial frictions can be analysed by representing these financial frictions in a forecast model. Risks concerning the level of resource utilisation and between two (or more) opposing points of view on how the economy works can also be analysed in a similar way.

WHAT EXACTLY ARE THE DIFFERENCES BETWEEN VARIOUS METHODS FOR MANAGING DECISIONS SUBJECT TO UNCERTAINTY AND RISK?

In a theoretical sense, there is one important difference between considering uncertainty and considering risks in a decision. In one case, as presented in this article, decisions that are subject to uncertainty are best managed by focusing entirely on the worst conceivable forecast, for example the forecasts that give the greatest variation in the target variables. This way of reasoning is a way of taking decisions under genuine uncertainty, which is to say when the decision maker is unable either to assess the scale of the risks or even to identify the various risks existing. However, using this principle, the central bank will also always focus its decision on the worst conceivable forecast, even if it is not a particularly likely forecast.

The other method concerns managing risks in decision-making and is based on the decision maker assessing the scale of the risks and the effects these have on the economy.

However, the differences between these methods need not be so great when a decision is made in practice. In theory, the worst case forecast may be a consequence of the risk preferences a central bank may conceivably have.[33] In practice, the worst case forecast

32 For example, the risk that the relationship between resource utilisation and inflation has become lower is represented by a model with a flatter Phillips curve. See Blake and Zampolli (2006) or Demers (2003) for an example of this.

33 See Hansen and Sargent (2008), page 40 onwards, for further discussion.

is often limited by a rule of action.[34] One such rule of action focuses on trying to find a value for the parameter θ (see equation (16)) with the assistance of statistical methods.[35] In other words, an indirect decision is taken as to what the worst-case forecast may be by limiting the results in advance. Sims (2001) also discusses the problems in seriously taking account of all the uncertainty existing over economic relationships. The tendency to limit the sample space when identifying the worst-case forecast is thus always present. In an actual decision-making situation, the different points of view may therefore have a closer resemblance than they do in theory.

CONCLUSION

In this article, we have addressed the issue of whether and how monetary policy decisions can deal with uncertainty and risks. However, the presence of risks does not always have to be a decisive factor for monetary policy. In many cases, it is difficult to quantify the risks and neither is it clear how monetary policy should actually deal with risks. Neither can it be ruled out that a satisfactory strategy for managing risks could be to act as if under certainty equivalence. However, entirely disregarding risks in this way has the disadvantage that the central bank may enter into situations in which a monetary policy decision seems to be well-balanced according to one forecast, a conclusion that needs not necessarily hold true if there is uncertainty over the relationships used to make the forecasts. It may then be attractive to use methods in which account can be taken of uncertainty in decision making. Completely focusing on decisions for managing uncertainty could, on the other hand, lead to average target fulfilment suffering. In the longer term, it cannot be ruled out that this approach will lead to other types of uncertainty arising.

A method lying between both of these approaches could then be a practical compromise. Different forecast models could represent various possible descriptions of the world. The risks in the decision can be highlighted by weighing monetary policy in the different descriptions of the world together with their respective probability. This will make it possible for monetary policy to be characterised by consideration of risks but, at the same time, these risks must be defined and quantified. It will also increase possibilities for monitoring and evaluating the account that has been taken of the risks in the decisions.

34 See the discussion in Sims (2001) and Hansen and Sargent (2008).

35 A method based on error detection probabilities is often used. See Chapter 9 of Hansen and Sargent for further discussion.

APPENDIX: THE METHOD OF SOLVING A MONETARY POLICY PROBLEM IN WHICH RISKS ARE REPRESENTED BY A MARKOV CHAIN

The starting point is that a central bank minimises the value of the following loss function:

(19) $$E_t\left(\sum_{i=0}^{\infty}\beta^i\left(w_{t+i}'Rw_{t+i}+u_{t+i}'Qu_{t+i}\right)\right)$$

where $w=\begin{pmatrix}z\\ \tilde{z}\end{pmatrix}$ and $z=\begin{pmatrix}\zeta^D\\ \tilde{z}^D\\ \zeta\end{pmatrix}$ are predetermined variables and $\tilde{z}=\begin{pmatrix}x\\ \hat{\pi}\end{pmatrix}$ are forwardlooking variables. The central bank employs a vector with control variables, u, and matrices R and Q contains weightings for the central bank's target variables. The parameter β is a subjective discount factor that specifies how the central bank weighs target deviations in the near future against those later on. Target variables and other state variables are evolving as follows:

(20) $$A_{01}(s_t)\,z_{t+1}=A_{11}(s_t)\,z_t+A_{12}(s_t)\,\tilde{z}_t+B_1(s_t)\,u_t+C_1(s_t)\varepsilon_{t+1}$$

(21) $$E_t(A_{02}(s_t)\,\tilde{z}_{t+1})=A_{21}(s_t)\,z_t+A_{22}(s_t)\,\tilde{z}_t+B_2(s_t)\,u_t+C_2(s_t)\varepsilon_{t+1}$$

To illustrate the possibility that the economy will function differently in different states, it is assumed here that the parameters are statedependent, where s_t signifies the state. We assume here that there are only two states in the economy ($N=0.1$) which is assumed to follow a Markov chain with transition probabilities:

(22) $$P=\begin{pmatrix}p_{00} & p_{01}\\ p_{10} & p_{11}\end{pmatrix}\quad \text{where } p_{ij}\equiv p(s(t+1)=i\,|\,s(t)=j).$$

The value function in a given state i is:

(23) $$(w_t'V(i)_t w_t+\omega)=\min_{\{u_i\}}(w_t'Rw_t+u_t'Qu_t+\sum_j^N p_{ij}E(w_{t+1}'V(j)_{t+1}w_{t+1}+\omega))$$

The time consistent (discretionary) solution involves monetary policy and the private sector's expectations having the following decision rules:

(24) $$u(i)_t=-F(i)\,z_t\quad \text{for } i=0,1$$

(25) $$E_t(\tilde{z}_{t+1})=G(i)\,z_t\ \text{ for } i=0,1$$

where $F(i)=[\tilde{Q}(i)+\sum_j^N p_{ij}\tilde{B}(j)'V(j)_{t+1}\tilde{B}(j)]^{-1}[\tilde{R}(i)+\sum_j^N p_{ij}\tilde{B}(j)'V(j)_{t+1}\tilde{A}(j)]$,

$G(i)=\bar{A}(i)-\bar{B}(i)F(i)$,

$\tilde{A}(i)=A_{11}(i)+A_{12}\bar{A}(i)$,

$\tilde{B}(i)=B_0(i)+A_{12}\bar{B}(i)$,

$$\tilde{R}(i) = \bar{A}(i)' R \bar{B}(i),$$

$$\tilde{Q}(i) = Q + \bar{B}(i)' R \bar{B}(i),$$

$$\bar{A}(i) = [A_{22}(i) - \Sigma_j^N p_{ij} G(j)\, A_{12}(j)]^{-1} [\Sigma_j^N p_{ij} G(j)\, A_{11}(j) - A_{21}(i)],$$

$$\bar{B}(i) = [A_{22}(i) - \Sigma_j^N p_{ij} G(j)\, A_{12}(j)]^{-1} [\Sigma_j^N p_{ij} G(j)\, B_0(j) - B_1(i)]$$

The decision rules, (24) and (25), are thus affected by the probability of changing state from the state currently prevailing.

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