Cyclically sensitive and exchange rate sensitive prices

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Summary

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Consumer prices are affected by many factors. In this commentary, statistical methods are used to divide Swedish consumer prices into those that are affected particularly strongly by fluctuations in economic activity and those that covary clearly with changes in the exchange rate. Such a decomposition can hopefully teach us something about the inflation development in recent years.

The analysis, which is inspired by earlier studies of US data, is based on 66 sub-indices in CPIF. Apart from energy prices, which weighs 7 percent in CPIF, the result shows that the prices that correlate with economic activity, the exchange rate or both are responsible for about 60 per cent of the total weight in the CPIF. At the same time, just over 30 per cent of prices seem to follow neither economic activity nor the development of the exchange rate over the period studied.

Inflation measured in terms of the CPIF excluding energy showed a rising trend, albeit a slow one, between 2014 and 2019 and it was the cyclically sensitive and exchange rate sensitive prices that contributed to the gradually higher inflation. During the crisis of 2020, the rate of increase for both cyclically sensitive and exchange rate sensitive prices fell clearly, while other consumer prices increased slightly more rapidly.

Such a rough division of consumer prices, guided as it is by models, occasionally gives rise to some random results that can only be explained with difficulty. The results nevertheless seem reasonable and indicate, among other things, that there is a clear connection between economic activity and the exchange rate on one hand and many consumer prices on the other.

1 Inflation, the exchange rate and economic activity

In the years following the financial crisis, economic activity strengthened clearly in the United States but core inflation nevertheless stayed well below the level of 2 per cent. Normally, the Federal Reserve should have been able to affect inflation through what is known as the demand channel. The Fed also held the policy rate at a record low level for several years and economic activity strengthened, but inflation nevertheless seemed to be following a downward trend, particularly in the years 2012-2016. At a press conference in September 2017, the then governor of the central bank, Janet Yellen, suggested that the continuing low inflation was something of a mystery.[2]

However, an analysis presented by the Federal Reserve Bank of San Francisco found support for the prices that usually covary with economic activity actually had risen. It was the other, acyclical prices that had increased slowly in recent years.[3] The analysis had divided a number of price indices, together forming the underlying measure of inflation core PCE, into cyclical and acyclical prices.[4] Among other things, it found that just over 40 per cent of the prices in the PCE seemed to covary with economic activity.

In May 2019, Deutsche Bank presented a similar study based on the same data, but where prices were also allowed to be affected by the development of the exchange rate. Among other results, with this modified specification, they found that just over 60 per cent of the prices in the PCE seemed either to be dependent on economic activity, to covary with the development of the dollar, or both.[5]

The development of inflation in Sweden resembles that in the United States. In conjunction with the financial crisis, CPIF inflation started to follow a downward trend that lasted for several years. Even if inflation started to rise gradually from around 2014-2015, the rate of increase seems overall to be restrained in light of economic developments being very good until the outbreak of the coronavirus pandemic. Can we perhaps learn something about the development of inflation in recent years if we try to decompose consumer prices in Sweden in the same way as in the studies of the US consumer prices? Which parts of the consumer price index tend to covary with economic activity, which prices seem to be affected by movements in the exchange rate and which ones demonstrate a weaker relationship with economic activity and the exchange rate?

The analysis of Swedish data presented here is based on 66 sub-indices in CPIF. The results show that the price index that seems to correlate with economic activity, the exchange rate or both amounts to more than 60 per cent of the weight in CPIF. At the same time, just over 30 per cent of the prices, on average over the last twenty-year period, follow neither the development of economic activity nor that of the exchange

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[2] See transcript of Janet Yellen's press conference, 20 September 2017. "Federal Reserve Board of Governors" https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20170920.pdf
[3] See Mahedy, T and Shapiro, A (2017).
[4] Personal Consumption Expenditures price index (PCE).
[5] See Luzzetti, M, Ryan, B and Weidner, J (2019).

rate. The rest consists of energy prices. The rate of increase for the cyclically sensitive prices gradually increased from 2014 until 2019, but slowed down heavily in 2020.[6] The prices that seem to covary with the exchange rate are more volatile but their rate of increase has also slowed down clearly since 2019. The annual rate of increase for prices that neither follow economic activity nor are affected by fluctuations in the exchange rate was relatively high in 2016 and 2017. Most recently, they have also increased more rapidly.

A presentation of studies made using US data follows below. This is followed by a description of the models used to classify Swedish prices. The final section reports the results.

2   Studies of US data

The analysis by the Federal Reserve Bank of San Francisco sorted 122 subgroups in the PCE using a simple relationship in which the monthly rate of increase in the various price indices was explained by the unemployment gap, a measure of expected inflation and previous rates of increase in the price index.[7] If the gap had a significant effect on the rate of price increases, the component was placed among the cyclical prices. Otherwise, it was not. The results showed that the cyclical price categories amount to 42 per cent of the total weights in the core PCE. This includes components such as housing, recreational services, restaurants and some simpler consumer goods. Among other things, the acyclical price index includes healthcare services, financial services, clothes and transport. The analysis also indicates that the acyclical prices, the rate of price increases for healthcare services in particular, contributed to keeping the rate of inflation down over the years until the end of 2017.[8]

The study by Deutsche Bank made a different classification of the prices. This investigated whether different sub-indices in core inflation are sensitive to economic activity, fluctuations in the dollar exchange rate, both or neither. There were thus four groups, three of which could be affected by the Federal Reserve via the effects of monetary policy on demand and/or the exchange rate. The analysis by Deutsche Bank used a finer division of the PCE (more sub-groups) and a less strict significance level in sorting. Another difference is that it used annual percentage price changes instead of monthly ones, with the intention of reducing short-term volatility and noise. Apart from a labour market measure, it also used the exchange rate as an explanatory variable in the regressions, which were estimated for the period 1990 to 2007. One of the conclusions reached is that prices that seem to be affected by economic activity, the exchange rate or both make up just over 60 per cent of the total weight of core PCE.

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[6] Inflation has been particularly difficult to interpret during the coronavirus pandemic and will remain so over the next few years. In addition to the problems with shifts in consumption and changed weights, there are also other problems connected to it being impossible to measure certain prices.

[7] Data from 1985 until 2007 was used in the estimates. For more information on the specification used, see: https://www.frbsf.org/economic-research/indicators-data/cyclical-and-acyclical-core-pce-inflation/

[8] See also Zaman (2019) for a similar analysis with a slightly more refined dataset. Another example that attempts to analyse the link between inflation and resource utilisation by studying various sub-indices of inflation (different components) is Stock and Watson (2019).

3 Models for and classification of Swedish consumer prices

The analysis in this Economic Commentary resembles the one made by Deutsche Bank but using Swedish quarterly data from 1998 to 2019 for 66 price indices that together form the CPIF excluding energy.[9] In a first step, two different models are used for each price index to identify the optimal time lag for the explanatory variables resource utilisation and exchange rate.[10] When a specific time lag (k) has been selected for the measure of resource utilisation and a specific moving average (i) has been selected for the annual percentage change in the exchange rate, the following equation is estimated for each sub-index in step 2.[11]

$$\Delta_4 p_t^j = c + \beta_1 \Delta_4 p_{t-1}^j + \beta_2 \Delta_4 p_{t-4}^j + \delta MA^{(i)}(\Delta_4 vxk_t) + \gamma ru_{t-k} + \varepsilon_t, \qquad (1)$$

in which $\Delta_4 p_t^i$ signifies annual percentage change in price index j, while ru_{t-k} is the measure of resource utilisation that is adjusted in time by k quarters. [12] $MA^{(i)}(\Delta_4 vxk_t)$ indicates a moving average (i quarters) of the annual percentage development of the exchange rate. The so-called RU indicator is used as a measure of resource utilisation, while the KIX is used for the exchange rate.[13]

If any sub-index gets an estimated γ that is positive and differs significantly from zero, the component is sorted into the group that is considered to covary with economic activity. If the estimated parameter δ is positive and differs significantly from zero, the index is placed in the group that is deemed to be sensitive to exchange rate movements. If neither γ nor δ are significant, or have the 'wrong' sign, the sub-index ends up in the group called other prices.[14] A sub-index can be sorted into both the cyclically sensitive and the exchange rate sensitive groups. One example is foreign travel (see Tables 1 and 2 in the appendix). This means that the three different groups do not add up to the CPIF excluding energy, as some price indices covary with both economic activity and exchange rate development.[15]

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[9] We do not use data from 2020 in this sorting phase, as some price indices have been affected in a highly particular way since April 2020 at least.

[10] For each index, lags (k) of 1-12 quarters and the moving averages (i) of 1-12 quarters are tested.

[11] Lengths of lags and moving averages are chosen according to the lowest p value.

[12] The specification thus resembles the one used in Luzzetti, M, Ryan, B and Weidner, J (2019). In Mahedy, T and Shapiro, A (2017), the various price components are modelled in monthly percentage changes.

[13] The RU indicator is a statistical measure of resource utilisation. Other measure of resource utilisation have also been tried, with somewhat varied results. The KIX (krona index) is a weighted average of the currencies in 32 countries that are important for Sweden's international trade.

[14] The right sign means that the prices shall tend to increase if the RU indicator has been on a high level for some time. Correspondingly, the rate of price increase should be positively correlated to a weakening of the exchange rate with a certain time lag.
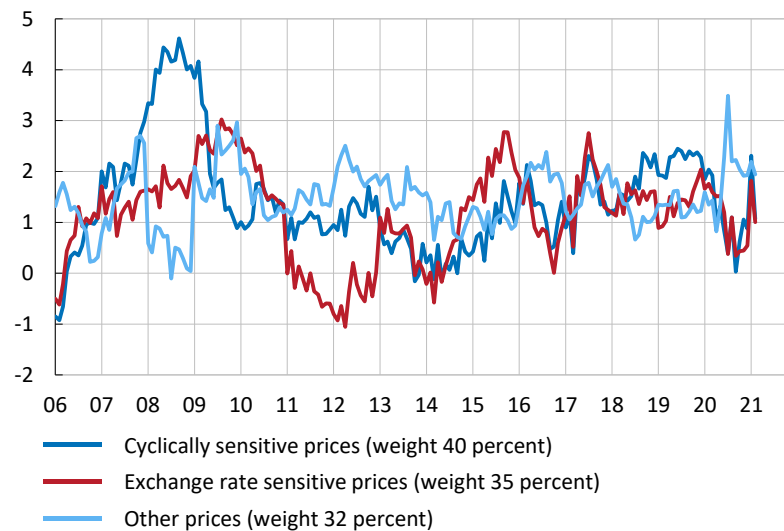
[15] Diagnostic tests indicate fourth order autocorrelation in several cases. To manage possible serial correlation in the residuals, a corrected standard error has also been calculated (according to Newey-West). However, this result does not lead to any major differences in the sorting of the various components and therefore an uncorrected standard error has been used.

4   Results

The annual percentage change of the constructed indices according to the classification above is shown in Figure 1 below. According to the analysis, 27 sub-indices out of 66 seem to be sensitive to fluctuations in economic activity (see the dark blue line). Their total weight in the CPIF is just over 40 per cent.

Figure 1. Annual percentage change for the composite indices[16]

Annual percentage change

Cyclically sensitive prices (weight 40 percent)
Exchange rate sensitive prices (weight 35 percent)
Other prices (weight 32 percent)

Sources: Statistics Sweden and the Riksbank

The indices that seem to be affected by movements in the exchange rate are together responsible for 35 per cent of the weight (see the red line), while price indices that react neither to fluctuations in economic activity nor to those in the exchange rate account for almost 32 per cent of the weight in CPIF. Medical care and books, among other things, belong to this group (see the light blue line).[17] In the figure, it can be seen that the rate of increase for the cyclically sensitive prices followed a relatively clear positive trend from 2014, but that it has slowed down quite abruptly since 2020. The rate of increase in the prices that are sensitive to the exchange rate has been relatively moderate since 2018 but also slowed down abruptly in 2020.[18] The annual rate of increase for prices that neither follow economic activity nor are affected by fluctuations in the exchange rate was relatively high in 2016 and 2017 but then slowed down. The rate of increase rose clearly again in conjunction with the pandemic, particularly in the summer of 2020, which is partly connected to it becoming more expensive to hire cars (see the light blue line). Table 1-3 in the appendix shows which components have ended up in which group. Table 4 in the appendix presents average rates of increase for different periods.

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[16] The weights do not add up to 100 because energy prices are not included and some prices are both exchange rate and cyclically sensitive.

[17] See Table 3.

[18] See note 6.

The correlation between the RU indicator and the prices categorised as cyclically sensitive in the estimate is 0.74 (see Figure 2 below). There is a tendency towards reduced covariation in recent years. This could be an indication of the transmission between economic activity and inflation having weakened, even if it is not possible to draw any far-reaching conclusions concerning causal relationships on the basis of this purely statistical analysis.[19] The correlation between the corresponding aggregated series for the exchange rate sensitive price group and the annual percentage change of the KIX index is 0.69 (see Figure 3). In that case, there are not such clear tendencies towards the relationship having weakened over time.

**Figure 2. Cyclically sensitive prices and the RU indicator**

Standard deviations and annual percentage change respectively

RU indicator (+ 6 quarters)

Cyclically sensitive prices
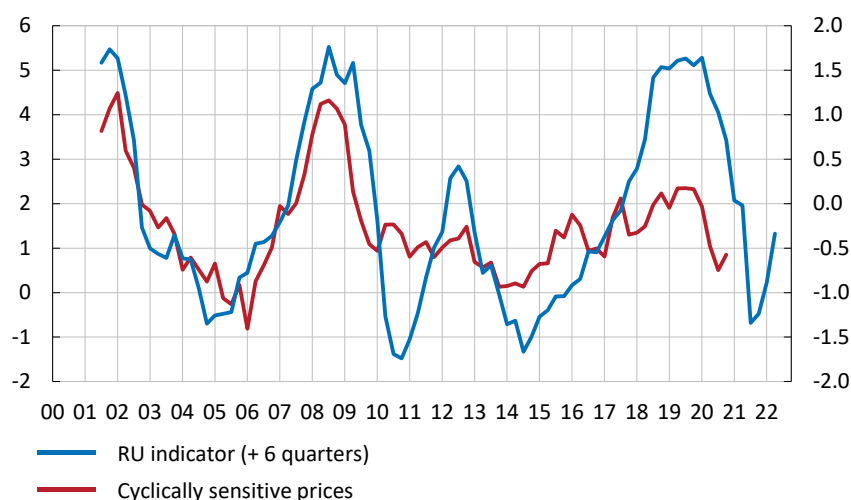
Sources: Statistics Sweden and the Riksbank

Figure 3. Exchange rate sensitive prices and the KIX index

Annual percentage change

KIX index (+ 3 quarters), right scale

Exchange rate sensitive prices
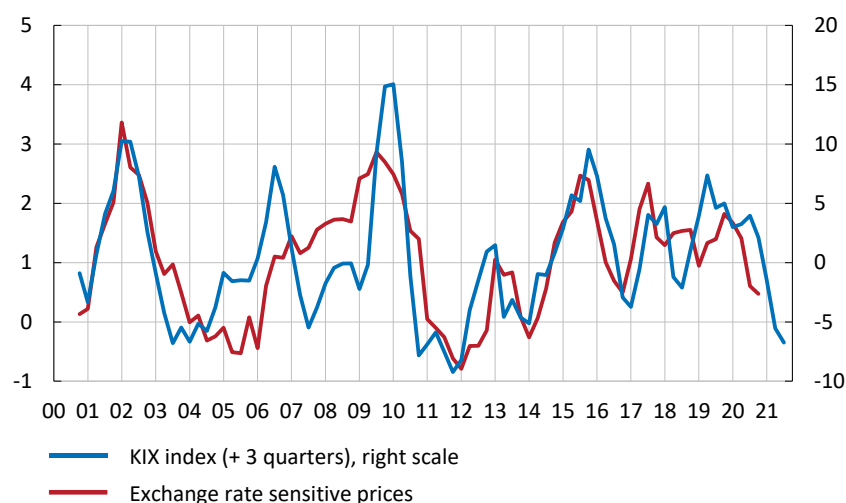
Sources: Statistics Sweden and the Riksbank

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[19] The observation is linked to a fairly comprehensive body of literature on an increasingly flat Phillips curve in many countries. For a discussion of possible causes for this, see Kuttner and Robinson (2010), among others

Figure 4 shows how much the three calculated indices and energy prices contribute to the rate of increase in the CPIF. In the figure, the cyclical prices and those that tend to correlate to the exchange rate have been combined so that it all adds up to the CPIF. Positive columns indicate a positive contribution to the change in the CPIF over the last 12 months, while columns below zero indicate a negative contribution.[20] Apart from 2016, the cyclical and exchange rate sensitive prices have contributed to gradually higher inflation between 2014 and 2019. In 2020, the contribution rapidly became lower. This also applies to the contribution made by energy prices. Other prices had no clear trend in their rates of increase between 2014 and 2019 but, in 2020, they increased somewhat more rapidly than an historical average (see Figure 1 and Figure 4).

Figure 4. The various components' contributions to CPIF inflation

Annual percentage change and percentage points respectively
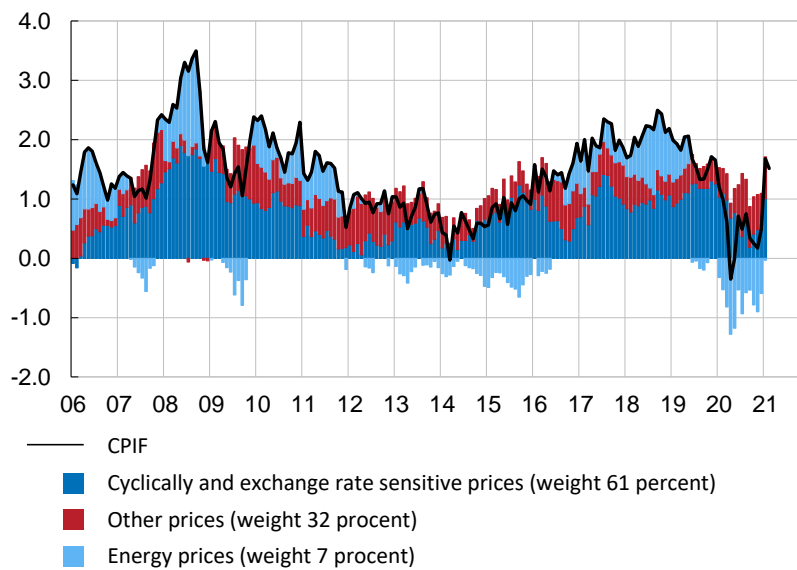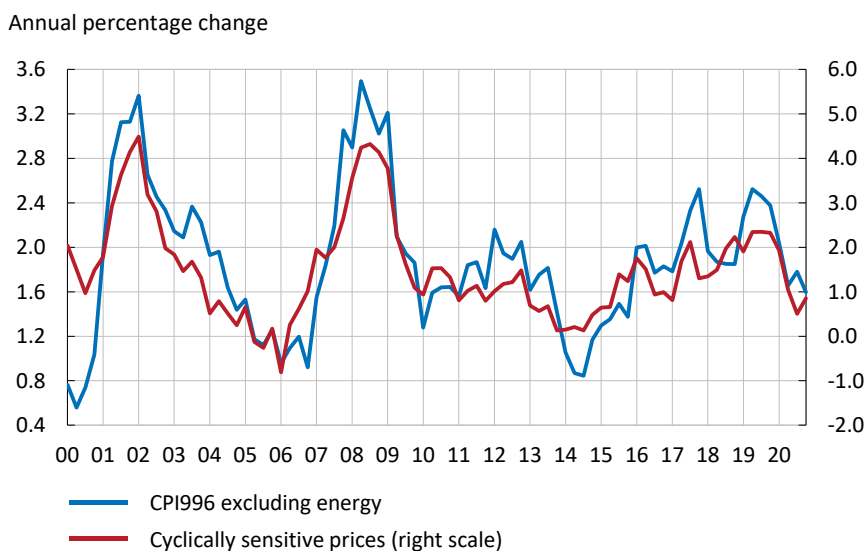

Sources: Statistics Sweden and the Riksbank

One indication that the results may be quite reasonable arises if these constructed indices are compared with other calculated indices. For many years, Statistics Sweden has calculated one price index for domestically produced goods and services in the CPI and one for mainly imported goods and services. The calculations are made on behalf of the Riksbank and are sometimes used in models and the monetary policy analysis. It could be expected that the first index would covary more with domestic economic activity, while the second would correlate more with the exchange rate. In Figure 5 and Figure 6 below, these calculated indices, excluding energy, are plotted together with the indices resulting from filtration using equation (1). In both cases, the correlation is high.[21]

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[20] The contribution can be interpreted as the annual rate of increase in the various components multiplied by their respective weights in the CPIF.

[21] The correlation is over 0.8 in both cases. The calculated indices are designated Price index for mainly domestically produced goods and services excluding energy (CPI996 excluding energy) and Price index for mainly imported goods and services excluding energy (CPI997 excluding energy), respectively. Seventeen components included in the estimate of the cyclically sensitive prices can also be found among the 44 components that together form KPI966 excluding energy. Fourteen components included in the index for exchange rate sensitive prices are also included in KPI997 excluding energy.

It should be mentioned that some random and hard to explain results must be expected when using such a rough, model-guided division of sub-groups, but the analysis nevertheless indicates that there is a clear relationship between economic activity, exchange rate and consumer prices.

Figure 5. Price index for mainly domestically produced goods and services excluding energy (CPI996 excluding energy) and cyclically sensitive prices

Annual percentage change

CPI996 excluding energy

Cyclically sensitive prices (right scale)

Sources: Statistics Sweden and the Riksbank

Figure 6. Price index for mainly imported goods and services excluding energy (CPI997 excluding energy) and exchange rate sensitive prices

Annual percentage change

CPI997 excluding energy

Exchange rate sensitive prices (right scale)
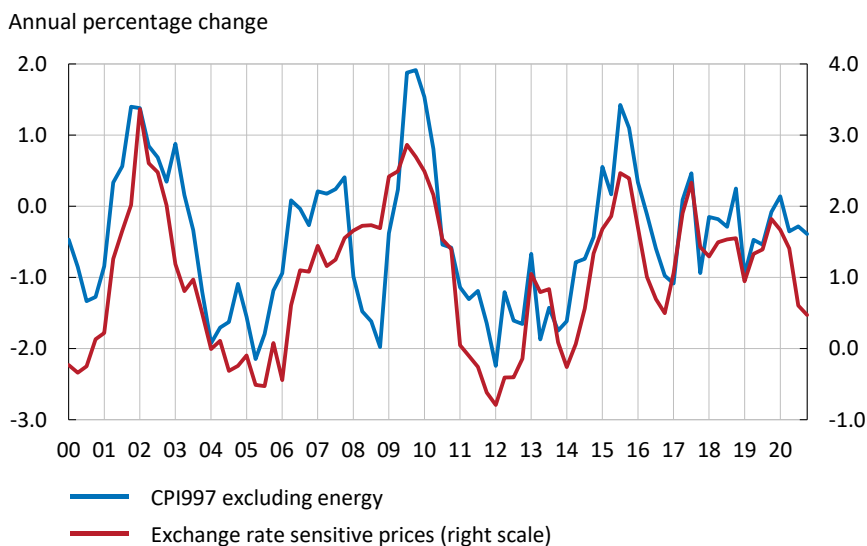
Sources: Statistics Sweden and the Riksbank

References

Kuttner, K, and Robinson, T (2010), "Understanding the flattening Phillips curve", *North American Journal of Economics and Finance*, 21, pages 110–125.

Luzzetti, M, Ryan, B and Weidner, J (2019), "Revisiting cyclical and acylical inflation: How much can the Fed impact core?", Deutsche Bank Research, US Economic Perspectives.

Mahedy, T and Shapiro, A (2017), "What's down with inflation?", *FRBSF Economic Letter*, 2017-35.

Stock, JH and Watson, MW (2019). "Slack and Cyclically Sensitive Inflation", *NBER Working Paper* no. 25987

Zaman, S (2019), "Cyclical versus Acyclical Inflation: A Deeper Dive", *Federal Reserve Bank of Cleveland, Economic Commentary*, (September 4) 2019-13.

APPENDIX – Tables

Table 1. Sub-indices in the group that covaries with economic activity

Classification	Weight (per cent)
Total weight sub-index	**40.1**
Entertainment and recreation	3.7
Housing: Water and sewerage, refuse collection, sweeping	3.5
Other foodstuffs	2.5
Meat products	2.4
Milk, eggs and cheese	2.3
Domestic travel excluding boat journeys, removals	2.2
Furniture, carpeting and lighting	2.1
Flour, grain and bread	2.0
Auto repairs and maintenance	2.0
Vegetables and fruit, mixed	1.9
Household utensils	1.6
Personal hygiene, services	1.4
Personal hygiene, goods	1.3
Diverse leisure goods excluding repairs	1.3
Lotteries, pools and tote betting	1.3
Pharmaceuticals	1.3
Household textiles, other furnishing	1.2
Soft drinks and non-alcoholic beer	0.9
Household appliances excluding repairs	0.7
Household items	0.7
Toys, games and hobby items	0.7
Accommodation	0.7
Health and medical care items	0.6
Children's wear, sportswear	0.6
Foreign travel	0.5
Own housing: Insurance fees	0.4
Vegetables, Swedish	0.3

Sources: Statistics Sweden and the Riksbank

Table 2. Sub-indices in the group that covaries with the exchange rate

Classification	Weight (per cent)
Total weight sub-index	**34.9**
Eating outside the home	4.5
Vehicle purchases	4.1
Capital stock	3.4
Radio, TV, video etc.	3.2
Other foodstuffs	2.5
Furniture, carpeting and lighting	2.1
Auto repairs and maintenance	2.0
Vegetables and fruit, mixed	1.9
Lotteries, pools and tote betting	1.3
Household textiles, other furnishing	1.2
Auto spare parts etc.	1.1
Wines, spirits, beer: Restaurants	0.9
Fish and tinned fish	0.8
Vegetables and fruit, imported	0.8
Household items	0.7
Toys, games and hobby items	0.7
Shoes, excluding heeling	0.7
Various goods excluding repairs and gold	0.6
Children's wear, sportswear	0.6
Foreign travel	0.5
Coffee, tea and cocoa	0.4
Vegetables, Swedish	0.3
Gold products	0.2
Musical instruments, CD, DVD	0.1
Beer, class II	0.1
Cameras including colour film	0.1

Sources: Statistics Sweden and the Riksbank

Table 3. Other sub-indices

Classification	Weight (per cent)
Total weight sub-index	**31.8**
Rented flat, tenant-owned apartment: basic rent, fees	10.7
Funeral, home insurance, bank, education	2.7
Telecommunications services	2.5
Medical care	1.7
Vehicle testing, driving lessons, car insurance	1.6
Tobacco products	1.4
Women's wear	1.3
Wine, Systembolaget	1.2
Menswear	1.1
Dental fees	0.8
Housing: Water and sewerage, refuse collection, sweeping	0.8
Own housing: Site leasehold, property tax	0.7
Sporting articles and leisure goods	0.7
Flowers etc.	0.7
Beer, Systembolaget	0.7
Newspapers and magazines	0.6
Own housing: Repairs, goods	0.5
Spirits, Systembolaget	0.5
Repairs, household services	0.4
Cooking fat	0.4
Books	0.4
Garage costs	0.1

Sources: Statistics Sweden and the Riksbank

Table 4. Calculated indices

Average annual percentage rate of increase for different periods

Classification	Weight	2006-2019	2014-2019	2020
Cyclically sensitive	41	1.47	1.33	1.08
Exchange rate sensitive	35	1.16	1.34	1.04
Other prices	32	1.43	1.36	1.88
Energy prices	7	2.92	2.27	-9.68

Note. Weight in the CPIF (per cent).
Sources: Statistics Sweden and the Riksbank