Staff memo

Quality adjustments and international price comparisons

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A staff memo provides members of the Riksbank's staff with the opportunity to publish advanced analyses of relevant issues. It is a publication for civil servants that is free of policy conclusions and individual standpoints on current policy issues. Staff memos are approved by the appropriate Head of Department.

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Summary

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Measuring macroeconomic variables is a difficult task. Although statistics agencies around the world do their very best, macroeconomic statistics are in practice often based on estimates of macroeconomic developments. The statistics are thus relatively uncertain. As data availability and resources for producing statistics vary from country to country, the international methods governing the production of statistics are fairly flexible. It is important to bear this in mind when making comparisons between countries. Consumer price statistics are no exception.

There are several reasons why the consumer price index may be difficult to compare between countries. Some of these are the differences in index construction, the composition of the CPI baskets and the means of measuring housing costs. In this Staff Memo, I will take a closer look at a further aspect, namely quality adjustments. Quality adjustments are an important element in all price indices and must be made when products in the indices are replaced. The adjustments are made because analysts want price indices to capture 'pure' price movements and not amendments due to changes in the quality of a product. The way these calculations are made differs from country to country. If there are systematic differences in how the quality adjustments are calculated, this could give rise to differences in the price movements measured, even if the actual sales prices have moved in a similar manner.

The movements in the sub-index in the consumer price index that are quality adjusted differ significantly between west European countries. Since 2000, Sweden has been one of the countries where the sub-index has developed most slowly. As many of the goods are relatively similar and they are traded between countries, the measured relative price movements may be difficult to understand, especially in the light of the krona, on average, having weakened during the period. Alternative data sources for relative price movements also show a different picture. It is therefore reasonable to suspect that differences in quality adjustment methods play a decisive role for differences in movements on these sub-indices. The differences are so large that they have an effect on the index as a whole. The difference in the contribution to the annual percentage change in the HICP from the groups that are quality adjusted has been more than one half of a percentage point between the countries with the slowest, which includes Sweden, and the fastest measured price movements for these groups.

Differences in how countries measure the consumer price index also affect the comparability of other macroeconomic variables. Some examples are the real

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exchange rate, real wages and real interest rates. Other real economic variables, such as real GDP growth and productivity growth are also affected.

Introduction

The consumer price index, CPI, is a central macroeconomic variable. The CPI with a fixed interest rate, the CPIF, is a target variable for monetary policy in Sweden, but the CPI is also used in other areas, such as to adjust different types of taxes and remunerations. Some other areas of use are to index prices in different agreements or as a measure of inflation compensation for inflation-indexed bonds. The development of the CPI and the CPIF is, in other words, important to many actors in society. The CPI and CPIF are calculated and published by Statistics Sweden (SCB).

Like many other central macroeconomic variables, such as GDP and unemployment, the consumer price index is not directly observable. The levels of these variables must therefore be estimated. This is normally done by national statistics authorities, in the case of Sweden by Statistics Sweden. Measuring macroeconomic variables is in general difficult, however. Although many statistics agencies around the world follow common calculation methods, the statistics are, nevertheless, relatively uncertain. This is because the statistics agencies must make a number of choices concerning how the survey on which the statistics are based should be designed, how large a sample should be used, how data should be gathered and processed, etc. There is no clear answer regarding the best way to do this, and resources are limited. The choices that are made can potentially have a large impact on the final statistics. How these questions are dealt with also differs somewhat from country to country, which will have a direct impact on the comparability of the statistics.

Consumer price statistics are no exception. Depending on how one gathers and processes the data collected, the final results in terms of consumer price index and inflation rate may differ, even if the same prices are used as a base for the calculations. It is important to bear this in mind when comparing different measures of consumer prices both within countries and between countries. One example of this is that, in Sweden, there are several different measures of consumer prices, in addition to the CPIF, which is used to measure inflation. The most established ones are the CPI and the EU-harmonised measure known as the HICP, which is based on the same collected price base as the CPIF. The HICP differs from the others by having a different index construction and it excludes large parts of owner-occupied housing expenses. The CPI captures the effect of changes in mortgage rates, while these are held constant in the CPIF. Overall, the development of the CPIF and HICP have been relatively similar over the past 20 years, while CPI inflation has, on average, been a few tenths lower every year. At times, the deviation between the CPI and the other measures has been several percentage points.[2]

When one wants to compare the development in consumer prices in different countries, several factors can cause the measurements to differ, which makes direct comparisons of prices more difficult. Within the EU, attempts have therefore been made to take certain steps to facilitate comparability through the harmonised HICP measure. However, this measure is not fully harmonised in more than a few dimensions, such as index construction and how to measure owner-occupied housing expenses. Several important aspects that can give rise to significant differences in the calculated development of consumer prices in different countries remain.

One such aspect is that the amount of data gathered and the way it is collected can differ. In Sweden, Statistics Sweden uses a number of different surveys of different sub-groups in the CPI. In some cases, they have access to data from cash registers but, in other cases, they must rely on manual collection in shops or on other data sources. The base can vary substantially from one country to the next.

Another aspect is that what is calculated as household consumption differs between countries. One example of this is that education and healthcare in the United States comprise a relatively large share of the household consumption basket, whereas these items carry

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[2] For further information, see, for instance, The Riksbank's inflation target – target variable and interval (2016).

much less weight in the CPI in Sweden and other European countries, where they are primarily financed through public expenditure. The price of these services usually rises faster than other prices and this therefore means that the measured rate of inflation in the United States has been higher than it would have been if the weight of these services in the consumer price index had been more like that in Sweden and most other European countries.

This Staff Memo focuses on a further important aspect that makes it difficult to compare price indices directly, namely quality adjustments when changing products. Quality adjustments are an important element of all calculations of the consumer price index and are made when products that are included in the index must be replaced with new ones for some reason. The adjustments are made because the aim of price indices is to capture 'pure' price movements and not amendments due to changes in the quality of a product. If, for instance, a mobile phone is taken off the market and replaced by a new and more expensive model with better performance, the statistics agencies endeavour, when calculating the price index, to adjust for the part of the price change justified by the new product being superior to the old one. As quality development is often largely subjective, it is difficult to determine how much better (or worse) a new product is in relation to the one replaced. It is thus also difficult to say how much the price, as measured in the consumer price index, has changed in connection with the exchange. The way these quality assessments are made differs from country to country. If the statistics agencies in some countries systematically make larger or smaller quality adjustments than others, this can give rise to differences in the measured price movement even if the prices of the products sold have moved in a similar way.

It can be concluded that price movements in the product groups' quality adjusted in the consumer price statistics differ quite a lot from one European country to another. As it is often the same products being sold and they can easily be traded between the countries, it may be difficult to understand these differences. Moreover, other data sources indicate that the differences are small. Quantitatively, these differences are not insignificant. The average contribution to the measured rate of inflation between 2000 and 2018 from these groups differs by more than half a percentage point between the countries with the slowest index development for these products, including Sweden, and the countries where these indices have more rapid development. The slower price movements in Sweden should also be regarded in the light of the krona having weakened by around 15 per cent against the euro during this period.

Difficulties in measuring and comparing the consumer price index also affect the comparability of other macroeconomic variables where the consumer price index is included in the calculation. Some examples of this are the real exchange rate, real wages and real interest rates. Differences in how prices are measured also affect, to some extent, the estimate of developments in the real economy. The consumer price index is used, for instance, in calculating household consumption expenditure in fixed prices in the National Accounts and, as consumption comprises a relatively large share of GDP, it has an effect, for instance, on how one sees the development of real GDP and productivity growth.[3]

Quality adjustments in the CPI and HICP

Prices in the shops compared to prices in CPI and HICP

There are different ways of constructing indices for consumer price movements, partly depending on the objective for which the index is to be calculated. However, regardless of the objective and area of use, some form of quality adjustment is always performed when a price index is calculated.

Different measures of consumer prices take slightly different theoretical approaches. In Sweden, the CPI uses the concept of the cost-of-living index as a theoretical starting point. In

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[3] The issue of measurement error in inflation and GDP statistics has been highlighted by, for example, Summers (2015).

brief, this theory can be described as CPI specifying "the relationship between the monetary amounts required to maintain, in two price situations, the same consumption standard or level of benefit".[4] One reason for this is that it must be possible to use the CPI for compensation purposes. For example, the CPI is used to calculate the size of the basic amount, which affects, for instance, the basic income tax deduction and the level of various public compensation systems. Instead, the HICP is often described as an inflation index, which means that the index construction diverges slightly, but, even in the HICP, quality changes must be excluded from the recorded development of prices.[5] Put simply, the relationship between the price faced by customers in the shops and the price the CPI (and HICP) aim to measure could be expressed as:

$$Price_{Shop} = Price_{CPI} * Volume * Quality$$

The development of prices in the shops thus only corresponds with that in the CPI if the goods measured maintain a constant volume and quality. If the shop price is adjusted because the volume changes, for example if the amount of coffee in a packet is changed, this will not change the price as it is measured in the CPI. That is, if the price of a packet of coffee is cut at the same time as the amount of coffee in the packet is reduced to the same extent, the price, as measured in the CPI, is constant. On the other hand, quality adjustments are a relatively vaguely defined term intended to reflect experienced customer benefit rather than purely technical performance. This means that, if we pay for a product at the same time as the customer benefit of the new product is higher, the CPI would not capture the entire price rise. One example is provided by the development of computers and smart telephones, where prices have not changed drastically while the assessed quality of the products has developed rapidly, which puts downward pressure on prices according to the CPI. As quality is not observable in the same way as the retail price and volume adjustments, different methods of quality adjustment can be an obstacle to international comparisons.

　　The debate over how quality adjustments should be made is nothing new. The fact that there are clear elements of subjectivity and therefore not necessarily any direct right or wrong in the matter contributes to different methods continuing to exist side by side without there being anything obviously wrong. This could be a contributory factor to harmonisation between countries not having proceeded further or faster. The fact that different methods for quality adjustment can lead to differing development of indices is something that Statistics Sweden has addressed in several memoranda to the Consumer Price Index Board.[6] The Riksbank has also addressed the matter in an Economic Commentary.[7] The matter is also under discussion internationally in various forums and is often regarded as a potential source of systematic error in the measurement of consumer prices. Quality adjustments are often seen as the source of the overestimation of inflation to varying degrees, which is to say that smaller quality adjustments are made than is justifiable.[8] Other analysts, however, find the opposite, which is to say that quality adjustments go too far in some countries.[9] This illustrates the difficulty in making quality adjustments and that quality adjustments differ from country to country.

How is quality measured?

When discussing quality, it is important to remember that this is very much a subjective concept. As was mentioned above, the relevant measure of quality must be seen in the light

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[4] Quote from CPI Inquiry, SOU 1999:124, page 27.

[5] For more information, see Johansson (2015).

[6] See its website for documentation https://www.scb.se/om-scb/scbs-verksamhet/rad-och-namnder/namnden-for-konsumentprisindex/underlag-namnden-for-konsumentprisindex/

[7] Johansson (2015).

[8] Much of this discussion has its origin in the so-called Boskin Report (1996), which established that the CPI in the United States had a clear upside bias. For a more comprehensive view of the literature, see, for example, Wynne et al. (2002), Wynne (2008), Tripplet (2004), Moulton (2018) and Sabourin (2012).

[9] See, among others, Keating and Murtagh (2018), Røed Larsen (2007) and Karsaulidze (2018).

of perceived consumer benefit and not from the perspective of performance. Perceived benefit is highly individual. Somebody who only uses their new smart telephone to make calls and send text messages will not have experienced the quality improvements of recent years in the same way as somebody who takes advantage of the telephone's full potential. Moreover, even if the potential entailed by technological developments is used, it can be difficult to assess how much better products have become. It is therefore not completely simple to answer whether a telephone today is twice as good or ten times as good as one from 10 years ago. Nevertheless, statistical authorities such as Statistics Sweden must reach decisions on questions like this when they calculate the consumer price index.

Quality adjustments come into the calculation of the CPI in two different ways. Firstly, implicit quality adjustments are made when the basket of goods and services and the selection of shops is updated at the start of each year; secondly, more explicit quality adjustments are regularly made over the year when goods and services have to be replaced because they are no longer available or representative.

Implicit quality adjustment at the end of the year

Both the CPI and HICP are what are known as chain indices, which means that Statistics Sweden updates the CPI basket with new goods and services at the start of each year. In addition, the selection of retailers is updated. The new basket is then used to calculate index development over the next year. At the start of the next year, the basket is updated again. To obtain an index, these baskets are linked together in a chain using an agreed calculation method.[10] The new products are initially measured in December of the year before they are included in the index. In December, two baskets are thus measured in parallel: the one used to calculate index development between November and December of the current year, and the new basket to be used to calculate development between December and January and over the following year. The price of both baskets in December can differ but the difference in prices between the baskets does not affect the development of the price index. Instead, the price difference between the new and old baskets attributed to difference in quality between the baskets. The method is based on the assumption that, if two products are sold for different prices over the same period, this price difference reflects a difference in quality. This assumption is not unreasonable, but neither is it completely unproblematic, for several reasons. One reason arises if the proportion of discounted goods is greater in the old basket than it is in the new one. This could be, for example, because the old basket is no longer fully representative and includes a larger proportion of products that are at the end of their life cycles and thus have lower prices. If this is the case, the change of baskets could result in price movements being underestimated over time.[11]

Quality adjustment in replacement of products over the year

A more explicit quality adjustment is made when a certain product must be replaced by another over the course of the year. This happens if a product is allowed to go out of stock or stops being representative. Clothes are a product group where replacements happen often, as each collection is only sold for a limited period. Products undergoing rapid technological development, such as computers, smart telephones and other home electronics, must also be replaced relatively often as old products are allowed to go out of stock in favour of new ones. When such replacements are made, Statistics Sweden and other statistical authorities must assess the difference in quality between the new product and the old one. This quality adjustment can be made using a number of different methods, but there is no comprehensive international coordination of the methods to be used for different products. Even under the framework of the harmonised statistics in the EU (HICP), it is largely up to the national statistics producer to choose the method. The guidelines for the HICP certainly specify about ten different alternative methods that national statistics producers can use.

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[10] See Statistics Sweden (2018) for details.
[11] There are some signs that this could be the case; see Strandberg and Nordberg (2014). See also the discussion in Dalén and Tarassiouk (2013).

There are also guidelines concerning which of these are considered most desirable and should therefore be used if possible. Even so, major differences remain between countries and, even if the same method were to be used, variations in application could lead to differences arising.

Three main methods are used for quality adjustment in Sweden: [12]

- Assessment-related quality adjustments
- Hedonic regressions
- Monthly chaining

Assessment-related quality adjustments mean that it is up to the price collector or official at Statistics Sweden to assess how quality differs between the new and the old product. This is obviously not entirely easy but, if the price collectors are considered to be representative consumers, the average of their assessments could be expected, overall, to reflect how consumers value the different products.

In Sweden, hedonic regressions are primarily used in the calculation of the sub-index for clothes and shoes. The method involves estimating regressions with different characteristics for the clothes as explanatory variables. These could include which brand the clothes are, the material they are made of and so on. The estimated parameters for these characteristics are then used to calculate the difference in quality in replacements. Naturally, the way these regressions are specified and the variables included affect the result.[13] In addition, the method demands resources, as the calculations require a lot of information about the product beyond the price.

Monthly chaining is a method that is relatively similar to the method used when products are replaced at the end of the year. No explicit assessment is made here, but rather the index development over two months is measured by price movements for products that are available in both months. If a product is allowed to go out of stock or stops being representative, it is no longer measured and will no longer affect the index but is replaced by a new one. This new product will not affect the development of the index until its price has been measured over at least two consecutive months. If new products are introduced for a higher price than those already existing on the market, the price gap will be assumed to be motivated entirely by the higher quality of the new products. Consequently, this method is also based on the assumption that two similar products of the same quality cannot have different prices. Statistics Sweden uses this method for products undergoing particularly rapid technological development such as computers and smart telephones. There is a risk that this method underestimates price movements for certain products. In practice, this method means that price movements, according to the CPI, for products falling in price over their lifetimes will always be negative. Pricing for mobile telephones, for example, is often such that new models are introduced at a higher price than earlier models, but the price then falls over the product's life cycle. However, the monthly chaining method means that the higher introductory price is only reported as an improvement in quality and not as a price movement as measured in the CPI.

To understand the impact of quality adjustments in different countries, it would be useful to examine the relevant statistics. These are very meagre, however. Statistics Sweden reports some statistics for the size of quality adjustments made over the year. For the years 2011 to 2018, this figure was about 0.3–0.4 percentage points per year for the index as a whole. For 2018, the figure was just over 0.4 percentage points. [14] It is harder to gain a view of the quality adjustments made in conjunction with the change of baskets at the start of the year, but this is presumably not insignificant. Examples from special studies of index calculations

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[12] Statistics Sweden (2018).

[13] See, for example, Norberg and Strandberg (2018).

[14] See Nordin and Öhman (2019) for details; the average for various product categories is reported in Table 1 in the appendix, which reports one measure of quality adjustment, IQI.

for cars and televisions shows that this effect could be at least as large as the effect from product replacements over the year.[15]

As far as we know, comparable figures for other countries are not publicly available. Unfortunately, it is not possible to determine completely the extent to which differences in indices for similar products in different countries depend on differences in price movements or on differences in quality adjustment. Taken together, however, the quality adjustments made have relatively great significance for the development of the index as a whole. If this is carried out in different ways in different countries, it could entail significant problems for comparisons between countries.

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[15] See Bubuioc et al. Examples from the United Kingdom also indicate that this effect could be significant; see Johnson (2015).

Comparison of developments between countries in Europe

Sub-index for quality-adjusted products weak in Sweden

In this section, we examine more closely the index development for the product groups that are quality adjusted in Sweden and compare it with other countries in western Europe. Many of the products that are quality adjusted are roughly the same products sold in all countries and they can be easily traded between countries. It is thus reasonable to assume that, disregarding exchange rate effects, the relative price movements between countries should be relatively stable.

Figure 1 shows the index development in Sweden for the CPIF as a whole and the sub-indices that are quality adjusted.[16] These groups on average sum up to 20 per cent during the period and comprise clothing and shoes (6 per cent), furniture, household equipment and white goods (5 per cent), cars (4 per cent), telephony (3 per cent) and home electronics (2 per cent).[17] Common to all the groups that are quality adjusted is that their price movements are weaker than the CPIF as a whole. This is not remarkable in itself, as several of these products involve rapid technological developments.

Figure 1. CPIF and sub-index for selected product groups in the CPI
Index 2000 =100
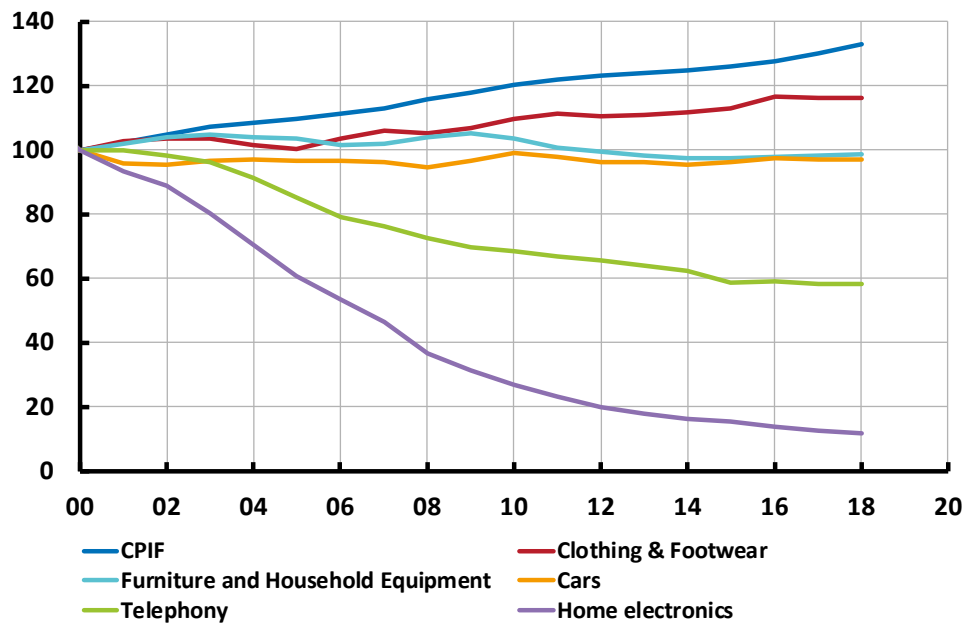
Source: Statistics Sweden

The sub-index for clothing and shoes has risen somewhat, but at a slower pace than the CPIF. The indices for furniture, household equipment and white goods and for cars are mainly at the same level in 2018 as in 2000, while the indices for telephony and home electronics have fallen. The weakest development has been in the index for home electronics, which has fallen heavily since 2000. According to this index, the price level for home electronics in 2018 was around 10 per cent of what it was in 2000. This could be due to some extent to prices of these products having fallen, but the most important reason is that the calculated quality of the products has improved. One contributory factor to the decline in the index for home electronics is the development of computers and accessories. Figure 2 shows that the price of

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[16] The picture is similar if one instead shows the corresponding sub-index in the HICP statistics, as the same basic data and quality adjustments are used for the calculation of both indices; see the corresponding figure for the HICP in Figure 15 of the Appendix.
[17] This sample corresponds to COICOOP-groups 3, 5, 7.1, 8.2-3 and 9.1. It does not cover all products that are quality adjusted, but a relatively large share of them.

computers as measured in the price statistics has fallen by more than 95 per cent since 2000. Although computers and accessories may have become somewhat cheaper in the retail trade during this period, most of the decline in the index is explained by the quality adjustments made. There is, of course, no doubt that today's computers are of much higher quality than the computers on sale 20 years ago, but it is difficult to assess the plausibility of how much the quality of computers has increased. One means of illustrating developments is to compare development in Sweden with those in other countries.

Figure 2. Sub-index for computers and accessories in HICP
Index 2000 = 100
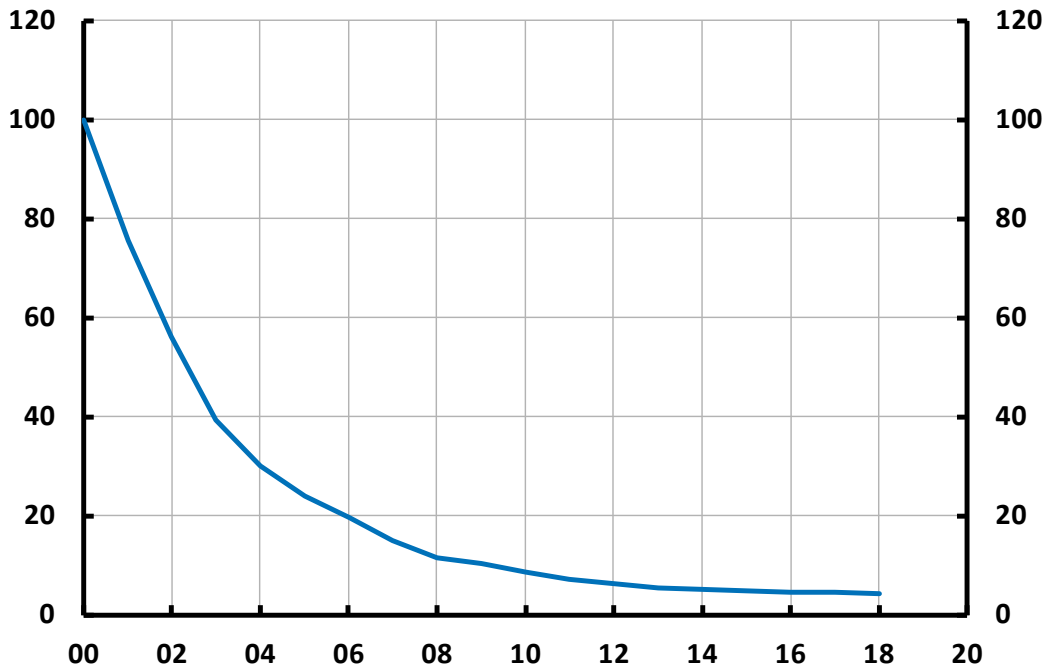
Source: Statistics Sweden

An international comparison

If one compares developments in prices in these sub-indices with the corresponding sub-indices in some other countries in Europe, there is a clear difference.[18] The difference is most evident in the sub-index for computers and accessories in the HICP. Figure 3 shows price movements in this sub-index for different countries in Europe and for the euro area as whole, relative to the average for the EU28. The calculated price development in Sweden is clearly lower than in other countries, with the exception of Ireland. According to the price statistics, prices of computers and accessories in Sweden have fallen by 70 per cent in relation to the average in the EU28 since 2000. Prices in the euro area have been in line with prices for the EU28 during the same period. At the same time, prices in Norway have risen by more than 150 per cent compared with the average in the EU28. In Luxembourg, where the relative price has risen the most, according to the index in the HICP, the calculated prices have risen by more than 250 per cent compared with the average in the EU28. Although the actual price movements may have differed between the countries compared during this period, it is unlikely that the movements have differed as widely as the sub-index in the HICP indicates. It is therefore reasonable to believe that the assessment of the development in quality is a contributing factor here. The differences do not mean that one can determine which country's statistics agency is doing right or wrong, but, on the other hand, they do indicate

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[18] The comparison uses HICP statistics for both Sweden and the other countries to facilitate comparison. The picture remains the same if the sub-indices in the CPIF for Sweden are compared with the corresponding sub-indices in the HICP for other countries.

that it can be difficult to compare price movements between countries when different methods of quality adjustment are used.

Figure 3. Relative development for sub-index for computers and accessories
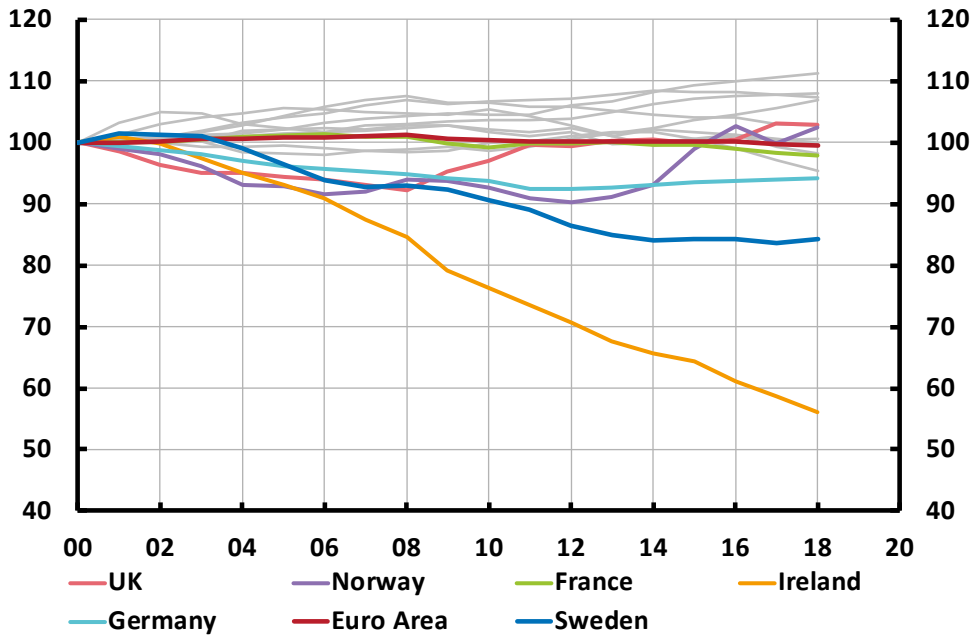Development in the respective country in relation to average for EU28, index 2000 = 100
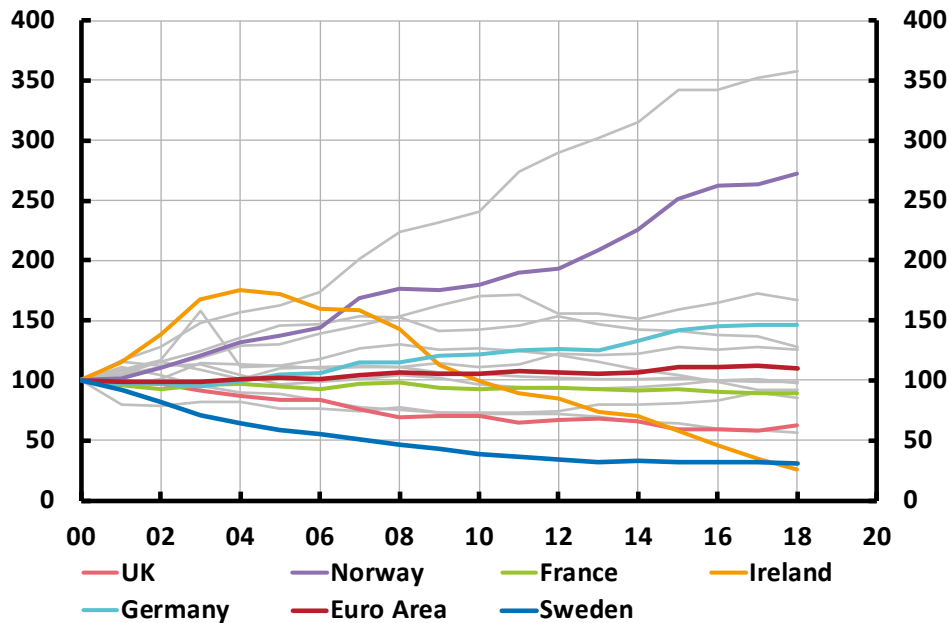
Note. A value below 100 means that the index development for the country has been lower than in the EU28. A figure of 50 should be interpreted as the price in the country being 50 per cent of what it is in the EU28 in relation to the situation in 2000. The grey line shows the development in Austria, Belgium, Denmark, Finland, Italy, Luxembourg, the Netherlands, Portugal and Spain.
Sources: Statistics Sweden and Eurostat

Although the sub-index for computers and accessories is an extreme case, the picture is largely the same for several other product groups where quality adjustments are common. That is, the index movement differs substantially between countries with regard to goods where there is reason to believe that the market situation would mean that actual price movements should be similar in the different countries. Figure 4 shows the development in the sub-index furniture, household equipment and white goods.[19] Here, it is also possible to see a large spread between countries. The weakest index development here is in Ireland and Sweden. Prices here have fallen, according to the HICP index, by around 40 per cent and 20 per cent respectively, compared with the average in the EU28 since 2000. The euro area has developed entirely in line with the average in the EU28, while the index in other countries show price movements from around 5 per cent slower to 10 per cent faster than the average in the EU28.

Figure 5 shows the index development for the sub-index clothing and shoes. Here, three countries clearly stand out from the rest. Once again, Ireland shows the weakest development, with a price fall of more than 50 per cent in relation to the average in the EU28. The indices in the United Kingdom and Norway also show heavy falls of 40 per cent in relation to the EU28 average. Developments in Sweden for this sub-index are in line with the average in the euro area and have risen somewhat in relation to the average in the EU28. The United Kingdom has identified that the deviation up to around 2010 can largely be explained by their method of managing product replacements. This method was therefore changed in 2010, and developments since then have been more in line with the other countries.[20] Ireland has also identified that its method for product replacement, which entailed an implicit quality adjustment for each replacement, had contributed to the weak index development.[21]

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[19] More precisely, the entire COICOP group shows 5.
[20] See Johnson (2015).
[21] See Keating and Murtagh (2018).

Figure 4. Relative development in sub-index furniture, household equipment and white goods
Development in the respective country in relation to average for the EU28, index 2000 = 100

Note. A value below 100 means that the index development for the country has been lower than in the EU28. A figure of 50 should be interpreted as the price in the country being 50 per cent of what it is in the EU28 in relation to the situation in 2000. The grey line shows the development in Austria, Belgium, Denmark, Finland, Italy, Luxembourg, the Netherlands, Portugal and Spain.
Sources: Statistics Sweden and Eurostat

Figure 5. Relative development for sub-index for clothing and shoes
Development in the respective country in relation to average for EU28, index 2000 = 100
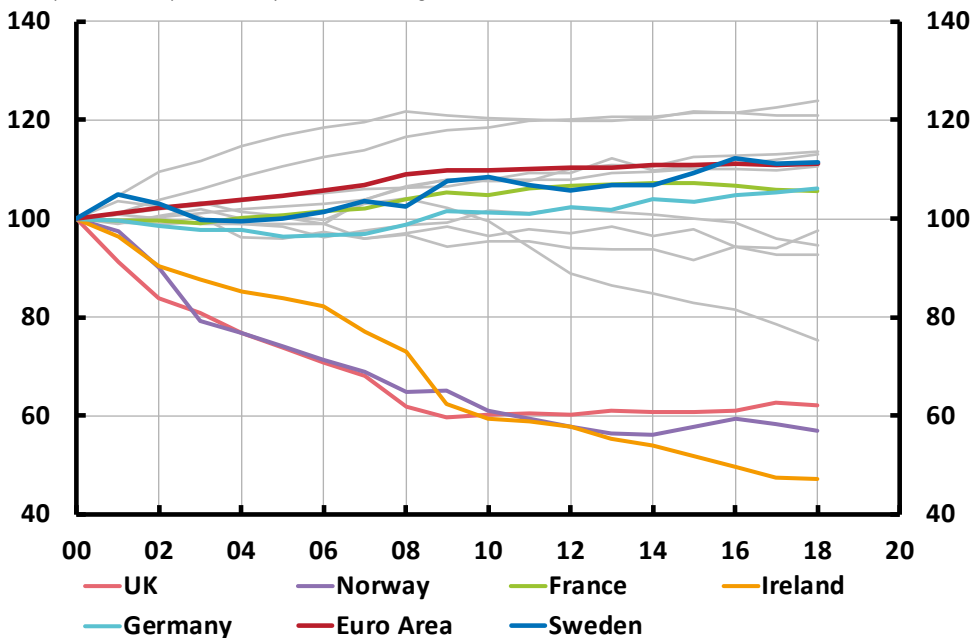
Note. A value below 100 means that the index development for the country has been lower than in the EU28. A figure of 50 should be interpreted as the price in the country being 50 per cent of what it is in the EU28 in relation to the situation in 2000. The grey line shows the development in Austria, Belgium, Denmark, Finland, Italy, Luxembourg, the Netherlands, Portugal and Spain.
Sources: Statistics Sweden and Eurostat

Figures 16-18 in the Appendix contain the corresponding figures for the sub-indices for home electronics (which includes computers and accessories as a part), cars and telephony. There are also substantial differences between countries in these cases. Sweden is one of the countries with the weakest index development for these sub-indices. In relation to the average for the euro area, Swedish prices for home electronics have fallen around 40 per cent, while those for telephony and cars have fallen by 15 per cent according to these indices.

Except from clothing and shoes, Sweden shows weak price movements in all of the sub-indices examined, as measured in the CPI and HICP, compared with most other west European countries and with the EU and euro area as a whole. This is despite the krona having weakened during this period by around 15 per cent against the euro and the HICP in total developing in a relatively similar manner.[22]

Contribution to inflation in different countries

So far, we have looked at index developments for various sub-indices in the HICP and seen that they clearly differ between countries. The next step is to see what significance these deviations have had for the development of the consumer price index as a whole.

Figure 6 shows the average contribution to CPIF inflation and HICP inflation from the sub-indices examined in Sweden and the HICP in other countries, as well as in the EU28 and the euro area, during the period 2000 to 2018.[23] Ireland is the country where the contribution from these groups to the inflation rate has been the most negative, -0.4 percentage points on average, while in Luxembourg the contribution has instead been +0.2 percentage points. In Sweden, the sub-indices for the product groups quality adjusted have fallen overall, and, on average, since 2000, contributed around -0.3 percentage points to CPIF inflation and -0.2 percentage points to HICP inflation. In Germany and the euro area, on the other hand, these sub-indices have remained largely unchanged during the period, and, therefore, have hardly contributed at all to price movements. The contribution in the United Kingdom is roughly the same as that in Sweden, while in Norway and France it is slightly less negative.

Figure 6. Contribution to inflation from quality-adjusted products
Average 2000-2018, Per cent
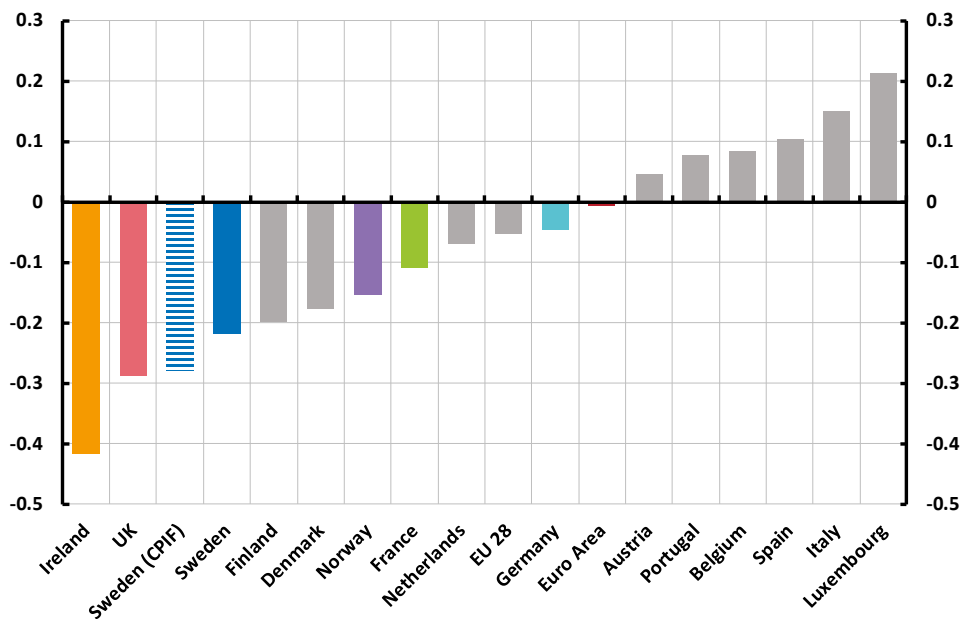
Note. The contributions are calculated as annual percentage change multiplied by the weight of the different sub-indices.
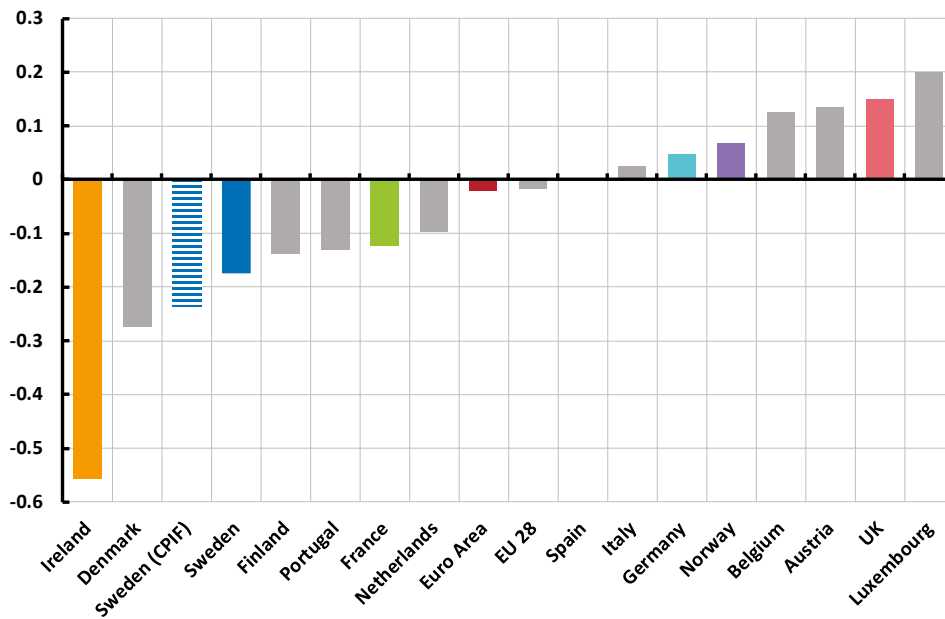Sources: The Riksbank, Statistics Sweden and Eurostat

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[22] On average, the price movements for other product groups, such as various services, have thus been higher in Sweden than in the euro area.
[23] The contributions are calculated as annual percentage change multiplied by the weight of the different sub-indices in the respective country. The weights are similar, but not identical, in the different countries.

As we saw earlier, developments in certain sub-indices can differ fairly substantially between different time periods in different countries. One example is the development for clothing and shoes in the United Kingdom, which shows a clear breach in trend in connection with the change in calculation method in 2010. It may also be interesting to look at a shorter time period to see how developments have been in recent years, as this might be more representative of how things look for these product groups at present. Figure 7 shows the contributions to inflation since 2010 and, for some countries, the picture is now different. This applies in particular to the United Kingdom and Norway, who, during this period, have instead had positive contributions to inflation from these product groups. For Sweden, Germany, France and the euro area, the differences are not particularly large between the two periods. For Ireland, the contribution has been even more negative for the shorter period.

Figure 7. Contribution to inflation from quality-adjusted products
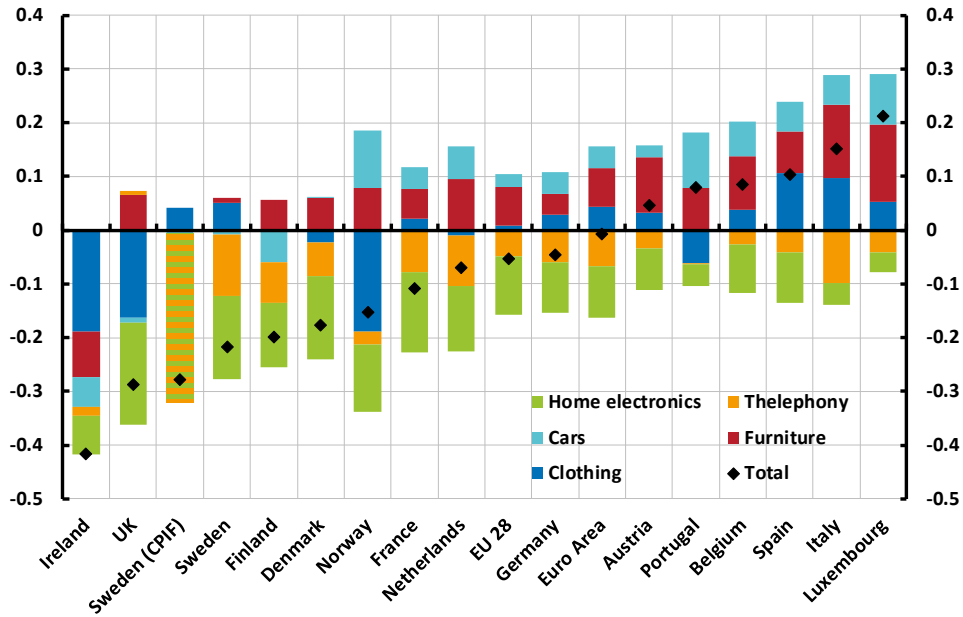Average 2010-2018, Per cent

Note. The contributions are calculated as annual percentage change multiplied by the weight of the different sub-indices.
Sources: The Riksbank, Statistics Sweden and Eurostat

To understand which product groups contribute to developments, one can look at the contributions to the index development from the different product groups. The contributions since 2000 are shown in Figure 8 and those since 2010 in Figure 9. The most strongly negative contributions come, in most countries, from home electronics and telephony. In Sweden, these products, which together weigh scarcely 5 per cent in the CPI basket, have contributed on average -0.3 percentage points to inflation since 2000, which is much more than in most other countries. Since 2010, the contributions in most countries are somewhat less negative, but, if anything, the difference between Sweden and the other countries is somewhat larger. Since 2000, the United Kingdom, Ireland and Norway have had strongly negative contributions from clothing and shoes, which in principle no other countries have, and which can also be explained by another method to manage product replacements in these countries. This method was changed in 2010 in the United Kingdom and largely explains why the contributions since 2010 have been more positive than the total during the whole period.[24] The United Kingdom has also introduced hedonic regressions for several technology products during the 2000s, which could explain why their contribution has changed.[25]

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[24] Courtney, M. (2018).
[25] Wells, J. and A. Restieaux (2014).

Figure 8. Contribution to inflation from different sub-indices 2000-2018
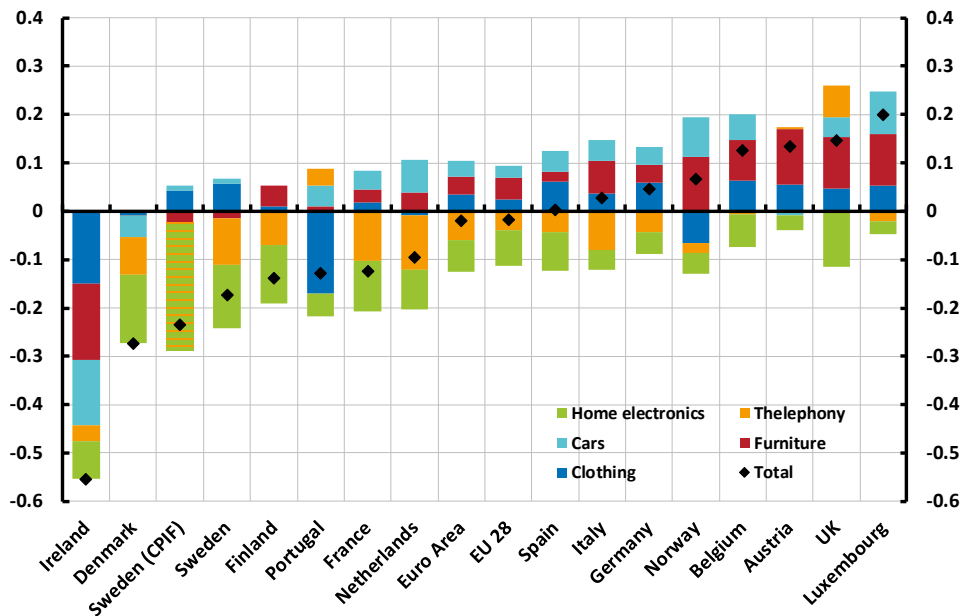Percentage points

Note. The contributions are calculated as annual percentage change multiplied by the weight of the different sub-indices. The CPI statistics do not have exactly the same division as the HICP statistics and it is therefore not possible to separate home electronics from telephony in the same way, and therefore these contributions are combined and shown as a broken line in the figure.
Sources: The Riksbank, Statistics Sweden and Eurostat

Figure 9. Contribution to inflation from different sub-indices 2010-2018
Percentage points

Note. The contributions are calculated as annual percentage change multiplied by the weight of the different sub-indices. The CPI statistics do not have exactly the same division as the HICP statistics and it is therefore not possible to separate home electronics from telephony in the same way, and therefore these contributions are combined and shown as a broken line in the figure.
Sources: The Riksbank, Statistics Sweden and Eurostat

Other measures indicate more similar price movements between countries

So far, we have used data from CPI and HICP statistics. There are, however, other data sources that measure relative price growth between countries. One such source is the purchasing power parities (PPP) statistics from the OECD and Eurostat. These statistics are primarily produced to allow GDP levels to be adjusted according to purchasing power, thereby making them more comparable between countries. However, statistics also exist in various sub-aggregates that correspond to the sub-aggregates in the CPI and HICP statistics. The advantage of these statistics is that they are more internationally coordinated and they attempt to measure prices for the same or very similar products in all countries. This means that the figures do not need to be quality adjusted; rather, comparability is achieved by deciding beforehand what is to be measured. However, compared with normal price statistics, the selection of products is much smaller. In addition, pricing information for each sub-aggregate is collected less often, in line with a three-year schedule. In addition, the statistics only become available after a certain delay. This means that the statistics are difficult to follow from one year to the next but, over time, they should reflect relative price growth between countries.

Figures 10 and 11 show the development of the index for Sweden and most other western European countries in relation to the EU28 for home electronics according to HICP and PPP statistics respectively. According to the HICP, as we have seen, prices in Sweden have fallen relatively heavily compared with other countries and the spread between countries is large. This cannot be seen in the PPP statistics, which instead suggest that the level of prices has risen slightly in Sweden, compared with the average for the EU28, and that the development of prices from country to country has been significantly more similar. This view is confirmed by an examination of individual products such as introductory prices for new iPhone models, which seem to have increased slightly faster in Sweden compared with some comparable countries (see Figure 19 in the appendix).

Figure 10. Relative development for home electronics according to the HICP
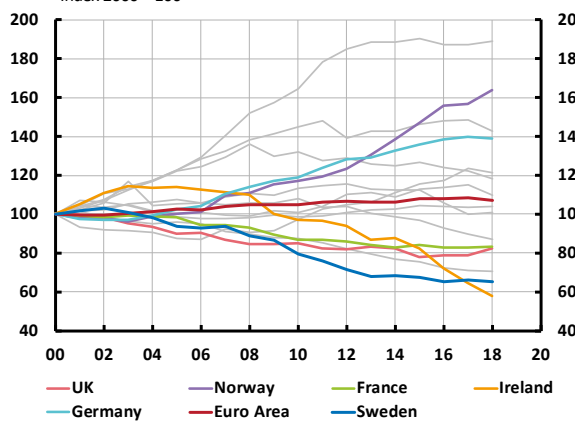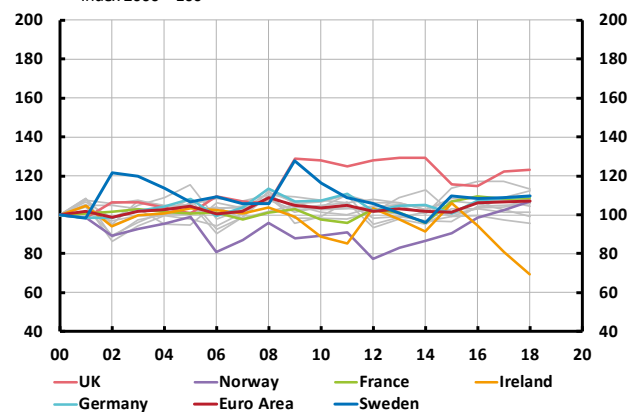Index 2000 = 100

Figure 11. Relative development for home electronics according to the PPP
Index 2000 = 100

Note. A value below 100 means that the index development for the country has been lower than in the EU28. A figure of 50 indicates that the price in the country is 50 per cent of what it is in the EU28 in relation to the situation in 2000. The grey line shows the development in Austria, Belgium, Denmark, Finland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

Sources: The Riksbank, Statistics Sweden and Eurostat

An available equivalent exists in the PPP statistics for other investigated sub-indices, with the exception of telephony. Figures 12 and 13 show the development for clothes and shoes in the HICP and PPP statistics. Here too, the different statistical sources show a relatively different development. The PPP statistics show development that is more similar across the countries. According to the HICP statistics, prices in the United Kingdom, Ireland and Norway

have clearly fallen in relation to other countries. According to the PPP statistics, these countries have instead seen a rise in prices in relation to the other countries. Sweden, which has approximately the same price movements as the euro area according to the HICP statistics, has instead seen a rise in prices of over 20 per cent against the euro area according to the PPP statistics. As a large part of the clothes sold in these countries are imported, it is reasonable to assume, all other factors being equal, that prices should rise more in countries where the exchange rate has weakened. Over this period, the Swedish krona, the Norwegian krone and the pound sterling have clearly weakened against the euro. It therefore seems reasonable that prices for clothes and shoes may have risen slightly more in these countries than in the euro countries.

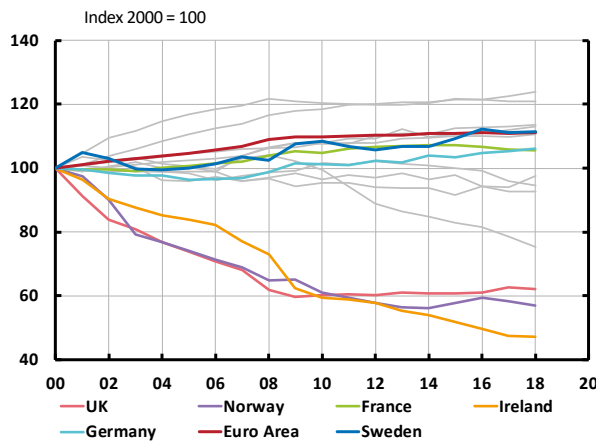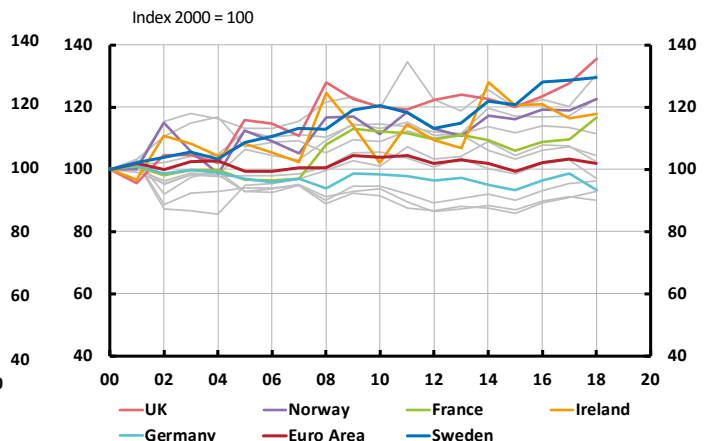**Figure 12. Relative development for clothes and shoes according to the HICP**
Index 2000 = 100

Figure 13. Relative development for clothes and shoes according to the PPP
Index 2000 = 100

Note. A value below 100 means that the index development for the country has been lower than in the EU28. A figure of 50 indicates that the price in the country is 50 per cent of what it is in the EU28 in relation to the situation in 2000. The grey line shows the development in Austria, Belgium, Denmark, Finland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

Sources: The Riksbank, Statistics Sweden and Eurostat

The equivalent price movements for cars and for furniture, household equipment and white goods are illustrated in Figures 20–23 in the appendix. For these groups too, the PPP statistics show development that is more similar across the countries. For the investigated price groups, the PPP statistics show slightly faster price growth in Sweden relative to the other countries than the HICP indicates.

As was mentioned above, these products are generally similar in different countries and are traded freely across the EU single market. Large relative price changes between different countries may therefore be difficult to rationalise. Development according to PPP statistics may therefore seem to be more intuitive than development according to the HICP, particularly as the krona weakened against the euro by about 15 per cent over the period. This is also a sign that quality adjustments play a major role in the development of HICP and CPI statistics.

Given that different measures give different views of the relative development of consumer prices between countries, it could be interesting to study several different measures. Figure 14 shows four different measures of the development of relative prices between Sweden and the euro area: firstly, relative consumer prices according to the HICP and CPIF; secondly, relative consumer prices according to the HICP and CPIF where we exclude quality-adjusted products; thirdly, relative consumer prices according to the HICP and CPIF where the quality-adjusted products are assumed to follow development according to PPP statistics; and, fourthly, the development of relative prices for all consumer goods according to PPP statistics. These four variants give no unanimous view of how consumer prices in Sweden have developed in relation to other countries. According to the official measure of consumer prices, prices in Sweden have increased at a slower rate than in the euro area. If the alternative index that excludes the price of the quality-adjusted products is examined instead, prices in Sweden have increased slightly in relation to the euro area. If we

instead allow the quality-adjusted products to follow price movements according to the PPP statistics, Swedish prices are higher yet. Finally, according to the PPP statistics, prices in Sweden have increased relatively strongly compared with the euro area.

It should be emphasised that PPP statistics have a smaller statistical base and could therefore be more uncertain than the official consumer price statistics. However, when used to compare prices between countries, they have the advantage of comparing similar goods and services. Any deeper analysis of these statistics is beyond the scope of this Staff Memo.

Figure 14. Relative development of consumer prices in Sweden, compared with the euro area, under different measures
Index, 2000 = 100
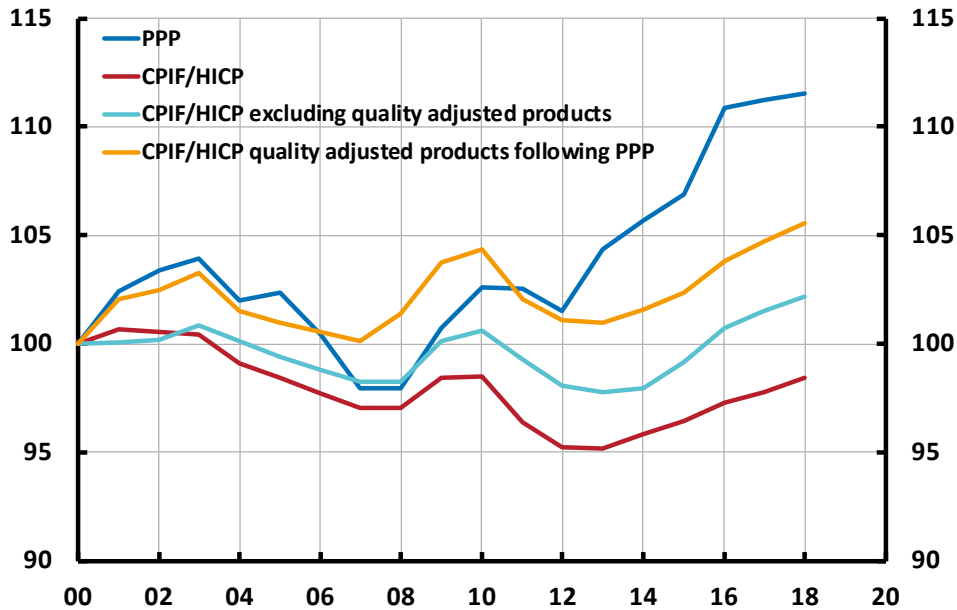
Note. The red, turquoise and orange lines are based on the CPIF for Sweden and HICP in the euro area. As we do not have access to a series for telephony from the PPP statistics, we have assumed that movements for telephony in Sweden follow movements in the euro area when calculating "CPIF/HICP quality-adjusted products as PPP" (orange line).
Sources: The Riksbank, Statistics Sweden and Eurostat

Conclusion

As with other macroeconomic statistics, measuring consumer prices is associated with great uncertainty. Despite the existence of international conventions for calculation, the statistics authorities must make a number of choices concerning how the investigations forming a basis for the statistics are to be designed, how large the selection used must be, how data is to be collected and processed, and so on. It is important to be aware of this when comparing statistics between countries. In this Staff Memo, we show, more specifically, how important differences in quality adjustments are for the final pricing statistics and their comparability between countries.

We have examined more closely the measured price movements for those product groups that are quality adjusted to gain a view of the quantitative impact quality adjustments could conceivably have. It is clear that relative price movements for products that are quality adjustment differ greatly from country to country. It can therefore be suspected that methodological differences in the quality adjustment procedure are an important explanation. Sweden is one of the countries with the weakest price development for these products.

Difficulties in measuring and comparing consumer price indices between countries also affects the comparability of other macroeconomic variables that are affected by these. Some examples are the real exchange rate, real wages and real interest rates. However, real economic variables, such as real GDP growth and productivity growth are also affected.

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Appendix

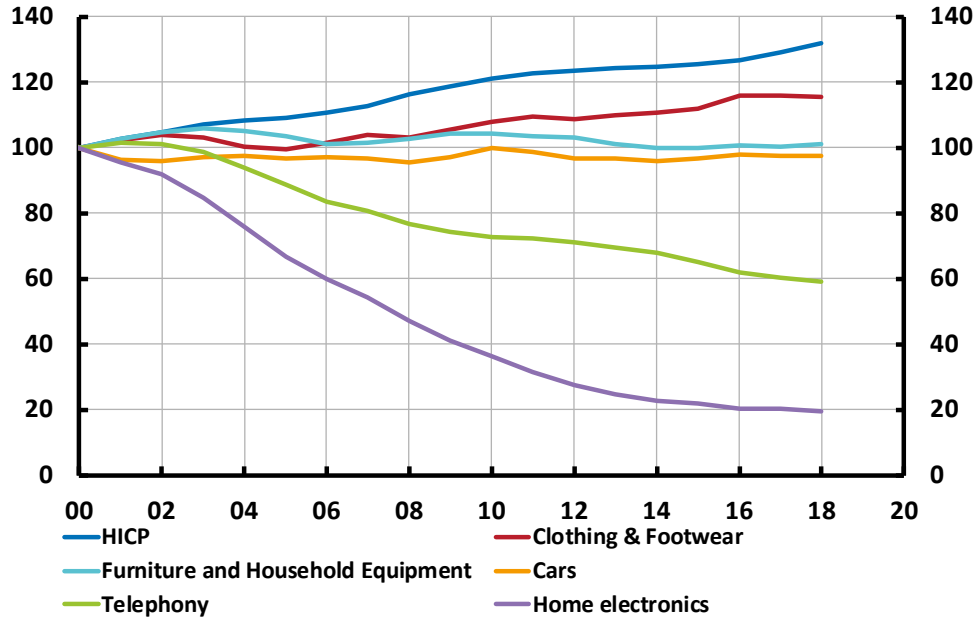**Table 1. Quality adjustment over the year according to IQI**
Weight in the CPI, parts per thousand, and IQI as a percentage, respectively

Method	Group	Weight 2018	Average for IQI 2011-2018
Assessment-related	Various goods excluding energy	6.2	1.8
	Vehicles and spare parts	45.0	0.5
	Home electronics	29.7	6.5
	Household equipment	3.7	1.0
	Household appliances	4.6	3.4
	Health and medical care	4.0	0.9
	Furniture	23.6	1.1
	Entertainment and culture	41.7	1.4
	Services excluding housing	39.5	0.2
	Tools	3.8	2.0
Hedonic	Clothing	45.1	-0.2
	Shoes	7.6	0.4
Monthly chaining	Mobile telephones	8.0	16.5
	Computers	5.2	9.9
	Computer accessories	1.7	5.9

Note. IQI is a measure of the size of quality adjustments made when changing products over the year. The figures in the last column should be seen as a measure of the average percentage quality adjustment per year over the period. For example, quality adjustments of computers have averaged 9.9 per cent per year. See Nordin and Öhman (2019) for a more detailed description.

Source: Statistics Sweden

Figure 15. HICP and sub-index for selected product groups in the HICP
Index 2000 =100

- HICP
- Clothing & Footwear
- Furniture and Household Equipment
- Cars
- Telephony
- Home electronics

Source: The Riksbank, Statistics Sweden and Eurostat

Figure 16. Relative development of sub-index for cars
Development in the respective country in relation to average for EU28, index 2000 = 100
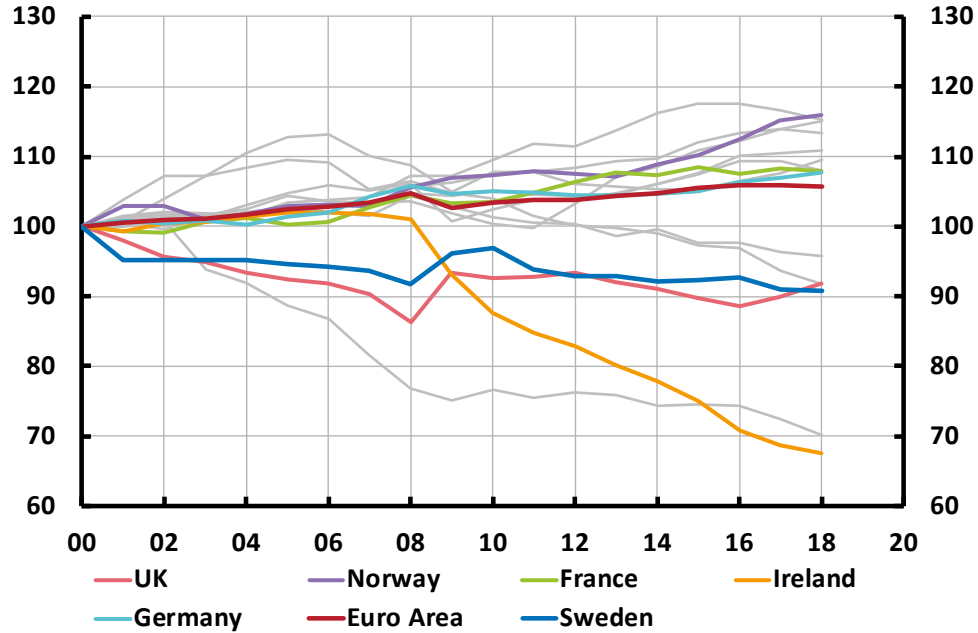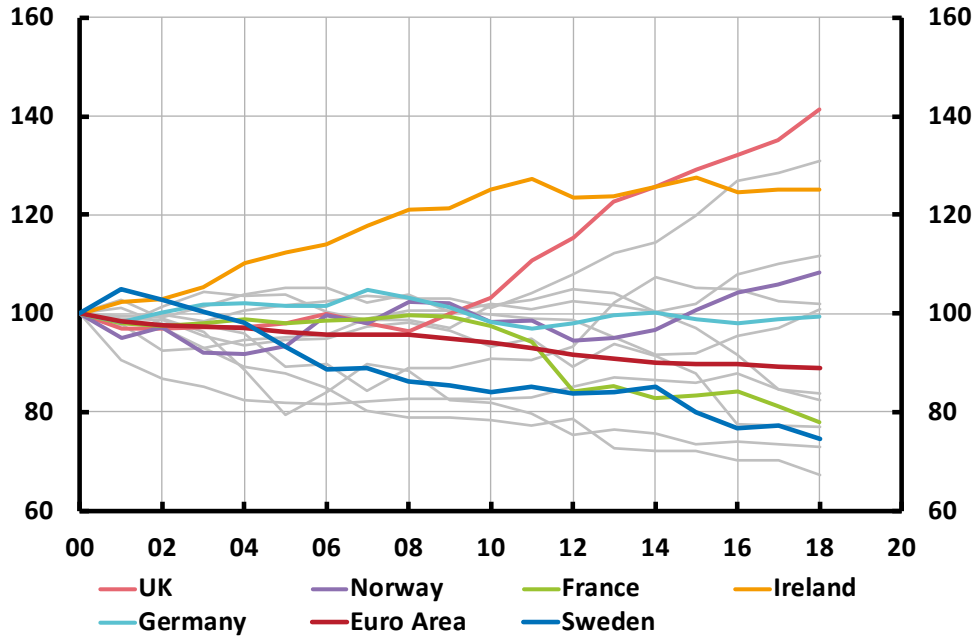

- UK
- Norway
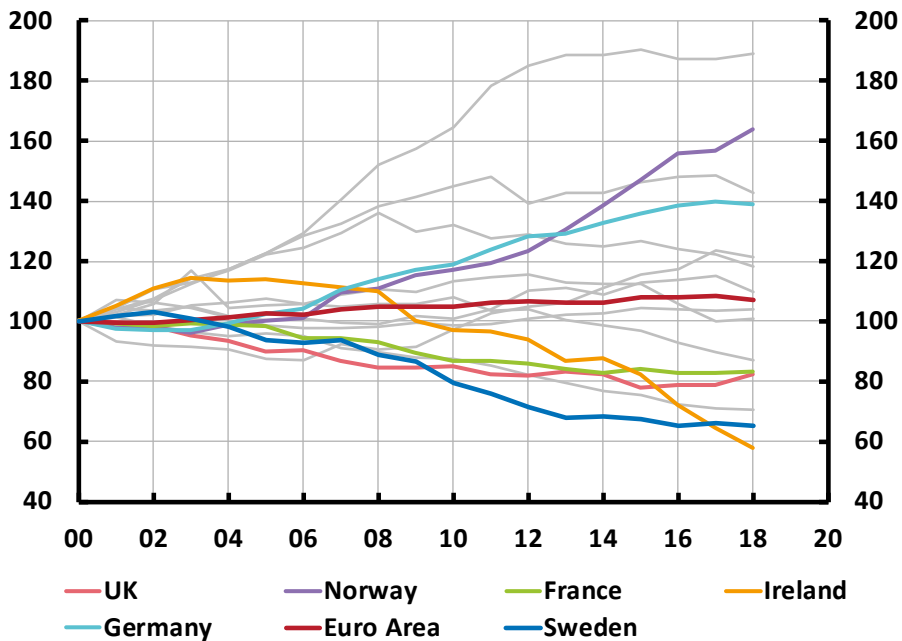- France
- Ireland
- Germany
- Euro Area
- Sweden

Note. A value below 100 means that the index development for the country has been lower than in the EU28. A figure of 50 indicates that the price in the country is 50 per cent of what it is in the EU28 in relation to the situation in 2000. The grey line shows the development in Austria, Belgium, Denmark, Finland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

Source: The Riksbank, Statistics Sweden and Eurostat

Figure 17. Relative development of sub-index for telephony

Development in the respective country in relation to average for EU28, index 2000 = 100
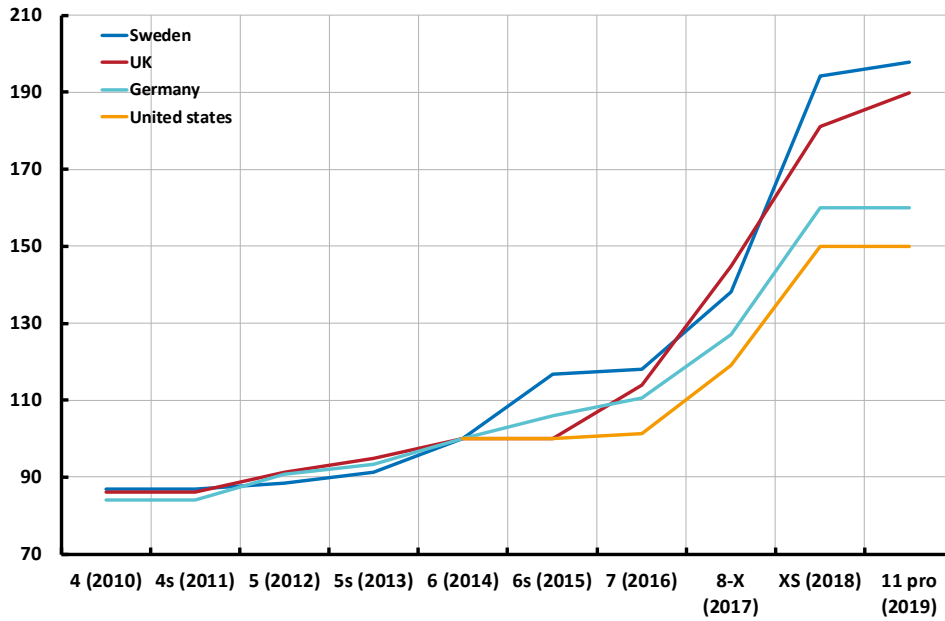

Note. A value below 100 means that the index development for the country has been lower than in the EU28. A figure of 50 indicates that the price in the country is 50 per cent of what it is in the EU28 in relation to the situation in 2000. The grey line shows the development in Austria, Belgium, Denmark, Finland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

Source: The Riksbank, Statistics Sweden and Eurostat

Figure 18. Relative development of sub-index for home electronics

Development in the respective country in relation to average for EU28, index 2000 = 100

Note. A value below 100 means that the index development for the country has been lower than in the EU28. A figure of 50 indicates that the price in the country is 50 per cent of what it is in the EU28 in relation to the situation in 2000. The grey line shows the development in Austria, Belgium, Denmark, Finland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

Source: The Riksbank, Statistics Sweden and Eurostat

Figure 19. Introductory price for cheapest version of each iPhone model
Index Iphone 6 (2014) = 100

Note. Calculated from collected launch prices for each model in various countries.

Source: Own calculations

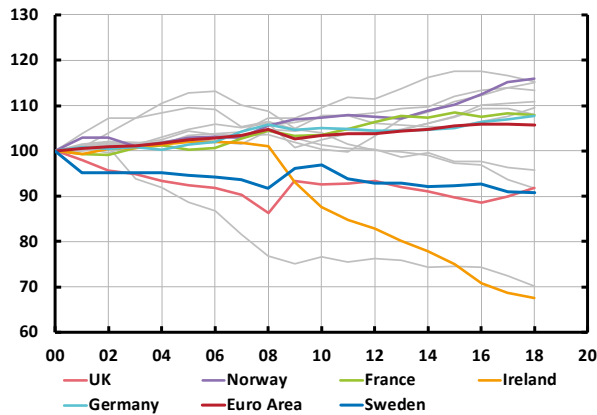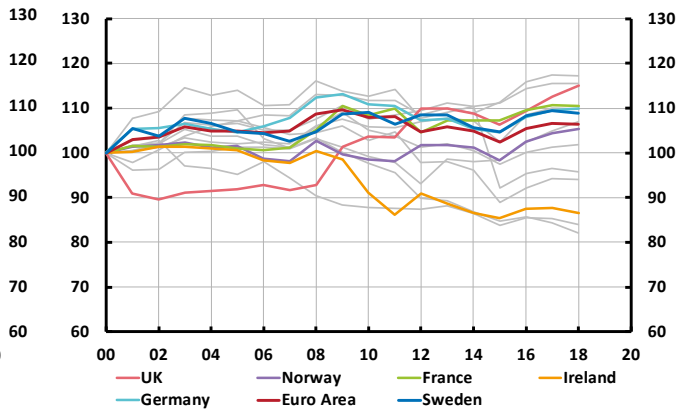**Figure 20. Relative development for cars according to the HICP**
Index 2000 = 100

Figure 21. Relative development for cars according to the PPP
Index 2000 = 100

Note. A value below 100 means that the index development for the country has been lower than in the EU28. A figure of 50 indicates that the price in the country is 50 per cent of what it is in the EU28 in relation to the situation in 2000. The grey line shows the development in Austria, Belgium, Denmark, Finland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

Source: The Riksbank, Statistics Sweden and Eurostat

Figure 22. Relative development for furniture, household equipment and white goods according to the HICP
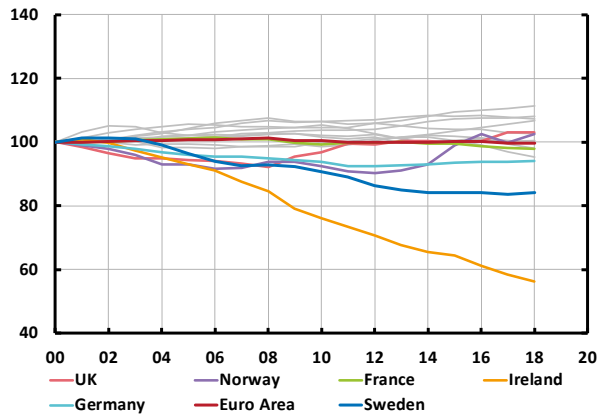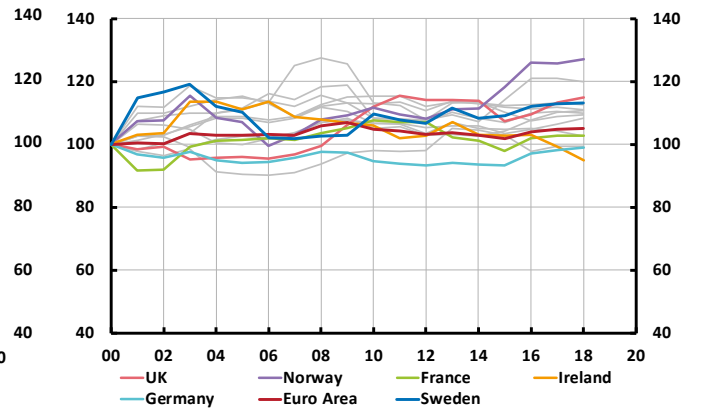Index 2000 = 100

UK — Norway — France — Ireland — Germany — Euro Area — Sweden

Figure 23. Relative development for furniture, household equipment and white goods according to the HICP
Index 2000 = 100

UK — Norway — France — Ireland — Germany — Euro Area — Sweden

Note. A value below 100 means that the index development for the country has been lower than in the EU28. A figure of 50 indicates that the price in the country is 50 per cent of what it is in the EU28 in relation to the situation in 2000. The grey line shows the development in Austria, Belgium, Denmark, Finland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

Source: The Riksbank, Statistics Sweden, Eurostat and national statistics authorities