Staff memo

What drove the surge in inflation?

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Staff memos

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Summary

The rapid rise in inflation in 2022 led to major forecast errors among central banks worldwide and created major challenges for policymakers around the world. At least initially, before inflation became really high, there was considerable discussion about how long the rise in inflation would last and what factors were behind it. Was it mainly more temporary factors responsible for the surge, such as higher energy prices together with shortages of input goods and supply chain bottlenecks? Or had other factors more closely linked to aggregate demand contributed to the development, such as low interest rates and strong monetary and fiscal stimulus?

This staff memo describes the various factors that businesses say have contributed to price increases in recent years. The responses suggest that demand has contributed to slightly higher prices, but that it has played a relatively limited role compared to other more cost-related factors. We also use some model approaches to decompose the rise in inflation into supply and demand factors. Overall, the models seem to suggest that supply factors have been more important than demand factors in explaining the development of inflation in 2021-2023. However, it is difficult to measure with any great precision which explanatory factor has been most important, especially as it is mainly imbalances between supply and demand that affect inflation. The results should therefore be interpreted with caution.

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1 Introduction

It is clear is that a series of supply-side events, such as various pandemic-related imbalances, disruptions in the European energy market and Russia's invasion of Ukraine, explain part of the rapid rise in inflation. However, sharp shifts in demand, in some cases substantial fiscal support, and changes in consumption and pricing behaviour should also have played a major role. The rapid rise in inflation in 2022 created major challenges for policymakers around the world. At least initially, before inflation became really high, there was considerable discussion about how long the rise in inflation would last and what factors were actually behind it. Were more temporary factors in the wake of the pandemic mainly responsible for the increase, such as higher electricity and fuel prices together with other negative supply shocks? Or were there more persistent factors, and factors more closely linked to the demand side of the economy, that had contributed to the development?[2] The persistence of the rise in inflation has clear policy implications. Therefore, early attempts were made to use models to explain the rise in inflation and to estimate the contributions of demand and supply factors. It is mostly imbalances between supply and demand that affect inflation For example, higher inflationary pressures arise if the demand for goods and services increases significantly without a corresponding increase in supply. Several analysts, including Hassler et al. (2024), argue that the high inflation since 2022 is due to various supply shocks, such as higher energy prices and increases in other world market prices, rather than to excessive demand pressures in Sweden.

One approach that received early attention had been developed at the Federal Reserve Bank of San Francisco (see Shapiro 2022). It uses monthly data on prices and volumes of US personal consumption expenditures (PCE). Time series models for price and quantity are estimated for about 100 consumption areas and the unexplained part of the development in prices and quantities, the residuals, are saved. When calculating the contributions, the sign of the residuals is used, and the decomposition is based on the theory that prices and quantities tend to move in the same direction if inflation is demand-driven. If inflation tends to be supply-driven instead, prices and quantities should move in different directions. In the Economic Outlook (OECD 2022), the OECD used the same approach for eight OECD countries, including Sweden. Up until the first half of 2022, the development of inflation in Sweden were dominated by supply factors, according to these results. The method has also been used for the euro area, where HICP and activity data are matched on a monthly basis (see Gonçalves and Koester, 2022). Using Shapiro's method, Firat and Hao (2023) find that the rise in inflation in the United States was driven more by demand shocks than in the euro area, where supply factors were relatively more important.

Other model approaches that have been used to describe the rise in inflation are structural factor models, see, for example, Eickmeier and Hofmann (2022), and dynamic factor models, Cascaldi-Garcia et al. (2023). Bayesian Vector AutoRegressive

[2] In 2021, the Riksbank assessed that inflation would be mainly transitory and that it would slow down in 2022 once the contributions from energy prices fell back, the supply problems were resolved and demand became more normal, see, for example, the article "Higher inflation - temporary or persistent?" in Monetary Policy Report, November 2021, Sveriges Riksbank.

(BVAR) models have also been applied, using different sign restrictions to decompose the development of inflation. Some examples using the latter approach are De Santis (2023), Ascari et al. (2023) and Bergholt et al. (2024). More recently, a semi-structural model originally presented by Bernanke and Blanchard (2023) has also been widely replicated for different countries. Bernanke and Blanchard (2024) summarise the results from 11 countries where their model was used. In most of the countries analysed, supply shocks, energy prices and food prices are important drivers of inflation in recent years. In some countries, notably the United States, the United Kingdom and France, wage inflation pressures have also been a contributing factor. In addition, general equilibrium (DSGE) models have sometimes been used to describe inflation models. In Johansson et al. (2022), for example, the Riksbank's DSGE-model MAJA is used to explain the Riksbank's forecast errors for inflation in 2021 and 2022.

In this staff memo, we analyse the factors that drove up inflation in the period 2021–2024. We also present various assessment-based decompositions that have been reported in the Riksbank's Monetary Policy Report in recent years. Chapter 2 describes the factors that have contributed to price increases in recent years based on data, and Chapter 3 describes businesses' perceptions of what has contributed to price increases. The chapters contain results from both the Economic Tendency Survey and the Riksbank's own business survey. Chapter 4 presents the results of various model estimates for Sweden, and Chapter 5 summarises the results.

2 Several exogenous events affected the development

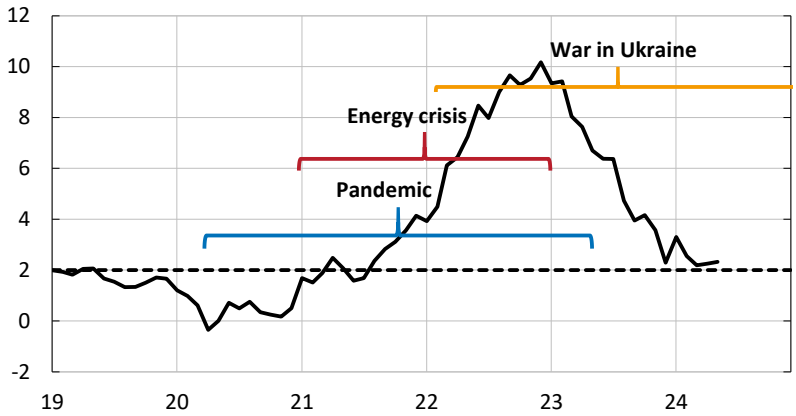
The exceptionally rapid rise in Swedish inflation in 2021 and 2022 was largely due to the direct effects of a number of events occurring outside Sweden. These included bottlenecks in supply during the pandemic and major energy price shocks in 2021 and 2022 that were amplified by Russia's full-scale invasion of Ukraine in early 2022.[3] Figure 1 below shows CPIF inflation and approximate timelines for these events, although the events are not entirely independent of each other.[4] Below we review them in chronological order and discuss the ways in which they may have affected inflation.

[3] A value chain is a network of different companies such as developers, producers, subcontractors, investors and retailers. The different companies all contribute at some stage of the production process.

[4] The timelines in the figure only give a rough idea of when the different events started and ended. The exact dates can always be subject to debate.

Figure 1. CPIF inflation

Annual percentage change



Note. The solid black line shows CPIF inflation and the dashed black line shows the 2-percent inflation target.

Sources: Statistics Sweden and the Riksbank.

2.1 Pandemic: Supply shocks and substantial changes in demand

The pandemic led to a substantial change in economic activity across the world. In spring 2020, some sectors of the economy shut down. Various restrictions caused people to adapt their behaviour, which contributed to a change in consumption patterns. Household demand for goods grew rapidly when the ability to consume services was limited. This led to imbalances between supply and demand, and it is largely such imbalances that affect inflation. Consumption, especially the demand for services, fell dramatically abroad and in Sweden (see, for example, Panel 1 in Figure 9, Appendix). Businesses in high-contact services were particularly hard hit. Large fiscal and monetary policy measures were then put in place, which contributed to a very rapid recovery as economies opened up.[5] In many countries, labour supply also decreased significantly as many people left the labour force during the pandemic. When demand picked up again, many businesses found it difficult to recruit labour with the right skills, which in turn led to relatively high wage increases in several countries.[6]

When freight orders dropped at the beginning of the pandemic, many shipping companies deregistered their vessels to reduce costs. Businesses therefore found it difficult to book and complete their deliveries as demand recovered and production picked up. As a result, shipping costs started to rise already in the summer of 2020 and increased dramatically in 2021, when freight traffic was also disrupted by several incidents in the spring and summer (e.g. the blocking of the Suez Canal, see Panel 2 in Figure 9, Appendix). The development in sea freight was probably driven by rapidly

[5] The size and nature of the support varied from country to country. Compared with the United States and other European countries, fiscal policy measures were smaller in Sweden.

[6] In Sweden, the labour force participation rate did not fall much, but many people chose to retrain or change sectors.

rising demand for goods combined with bottlenecks in the global trade chain. Examples of such bottlenecks were congested or closed ports and an undersized freight fleet.[7]

The rapid change in demand, together with freight issues and various production interruptions, also led to major disruptions in global value chains in the form of raw material and input good shortages and longer delivery times. One example of the input good shortage was semiconductors, which are an important component in many sectors, such as the automotive and consumer electronics industries. Panel 3 in Figure 9, Appendix shows normalised values of the New York Fed's stressed global supply chain index. The index shows a clear upturn during the beginning of the pandemic when large parts of the world economy shut down and a new upturn during the rapid recovery in autumn 2021. The same panel shows normalised values of delivery times in Swedish industry, according to the Purchasing Managers' Index (PMI), which shows a similar trend.[8] The prices of some commodities also started to rise rapidly already in the second half of 2020 (see Panel 4 in Figure 9, Appendix). Examples include the prices of metals and other raw materials used in industry, as well as food raw material prices.

An article in the July 2020 Monetary Policy Report assessed the prices for goods excluding food that could be affected by disruptions to value chains during the pandemic.[9] The contribution to CPIF inflation from price developments for such goods is shown in Figure 2 below (see the bars highlighted in red). Figure 2 also shows the contribution from prices that should have been affected by an increase in demand when the economy reopened after the pandemic. These include prices for different forms of entertainment, travel, restaurants and accommodation (see light blue bars). Here, too, there are of course elements of cost increases, such as restaurant prices, which correlate strongly with food prices over time. More expensive input goods and higher freight prices should not affect the services sector as directly as other sectors, but in the Riksbank's 2021 business surveys, service companies also reported rising costs and that sales prices were expected to increase. This picture is also confirmed by statistics from the Economic Tendency Survey. The contribution of such services prices increased slightly in 2022 and became significantly larger in 2023.[10]

[7] Many restrictions remained in place for a long time in countries such as China.

[8] According to De Santis (2023), various indices of delivery times were closely monitored by, among others, US Federal Reserve Chairman Alan Greenspan in the 1990s. During that time, Mr Greenspan is reported to have said something like the following in a congressional hearing: "suppliers' deliveries are far more relevant than the Fed's own capacity utilization figures at gauging price pressures in the economy".

[9] See the article "Inflation outlook during the corona crisis" in Monetary Policy Report, July 2020, Sveriges Riksbank.

[10] Changes in consumption behaviour during the pandemic resulted in large weight adjustments within the services price aggregate, which have also affected annual price growth. This is the case, for example, for international travel, where clear seasonal variations in prices over the year, combined with weight changes, have contributed to sharp fluctuations in price growth in the services aggregate.

2.2 Energy crisis and war: More shortages of input goods, higher energy costs and indirect effects

The price of oil rose rapidly in 2021 due to higher demand and various production cuts. Over the year, the price rose from nearly USD 30 per barrel to almost USD 80 per barrel. This development affected fuel prices in both the United States and Europe. In Sweden, petrol prices rose by 25 per cent, or almost SEK 4 per litre, over the same period (see Panel 5 in Figure 9, Appendix). In the context of the war in Ukraine, oil prices rose further. Petrol prices in Sweden peaked in June 2022, and had risen by almost SEK 10 since the end of 2020. The development of diesel prices was even more dramatic, rising from SEK 14.2 in December 2020 to SEK 27.9 in October 2022.

In 2021, natural gas supplies from Russia were unexpectedly low. Gas prices rose rapidly in Europe as the volumes of stored gas in Europe fell. Electricity prices were also substantially affected, as around one fifth of the EU's electricity production was then based on natural gas. This in turn contributed to higher demand for coal in electricity generation, which contributed to higher prices for coal and emission allowances.[11] The rapidly rising electricity prices in Europe also affected prices in Sweden during the autumn, as part of Swedish electricity production is exported. Prices in Sweden were also driven up by a deficit in water reservoirs and lower hydropower capacity. In 2022 and during Russia's full-scale invasion of Ukraine, the energy crisis worsened further and electricity prices remained at record highs throughout the year (see Panel 6 in Figure 9, Appendix).

Higher energy prices in 2021 and 2022 contributed to higher CPIF inflation in 2021 and 2022 (see the grey bars in Figure 2 below). The figure shows only the direct effect of higher energy prices, but other prices were also affected by higher energy prices. One example is higher costs for machine operation and transport. Rising energy costs in agriculture, for example, affect the entire food industry supply chain, from farm production to transport, processing, storage and sales. Higher energy prices contributed to lower margins and exerted upward pressure on food prices.

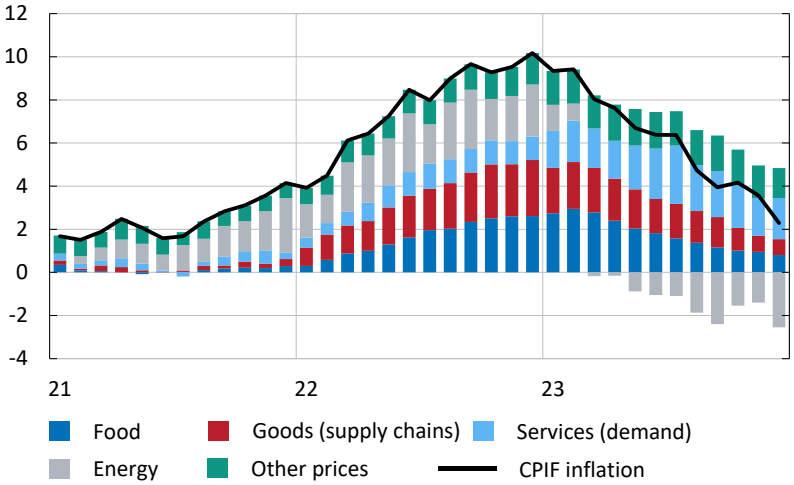
One agricultural input good that rose particularly rapidly in price in 2022 was chemical fertiliser, one of the most expensive annual purchases for many farmers. Import restrictions from Russia and Belarus, as well as export restrictions from China, contributed to this development. Russia and Belarus had up until then been among the biggest exporters of several types of fertiliser before the war. The production of ammonia requires hydrogen from natural gas, which meant that the price of fertiliser was also affected by the price of natural gas. This in turn made the reorganisation of production in other regions and countries difficult and expensive. Panel 7 in Figure 9, Appendix, shows the so-called means of production price index for agriculture. The index shows the price development of the means of production used in agriculture. Prices rose rapidly in 2021 and continued to rise in 2022.[12] The panel also shows food price

[11] As burning coal produces more carbon dioxide than burning natural gas, the price of emission allowances rose.

[12] The means of production price index is comparable to the Input Price Index in the EU.

developments in the CPIF. In the context of the war in Ukraine, the problem was compounded by shortages of plastics, packaging and higher grain prices, which also affected consumer prices. The development of food prices is similar to that of other goods prices in 2022 and 2023 (see the dark blue and red bars in Figure 2). Many goods prices are judged to have been affected by various supply problems. The rise in food prices could also be explained by rising prices of key input goods, indirect effects of energy costs and various delivery problems.

Figure 2. Different prices and their contributions to CPIF inflation
Annual percentage change



Note. The weight for food was 16.8 per cent in 2023. Goods that should have been affected by disruptions in value chains had a weight of 24.9 per cent, while services that should have been affected by sudden shifts in demand had a weight of 20.1 per cent. The weight of energy was 6.3 per cent, while the weight of other goods and services was 31.9 per cent. Positive bars indicate a positive contribution to the change in the CPIF over the past 12 months, while bars below the zero line indicate a negative contribution. The contribution can be interpreted as the annual growth rate of the different components multiplied by their respective weights in the CPIF.

Sources: Statistics Sweden and the Riksbank.

The aggregate called other prices include prices of goods such as musical instruments, flowers and books, and housing-related services such as rent, water and sanitation, insurance and medical care. These prices also started to contribute more significantly to the inflation rate in 2022, although the contribution is relatively small compared with other groups.

In addition to the factors mentioned above, the krona depreciated significantly in 2022 and 2023 (see Panel 8 in Figure 9, Appendix). As a weaker exchange rate tends to increase the prices of imported products measured in kronor, the exchange rate was another reason for Swedish businesses' cost increases in 2022 and 2023. There

are also some signs that the pass-through of the depreciation of the krona to consumer prices has been significantly larger and faster than before.[13] For example, goods prices increased faster in Sweden than in the euro area, and compared with neighbouring countries, goods prices increased faster in Sweden and Norway than in Denmark. This can be explained by the fact that Sweden and Norway's krona depreciated against the euro, while Denmark's krona is pegged to the euro.

3 Higher costs have contributed to price increases according to businesses

The National Institute of Economic Research's quarterly business tendency survey reports on factors that have affected price changes in trading firms and service companies.[14] The results since 2015 are shown in Figures 3 and 4 below. The bars show the upward or downward impact of each factor on prices in the last quarter. A bar above zero means that the factor has contributed to rising prices and a negative bar means that it has contributed to falling prices.

Among trading companies (see Figure 3), domestic costs (light blue bars) and import-related costs (yellow bars), driven to some extent by the weaker krona, are cited as the most important factors explaining price changes in recent years. In 2020, weaker demand contributed to lower prices.

Up until the end of 2019, price increases among service companies were mainly driven by demand and higher domestic costs (see Figure 4). As for trading firms, weaker demand appears to have contributed to price cuts in 2020. Since 2021, it is mainly domestic and import-related costs that have contributed to higher prices among service companies. Demand has contributed to slightly higher prices, especially in late 2021 and most of 2022. But compared to the cost components, demand has played a very limited role.

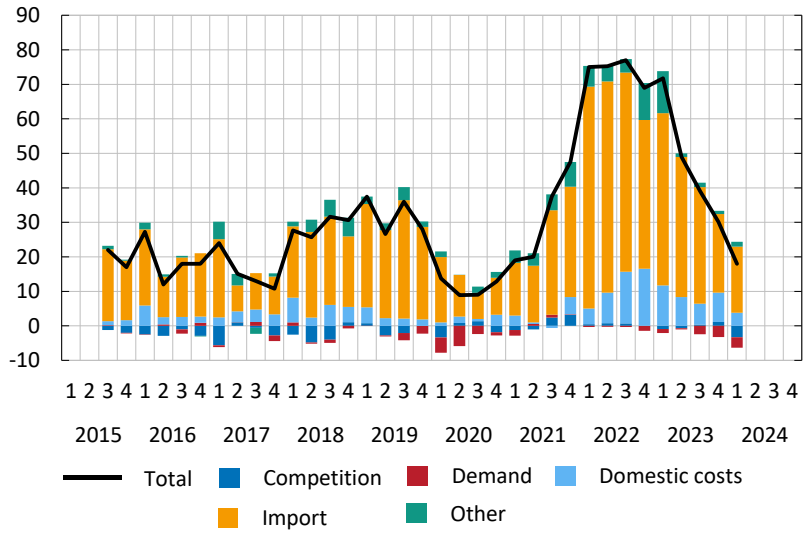
The Riksbank's own business survey also asks about the drivers of pricing policies. Here, however, the question is forward-looking, unlike the one in the Economic Tendency Survey. The outlook for future price developments has differed somewhat between household-related businesses, such as retailers and companies that mainly sell services to households, and other businesses, see Figure 5. Demand appears to have played a slightly larger role as a price-increasing factor among non-household-related businesses, especially in 2021. In 2022 and 2023, costs and the exchange rate dominate as explanatory factors behind price increases among household-related businesses.

[13] See the article "The pass-through of the krona to inflation appears to have been larger than usual", in Monetary Policy Report, November 2023, Sveriges Riksbank and Almgren and Stoyko (2024).

[14] The National Institute of Economic Research's Economic Tendency Survey is based on responses to online surveys from around 1,500 households and 6,000 businesses.

Figure 3. The driving forces behind price changes among trading companies

Net figures

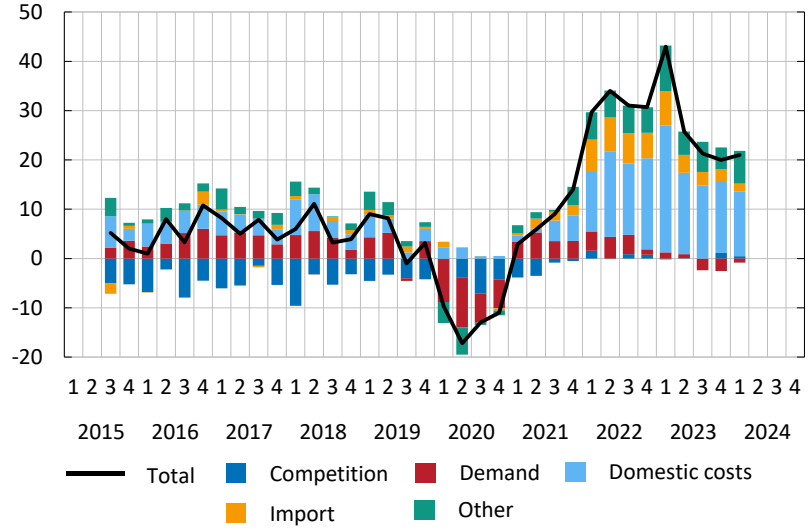


Note. Companies answer whether prices have risen or fallen in the last quarter and then indicate which factor has been the most important in explaining price developments.

Sources: The National Institute of Economic Research and the Riksbank.

Figure 4. The driving forces behind price changes among companies in the service sectors

Net figures

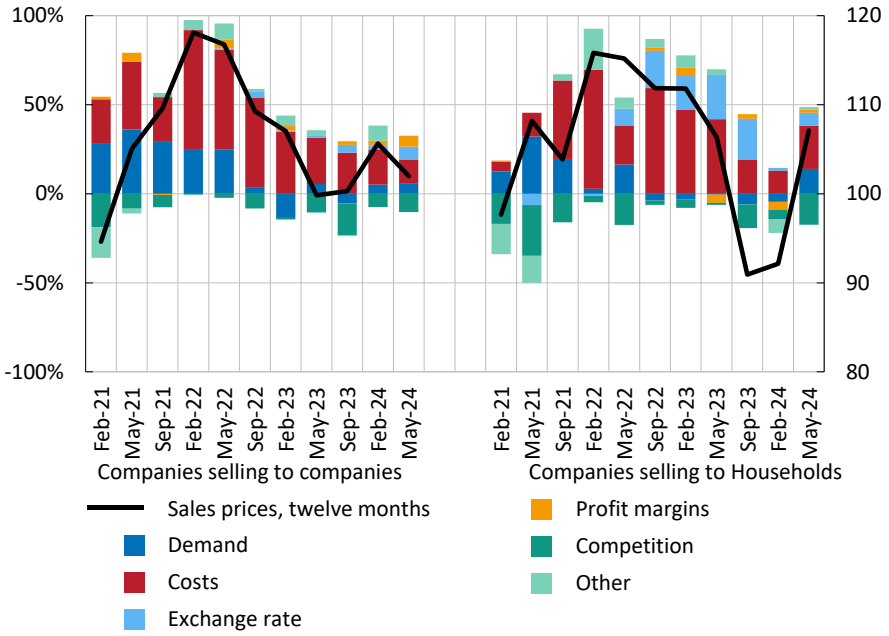


Note. Companies answer whether prices have risen or fallen in the last quarter and then indicate which factor has been the most important in explaining price developments.

Sources: The National Institute of Economic Research and the Riksbank.

Figure 5. The driving forces behind price changes over the next 12 months

Net percentages (left scale) and index figures (right scale)



Note. The bars in the left-hand scale show the net of responses to whether the factor will affect prices upwards or downwards in the coming year. A bar above zero means that the factor contributes to rising prices in the future and one below zero means that it contributes to falling prices. The index figures in the right-hand scale show a standardised value (mean = 100 and standard deviation = 10) of the net figures for those companies that answer the question whether sales prices will be increased or decreased over the next 12 months. Non-household-related companies refer to industrial and construction enterprises and those companies that mainly sell services to other companies. Household-related companies refer to retailers and those companies that mainly sell services to households. The item "Costs" includes purchase costs, labour costs and energy costs. The item "Other" includes spare capacity and productivity growth.

Source: The Riksbank.

Although higher costs seem to be the clearly dominant reason behind price increases according to businesses, there may be other underlying explanatory factors that are also important. It should also be borne in mind that businesses can usually only highlight one or sometimes a few explanatory factors. For example, the strong purchasing power in Sweden should have created the conditions for a change in pricing behaviour in the economy, whereby businesses' cost increases could be passed on to consumers more quickly than before. Price increases also seem to have been more accepted by consumers than before, at least initially.[15]

[15] See Business Survey February 2022, "I've never before experienced customers accepting price increases so easily", Sveriges Riksbank.

4 Explanatory factors according to some model approaches

Below is a presentation of some model approaches that attempt to decompose the high inflation of recent years into different explanatory factors. The results should not be seen as a definitive analysis, but instead be interpreted as a compilation of the approaches the Riksbank has examined so far.

4.1 Disaggregated time series models

Shapiro (2022 and 2024) presents a relatively simple way of analysing how inflation in the United States has been affected by supply and demand factors over time.[16] The analysis, which uses monthly data on personal consumption expenditures (PCE), specifies bivariate equations to model both quantity and price for 100 different consumption categories.[17] The analysis sorts the residuals from the estimated equations into two different groups based on their sign. The method is based on the actual definition of supply and demand shocks. Assuming an upward-sloping supply curve and a downward-sloping demand curve within each consumption category, unexpected changes in prices and quantities should move in the same direction if a demand shock is behind the change, according to the definition of supply and demand shocks. If, on the other hand, unexpected changes in prices and quantities move in different directions, it is more likely that a supply shock is behind the development.

Using weights for the different consumption groups and the signs of the residuals, two contributions to the aggregate price change in the PCE index can then be calculated, one supply-related and one demand-related. According to the results, the recent rise in inflation appears to be explained by both supply-related and demand-related factors in the United States. Both factors also seem to be roughly equally important. The dynamics and historical patterns of the estimated contribution series also look plausible when compared with periods of aggregate supply and demand shocks that have been filtered out by other means. The results found by Shapiro also appear to be relatively robust for different equation specifications, among others.

Here we do a similar analysis, using data from the Swedish National Accounts (NA) for consumption in 75 different categories.[18] In step 1, deflators are calculated for the different consumption areas using consumption volumes in constant and current prices. In step 2, consumption in constant prices and price indices are seasonally adjusted. In step 3, quarterly seasonally adjusted weights are calculated for the different consumption areas. The following Vector Autoregressive (VAR) model is then estimated for each consumption category:

[16] See Shapiro (2022) and an updated version of the same analysis Shapiro (2024).

[17] Personal Consumption Expenditures (PCE).

[18] In this and the next sub-chapter, we use models with only domestic variables in accordance with, for example, Bergholt et al. (2024) and de Walque and Lejeune (2024).

$$q_t^k = \alpha_1 + \sum_{j=1}^{4} \beta_{qq,j}\, q_{t-j}^k + \sum_{j=1}^{4} \beta_{qp,j}\, p_{t-j}^k + v_t \quad (1)$$

$$p_t^k = \alpha_2 + \sum_{j=1}^{4} \beta_{pp,j}\, p_{t-j}^k + \sum_{j=1}^{4} \beta_{pq,j}\, q_{t-j}^k + \varphi_t \quad (2)$$

where *q* and *p* are logarithmised consumption and price indices from the respective consumption category *(c)*.[19] If the product of the estimated residuals in quarter *t is*

$$v_t \varphi_t < 0, \quad (3)$$

a supply shock is assumed to be behind developments over the period. If instead the product of the estimated residuals is greater than zero:

$$v_t \varphi_t > 0, \quad (4)$$

demand-related factors are assumed to have dominated during the quarter. In step 4, quarterly percentage price changes are multiplied by the weight of the respective consumption area *(w)*:

$$\Delta p_t^k w^k$$

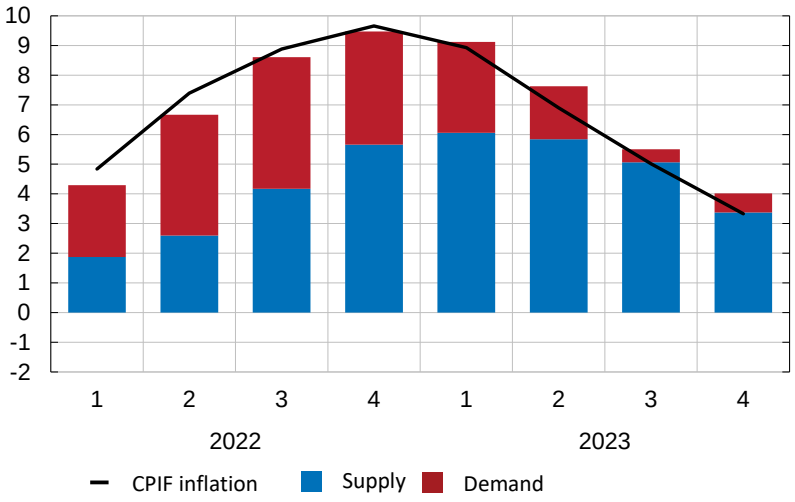
to derive contributions to overall price developments. The contributions are then sorted according to (3) and (4) and added together into two aggregated contribution series. Finally, a 4-quarter moving sum of the quarterly contributions is calculated in order to be interpreted as contributions to the annual rate of the consumption deflator. These annual contributions are shown together with the annual percentage change in the CPIF in Figure 6 below.[20] The results suggest that supply shocks dominated when inflation was at its highest. Figure 10 in the Appendix shows the same decomposition for the period 2010–2021. Over the longer period, supply and demand shocks appear to explain roughly equal amounts of the development of inflation.

[19] In Shapiro (2024), the equations with the variables are also estimated in levels.

[20] In Sweden, as in the United States, the consumption deflator and the CPI/CPIF differ in various ways. Among other things, the difference depends on the consumption areas included and their weights. In Sweden, the calculation of the consumption deflator is also based on quarterly data, while the CPI/CPIF is calculated on a monthly basis.

Figure 6. Contributions to the rate of increase in the consumption deflator

Annual percentage change



Note. Equations 1 and 2 above are estimated with included series in logarithmised levels.

Sources: Statistics Sweden and the Riksbank.

In Figure 11 in the Appendix, the same method has been used but with energy-related consumption categories excluded. The annual contributions of supply and demand factors are shown there, together with the annual percentage change in the CPIF excluding energy. The results are similar, but the supply factors are slightly larger, especially in 2022. Figure 12 in the Appendix shows the same approach again, but here food components, other goods components and services components have been modelled separately and then weighted together according to weights in the CPIF.[21]

Taken together over the period 2022–2023, the results in this section suggest that supply shocks have been a slightly more dominant explanatory factor.[22]

4.2 Aggregated time series model

In this section, we use the model by Ascari et al. (2023) that was developed to quantify the importance of supply and demand shocks. In the analysis, this is done with a Vector Autoregressive (VAR) model estimated using Bayesian methods.[23] The model contains 4 variables: inflation (measured as the monthly percentage change in the HICP), industrial production index (used as a proxy for monthly output), two-year overnight index swap and energy prices (measured as the monthly percentage change). They use conventional sign restrictions to identify supply and demand

[21] Among the food components, supply shocks have clearly dominated since 2022. Among the other components of goods and services, supply shocks have also dominated, but the distribution between supply and demand is slightly more even.

[22] Specifications where the variables in equations 1) and 2) are expressed in quarterly and annual percentage changes have also been tested, with similar results.

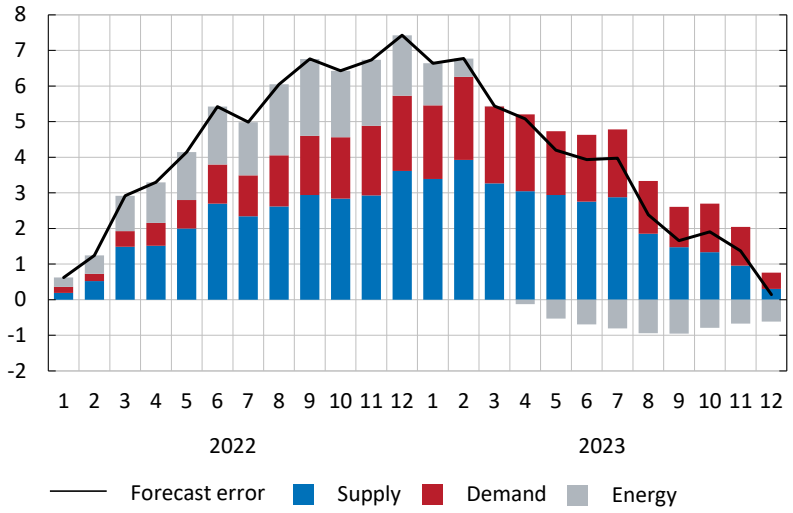
[23] The model uses steady-state priors and the same prior settings as in Villani (2009). All variables have 6 time lags.

shocks, with supply shocks affecting inflation and output in opposite directions while demand shocks affect them in the same direction. The thinking is thus much the same as in the analysis by Shapiro above. Among the supply factors, they also identify an energy price shock specific to the energy price component that affects inflation in the same period.

Here, instead of the HICP, we use the monthly percentage change in the Riksbank's CPIF target variable and the energy price component in the CPI. To isolate the significance of supply and demand factors, we, like Ascari et al. (2023), use the VAR model's forecast errors. This is done by first estimating the model using data from August 2011 to October 2021.[24] Forecasts are then calculated for the period November 2021 to December 2023 and the forecast errors are calculated as the differences between the outcomes and the forecasts for the same period. Depending on the relative movements in output and inflation, the model's forecast errors are then decomposed into demand and supply. In this way, it is possible to identify the main economic drivers explaining the unexpected movements in inflation (also in the other variables included in the VAR model if they are of interest). Figure 7 shows the decomposition of the VAR model's forecast errors in 2022 and 2023 into the three different shocks.[25]

Figure 7. A breakdown of the forecast errors for CPIF inflation according to the aggregated time series model

Percentage points



Note. The solid line shows the forecast errors for CPIF inflation defined as outcomes minus forecasts. A positive forecast error thus implies an underestimation of the outcome and vice versa.

Source: The Riksbank.

[24] The starting point of the estimation period is based on data availability and the end point is the same as the one used in the MAJA exercise in Chapter 4.3. In both approaches, we have chosen an end point before inflation really took off. The breakdown of the shocks and the interpretations are robust also for other estimation periods.

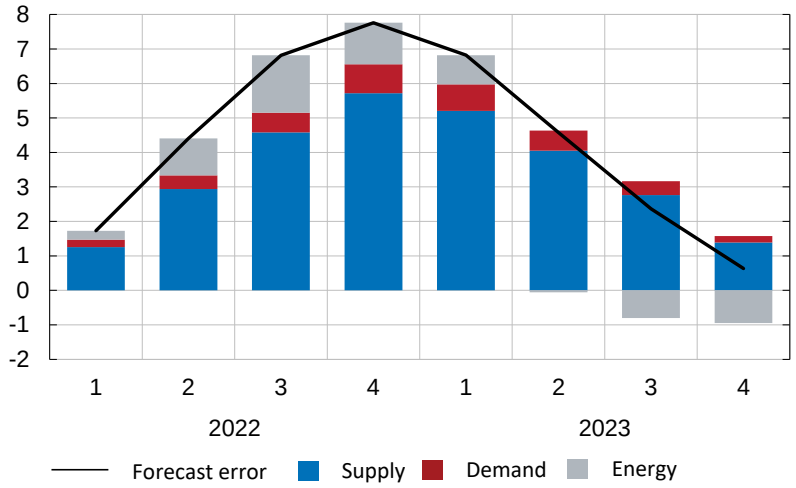
[25] Quarterly rates have now been converted to annual rates to facilitate interpretation.

It is clear that the VAR model has underestimated inflation. In 2022, about half of this is explained by the unexpectedly weak supply following the outbreak of war in Ukraine. The rest is explained in roughly equal parts by unexpectedly high energy prices and strong demand. In 2023, the forecast errors decrease, largely due to lower-than-expected energy prices but also to other supply problems having eased.

4.3 General equilibrium model

Here is an interpretation of the Riksbank's forecast errors in November 2021 according to the MAJA macro model.[26] According to the model, the forecast errors were due to the Riksbank being surprised mainly by supply shocks that drove up inflation (see Figure 8).[27] In addition to productivity shocks, this group of shocks also includes price mark-ups. This means that higher-than-expected price mark-ups also contributed to the underestimation of inflation. In 2022 and 2023 demand has also been higher than expected, contributing to the underestimation of inflation, but this effect is much smaller than the supply shocks. In 2022, higher-than-expected energy prices also contributed to the underestimation, an effect that faded in 2023.

Figure 8. A breakdown of the forecast errors for CPIF inflation according to MAJA
Percentage points



Note. The solid line shows the forecast errors for CPIF inflation defined as outcomes minus forecasts. A positive forecast error thus implies an underestimation of the outcome and vice versa.

Source: The Riksbank.

[26] MAJA is a dynamic stochastic general equilibrium (DSGE) model used at the Riksbank to analyse and forecast the Swedish economy, see Corbo and Strid (2020). As in the VAR exercises, we have defined supply shocks as shocks that affect inflation and output in opposite directions, while demand shocks affect them in the same direction. Among the supply shocks, energy prices and two price mark-up shocks in particular have major effects on inflation, but what they have in common is that they also have only minor effects on output.

[27] The results are relatively robust if, like Shapiro (2022), we instead split the outcomes for CPIF inflation instead of the forecast errors.

5 Conclusions

In this study, we analyse the factors that have fuelled the recent surge in inflation. To a large extent, the rise in inflation can be attributed to a series of events abroad, including global supply and value chain problems caused by the pandemic, significant energy price fluctuations and the economic impact of Russia's invasion of Ukraine. These events are not entirely independent of each other.

The pandemic initially caused a dramatic drop in demand and a change in consumption behaviour. As economies reopened, demand increased rapidly, which, together with bottlenecks in the global supply chain, resulted in higher freight prices and longer delivery times. The energy crisis and the war in Ukraine aggravated the situation. Oil prices rose sharply in 2021 and increased further with the outbreak of war. Natural gas supplies from Russia unexpectedly declined, pushing up gas and electricity prices in Europe and indirectly in Sweden. Higher energy prices affected both industry and agriculture, resulting in higher production costs and price mark-ups along the supply chain.

In the National Institute of Economic Research's survey-based quarterly tendency survey, businesses responded that domestic and import-related costs have been important factors behind the price increases. This is confirmed by the Riksbank's business survey, in which respondents emphasise costs and the exchange rate as key drivers of pricing in recent years. According to both surveys, demand is considered to have contributed to slightly higher prices, but compared to other more cost-related components, it has played a more limited role.

What the companies say is supported to some extent by models estimated on Swedish data. Shapiro's (2022) approach, among others, is used to decompose consumer prices in the National Accounts (NA). The results of some variants are summarised in Table 1 below (see row 1 "Shapiro"). Overall the results suggest that various supply factors explain a slightly larger share of the development of inflation in recent years (see the figures in the columns labelled supply and demand respectively). However, the results depend on the specifications and the consumption areas included.

Table 1. Decomposition of inflation into supply and demand factors

Contribution to price growth over the period 2022 to 2023

Method	Supply	Demand
1) Shapiro (mean of 3 specifications)	0.7	0.3
2) Ascari et al. (BVAR)	0.7	0.3
3) MAJA (DSGE)	0.9	0.1

Note. Method 1) is an average of three different model specifications. In the first variant, the energy price components in the NR are included. In the second variant, the energy price components are excluded and in the third, food components, other goods components and services components are modelled separately and then weighted together according to CPIF weights. In Methods 2) and 3), energy is included and has been categorised as a supply factor in the table.

Source: The Riksbank.

The model suggested by Ascari et al (2023) suggests that about half of the unexpected pick-up in inflation in 2022 is explained by supply shocks other than energy. The rest of the increase in inflation is explained, in equal parts, by unexpectedly high energy prices and strong demand (see Figure 7 and row 2 of Table 1). In 2023, the model's forecast errors decrease, largely due to lower-than-expected energy prices. But it was also due to the easing of other supply problems. These results are in line with what Ascari et al. (2023) finds for the euro area. In the Riksbank's general equilibrium model MAJA (see Corbo and Strid, 2020), demand shocks have contributed to higher inflation, but this effect is much smaller than the supply-side shocks (see row 3 in Table 1). In 2022, higher-than-expected energy prices also contributed to the underestimation of inflation, an effect that faded in 2023.

The fact that supply shocks appear to have dominated the recent development of inflation is supported by Hassler et al. (2024). They emphasise that it is mainly supply-demand imbalances that affect inflation. It is supply shocks *combined* with high demand that have an impact on inflation. They also write that negative supply shocks cannot be neutralised by raising interest rates, but that a period of high inflation can lead to a loss of confidence in the inflation target. This is true regardless of the reasons for the high inflation. Restoring this confidence in the target is also very costly. Therefore, according to Hassler et al. (2024) responding to supply shocks with interest rate hikes is fully in line with established theory and proven experience. English et al. (2024) also emphasise that it may be important for monetary policy to respond to supply shocks in certain situations.

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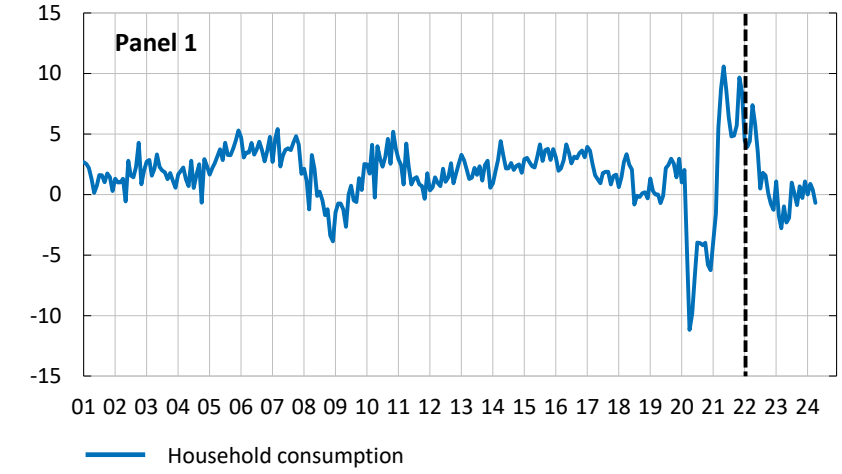
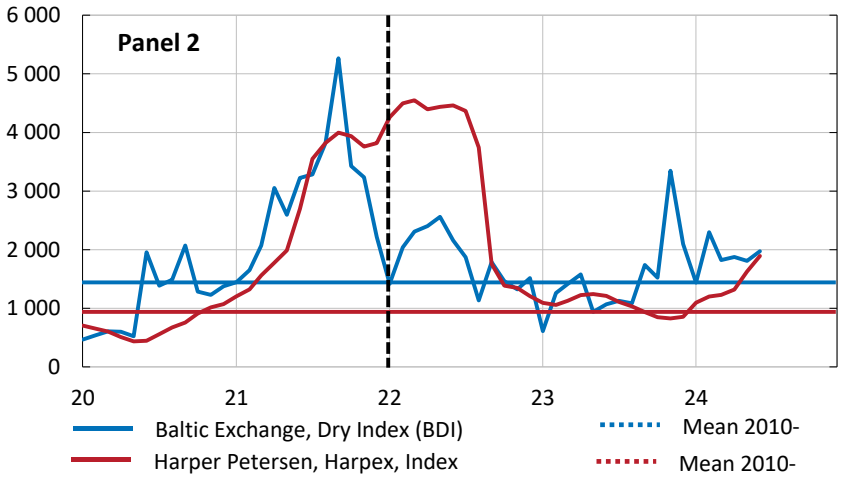
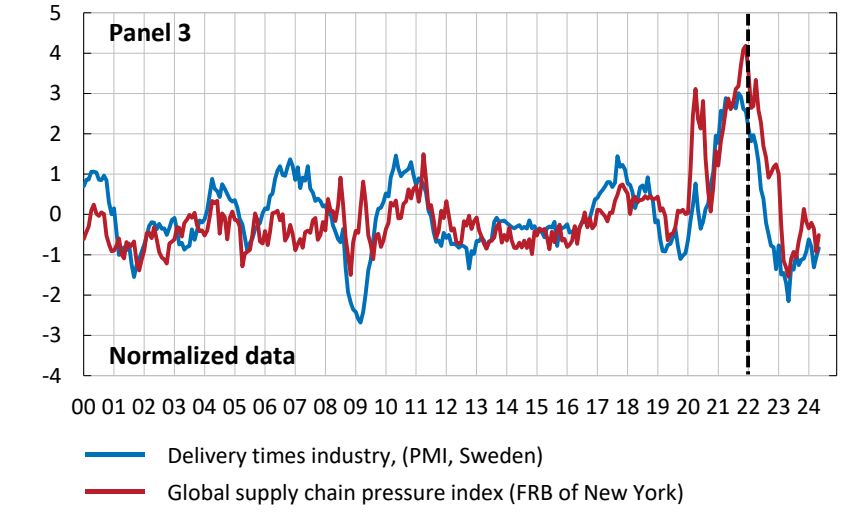
APPENDIX

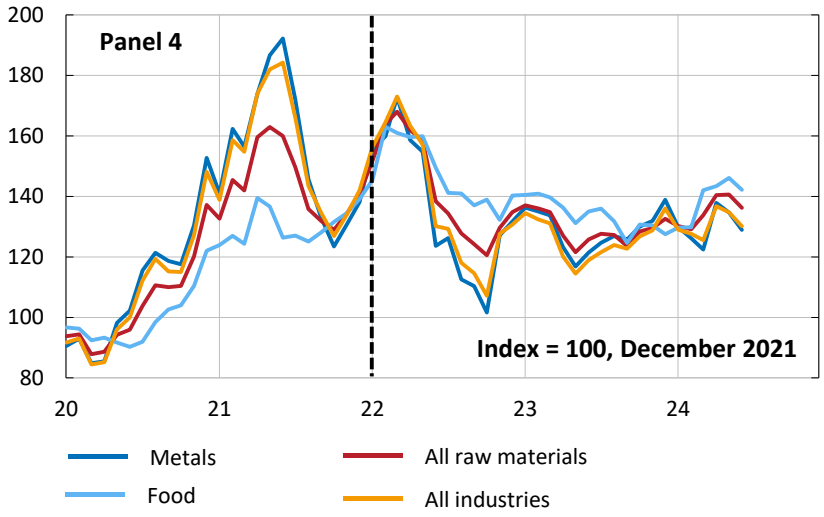
Figure 9. Inflation indicators

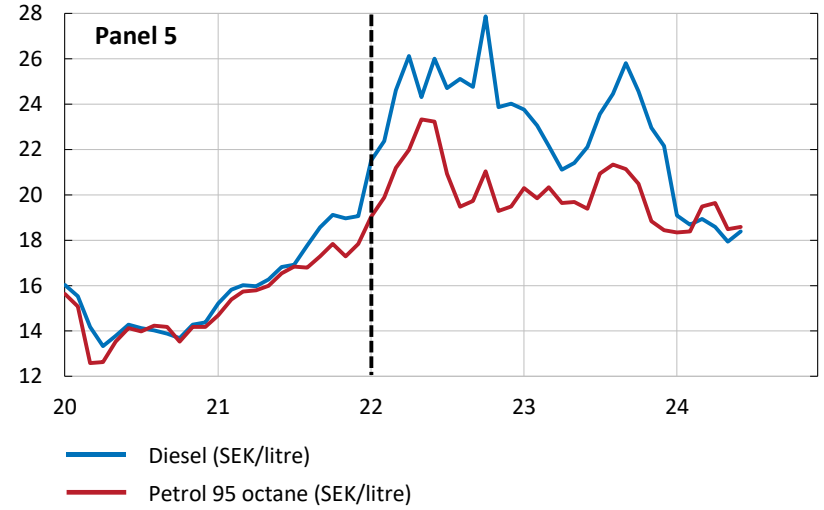
Panels 1-8 below (note after Panel 8)

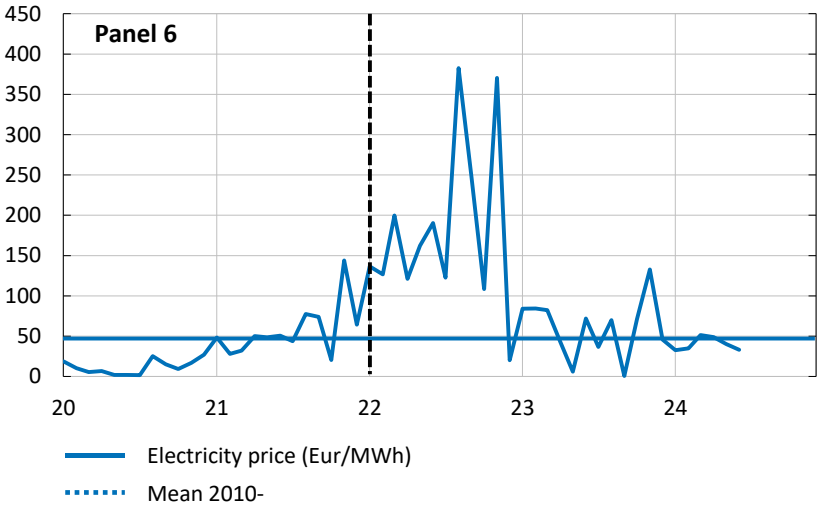


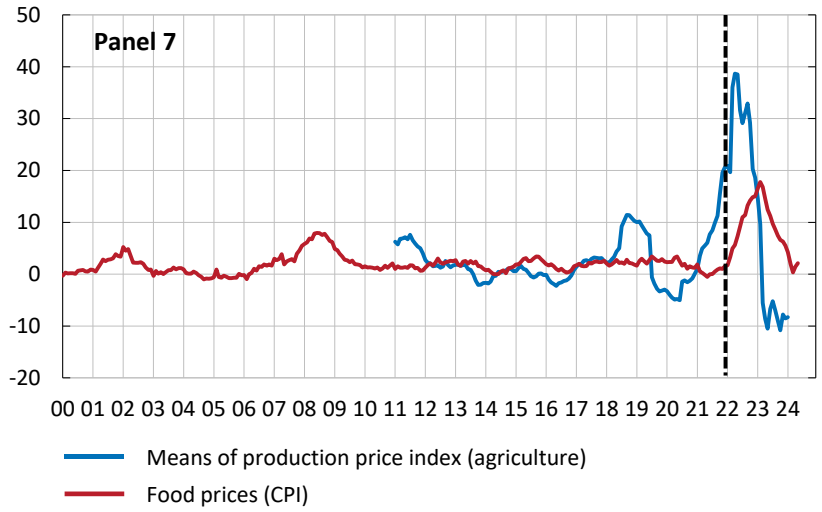


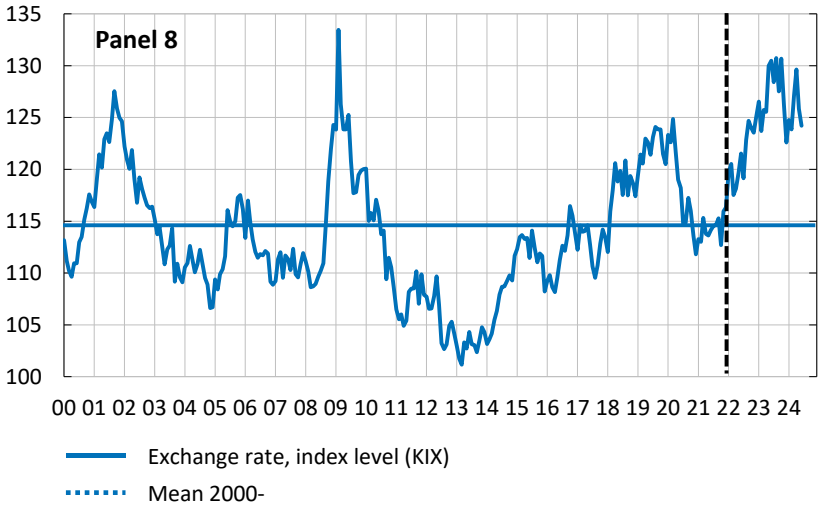



Panel 4
Index = 100, December 2021
200
180
160
140
120
100
80
20
21
22
23
24
Metals
Food
All raw materials
All industries


Panel 5
28
26
24
22
20
18
16
14
12
20
21
22
23
24
Diesel (SEK/litre)
Petrol 95 octane (SEK/litre)


Panel 6
450
400
350
300
250
200
150
100
50
0
20
21
22
23
24
Electricity price (Eur/MWh)
Mean 2010-



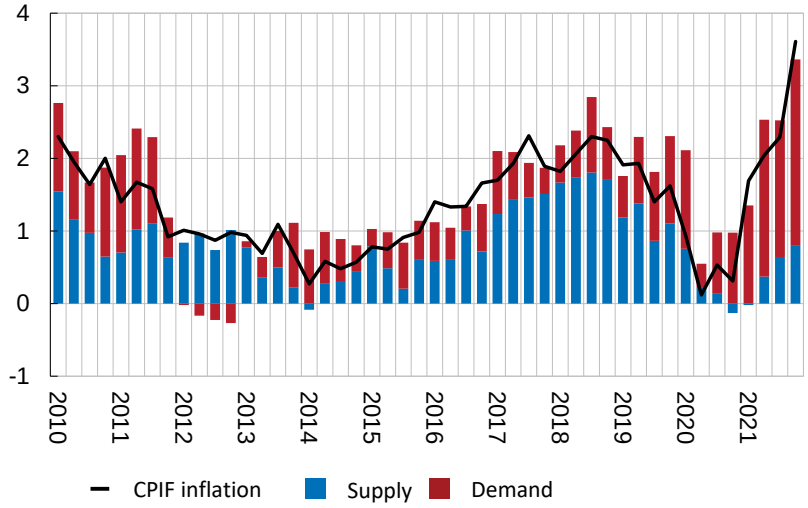


Note. Vertical line indicates December 2021, before inflation excluding energy picked up in Sweden. Panel 1 shows annual percentage change and Panel 2 shows index levels. Panel 3 shows normalised index levels, while Panel 4 shows index levels where December 2021 = 100. Panel 5 shows SEK per litre and Panel 6 shows the electricity price in EUR/KWh. Panel 7 shows the annual percentage change while Panel 8 shows an index level.

Sources: Macrobond and the Riksbank.

Figure 10. Contributions to the rate of increase in the consumption deflator

Annual percentage change

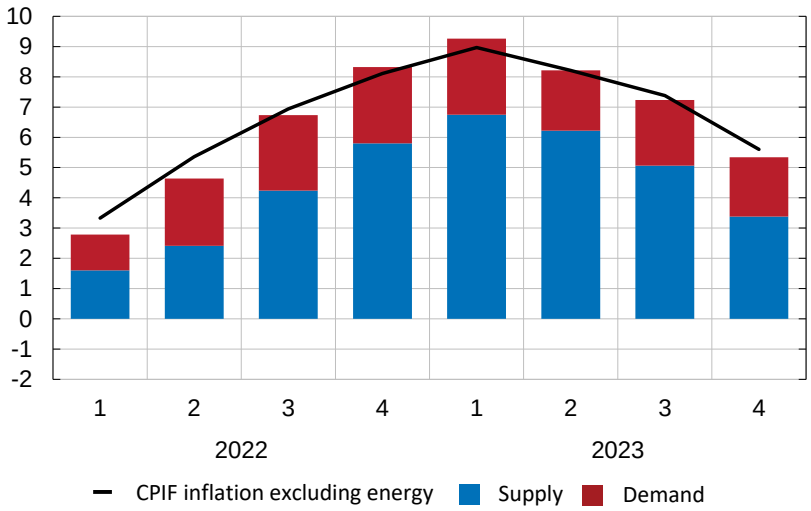


Note. Equations 1 and 2 above are estimated with included series in logarithmised levels.

Sources: Statistics Sweden and the Riksbank.

Figure 11. Contributions to the rate of increase in the consumption deflator

Annual percentage change

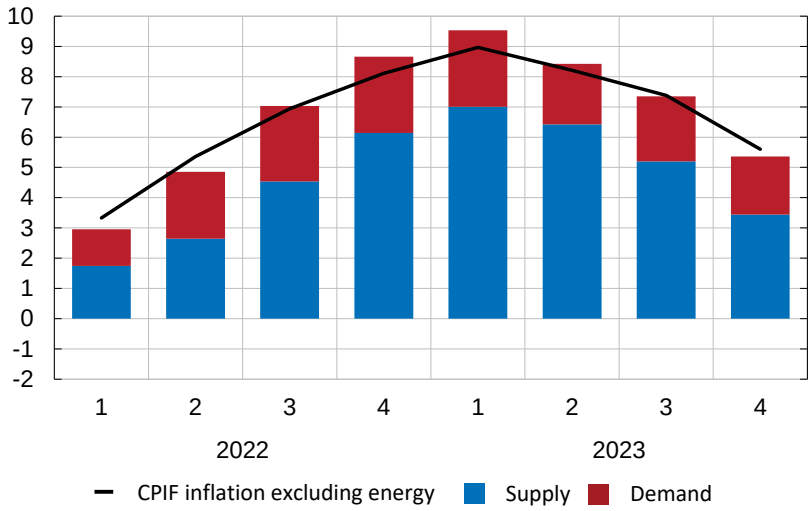


Note. Equations 1 and 2 above are estimated with included series in logarithmised levels. In this variant, the energy price components in the National Accounts have been excluded.

Sources: Statistics Sweden and the Riksbank.

Figure 12. Contributions to the rate of increase in the consumption deflator

Annual percentage change



Note. Equations 1 and 2 above are estimated with included series in logarithmised levels. Here, food components, other goods components and services components are modelled separately and then weighted together according to CPIF weights.

Sources: Statistics Sweden and the Riksbank.

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