Lessons from the high inflation period

Selena Durakovic, Jesper Johansson and Oskar Tysklind*
Monetary Policy Department, Sveriges Riksbank

Inflation rose rapidly and unexpectedly in Sweden in early 2022. It then fell back at a similar pace, approaching 2 per cent in 2024. This surge in inflation was a result of major changes in both supply and demand following the pandemic and Russia's invasion of Ukraine. The large shocks to the economy at that time also changed the pricing behaviour of firms, which meant that the shocks had a faster and greater impact on inflation than before.

The pandemic and the economic disruptions that followed in its wake were not possible to foresee. Nor was the war in Ukraine. But it is reasonable to ask whether we as forecasters could have better understood the economic impact of these shocks on inflation and the wider economy using economic models and the data available at the time. In this article we summarize the analyses that the Riksbank and others have made to better understand the causes of the surge in inflation in Sweden. Based on this analysis we draw some conclusions for better forecasting in the future, the most important being that inflation dynamics can be very different in an environment with many and large shocks, and that it is important to be able to recognise such an environment at the earliest possible stage.

1 Introduction

In recent years, we have seen very large fluctuations in inflation both in Sweden and in other countries. Inflation rose rapidly in 2021 and 2022, before falling back almost as quickly again. In Sweden, CPIF inflation started to rise at the end of 2021 due to rising energy prices. Measured as the CPIF excluding energy, inflation only started to rise significantly in January 2022 (see Figure 1 on the next page). Inflation peaked around the turn of the year 2022/2023 and then fell back and was close in 2024 to the Riksbank's inflation target of 2 per cent.

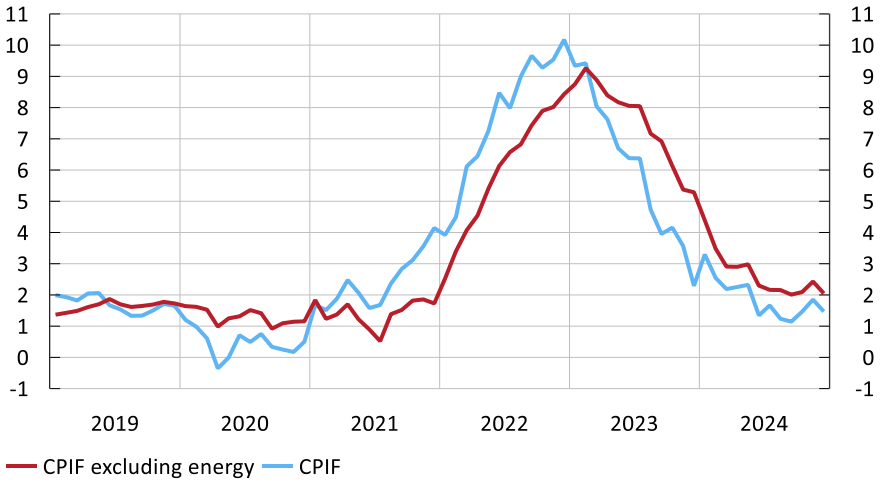
However, while inflation has slowed, prices have remained at a higher level. In Figure 2 we can see the evolution of the price level in relation to a historical trend over these years. Here we see that the price increases have been largest for goods and food. It also shows that most of the price increase took place in 2022. Energy prices also rose

* We would like to thank Vesna Corbo, Ingvar Strid, Mårten Löf, Pär Stockhammar, Ulf Söderström and Marianne Nessén for valuable comments on the article. The opinions expressed in the article are those of the authors and are not to be seen as the official view of the Riksbank.

rapidly in 2022 but have since fallen back significantly and are now back roughly to their historical trend. Service prices have risen slightly less and more gradually than prices on goods and food.

Figure 1. The CPIF and the CPIF excluding energy 2019 - 2024

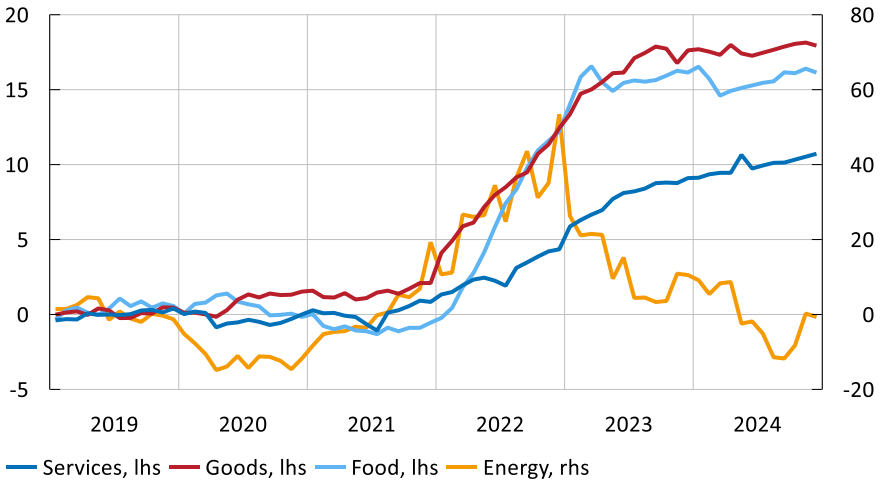
Annual percentage change



Sources: Statistics Sweden and the Riksbank.

Figure 2. Price levels in sub-groups of the CPIF

Deviation from historical trend, per cent



Note. The trend is estimated as an exponential trend over the period 2000–2021 and then projected at the same rate of increase for the years 2022 onwards.

Sources: Statistics Sweden and the Riksbank.

In this article, we summarise what we have learned from the analysis and studies published on inflation in recent years.[1] We also add new analysis to provide a

[1] In the past years the Riksbank has published a sequence of analyses that in different ways are about the surge in inflation, see for example Den Reijer et al. (2025), Håkansson and Laséen (2024), Johansson et al.

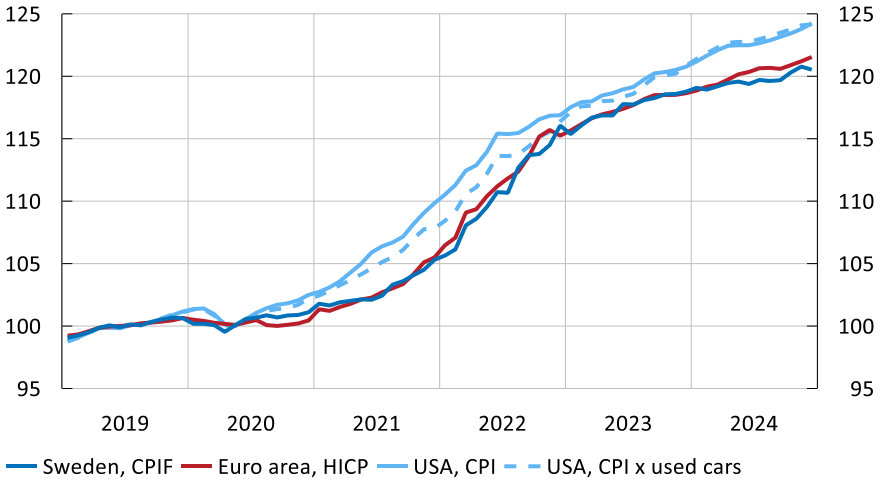
comprehensive picture of what was behind price developments during this period. Additionally, we try to gather lessons learnt for the future.

The article is organised as follows. First, we make a global comparison of inflation trends. We then take a closer look at macroeconomic developments in Sweden and firms' pricing behaviour to tell a coherent story about developments over the period. Finally, we discuss lessons learnt from this period and how they have affected, and will affect, the Riksbank's inflation analysis going forward.

2 A global comparison of inflation

It was not only in Sweden that inflation rose. Figure 3 below shows the price development of the CPIF in Sweden compared with the HICP in the euro area and the CPI for the United States.

Figure 3. Price developments in various countries and regions 2019 -2024
Index 2019 =100



Note. Figure refers to the CPIF for Sweden, the HICP for the euro area and the CPI for the United States.

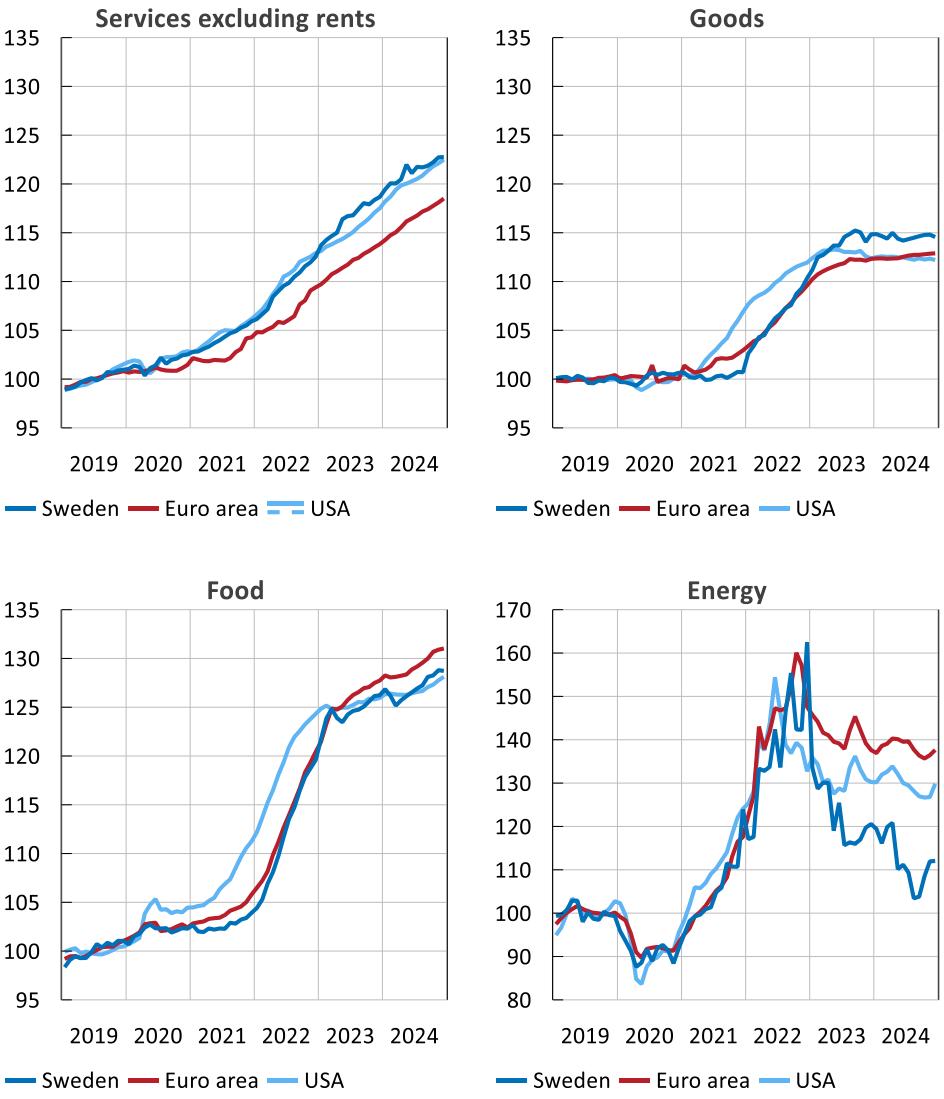
Sources: Statistics Sweden, Eurostat and the US Bureau of Labor Statistics.

What can be noted is that the price increase started a little earlier in the United States than it did in Europe, but that the development has been broadly similar. The fact that inflation started rising a little earlier in the United States has several explanations. One is that there are relatively large differences in the goods and services included in the index calculations and also in their weighting. In the United States, prices of used cars contributed to the initial increase. This is because used cars have a greater weight in the US index than in Europe and price increase there was greater in 2021. Excluding this component, the increase in inflation in the United States leads that in Europe by around three months.

(2022), Johansson and Tysklind (2024), Klein et al. (2024a and 2024b), Lindskog and Lovéus (2023), Löf and Stockhammar (2024), Petterson et al. (2024) and Tysklind (2024).

To enhance the comparability, we also look at measures where some of the weight differences and effects from index construction are smaller. One way to do this is to look at developments in different sub-aggregates. Figure 4 shows the price development of services excluding rents, goods, food and energy for the same regions.[2] Rents are excluded because they represent a large share of service prices – especially in the United States – and because rent setting works differently in different regions. Therefore, they are not deemed to reflect the underlying and comparable service price developments.

Figure 4. Index development for different sub-aggregates 2019- 2024
Index 2019 =100



Note. The figure refers to the CPIF for Sweden, the HICP for the euro area and the CPI for the United States.

Sources: Statistics Sweden, Eurostat and the US Bureau of Labor Statistics.

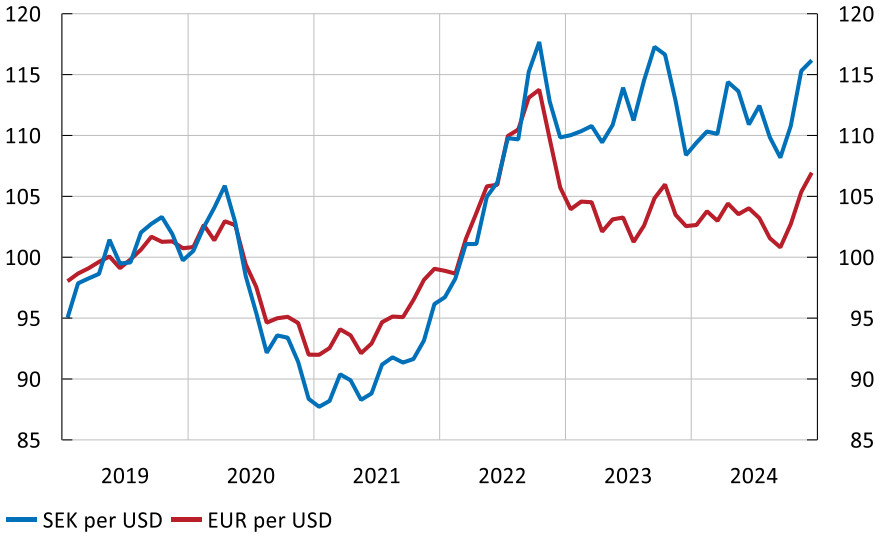
[2] The data In Figure 4 are not trend-corrected as in Figure 2. Therefore, the figures for Sweden differ between Figure 2 and Figure 4.

Even at the sub-index level, the price increases are similar. The main differences are that service prices rose a little later and a little less in the euro area and goods and food prices rose a little earlier in the United States. The rise in consumer energy prices was highly synchronised, but prices have since fallen back relatively quickly in Sweden compared with the United States and even more so compared with the euro area.

One explanation for the earlier rise in goods and food prices in the United States could be the weakening of the US dollar in 2020. Figure 5 shows the development of the exchange rate between the US dollar and the Swedish krona and the euro. A higher value implies a stronger US dollar. It can be seen that the dollar weakened relatively significantly in 2020 and 2021, which had a dampening effect on price developments in Sweden and the euro area relative to the United States. However, at the beginning of 2022, the dollar started to strengthen strongly in connection with Russia's invasion of Ukraine, while the Swedish krona in particular was relatively weak. The krona remains on a relatively weak level, which may have contributed to the fact that the overall increase in goods prices has been somewhat greater in Sweden than in other regions during the period.

Figure 5. Nominal exchange rate against the USD 2019 – 2024

Index 2019 =100



Note. The figure shows the development of the Swedish krona and the euro, respectively, against the USD. A higher value implies a stronger USD.

Source: Macrobond.

Nevertheless, overall, price developments are very similar in all three regions, and national factors such as the exchange rate and domestic wage developments seem to have played only a marginal role.

3 Why did inflation rise?

Given the similarity of inflation developments across the regions, it is reasonable to assume that inflation in these countries has been driven to a large extent by the same

global factors or at least similar forces. Looking back over the past few years, there have also been a number of major global events, the most notable being the coronavirus pandemic and Russia's invasion of Ukraine. In this section, we will focus on developments in Sweden, but the explanations presented largely apply globally as well.

3.1 Demand rose rapidly across sectors

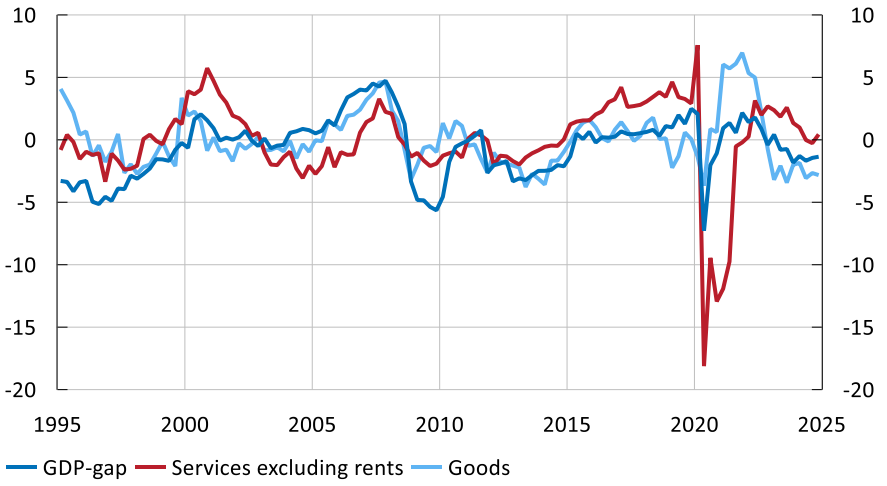
Aggregate demand, measured for example by the Riksbank's GDP gap, was at a high, but not exceptionally high, level when inflation picked up.[3] This could be interpreted as suggesting that demand was not a major factor behind the rise in inflation, as the GDP gap has been at higher levels in the past without inflation picking up (see Figure 6). However, what is not reflected in aggregate measures of demand is that there were large shifts in demand for goods across sectors during and after the pandemic. During the pandemic, demand was sustained by monetary and fiscal stimulus, while the restrictions imposed held back the consumption of services. Demand therefore shifted from services to goods during the pandemic. Once the pandemic was over and restrictions were lifted, demand for services increased rapidly.

One way to illustrate these developments is to construct measures of demand for different types of consumption. In Figure 6, the Riksbank's aggregate GDP gap is shown together with consumption broken down into goods and services, expressed as a percentage deviation from an estimated trend. These figures show, for example, that the demand for goods at the beginning of 2021 was at the highest level recorded during the inflation targeting period and that the demand for services was high in 2022. This demonstrates that although total demand as measured by the GDP gap has not been remarkably high over the period, it has periodically been so in different parts of the economy. What is also evident is that consumption fluctuated very strongly at the sectoral level over the period. This pattern is not seen just in Sweden, but in many other countries as well.

[3] The GDP gap describes the evolution of GDP relative to an estimated trend level.

Figure 6. GDP and consumption gaps 1995 - 2024

Deviation from trend, per cent



Note. The GDP gap is the Riksbank's estimated gap. Gaps for goods, services refer to the percentage deviation from the HP trend of seasonally adjusted data at constant prices as shown in the national accounts.

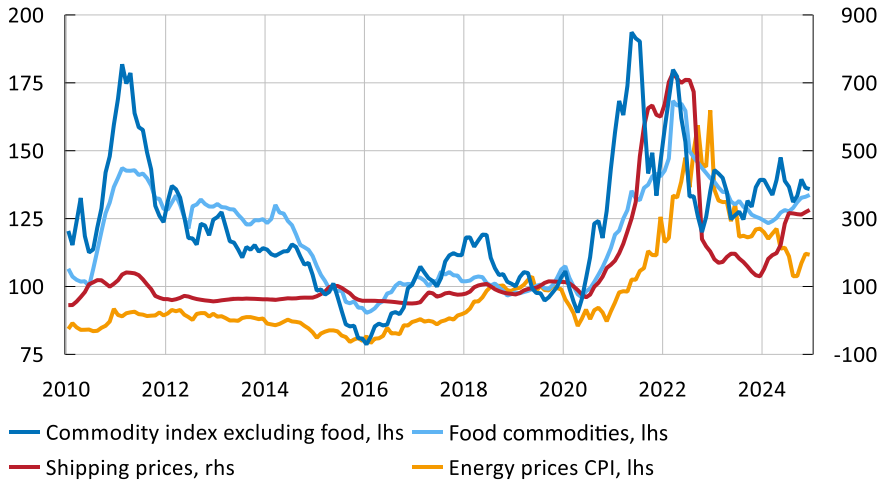
Sources: Statistics Sweden and the Riksbank.

3.2 Increases in commodity prices and labour costs

Other important factors behind the consumer price increases were rising commodity prices and labour costs. Figure 7 shows developments in prices of energy, other commodities and freight on the world market from 2010 onwards. It shows that the prices of industrial commodities began to rise sharply as early as the beginning of 2020. Towards the end of 2020 and the beginning of 2021, freight and food commodity prices also started to rise sharply. Finally, energy prices for end consumers also picked up significantly towards the end of 2021. This increase was mainly driven by a relatively strong rebound in the price of natural gas, but also by the recovery of oil prices after a sharp decline at the start of the pandemic. At the same time, electricity prices in Sweden rose due to abnormally low levels in Nordic water reservoirs and little wind. Forward pricing at the beginning of 2022 pointed clearly to falling prices for almost all energy types (see Figure 8). In other words, the market at the time judged the energy boom to be temporary.[4]

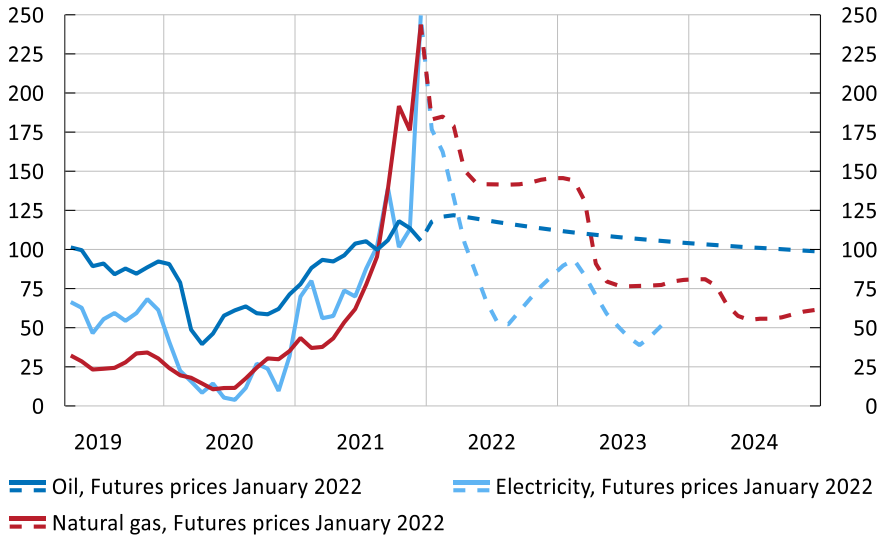
[4] For a longer discussion of how this was assumed to affect other prices, see Sveriges Riksbank (2022a).

Figure 7. Energy and commodity prices on the world market 2019 - 2024
Index 2019 =100



Sources: ICE, The Economist and Baltic dry.

Figure 8. Energy prices 2019 – 2021, forward prices as of January 2022
Index 2021=100

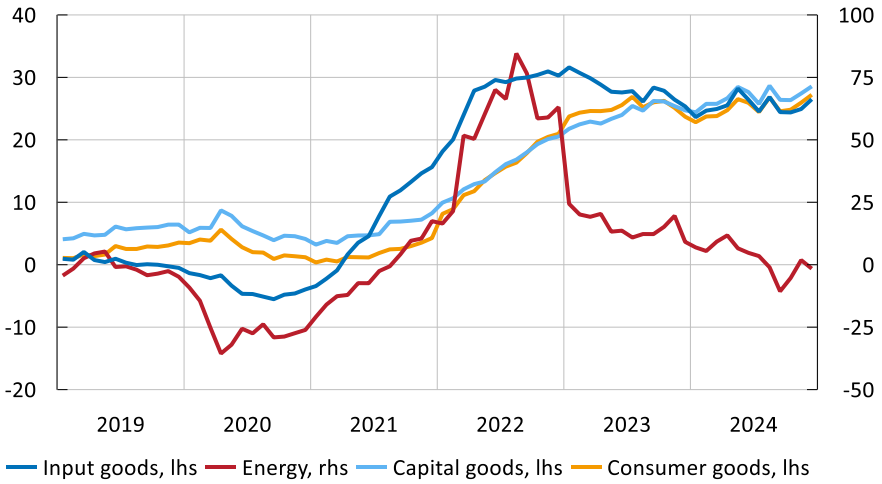


Sources: ICE and Nordpool.

Changes in commodity prices have a limited direct impact on consumer prices. The biggest impact instead comes from the fact that commodities are used as input in production. Hence, in Figure 9 we show the development of producer prices in Sweden relative to trend between 2000 and 2020. We can see that producer prices for intermediate goods started to rise significantly faster than before as early as the beginning of 2021, almost a year before the prices of consumer goods and capital goods aggregates started to rise significantly faster. Energy prices also rose in 2021, but from relatively low levels. Only towards the end of 2021 and especially in 2022 did the energy price level start to become clearly above its historical trend. Energy prices then fell back relatively quickly already in 2023, while the other sub-indices remained at the new elevated level.

Figure 9. Producer prices 2019 -2024

Deviation from historical trend in per cent



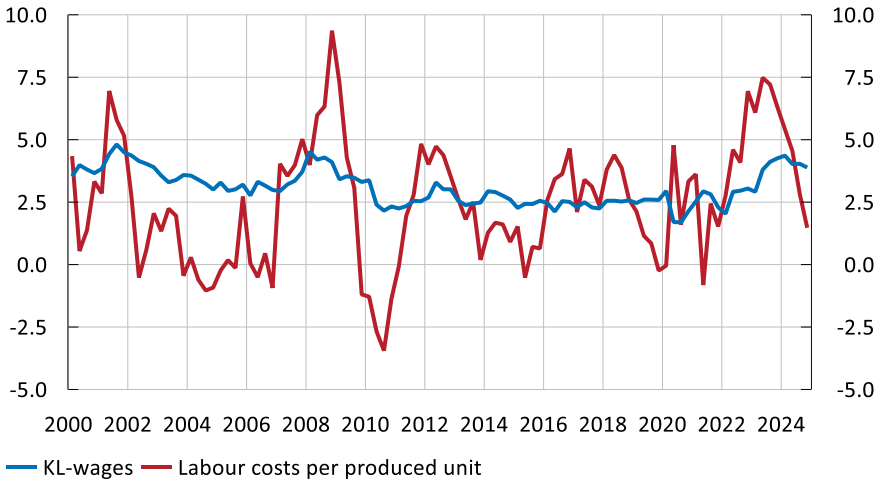
Note. The figure refers to the price index for domestic supply. The trend is estimated as an exponential trend over the period 2000–2020 and then projected at the same rate of increase for the years 2021 onwards.

Sources: Statistics Sweden and own calculations.

Figure 10 shows how wages and labour costs have developed. There, we can see that unit labour costs started to rise faster in 2022, mainly driven by a fall in productivity when output fell more than the number of hours worked. Wage growth remained subdued in 2022 before new, higher wage agreements were negotiated from 2023. Wage growth in Sweden was also lower than in many other European countries in 2022 and 2023.

Figure 10. Wages and unit labour costs 2000 - 2024

Annual percentage change



Note. Unit labour costs are intended to measure labour costs adjusted for productivity and are calculated using national accounts data as total labour costs divided by GDP.

Sources: Statistics Sweden, the Swedish National Mediation Office and the Riksbank.

Overall, we thus see that firms' costs increased broadly in 2021 and 2022, with both input and labour prices rising unusually fast.

3.3 Both supply and demand contributed to the upturn in inflation

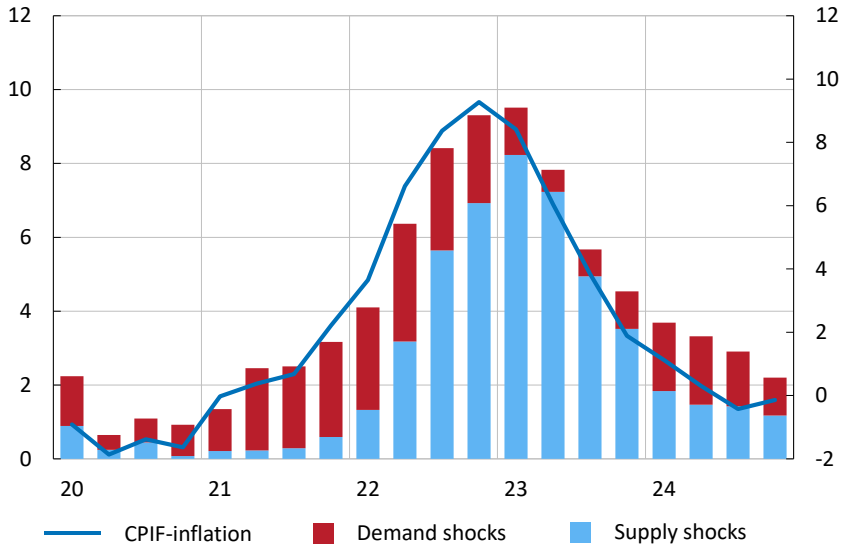
In Sweden as well as internationally, economists have discussed what primarily drove the rise in inflation: supply or demand. The reason for this is that the underlying driving forces can have a major impact on the design of monetary policy.

A number of studies have used different modelling approaches to decompose the rise in inflation into supply and demand factors. Löf and Stockhammar (2024) estimate a few different models that have been used internationally on Swedish data. In this section, we present updated results from them, supplemented with new analyses.[5]

We build on previous work by Shapiro (2024) to estimate simple VAR models for 75 different consumption sub-aggregates. Based on these estimates, we then group the price movements of the different sub-indices in each period as either demand or supply driven. In Figure 11 these estimates have been updated to include 2024. We can see that the implications from the analysis conducted by Löf and Stockhammar in 2024 are still valid suggesting that supply shocks dominated during the period when inflation was at its highest, but that demand have had a non-negligible role. As inflation fell back, this analysis suggests that it is mainly supply-side shocks that have subsided.

Figure 11. Decomposition into supply- versus demand-driven inflation, based on Shapiro (2024)

Annual percentage change



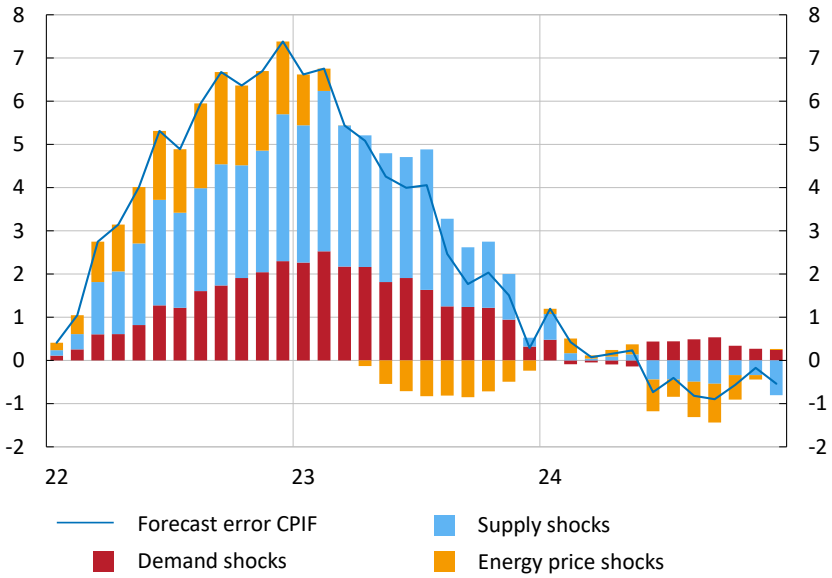
Source: The Riksbank.

[5] See the Appendix for short descriptions of the models.

The model above is very simple but can still give some indication of the inflation drivers. A slightly more developed approach is based on a model by Ascari et al. (2023), which uses a small structural VAR model with sign restrictions to identify exogenous shocks to demand, supply and energy. Based on that, it is possible to calculate how much these shocks have contributed to the development of inflation.

Figure 12 shows the results of a breakdown of the forecast errors for CPIF inflation up to 2024. In this model, too, the supply effects are greatest, but here the demand element is somewhat greater. In 2024, easing supply problems and lower energy prices contributed to CPIF inflation being slightly below 2 per cent. One disadvantage of this model is that it does not take into account the fact that Sweden is a small open economy with high external dependence.

Figure 12. Decomposition of CPIF inflation, based on Ascari et al. (2023)
Percentage points of annual percentage change



Note. Model forecast errors are used to isolate the role of supply and demand factors. The line shows the forecasting error for CPIF inflation defined as outcome minus forecast. A positive forecasting error thus implies an underestimation of the outcome and vice versa.

Source: The Riksbank.

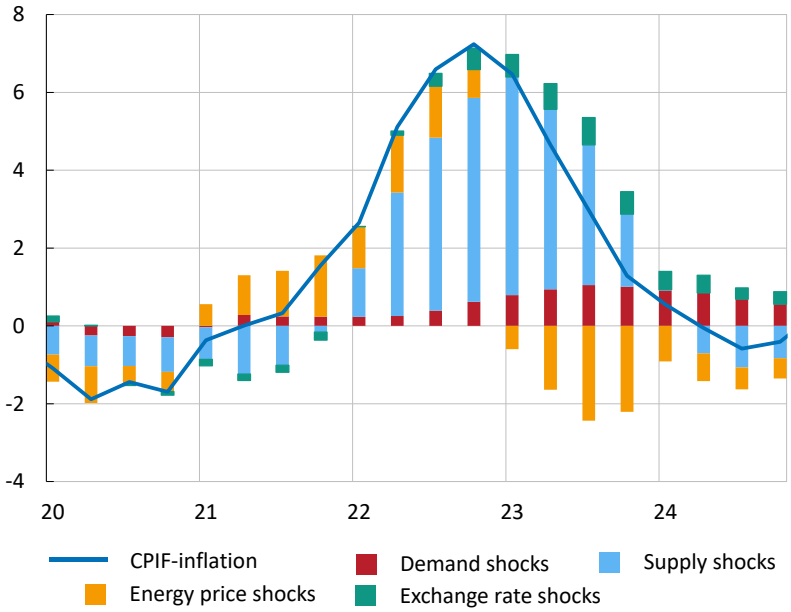
However, the Riksbank's general equilibrium model MAJA has this dimension inbuilt (see Corbo and Strid 2020). If, like Löf and Stockhammar (2024), we allow MAJA to interpret which shocks drove the rise in inflation, it indicates that it was mainly supply shocks that drove up inflation (see Figure 13).[6] In addition to productivity shocks, this group of shocks also includes price mark-ups.[7] This means that firms raised prices more than usual in relation to their costs and that this contributed to the rise in inflation. In 2022 and 2023 demand was also higher than expected, contributing to the underestimation of inflation, but this effect is much smaller than the supply shocks. In

[6] By supply shocks, we mean shocks that affect GDP and inflation in different directions.

[7] This may be more linked to corporate behaviour as discussed in the next section.

2022, higher energy prices also contributed to the upturn, an effect that faded in 2023, when the contribution was instead negative. However, this only captures the direct contribution of energy to the CPIF and not the indirect effects that may be present.

Figure 13. Decomposition of the deviation of CPIF inflation from 2 per cent in MAJA
Percentage points



Note. The CPIF is expressed as the difference against 2 per cent. Others show contributions to this difference.

Source: The Riksbank.

An important aspect of the inflation upswing that is not really captured in any of the previous models is the impact of supply chain disruptions on inflation. However, this mechanism is included in the Bernanke and Blanchard (2023) model. Here we estimate their model using Swedish data. According to our results, there were initially large contributions from increases in energy and food prices that lifted CPIF inflation (see Figure 14). When they started to fade away, they were partly replaced by relatively large contributions from a variable used to capture disturbances in global value chains.[8] These disruptions may be partly due to supply-related problems, such as the closure of factories and ports during parts of the coronavirus pandemic, but also to the occasionally very high and especially volatile demand for goods. It can also be noted that the contributions from high energy prices to inflation measured as the CPIF excluding energy are small. This model thus also indicates that the high energy prices had relatively small indirect effects on the price increases of other products.[9]

[8] Disruptions to global value chains are measured here using the 'Global supply chain pressure index' from the Federal Reserve Bank of New York.

[9] These results are relatively similar to applications to many other countries. See, for example, Bernanke and Blanchard (2024) for a comparison.

Figure 14. Decomposition based on Bernanke and Blanchard (2023)
CPIF (left), CPIFxe (right), seasonally adjusted quarterly rate annualised

Note. The bars show the overall inflation rate.

Source: The Riksbank.

To summarise, the empirical studies suggest that the results differ somewhat depending on the approach used, the way data are processed and the precise definition of supply and demand factors. But the overall picture is that it was a combination of many and large shocks to both supply and demand that caused inflation to rise as it did. However, it is difficult to measure with any great precision which explanatory factor was the most important and the results should therefore be interpreted with caution.[10]

3.4 What role has firms' behaviour played?

Another aspect that has been much discussed during the period of high inflation concerns the pricing behaviour of firms, i.e. whether, for example, they raised prices more and faster than normal in relation to their cost changes. There are studies indicating that firms pass on more of their increased costs to consumer prices when inflation and demand are high (see, for example, Borio et al. 2023, De Abreu Lourenco and Lowe 1994 and Harding et al. 2023). Thus, there appear to be non-linearities in how firms set their prices in relation to costs. If costs increase slightly and are not expected to remain at the higher level, firms tend to let some of the increase be absorbed by their margins. But if costs increase sufficiently, firms will be forced to change their prices (see discussion in Sveriges Riksbank 2024).

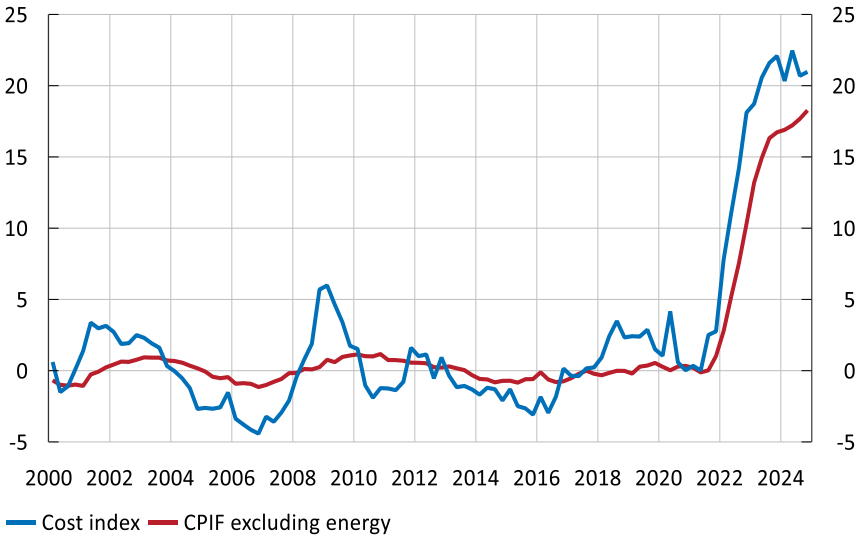
A study by the National Institute of Economic Research (2023) showed that Swedish firms, on average, raised their prices in line with how their costs rose in the period from 2019 to the second quarter of 2023. Historically firms have tended to even out price changes and allow part of their cost changes to be absorbed by profit margins,

[10] For example, there are studies on the euro area that indicate that the overall contribution of high energy prices in 2022 had a slightly larger contribution to the price increase. See, for example, Banbura et al. (2024).

but this did not occur during the period of rising inflation in 2022 and 2023.[11] This indicates that this part of companies' price-setting behaviour changed during the period of high inflation.

Figure 15. Developments in prices and firms' costs since 2000

Index development, deviation from historical trend, per cent



Note. The cost index is calculated as 0.05 * energy prices + 0.65 * unit labour costs + 0.3 * IMPI, consumer goods. The IMPI, consumer goods, is an index of import price developments, i.e. what importers are paid for their goods. The trend is estimated as an exponential trend over the period 2000–2020 and then projected at the same rate of increase for the years 2022 onwards.

Sources: Statistics Sweden and the Riksbank.

An illustration of this is shown in Figure 15. In the figure, we compare the CPIF excluding energy with a rough measure of firms' costs.[12] We then see that costs tend to vary significantly more than the CPIF excluding energy. However, in 2022 and 2023, the CPIF excluding energy increased at about the same rate as costs, in line with the conclusions of the NIER study.[13]

Two studies by Klein et al. (2024a and 2024b), from one of the Riksbank's research projects, examine how often and how much the prices of the products included in the CPI change. The results show that it is primarily the frequency of price changes that correlates with the rate of inflation – not their size.[14] This was evident in 2022 and 2023, when inflation was high. At that time, companies increased their prices much

[11] Motives for firms to smooth their price changes may be, for example, to maintain market share and/or to recognise the temporary nature of cost changes.

[12] This is a simplified measure to roughly describe the cost development of companies and does not intend to fully reflect all costs that a company has.

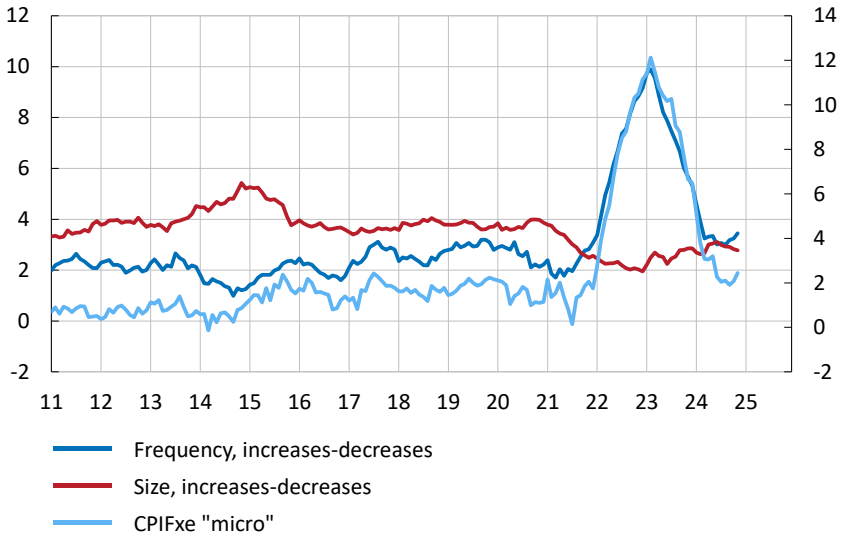
[13] The cost index is calculated as 0.05 * energy prices + 0.65 * unit labour costs + 0.3 * IMPI, consumer goods. The weights are set on the basis that about 30 per cent of private consumption consists of imports. See Table A2 in Hansson and Johansson (2007) for estimates of import content. See also the discussion in Lindskog and Lovéus (2023) and Sveriges Riksbank (2024).

[14] The same conclusion is drawn in studies by the Federal Reserve and the Bank of Canada. See Montag and Villar (2023) and Bilyk et al. (2024).

more frequently than before, while the average size of price changes did not change much (see Figure 16). It is not possible to say why from this analysis, but one contributing factor should be that companies feel they need to change their prices more frequently when their cost increases are large, and that the pass-through of costs is then both greater and faster than normal.

Figure 16. Frequency and size of price changes

Annual percentage change (CPIFxe), percentage points (others)



Note. Frequency and magnitude are expressed as the difference in the frequency of price increases and price decreases and the difference in the absolute magnitude of price increases and price decreases. In the CPIFxe 'micro', some individual components not included in the micro data have been excluded from the CPIF excluding energy.

Sources: Statistics Sweden and Klein et al. (2024a and 2024b).

As inflation has fallen, companies have also started to change their prices less frequently. This indicates that overall pricing behaviour is now more in line with what it was before the period of high inflation. The same conclusion is drawn from the Riksbank's own business surveys. Early in 2022, firms responding to the survey stated that they were adjusting prices more frequently than usual and that it was easier than usual to gain acceptance from customers for increased prices (see, for instance, Sveriges Riksbank 2022).

A related discussion to that of firms reacting more quickly to cost changes is whether the slope of the Phillips curve has changed in recent years. The Phillips curve is an analytical tool often used to describe the relationship between resource utilisation in the economy and inflation.[15] This relationship tends to be positive, i.e. high resource utilisation coincides with high inflation. In the period before inflation rose in 2021 and 2022, many economists believed that the Phillips curve was flat, i.e. that the relationship between resource utilisation and inflation was weak (see, for example, Del Negro et al. 2020, Inoue et al. 2024, From 2019, and Jonsson and Theobald 2019).

[15] The original Phillips curve, introduced by economist A.W. Phillips, described the relationship between unemployment and wages.

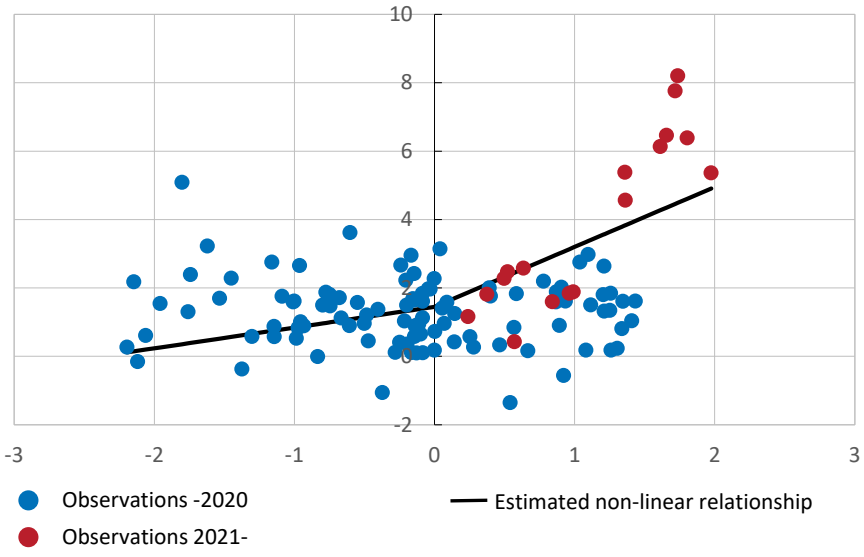
This view was based on the fact that inflation was low despite relatively strong resource utilisation (RU).

More recently, however, a number of studies have suggested that the slope of the Phillips curve has become steeper or that we have been on a steeper part of a non-linear Phillips curve during the period of high inflation (see, for example, IMF 2024, Levy 2024, Hobijn et al. 2023, Harding et al. 2023, and Benigno and Eggertsson 2023). For example, Benigno and Eggertsson (2023) point out the importance of considering non-linearities when estimating the Phillips curve, as changes in the amount of unutilised resources in the economy are likely to affect inflation differently depending on where in the business cycle one is. This can have important implications for monetary policy decisions, since a steep Phillips curve implies an easier trade-off between inflation and real economic developments.

We have estimated the model in Benigno and Eggertsson (2023) on Swedish data. This means that we start from the New Keynesian Phillips curve and use a measure of labour market tightness - the number of vacancies divided by the number of unemployed - as a proxy for the amount of slack. Figure 17 shows the combinations of outcomes for CPIF inflation excluding energy and food and the measure of labour market tightness together with the estimated non-linear relationship between them.

Figure 17. Scatterplot of labour market tightness and CPIF excluding energy 2000 - 2024

Annual percentage change of CPIFxe (vertical axis) and ratio of vacancies to unemployed (horizontal axis)



Note. The estimated relationship is based on the model from Benigno and Eggertsson (2023). The chart is drawn with data at quarterly frequency from 2000 until 2024. Red dots show the relationship from 2021 onwards and blue dots from 2000 to 2020.

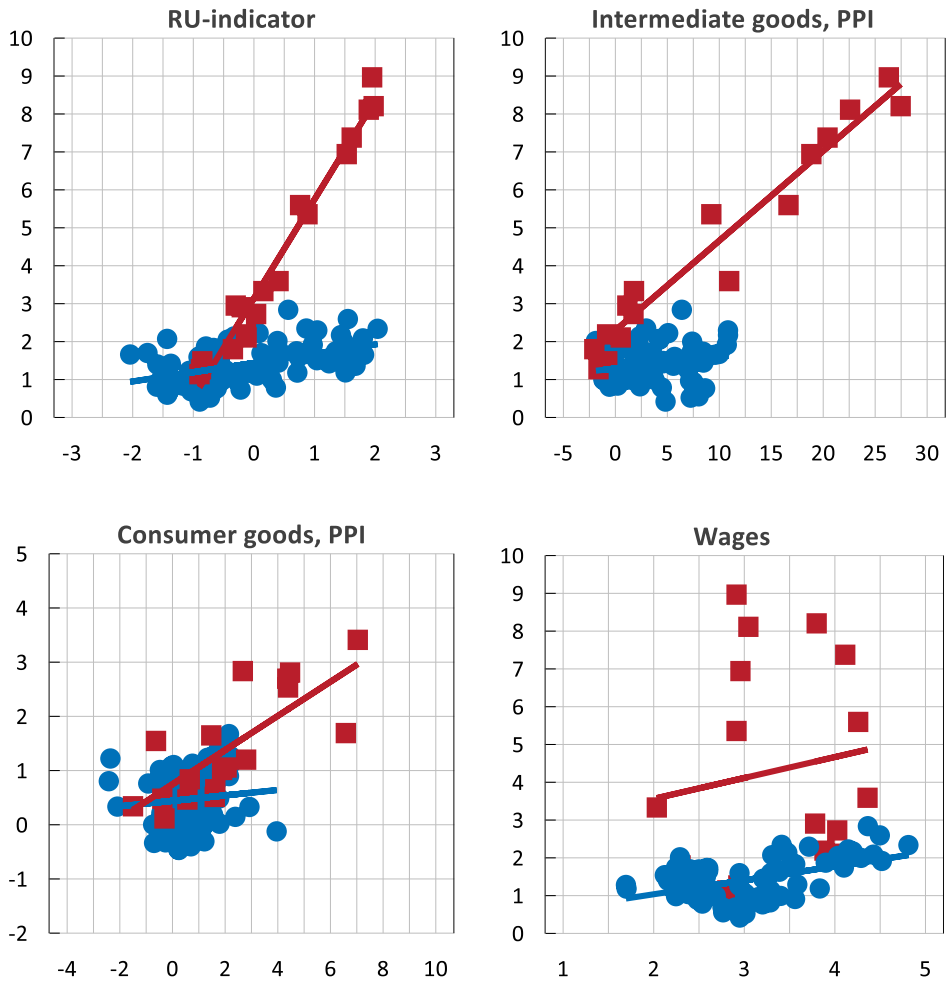
Sources: Statistics Sweden and the Riksbank.

The estimates here suggest that there is a non-linear relationship in Sweden as well, which could explain a relatively large part of the rise in inflation. However, the results are driven entirely by the observations during the high-inflation period, which may be

an indication that there is rather something specific about this period that drives the results.

Looking at the relationship between inflation and other factors that may be important for inflation, we can see that they also appear to have changed dramatically over this period (see Figure 18). In the diagram, we have plotted the relationship between the annual percentage change in the CPIF excluding energy and a number of other variables, both for the period up to 2020 and for the period from 2021 onwards. This suggests that this non-linearity is not necessarily driven primarily by the level of labour tightness. Instead, it seems to be more dependent on time or the economic situation more generally. An alternative explanatory model, which is suggested by, for instance, Karadi et al. (2024), points out that it is the fact that the economy has been subjected to such large shocks and that companies have reset their prices more often than before that explain the change in the slope of the correlation, and not a non-linear correlation in itself. One notable exception is that the relationship between wages and inflation has continued to be weak, which is also an indication that it is not via a tight labour market that inflation gained momentum in Sweden.

Figure 18. The correlation between CPIFxe and a number of determinants
RU indicator in standard deviations, others in annual percentage change



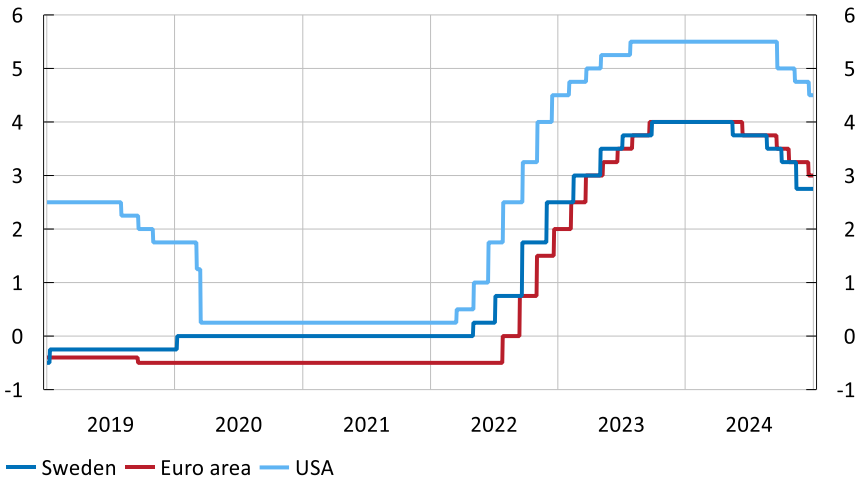
Note. Blue line and dots show the relationship between 2000 and 2020, red lines and dots show the relationship from 2021 onwards.

Sources: Statistics Sweden and The Riksbank.

3.5 The policy rate was raised, and then lowered as inflation fell back

Like many other central banks, the Riksbank started to raise the policy rate in early 2022. The first increase was followed by several more. The highest level was reached in September 2023 at 4 per cent, which was maintained until May 2024 (see Figure 19). The Riksbank then began to cut the interest rate as they saw an increasing number of signs that monetary policy was having an effect and that inflation was beginning to stabilise close to the inflation target.

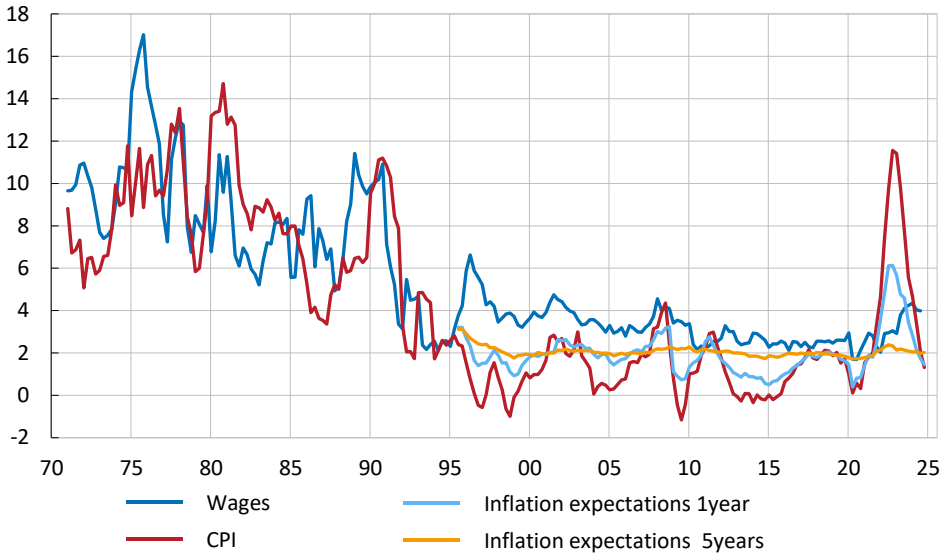
Figure 19. Policy rates in Sweden, the euro area and the United States 2019 - 2024
Per cent



Sources: The Riksbank, ECB, and Federal Reserve.

Long-term inflation expectations remained stable even during the period of high inflation, signalling that confidence in the inflation target remains high. Another sign of this is that wage agreements, negotiated at the peak of measured inflation in early 2023, were based on the inflation target and set at a level consistent with it (see Figure 20).

Figure 20. Wages, inflation and inflation expectations since 1970
Annual percentage change



Sources: Statistics Sweden, the National Mediation Office and TNS Sifo Prospera/Origo group.

Thus, tighter monetary policy and the fading of the impact of various shocks contributed to the decline in inflation.

4 Could the rise in inflation have been foreseen?

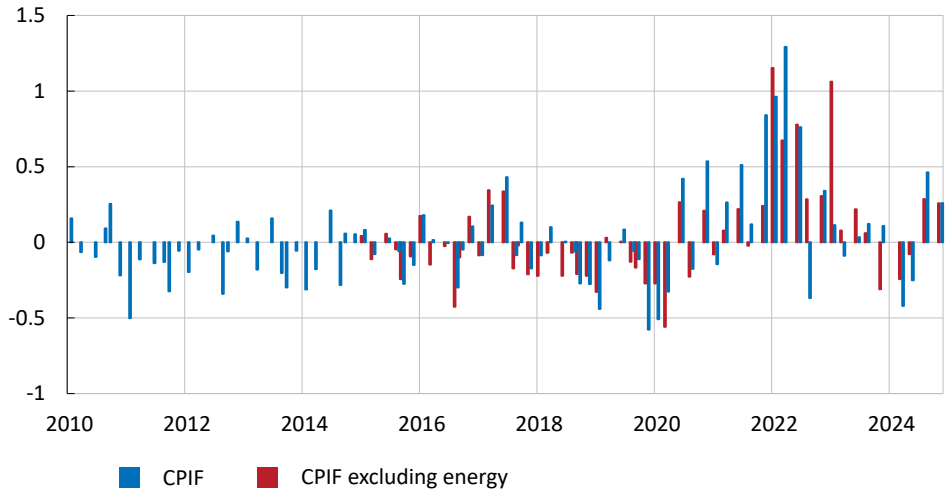
So far, we have tried to explain why inflation rose as quickly as it did based on the data we have today. Instead, in this section we try to look more closely at what information was available before inflation started to rise, and whether it could have been used to better predict what would happen next.

4.1 The Riksbank's forecasting errors

Figure 21 shows the forecasting errors in the Riksbank's published short-term forecasts since 2010. In normal times, there should be no bias in the forecasting errors and they should vary around zero over time. If there had been a systematic approach, the forecast could have been improved by subtracting or adding a constant factor. This would have been a clear indication that there was something in the inflation process that was not captured in the Riksbank's forecasting methods.

Figure 21. Average forecast errors 2010 – 2024

Percentage points



Note. The average forecasting errors refer to outcome minus forecast at the 1 to 3 month horizon and relate to published forecasts of annual percentage changes in the respective measures from Monetary Policy Reports.

Source: The Riksbank.

There was some tendency for CPIF inflation to start surprising on the upside as early as 2020. This was partly due to slightly higher-than-expected energy prices. The forecasting errors for the CPIF excluding energy varied around 0 in 2020 and 2021.

From the beginning of 2022, forecast errors became large and positive, i.e. inflation outcomes were higher than projected. The forecasting errors for the CPIF excluding energy were positive for each forecast from early 2022 to mid-2023. This suggests that the Riksbank's forecasting methods did not fully capture what happened to inflation during that period. As of the end of 2023, there no longer appears to be a systematic pattern of forecast errors.

4.2 An aggregated picture of several indicators could have given a clue

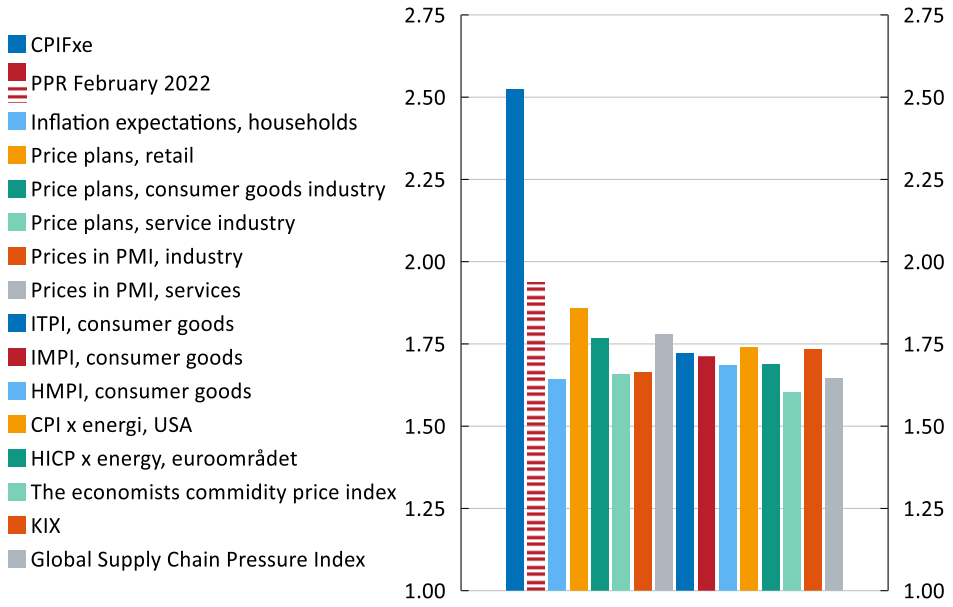
The Riksbank, like all other forecasters, thus underestimated the strength of the upturn in inflation in 2022 (see, for example, Håkanson and Laséen 2024 where a comparison is made between forecast errors made by the Riksbank and other central banks). In this section, we ask whether the rise in inflation could have been anticipated with the information available in late 2021 and early 2022.[16] In the previous section, we showed that the relationship between inflation and the cost and demand situation was different in the period of high inflation. Here we ask whether the relationship between inflation and various indicators of price developments was also different.

In Sweden, the rapid rise in inflation started in January 2022, when the rate of increase in the CPIF excluding energy rose to 2.5 per cent, from 1.7 per cent in December 2021. The rebound was largely unexpected and one of the largest forecast errors during the high-inflation period was made for the January 2022 outcome in the forecast published in the Monetary Policy Report in early February 2022. In the forecast, which was made a couple of weeks before the outcome was published, the rate of increase in the CPIF excluding energy was expected to rise to 1.9 per cent, which means that the Riksbank underestimated developments by 0.6 percentage points. Other forecasters made the same forecasting error. In the compilation of forecasts from other forecasters regularly made by Bloomberg, the average forecast the day before the outcome was also 1.9 per cent (see Figure 4 in Johansson et al. 2022).

Were the Riksbank and other forecasters looking at the wrong variables and the wrong relationships? In Figure 22, we show forecasts for January 2022 made using estimated linear relationships between the CPIF excluding energy and some common indicators. The projections are made using data available at the beginning of February 2022 and the estimated historical relationships between the CPIF excluding energy and each indicator. We then compare them with outcomes and the Riksbank's published forecast. It is clear from the figure that no single indicator model suggested that inflation would rise as fast as it did.

[16] Johansson et al. (2022) showed that the rise in inflation could not be explained by developments in the producer price index and unit labour costs, which normally together tend to explain developments in inflation quite well. In other words, the forecasting errors for inflation are due, at least in part, to the fact that firms appear to have been able to increase their margins by raising consumer prices to a greater extent than they usually do when demand was high. This is in line with the conclusions of the NIER study.

Figure 22. Outcomes and forecasts for the CPIF excluding energy for January 2022
Annual percentage change



Note. The figure shows forecasts from bivariate models together with outcomes. All models are estimated with the annual percentage change in the CPIF excluding energy as the dependent variable. The explanatory variables are a constant, the first lag of the CPIF excluding energy, and the first to fourth lags of the outcome in each indicator. Price index expressed as annual percentage change. The models are estimated from January 2000 to December 2021.

Sources: Statistics Sweden, the Riksbank and the respective institutions.

This is not particularly surprising, as the models are estimated on historical data that do not include any episode of large changes in inflation. The historically normal relationship between the indicators in Figure 22 and the inflation rate has been weak. However, if we instead look at the level of the indicators in the outcomes available in February 2022, we see that, in many cases, they were at levels two to three standard deviations higher than normal (see Figure 23). And this is roughly consistent with a rate of increase in the CPIF excluding energy of around 2.5 per cent, which would turn out to be the outcome in January 2022. Thus, if, instead of relying on historical correlations, we had looked at the level of the indicators, we could have better predicted the rise in inflation. However, this strategy has not produced good forecasts on average over longer periods, as it would have meant overreacting to changes in indicators in normal times.

Figure 23. The CPIF excluding energy in February 2022 and indicators of price developments available at the beginning of February 2022

Standardised values, standard deviations.

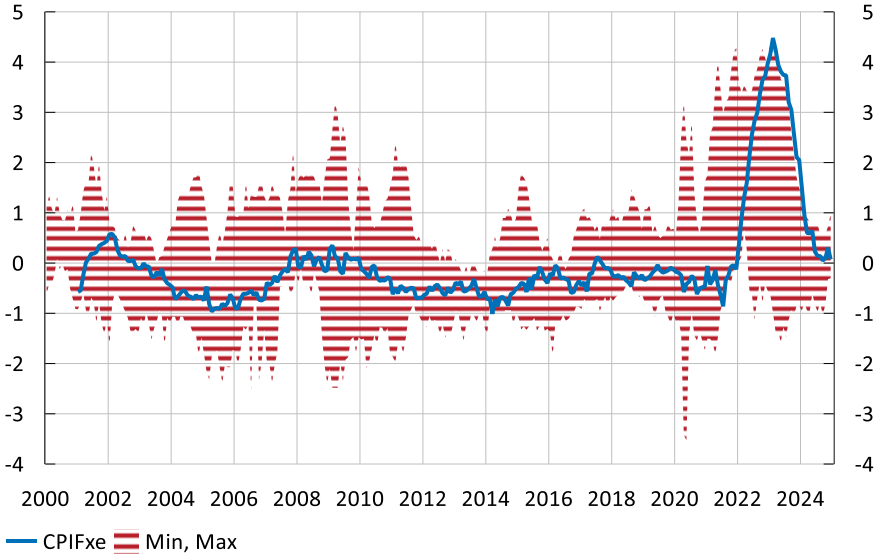
Note. The standardisation is done for the period 2000 to 2021.

Sources: National Institute of Economic Research, Swedbank, Statistics Sweden, Federal Reserve and the Riksbank.

In Figure 24, the standardised indicators have been collected in one field and plotted over time together with the CPIF excluding energy. It can then be noted that the field is usually relatively symmetrical, with some indicators slightly above their mean value and some below, while inflation measured as the CPIF excluding energy is roughly in the middle of the band. However, during 2021 it looks a little different. At that time, most indicators started to rise well above their historical averages, while there was virtually no indicator that was below. Moreover, a number of indicators were more than three standard deviations away from their historical average. Another way to look at it is to look at how many indicators are at a certain number of standard deviations from their average. We do this in Figure 25, which shows the indicators until December 2021. Even in real time, a large share of the indicators was at historically high levels. Almost 60 per cent of the indicators were more than two standard deviations above their mean and almost 50 per cent of them were as much as three standard deviations above their mean. This is markedly different from previous periods in the 2000s and indicated that something different was happening.

Figure 24. The CPIF excluding energy and indicators

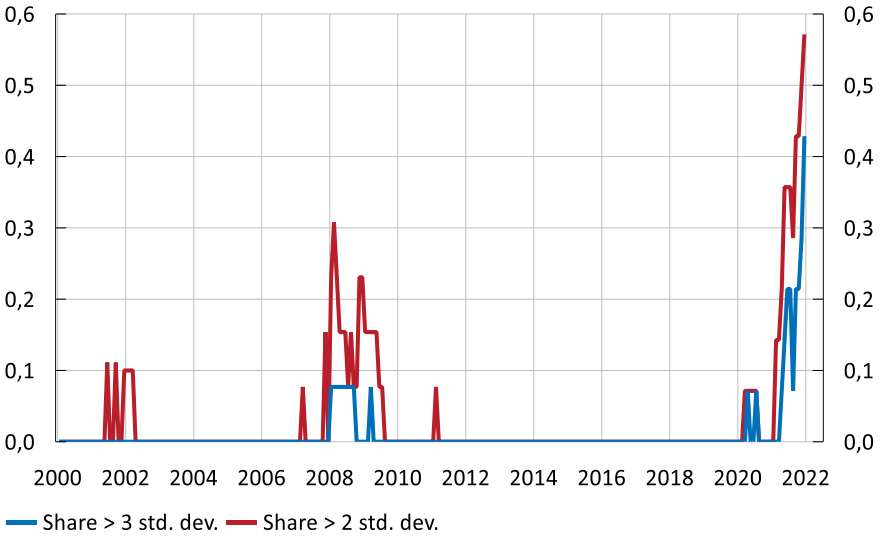
Annual percentage change, net figures and index. Standardised values



Note. Standardised values from 2000 onwards. The red band shows the highest and lowest values of the indicators listed in Figure 23. Price index expressed as annual percentage change.

Sources: The Economist, Eurostat, Federal Reserve, NIER, Statistics Sweden, Swedbank, US Bureau of Labor Statistics and the Riksbank.

Figure 25. The proportion of indicators higher than 2 or 3 standard deviations



Source: Statistics Sweden, National Institute of Economic Research, Swedbank and own calculations

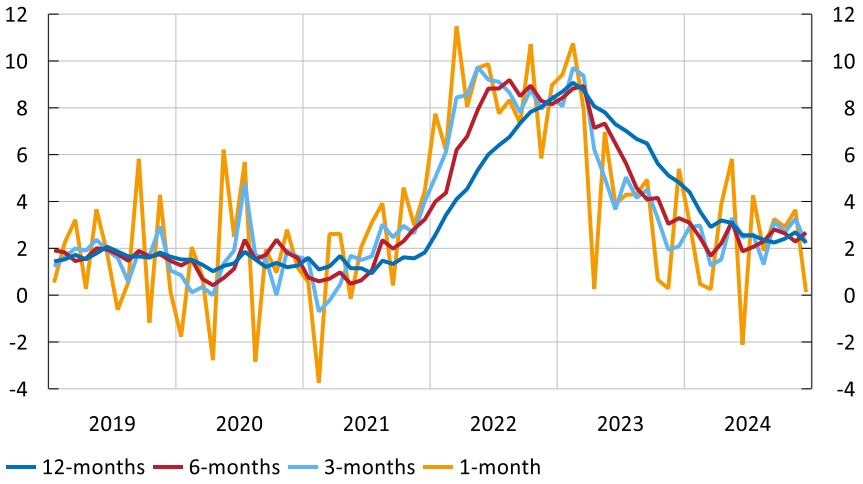
4.2.1 High-frequency measurements

In light of the rapid rise in inflation, the Riksbank has focused more on higher frequency measures of price changes than twelve-month changes, such as seasonally adjusted changes over one, three or six months. In Figure 26, it can be seen that more high-frequency measures rose relatively steeply as early as late 2021 and early 2022.

However, seasonally adjusted measures are relatively strongly influenced by data points both before and after the current observation. If we instead look at how the data looked in real time after the outcome for December 2021, as we do in Figure 26, this trend is not visible in the same way. In an earlier study by the Riksbank, the forecasting ability of these measures has been evaluated more formally, and they turn out to have relatively high information value during the period of high inflation, particularly the three-month and six-month measures (see Johansson and Tysklind 2024).

Figure 26. Price changes in the CPIF excluding energy at different frequencies 2019 - 2024

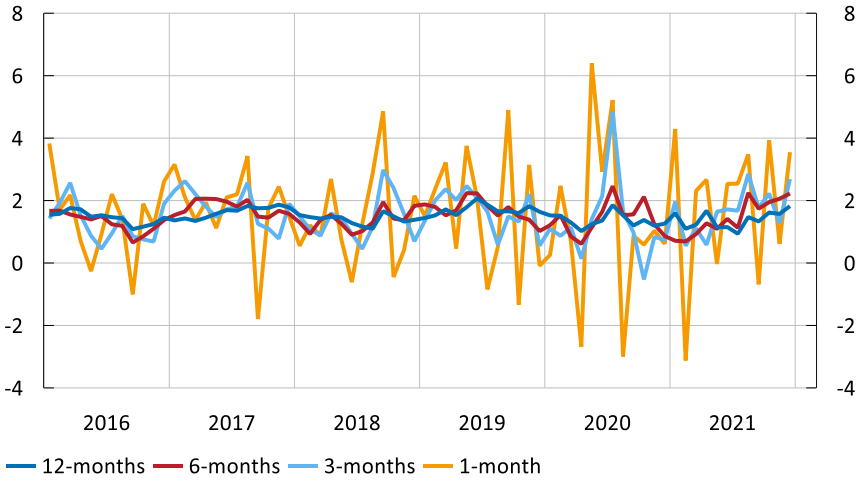
Percentage change, seasonally adjusted and annualised



Sources: Statistics Sweden and the Riksbank.

Figure 27. Price change in the CPIF excluding energy at different frequencies until end of 2021

Percentage change, seasonally adjusted and annualised



Sources: Statistics Sweden and the Riksbank.

5 Conclusions and lessons learnt

It was not possible to predict the pandemic and the economic disruptions that followed in its wake. Nor the war in Ukraine. But it is reasonable to ask whether we as forecasters could have better understood the economic impact of these shocks on inflation and the wider economy using economic models and the data available at the time.

After many years of inflation rates that tended to be slightly below the 2 per cent target, inflation in Sweden rose rapidly and unexpectedly in 2022. The upturn reflected a combination of global supply and demand shocks that created large imbalances in the economy, while firms started to pass on a larger share of their cost increases to consumer prices than before.

Average historical correlations between common indicators and explanatory variables for inflation could therefore not predict more than a small part of the rise in inflation. Many studies have documented that the relationship between inflation and both costs and demand has been different during the period of high inflation compared with what has been normal in the past. Macro models that had been estimated on historical relationships were thus unable to handle these types of very large changes.

Therefore, to predict the next rise in inflation, it is likely that a different type of analysis is needed that can take into account changes in the relationship between inflation and its explanatory variables. Changing relationships appears to be the case during periods of rapidly rising costs and high demand. The challenge will then be to recognise as early as possible that the economy is in a new state, where companies change prices more frequently and more in relation to their costs than is normal. One way forward could be to use forecasting methods based on artificial intelligence and machine learning. This type of modelling is good at capturing non-linear relationships early on and has been shown to make relatively good predictions in evaluations (see Den Reijer et al. 2025).

One lesson here has been that more continuous analyses of high-frequency measures of inflation than the twelve-month figures can provide a clearer insight into where inflation is heading (see Johansson and Tysklind 2024). Another lesson learned for future forecasting work is that it is important to spot early signs that firms are starting to adjust their prices more frequently during periods of major changes in costs and high demand. Indeed, the frequency of price changes has been shown to be more indicative of inflation than their size. One source of such information is the microdata underlying the CPI calculations, where the frequency of price-setting can be observed. These data are used for a research project at the Riksbank, and the results of that project may also be useful for the Riksbank's ongoing analyses. Another source is the Riksbank's own business surveys. For example, firms reported in early 2022 that they were changing prices more frequently than usual, and that it was easier than usual to get customers to accept price increases (see Sveriges Riksbank 2022b).

Other types of new data sources have also been shown to provide timely information. For example, the Riksbank should continue to use online prices for items such as food to detect early signs of rising consumer prices. Since spring 2023, the Riksbank has

subscribed to data from Matpriskollen, which is used as an indicator in the Riksbank's short-term models for forecasting food prices (see Tysklind 2024). It is also important to continue to monitor how companies plan to change their prices in the Economic Tendency Survey and how they view their input costs in the Purchasing Managers' Index.

Forecasters will never be able to predict exogenous shocks. It is also difficult to determine in real time if and when we will enter a different mode or regime of inflation, and this will continue to be the case in the future. Instead, the task will be to constantly improve our understanding of how these shocks propagate through the economy. In this respect, the recent period of inflation has given us a lot of new insights that help us understand inflation and its determinants.

References

Ascari, Guido, Paolo Bonomolo, Marco Hoeberichts and Riccardo Trezzi (2023), 'The euro area great inflation surge', *De Nederlandsche Bank Analysis Series*, March.

Banbura, Marta, Elena Bobeica and Catalina Martínez Hernández (2024), 'Shocked to the core: a new model to understand euro area inflation', *Research Bulletin* no. 117, European Central Bank.

Benigno, Pierpaolo and Gauti Eggertsson, G. (2023), 'It's baaack: the surge in inflation in the 2020s and the return of the non-linear Phillips curve', Working paper no. 31197, National Bureau of Economic Research.

Bernanke, Ben and Olivier Blanchard (2023), 'What caused the US pandemic-era inflation?', Working Paper no. 31417, National Bureau of Economic Research.

Bernanke, Ben and Olivier Blanchard (2024), 'An analysis of pandemic-era inflation in 11 economies', Working paper no. 32532, National Bureau of Economic Research.

Bilyk, Olga, Mikael Khan and Olena Kostyshyna (2024), 'Pricing behaviour and inflation during the COVID-19 pandemic: Insights from consumer prices microdata', *Staff analytical note* no. 6, Bank of Canada.

Borio, Claudio, Marco J. Lombardi, James Yetman and Egon Zakrajšek (2023), 'The two-regime view of inflation', *BIS papers,* no. 133, Bank for International Settlements.

Corbo, Vesna and Ingvar Strid (2020), 'MAJA: A two-region DSGE model for Sweden and its main trading partners', Working Paper Series no. 391, Sveriges Riksbank.

De Abreu Lourenco, Richard and Philip Lowe (1994), 'Demand shocks, inflation and the business cycle', Research discussion paper no. 9411, Reserve Bank of Australia.

Del Negro, Marco, Michele Lenza, Diorgio E. Primiceri, and Andrea Tambalotti (2020), 'What's up with the Phillips curve?', *Brookings Papers on Economic Activity*, no. 1, pp 301-357, Brookings Institute.

Den Reijer, Ard, Pär Stockhammar, David Vestin, Davide Vincenzo Bucci and Xin Zhang (2025), 'AI-based forecasting in Sweden', *Staff memo*, Sveriges Riksbank.

From, Erik (2019), 'The relationship between resource utilisation and inflation: a microdata perspective', *Economic Commentaries* no. 1, Sveriges Riksbank.

Hansson, Jesper and Jesper Johansson (2007), 'Alternative measures of inflation for monetary policy analysis', *Sveriges Riksbank Economic Review*, no. 3, pp. 45-58.

Harding, Martin, Jesper Lindé and Mathias Trabandt (2023), 'Understanding post-COVID inflation dynamics', BIS Working papers no. 1077, Bank for International Settlements.

Hobijn, Bart, Russell Miles, Jim Royal and Jing Zhang (2023), 'The Recent Steepening of Phillips Curves', *Chicago Fed Letter*, no. 475, Federal Reserve Bank of Chicago.

Håkanson, Christina and Stefan Laséen (2024), 'Cruising to victory or a dead heat? Central Bank Championships in forecasting ability 2021 and 2022', *Economic Commentaries* no. 1, Sveriges Riksbank.

IMF (2024), 'The great tightening: insights from the recent inflation episode', IMF World Economic Outlook—Analytical Chapter 2, October.

Inoue, Atsushi, Barbara Rossi and Yiru Wang (2024), 'Has the Phillips Curve Flattened?', French Stata Users' Group Meetings 2024 22, Stata Users Group.

Johansson, Jesper, Mårten Löf, Pär Stockhammar and Ingvar Strid (2022), 'What explains the Riksbank's forecast error for inflation?', *Staff memo*, Sveriges Riksbank.

Johansson, Jesper and Oskar Tysklind (2024), 'Price changes at different time horizons', *Economic Commentaries* no. 8, Sveriges Riksbank.

Jonsson, Magnus and Emelie Theobald (2019), 'Changed labour market – effects on prices and wages, the Phillips curve and the Beveridge curve', *Sveriges Riksbank Economic Review*, no. 1, pp. 28-49, Sveriges Riksbank.

Karadi, Peter, Anton Nakov, Galo Nuno, Ernesto Pasten and Dominik Thaler (2024), 'Strike while the Iron is Hot: Optimal Monetary Policy with a Nonlinear Phillips Curve', CEPR Discussion Paper no. 19339. CEPR Press.

Klein, Mathias, Klara Strömberg and Oskar Tysklind (2024a), 'Inflation dynamics during the high-inflation period: insights from microdata', *Economic Commentaries* no. 14, Sveriges Riksbank.

Klein, Mathias, Emanuel Skeppås and Oskar Tysklind (2024b), 'Price changes for goods and services during the high-inflation period: insights from microdata', *Economic Commentaries* no. 15, Sveriges Riksbank.

National Institute of Economic Research (2023), *Price setting by Swedish companies in 2023*, special study, NIER.

Levy, Philip (2024), 'Did Supply Chains Deliver Pandemic-Era Inflation?', *Policy brief* 2024-10, Peterson Institute For International Economics.

Lindskog, Magnus and Hanna Lovéus (2023), 'Import prices, labour costs and profits – what role have they played in inflation dynamics?' *Staff Memo*, Sveriges Riksbank.

Löf, Mårten and Pär Stockhammar (2024), 'What drove the surge in inflation?', *Staff memo*, Sveriges Riksbank.

Montag, Hugh and Daniel Villar (2023), 'Price-setting during the Covid era', *FEDS Notes*, Board of Governors of the Federal Reserve System.

Pettersson, Bengt, Ingvar Strid and Anna Österberg (2024), 'What is the relationship between Swedish and global inflation?', *Staff memo*, Sveriges Riksbank.

Shapiro, Adam (2024), 'Decomposing supply and demand driven inflation', *Journal of Money, Credit and Banking*, October.

Sveriges Riksbank (2016), 'The impact of the exchange rate on inflation', article in *Monetary Policy Report*, December.

Sveriges Riksbank (2022a), 'High energy prices – how will other consumer prices be affected?' article in *Monetary Policy Report*, February.

Sveriges Riksbank (2022b), 'I've never before experienced customers accepting price increases so easily', Riksbank's Business Survey, February.

Sveriges Riksbank (2023), 'The pass-through of the krona to inflation appears to have been larger than usual', article in *Monetary Policy Report*, November.

Sveriges Riksbank (2024), 'The relationship between producer and consumer prices', article in *Money Policy Report*, March.

Tysklind, Oskar (2024), 'New data sources in forecasting – high-frequency data for food', *Economic Commentaries*, no. 10, Sveriges Riksbank.

Appendix

This appendix provides brief descriptions of the models used in section 3.3.

Decomposition of inflation into supply and demand

In this analysis, as in Löf and Stockhammar (2024), we use data from the Swedish national accounts broken down into 75 different categories.

Step 1: We start by calculating price deflators for each consumption area, based on consumption volumes in both constant and current prices.

Step 2: Consumption at constant prices and price indices are then seasonally adjusted.

Step 3: We produce quarterly, seasonally adjusted weights for each consumption category. Then a VAR- model is estimated for each category as follows:

1. $q_t^k = \alpha_1 + \sum_{j=1}^{4} \beta_{qq,j} * q_{t-j}^k + \sum_{j=1}^{4} \beta_{qp,j} * p_{t-j}^k + v_t$
2. $p_t^k = \alpha_2 + \sum_{j=1}^{4} \beta_{pp,j} * p_{t-j}^k + \sum_{j=1}^{4} \beta_{pq,j} * q_{t-j}^k + \varphi_t$

Here q and p represent logarithmised consumption and price indices respectively for category k.

Interpretation of residuals:

- If the product of the residuals in quarter t is negative, $v_t * \varphi_t < 0$, it is interpreted to mean that a supply shock has affected developments.
- If instead the product is positive, $v_t * \varphi_t > 0$, demand factors are assumed to have been the dominant driver.

Step 4: Quarterly percentage changes in price are multiplied by the respective weight of the consumption area. This provides contributions to overall price developments. These contributions are then sorted according to whether they are classed as supply or demand-driven (as described above) and summarised into two aggregated series.

Finally, a four-quarter moving sum of these contributions is calculated, which allows them to be interpreted as contributions to the annual rate of the consumption deflator.

Model by Ascari et al. (2023)

In this section, we use the same model as in Löf and Stockhammar (2024), which in turn is based on a model developed by Ascari et al. (2023), to find out how much of the inflation can be explained by supply, demand and energy price shocks. The model used is a VAR model, estimated using Bayesian methods.

The model contains four key variables: inflation (measured as the monthly percentage change in the CPIF), industrial production (as a measure of how much is produced in

the economy each month), two-year interest rate (overnight index swap) and energy prices (measured as monthly percentage change in the CPIF energy index).

To distinguish between supply and demand shocks, sign restrictions are used where demand shocks affect inflation and output in the same direction while supply shocks affect the variables in different directions. We use data from August 2011 to October 2021 to train the model. Then we make projections for the period November 2021 to December 2024 and compare these with what actually happened. By analysing these errors and how inflation and output have moved, we can determine whether unexpected changes in inflation were caused by supply or demand.

Decomposition with MAJA

Here we have used MAJA to perform a decomposition to see which types of shocks the model reads as the most likely combination to explain the trend in the data over the period. For more details on the model, see Corbo and Strid (2020).

The Blanchard and Bernanke model

This is a dynamic model with four equations as described below. Energy and food prices are measured in relation to wages. Shortages are measured by the 'global supply chain pressure index' from the Federal Reserve Bank of New York. Labour market tightness is measured as the ratio of vacancies to unemployment. Short-term and long-term inflation expectations come from the ORIGO group survey.