

The development of the Swedish real exchange rate over a longer perspective

Carl-Johan Belfrage*

The author works in the Riksbank's Monetary Policy Department

The real exchange rate of the Swedish krona has shown a weakening trend since the 1970s in a way that is unique among advanced economies in terms of scope and duration. However, other measures of the real exchange rate indicate that the krona has not depreciated quite as much as the usual measure indicates, among other reasons due to differences in how price levels are calculated in different countries. The real exchange rate movement can be explained, at least partly, by the relatively weak development of Swedish productivity and the trend decline in Sweden's terms of trade. The article places the development of the real krona exchange rate in a longer historical perspective, describes how alternative measures modulate the picture, discusses possible explanations and presents a model estimate of the trend and what has driven it.

1 A long-term trend towards a weaker real krona exchange rate

When the Swedish krona exchange rate depreciated by up to 20 per cent over the years 2014–2019, it caused an intensive debate.¹ In this, it was frequently pointed out that a Swedish krona bought fewer and fewer goods and services abroad compared with in Sweden. In other words, we experienced a weakening of the real krona exchange rate. The real exchange rate is usually expressed as

$$\text{real exchange rate} = \frac{\text{nominal exchange rate} \times \text{foreign price level}}{\text{domestic price level}}$$

The real exchange rate for the krona thus compares the price level abroad, translated into kronor, with the price level in Sweden. Using the definition above, a higher value for the real exchange rate corresponds to a lower price level in Sweden compared to abroad, which is to say a weaker real exchange rate. The weakening of the real krona exchange rate that I mentioned above thus means that the price level in Sweden has risen more slowly than it has abroad, expressed in the same currency.

One important detail in this context is what is more specifically meant by price level. This is because there are a number of conceivable alternatives. Sometimes price levels are measured using narrow baskets of goods to make the calculations easy to understand.² However, gaining a more reliable picture requires broader indices of the prices of goods and services. In general, therefore, the consumer price index is used to calculate real exchange rates. In this article, I will use consumer price index-based measures of the real exchange rate

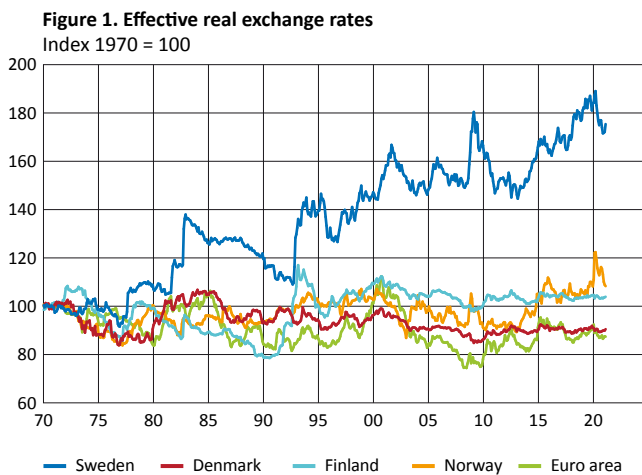
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1 Measured in terms of the krona index (KIX).

2 The so-called Big Mac index is such a price level measure; see The Economist (2020).

for the discussion, but, to complement the picture and shed light on the causes underlying changes in the real exchange rate, I will also employ calculations using other price level measures.

In general, major exchange rate fluctuations awaken both curiosity and discussion. However, this is far from being a unique phenomenon; instead, it is something that most countries have been through. Even so, seen over longer time periods, real exchange rates largely tend to fluctuate around the same level. In statistical terms, they are described as stationary.³ But Sweden's real exchange rate deviates clearly from this pattern. Figure 1 shows what are known as effective real exchange rates, which is to say the trade-weighted average of bilateral real exchange rates, for Sweden and our neighbours since 1970.⁴ We can see that, unlike developments in neighbouring countries, the Swedish effective real exchange rate has shown a weakening trend since the 1970s. In a broader international perspective too, this is a unique development. With the exception of when the real exchange rate more than doubled for the Japanese yen between 1970 and 1995, none of the countries classified as an industrialised country in 1970 has since then been through a greater change in its currency's real exchange rate than Sweden has.⁵



Note. Monthly data. Calculated using the consumer price index as measure of price levels. A higher value corresponds to a weaker effective real exchange rate.
Source: BIS

In this article, I will investigate what may lie behind this remarkable development. In section 2, I explain what generally suggests that real exchange rates are stationary. In section 3, I calculate the effective real exchange rate of the krona even further back in time to see whether the development shown in Figure 1 forms a continuation of an even longer trend or whether it is perhaps an adjustment of relative price levels to an earlier appreciation. In section 4, I discuss the contribution made by various bilateral real exchange rates to this development. In section 5, I show how the choice of index to represent the

3 Ca' Zorzi et al. (2017) point out that the usual assumption in modern research into exchange rates is that real exchange rates tend to return to their mean values. This fact is being used to do what Meese and Rogoff (1983) found to be far too difficult (at any rate over the time frame in which their investigation was conducted, which is to say up to one year ahead), namely to make better forecasts for exchange rates than a random walk (which simply means assuming that the future exchange rate will be the same as today's exchange rate).

4 The aggregation into an effective real exchange rate for Sweden in this diagram, which comes from the BIS, differs slightly from later diagrams showing effective real exchange rates for Sweden, which use what are known as KIX weights. The reason for this is a desire here to show effective real exchange rates for several countries from the same source using the same principles for weighting.

5 This has been measured as the ratio between the highest and lowest monthly listings for the CPI-based effective real exchange rate over the period 1970 to 2020 according to the exchange rate indices published by the BIS and JP Morgan. According to the World Bank (1970), the industrialised countries were Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom and the United States. The appreciation of the yen was partly reversed after 1995 and the Swedish krona is the currency that has had the greatest absolute percentage change in its effective real exchange rate between 1970 and 2020.

price level affects the view of the development of the real exchange rate – could the trend depreciation possibly be an effect of how prices are measured in Sweden, as compared to abroad? In section 6, I explain how the trend development of the real exchange rate could be connected to the development of fundamental variables. In section 7, I present an empirical estimate of the development of the long-run real exchange rate since 1995, together with what this says about how the gap between the actual real exchange rate and its long-run level has developed. In section 8, I draw a few conclusions.

2 What is there to suggest that real exchange rates are stationary?

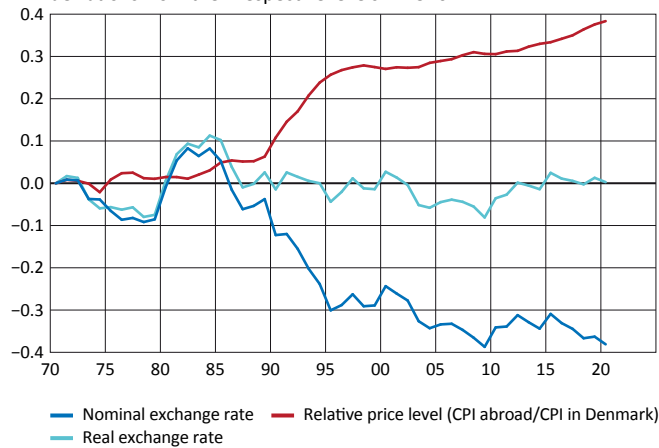
Before I go into more detail as to why the trend development of the krona's real effective exchange rate has been different from those of its more stationary equivalents in neighbouring countries, it may be helpful to remind ourselves of what there is to suggest that real exchange rates are stationary.

When analysing real exchange rates, the general assumption is that the purchasing power of a currency is the same in different countries, which is to say that absolute purchasing power parity prevails, or at least that the relationship between purchasing power in one country and purchasing power in another country is constant, which is to say that relative purchasing power parity prevails. One person who made this argument early on was the Swedish economist Gustav Cassel, who coined the actual expression purchasing power parity over a hundred years ago (Cassel 1918, p. 413). Cassel argued that, if the price level in one country were to increase more than in another, trade between the countries would lead to the differences being evened out over time, either by the actual prices changing or by the nominal exchange rate being adjusted. Somewhat simplified, we can imagine that if goods in Denmark, for example, are cheaper, then it will be worth exporting them to other countries. Eventually, however, the higher demand for Danish goods should lead either to higher prices in Denmark too or to the Danish krone rising in value.

Figure 2 shows the development of prices and the exchange rate in Denmark since 1970. From this, we can see that the red line that shows the ratio between world prices and Danish prices rises until the present day, meaning that Danish prices have risen more slowly than prices abroad. At the same time, however, the dark blue line shows that the nominal exchange rate of the Danish krone has appreciated so much that the real exchange rate has become relatively stable. The Danish real exchange rate thus seems to be stationary.

Developments in Sweden since 1970 look different, however. Figure 3 shows that, between 1970 and 1996, the development of prices in Sweden was approximately the same as abroad in that the red line is relatively stable until 1996. However, at the same time, we see that the nominal exchange rate depreciated in that the dark blue line rises. The light blue line thereby rises over this period and shows a weakening of the krona's real exchange rate. It has also continued to depreciate after 1996, but then for a different reason. While the nominal exchange rate has varied around one and the same level, the Swedish price level has risen more slowly than it has abroad, which is to say that the rate of inflation has been lower in Sweden than abroad. Seen over the entire period since 1970, an initial nominal exchange rate depreciation followed by relatively weak domestic price growth have thus contributed to a weakening trend for the real exchange rate of the krona.

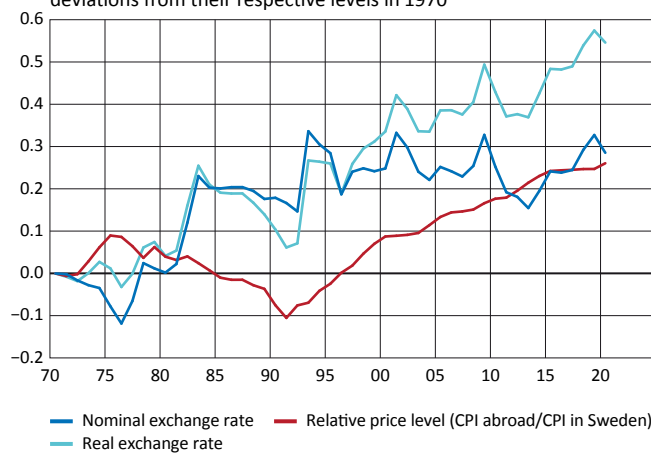
Figure 2. Denmark's real and nominal exchange rates, and the country's domestic price level in relation to the world level
Exchange rates and relative domestic price level expressed as log deviations from their respective levels in 1970



Note. Annual data. The real exchange rate development for Denmark differs slightly from that in Figure 1, as it is based on different sources. The difference may be due to the sample and weighting of countries in the calculation of effective exchange rates.

Sources: JP Morgan and own calculations

Figure 3. Sweden's real and nominal exchange rate and the country's domestic price level in relation to the world level
Exchange rates and relative domestic price level expressed as log deviations from their respective levels in 1970



Note. Annual data.

Sources: BIS, Macrobond and own calculations

3 A hundred-year perspective over the real exchange rate of the krona

Despite the trend depreciation of the krona's real exchange rate in Figures 1 and 3, a tendency towards purchasing power parity cannot be ruled out if developments are viewed over an even longer period. This is because the empirical research literature shows that purchasing power parity only holds up over long periods of time.⁶ There are many possible explanations as to why it should be this way. When it takes time for production and prices to adjust to new conditions, changes in real exchange rates can be long-lasting, even if they are

⁶ See Taylor and Taylor (2004) for a review of empirical studies of purchasing power parity.

transitory. In addition, there are factors that may give rise to lasting trends in real exchange rates. Above all, these concern differences in productivity growth and trends in world market prices for the country's exports and imports respectively, factors examined in more depth in section 6 below. However, even such factors can be neutralised in the very long term through ideas and technology, like capital and labour, moving across borders.⁷

However, investigations of a possible tendency towards purchasing power parity over long time periods come up against the problem that there is a lack of published real effective exchange rate series stretching further back in time. For most countries in the Riksbank's official exchange rate index (the krona index or KIX), however, there is access to both consumer price indices and nominal exchange rates against the US dollar from the 1950s or even earlier for some countries. This makes it possible to calculate long time series for bilateral real exchange rates.⁸ The trade-based weights included in the calculation of KIX or the similar index I showed in Figure 1 are harder to get at, however. The KIX weights vary over time but have not been calculated for the period prior to 1994. The bilateral real exchange rates, aggregated using 1994's KIX weights, may, however, give an indication of how the krona's real effective exchange rate developed further back in time.⁹

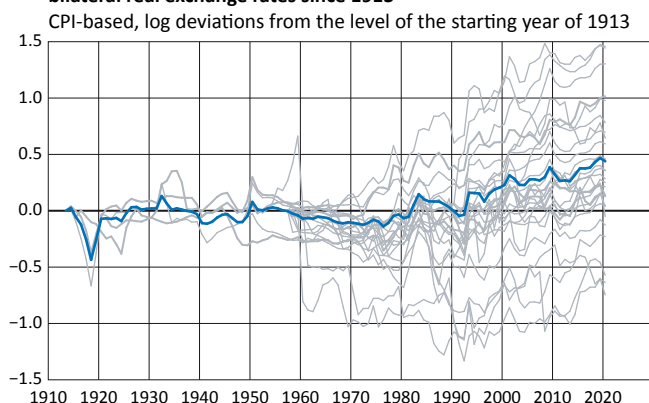
Figure 4 shows the results of these calculations. Here, we have both a number of bilateral real exchange rates (some going all the way back to 1913) and an aggregate produced using KIX weights from 1994, shown by the blue line. For the first decades, the aggregated, i.e. effective, real exchange rate only includes bilateral real exchange rates against the United States, United Kingdom, Norway and Switzerland. However, from 1957, the aggregate includes 97 per cent or more of the currencies included in the current KIX index.

7 Froot and Rogoff (1995, p. 1674) express it like this: 'It is arguable whether one should expect to detect a Balassa-Samuelson effect in really long-run data. Even though technology can differ across countries for extended periods, the free flow of ideas together with human and physical capital produces a tendency towards long-run convergence of incomes.' Another approach, which also leads to the conclusion that real exchange rates should be stationary over the long perspective, is based on variations in the price indices being dominated by monetary factors that, in turn, are neutral in the long term in the sense that they do not affect relative prices between goods or between goods and foreign currency; see Dornbusch (1985).

8 KIX aggregates the bilateral exchange rates for the 32 countries that are most relevant to Sweden's foreign trade. The weights are so-called trade weights and are updated annually. See Alsterlind (2006) for a discussion of fundamental issues around the construction of effective exchange rate indices and Erlandsson and Markowski (2006) on the theory and practice behind the construction of KIX.

9 Using fixed instead of time-varying weights is not unique in itself for effective exchange rate indices. The most commonly used Swedish effective exchange rate index was, until a few years ago, the so-called TCW index, which uses weights set at the start of the 1990s. The Riksbank now publishes both the TCW index and the KIX index on its website.

Figure 4. Sweden's effective real exchange rate and its component bilateral real exchange rates since 1913



Note. Annual data. The blue effective real exchange rate has been calculated as the KIX-weighted sum of the annual log changes in the bilateral real exchange rates at any given time, shown by grey curves. Up to and including 1994, KIX weights from 1994 have been used. In the figure, the bilateral rates have been indexed at the level of the KIX-weighted rate at their respective starting points. For the blue curve, the scale means that a level of 0.1 corresponds to a real exchange rate that is approximately 10 per cent weaker than at the starting point of 1913, but this approximative translation to percentage deviations becomes worse as the deviation becomes larger.

Sources: BIS, Macrobond, Sveriges Riksbank and own calculations

Just like Figure 1, Figure 4 shows that the real exchange rate of the krona has weakened in recent decades. But what Figure 4 also shows is that, with a longer perspective, the krona's effective real exchange rate appears somewhat stationary until the start of the 1990s. When the real exchange rate weakened between the mid-1970s and the start of the 1990s, this could be seen as a return to the same level that the real exchange rate had fluctuated around over most of the 1900s. This was a period in which Sweden entered into various different fixed exchange rate systems. When prices then increased more rapidly in Sweden than in other countries, Swedish competitiveness worsened, which is to say that the real exchange rate appreciated. At the end of the 1970s and start of the 1980s, Sweden therefore carried out several devaluations to restore competitiveness.¹⁰ The real exchange rate then appreciated again and, in 1992, the year in which a floating exchange rate was adopted, it was at the same level that it had fluctuated around over most of the 1900s. However, the krona has subsequently depreciated in real terms against all currencies included in the KIX index.

4 A broad depreciation but mostly against rapidly growing countries' currencies

One way of examining in more detail how an effective real exchange rate has developed is to study the bilateral real exchange rates it consists of. This makes it possible to see if the development is being driven by certain countries and, if so, what these countries have in common.

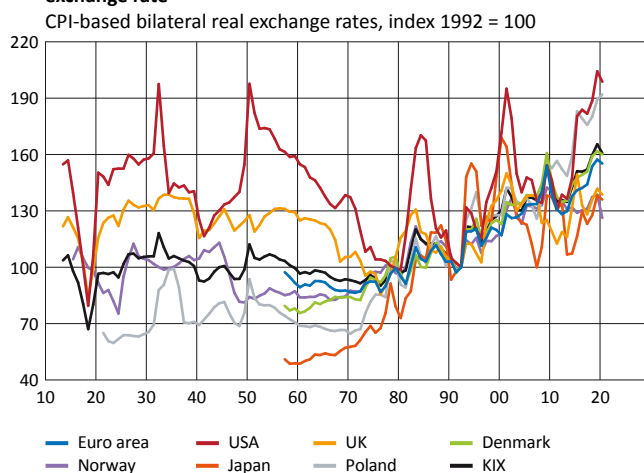
The krona's real exchange rate appreciated against most currencies between the end of the 1950s and the start of the 1990s. This can be anticipated in Figure 4, where most of the grey lines are at or above zero at the end of the 1950s but below zero at the start of the 1990s.¹¹ However, since 1992, the krona has depreciated clearly against all KIX currencies with available data. This can be seen by the grey lines finishing at a higher level than they

¹⁰ See Bordo et al. (2017) for a historical overview of economic policy regimes that have tended to affect the global development of exchange rates since 1880 and Sveriges Riksbank (2000) for a description of Sweden's participation in various fixed exchange rate systems.

¹¹ In most cases, data that allows calculations of bilateral exchange rates is available from 1957 on, which, as the figure is constructed, means that the data started on the blue KIX line's level in 1957 when this was very close to zero.

had in 1992.¹² Figure 5 shows the bilateral real exchange rates that affected the KIX-weighted real exchange rate the most.¹³ The krona's effective real exchange rate with the KIX countries and its most important bilateral component, the euro area, follow each other closely, while the pattern for other bilateral real exchange rates varies both among themselves and over time. The bilateral real exchange rate with the United States has fluctuated heavily. A gradual appreciation between 1950 and 1980 was followed by several decades with large changes in value. However, since 1980, the krona's real exchange rate against the US dollar has depreciated and the current level is approximately the same as it was 70 years ago.

Figure 5. Bilateral real exchange rates against the currencies that have contributed most to the depreciation of the KIX-weighted real exchange rate



Note. Annual data. The bilateral real exchange rates shown are those that have made a contribution of more than 2 percentage points to the depreciation of the KIX-weighted index since 1957, 1970 or 1992. Since 1994, KIX weights from 1994 have been used.

Sources: BIS, Macrobond, Sveriges Riksbank and own calculations

The picture is, to some extent, compatible with the Balassa-Samuelson hypothesis – that the real exchange rate can be expected to appreciate in countries with strong productivity growth against the rest of the world. The hypothesis is based on the assumption that productivity primarily changes in the production of goods and services that are traded internationally and whose prices will develop in the same way in different countries precisely because they are traded internationally. When productivity rises in this part of the economy, wages rise. In turn, the higher wages drive up prices for the goods and services that are not traded internationally, so-called domestic market goods. Prices for domestic market goods (and therefore also the price level in a common currency as a whole) thereby rise faster in countries with stronger productivity growth. I write more about this in section 6.

With a few isolated exceptions, over the period 1957–1992, the Balassa-Samuelson hypothesis works well to explain the development of the bilateral real exchange rates in Figure 5. The real exchange rate depreciated heavily against Japan, which then had significantly faster productivity growth than Sweden. The difference is shown by the blue bars in Figure 6. The real exchange rate also weakened against the euro area, Denmark and Norway, which all had higher productivity growth, at the same time as it strengthened against the United States, whose productivity growth was weaker than Sweden's. The exception in this period is that the real exchange rate weakened against Poland, even though productivity growth there was significantly weaker than in Sweden.

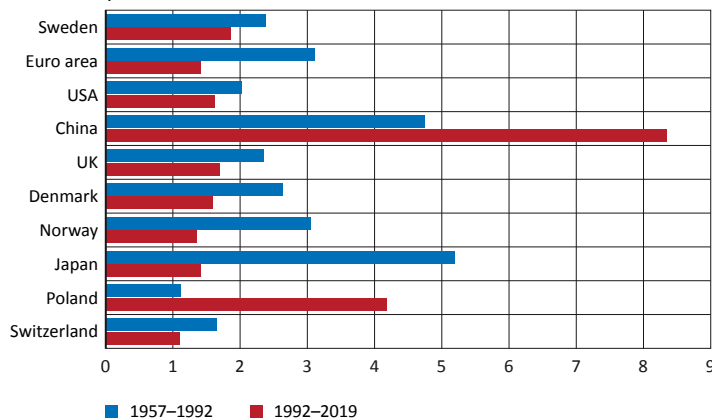
¹² There is no data for Slovakia prior to 1994 and none for Russia prior to 2001.

¹³ In this figure, China and Switzerland have been excluded, however, as the differences between the highest and lowest listings in their cases would require a scale that would make the figure hard to read. See the appendix for a version of this figure that also includes China and Switzerland.

Between 1992 and 2019, the Balassa-Samuelson hypothesis does not hold up as well as an explanation for how the bilateral real exchange rates that I presented in Figure 5 developed. The krona's real exchange rate weakened overall, even though Sweden had higher productivity growth than all these countries and regions apart from Poland and China. Within the group advanced economies, the real exchange rate depreciation has certainly been least against Norway and Japan, which have had the weakest productivity growth over this period, but, at the same time, the depreciation has been relatively strong against Switzerland, which had the weakest productivity growth over this period.

Figure 6. Productivity growth in the economies whose currencies have contributed most to the depreciation of the KIX-weighted real exchange rate

Average annual percentage change in GDP per inhabitant aged 15–64 years



Note. Due to a lack of data, the change in the entire population has been used when calculating productivity growth in the first three years. For the euro area, the blue bar represents the period 1960–1992.

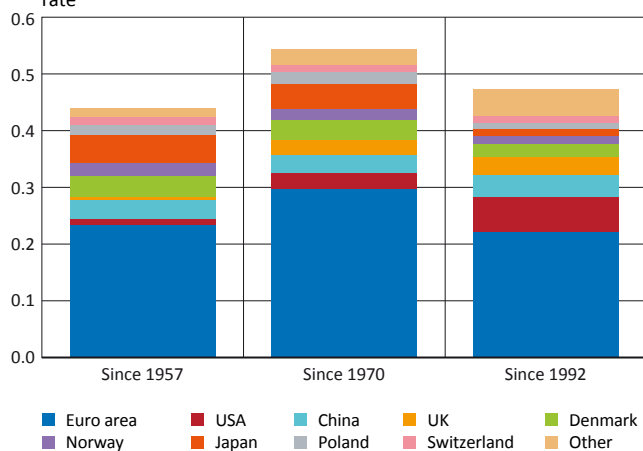
Sources: OECD, Penn World Table and World Bank

The fact that the krona has depreciated in real terms against as good as all other currencies also means, of course, that no single bilateral relationship lies behind the weakening of the effective real exchange rate. This is also illustrated by Figure 7, which shows contributions to the weakening of the KIX-weighted real exchange rate since 1957, 1970 and 1992. The euro is responsible for the single greatest contribution but this is primarily due to the euro's great weight in the KIX index, which is around 50 per cent. The fact is that the bilateral real exchange rate against the euro does not deviate significantly from the KIX rate (see Figure 5). The relatively heavy depreciation against the US dollar in recent years has also clearly contributed to the weakening of the KIX-weighted index, not least since 1992. Alongside the currencies of these two major western economies, the Chinese yuan has made the largest contribution to the weakening of the KIX-weighted real exchange rate since 1992.¹⁴ Alongside the yuan and the euro, the currencies of our Scandinavian neighbours and the Japanese yen have made the greatest contribution to the weakening of the krona's real exchange rate since 1957.

¹⁴ The bilateral real exchange rate against China is included in Figure A1 in the appendix. This also makes clear that the bilateral real exchange rate against China appreciated heavily in the years prior to 1992, at least according to available data on nominal exchange rates and inflation. However, this did not significantly affect the KIX-weighted real exchange rate, as China's weight in KIX was very small then, one half of one per cent.

Figure 7. Contribution to the weakening of the KIX-weighted real exchange rate

Contribution to log deviation in KIX-weighted CPI-based real exchange rate



Note. The bilateral real exchange rates mentioned are those that have made a contribution of more than 2 percentage points to the depreciation of the KIX-weighted index since 1957, 1970 or 1992. Each country's contribution has been calculated as the sum of its KIX-weighted log changes over the period for which data has been available for the country in question. Up to and including 1994, KIX weights from 1994 have been used.

Sources: BIS, Macrobond, Sveriges Riksbank and own calculations

To sum up, the krona's effective real exchange rate seems to have been stationary over the greater part of the 1900s. A weakening trend started in the 1970s, the first part of which, up until 1992, can be seen as a return to the level around which this exchange rate fluctuated since the start of the 1900s. Regardless of whether we start from 1970 or 1992, the real exchange rate of the krona has developed in a way that has been unique among industrial countries. A depreciation has taken place against all trading partners of significance, albeit to varying degrees.

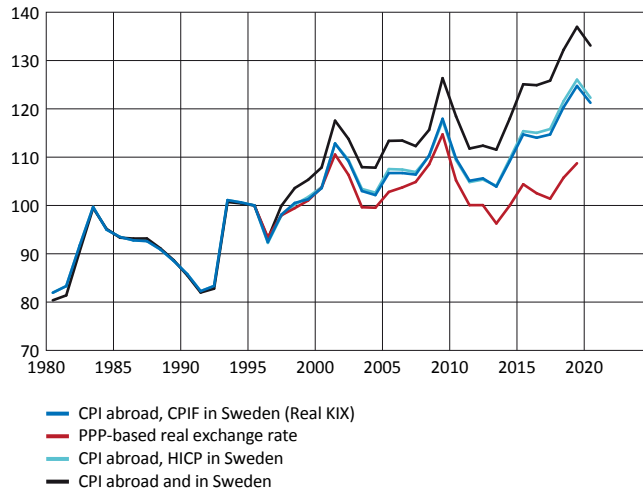
5 Differences in CPI content and price measurement methods may give an exaggerated view of changes in the real exchange rate

So far, my analysis of the real krona exchange rate has focused on measures in which domestic price levels are represented by the consumer price index (CPI). But the choice of price index plays a part. Using other measures of price levels gives us a slightly less dramatic image of the development of the real exchange rate. Among other reasons, this is because different price indices are constructed in different ways. One example is the CPI, where one known difference between Sweden and other countries is that mortgage interest costs are included in the calculation of CPI for Sweden as they are treated as part of households' housing costs here. The trend decrease in interest rates in recent decades has had a clear impact on CPI inflation. Other price indices do not include these effects of interest rate adjustments, for example the European harmonised index of consumer prices (HICP) or the Swedish CPIF, which is the CPI with a fixed interest rate.¹⁵ If the CPI is exchanged for the HICP or CPIF, the measured real depreciation of the krona since 1992 becomes about 15 percentage points less; see Figure 8. This reflects the considerable fall in interest rates since

¹⁵ Statistics Sweden (2017) describes the main differences between these three consumer price indices.

the mid-1990s.¹⁶ It is this KIX-weighted effective real exchange rate for the krona, calculated using the CPI for other countries and the CPIF for Sweden, that the Riksbank usually uses and sometimes shows in its Monetary Policy Reports. Hereinafter, it will be referred to as the ‘real KIX’.

Figure 8. KIX-weighted real exchange rate with different measures of the consumer price level
Index 1995 = 100



Note. Annual data. The difference between the three upper curves is exclusively due to different choices of price index for Sweden, which is to say the denominator in equation (1). The black curve corresponds largely with the curve for Sweden in Figure 1 but differs slightly due to differences in the selection of trading partner and their weights. Up to and including 1994, KIX weights from 1994 have been used.

Sources: BIS, National Institute of Economic Research, Macrobond, Statistics Sweden, Sveriges Riksbank and own calculations

Figure 8 also shows an effective real exchange rate for the krona, constructed using statistics on price levels from the international comparison programme used to calculate purchasing power parity adjusted (PPP-adjusted) GDP levels.¹⁷ This statistic is based on comparisons of prices for identical or very similar products in all countries. However, the comparisons are based on a significantly smaller sample of products than normal price statistics and price data is collected less frequently. Short-term fluctuations in price levels are thereby not captured so well but, seen over a number of years, the international comparisons should give a picture of the development of the real exchange rate that can be compared with other measures of the real exchange rate.¹⁸

As the short-term variations of the real exchange rate, regardless of measure, are dominated by variations in the nominal exchange rate, the variations in the effective real exchange rate for the krona that can be extracted from the PPP statistics are clearly reminiscent of the variations we see in the CPI/CPIF-based real exchange rate. On the other hand, the PPP-based real exchange rate does not demonstrate the same clear depreciation trend. This is primarily due to developments between 2008 and 2019. During this period, the real KIX weakened by 13 per cent, while the PPP-based real exchange rate was unchanged. This pattern for the difference between CPI/CPIF-based and PPP-based real exchange rates can also be found in the most important bilateral relationships, with the exception of Norway; see Figure 9. The difference is particularly clear for how the krona’s bilateral real

¹⁶ The development in the figure is based on data available from 1980. Even before that, trend changes in the level of interest rates have taken place that may have affected how measured inflation in Sweden related to the rest of the world. However, these historical trend interest rate fluctuations appear to be smaller than the one taking place since the mid-1990s.

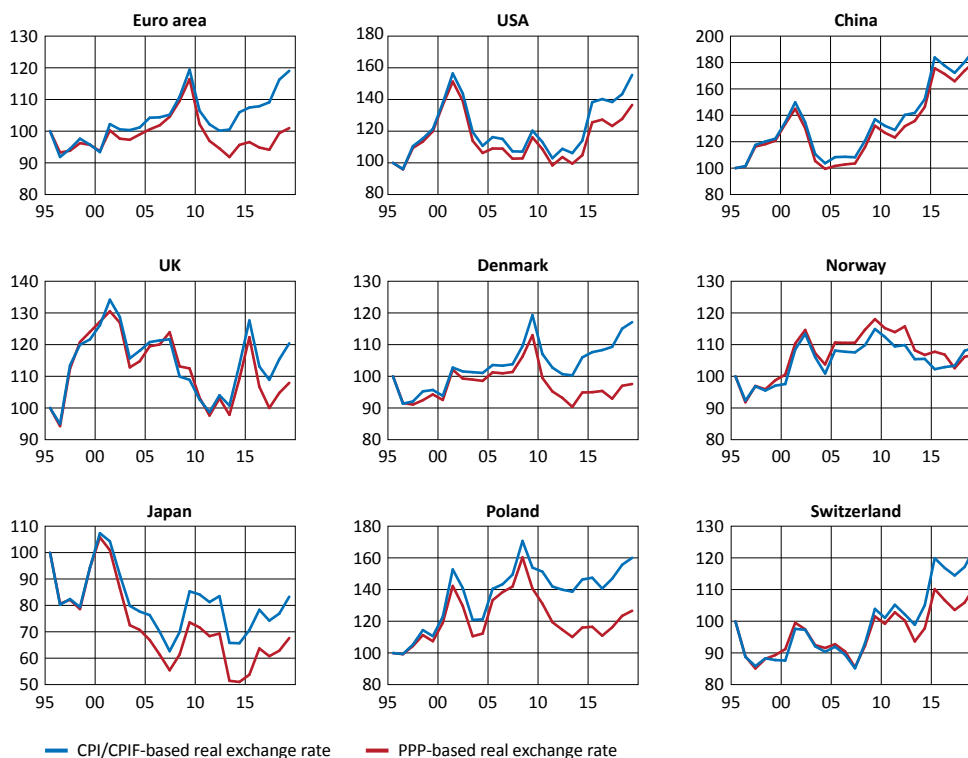
¹⁷ PPP stands for purchasing power parity. See EU and OECD (2012) for details of how this statistic is calculated.

¹⁸ The comparison does not go back further in time than 1995 because published PPP data from before that point are backdates based on the consumption deflators of the countries included (see OECD, 2016).

exchange rate has developed against the euro. It weakened by 19 per cent between 2008 and 2019 according to the CPI/CPIF-based measure but only by 1 per cent according to the PPP-based measure.

Figure 9. Bilateral real exchange rates – PPP vs. CPI/CPIF

Bilateral real exchange rates based on CPI/CPIF and comparative price level indices, index 1995 = 100



Note. Annual data. CPI/CPIF-based real exchange rate means that the calculation of the real exchange rate has used the CPI for other countries and the CPIF for Sweden. The PPP-based real exchange rates are the comparative price level indices calculated as the ratio of the PPP exchange rate and the actual nominal exchange rate.
Sources: BIS, Eurostat, Macrobond, OECD, Statistics Sweden and own calculations

One possible contributing explanation for the difference between these measures of the real exchange rate may be differences between how statistical authorities make quality adjustments when producing various price indices, which does not have to be done at all when producing PPP statistics. For example, Tysklind (2020) shows that price growth measured for quality-adjusted product groups differs significantly between different countries in Europe, of which the measured price growth in Sweden is one of the slowest. This is despite these largely being products that are similar and can easily be traded between countries. This indicates that the prices for these goods are adjusted downwards for quality improvements more in Sweden than in other countries.

As I mentioned above, the PPP-based real exchange rate measure does not risk being disrupted by differences in quality adjustment. At the same time, there may be a tendency for prices included in the PPP statistics to comply with the law of one price to a greater extent than consumer prices in general.¹⁹ The desire for comparability in the products included may push the sample towards those products that are easiest to compare from country to country. Consequently, their prices can be expected to be smoothed out by

¹⁹ The law of one price means that identical goods are sold for the same price on all markets expressed in a common currency.

trade from country to country to a greater extent than other products.²⁰ This could be an explanation for why the PPP-based measure conveys a less clear trend in the real krona exchange rate.

The differences between the various measures of the real exchange rate that we have compared so far suggest that it would be appropriate to complement the picture with other measures. One way of proceeding would be to use costs instead of prices. We can do this by calculating the real exchange rate based on unit labour cost (ULC).²¹ This uses ULC for the entire economy, or some sector such as the manufacturing sector, instead of the consumer price index. Instead of being a measure of how many baskets of Swedish goods and services Swedish consumers would have to give up to purchase a similar basket of goods and services abroad, the ULC-based real exchange rate indicates how many units of Swedish labour would be needed to produce what would be required to buy what a unit of labour produces abroad. Use of the ULC-based method avoids variations stemming from changes in price mark-ups as well as the difficulties in comparing data to which consumer price indices can give rise. At the same time, the unit labour cost captures the labour cost and not the total cost of a produced unit, which could affect the picture of the relative price level development if the labour cost's share of the total cost were to develop differently in Sweden and abroad. Another difference from the consumer price index is that ULC refers to what is produced and not what is consumed in each country. Consequently, it does not include costs for producing whatever is imported but does include costs for producing export goods, investment goods and public services, which is to say goods and services that are not included in the consumer price index.

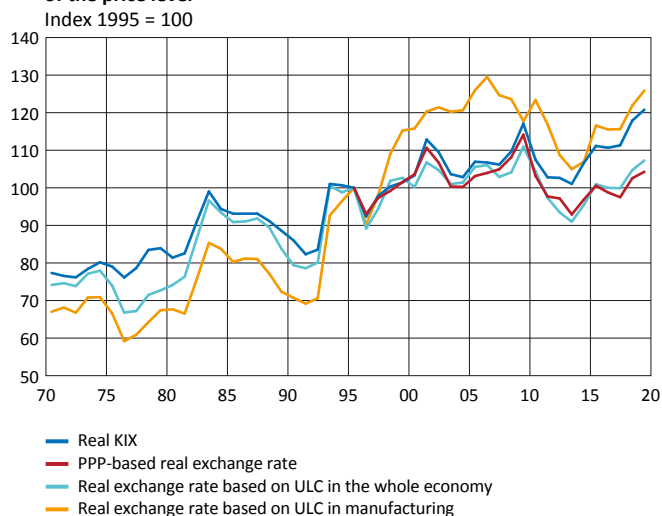
Available statistics make it possible to create ULC-based real exchange rates from 1970 on. Figure 10 shows that, despite the not inconsiderable differences between what is included in the measures, the development of the real krona exchange rate based on ULC for the entire economy is similar to the development of the real KIX until 2006. On the other hand, there arises a deviation after the global financial crisis when real KIX develops considerably more weakly.²² The development of the ULC-based measure is then more consistent with the PPP-based measure. The figure also shows the real exchange rate based on ULC in the manufacturing sector, which shows a much more powerful depreciation than the other measures of the real exchange rate between 1992 and 2006. This measure only captures costs associated with the production of goods that are traded internationally to a very great extent. The depreciation therefore probably reflects the deterioration of Sweden's terms of trade over the same period – a development that I will discuss in more detail in the next section.

20 The manual for data collection for PPP statistics explicitly specifies how the selection of products is to be carried out and that it is desirable to select products that are available for price determination in many countries; see EU and OECD (2012). Ravallion (2018) finds indirect support for the hypothesis of an implicit preference for internationally comparable traded goods in the international price comparison programme. In addition, it can be demonstrated that, even if all prices are measured perfectly, the development of relative CPI and relative PPP will differ due to relative price changes as long as the consumption baskets differ among the countries compared (see Deaton and Aten, 2017).

21 Comparisons of ULC in common currency are also made with the aim of studying competitiveness; see, for example, Sveriges Riksbank (2019).

22 It is possible that the differences in the development of the different measures can, to some extent, be explained by differences in the development of the labour share in Sweden and abroad. According to the Penn World Table, the share of labour cost in GDP fell more in Sweden than abroad between 1977 and 1998, which coincides well with a period in which the krona's ULC-based real exchange rate depreciated more than the CPI/CPIF-based one. After that, the labour share again increased somewhat in Sweden, at the same time as it fell or remained unchanged in the most important KIX countries. The ULC-based real exchange rate then showed less weak development than the CPI/CPIF-based one.

Figure 10. KIX-weighted real exchange rate with different measures of the price level



Note. Annual data. Up to and including 1994, KIX weights from 1994 have been used in the aggregation. For real KIX, the CPIF has been used as price index for Sweden from 1980 on, and the CPI before this. Data access is more limited for ULC in the manufacturing sector than for other measures. To promote comparability between the series, the index for other series has therefore only been calculated with the aid of the observations (for countries and dates) that are also available for ULC in the manufacturing sector. One implication of this is that data for the largest emerging market economies (Brazil, India, China and Russia) is completely absent and data for certain other countries only affects the index over part of the period. This makes the weakening of the real KIX and the PPP-based real exchange rates somewhat smaller than in the other figures.

Sources: BIS, European Commission (DG ECFIN AMECO), National Institute of Economic Research, Macrobond, Statistics Sweden, Sveriges Riksbank and own calculations

6 Terms of trade and relative productivity are key variables for the real krona exchange rate

As was mentioned above, normally, a trend weakening of a country's real exchange rate is traditionally explained by the country having weaker productivity growth than other countries.²³ In addition, it is often pointed out that worsened terms of trade can explain a weakening of the real exchange rate.²⁴ The basic idea behind this is that international trade evens out prices of goods and services that can be traded internationally. The more a country can produce with the available resources (its productivity) or obtain through trade (its terms of trade), the higher the wages in that country can be expected to be. In turn, these determine prices for domestic market goods, which is to say the only prices that can differ more permanently from country to country, and thereby the strength of the country's real exchange rate.

6.1 The trend of relative productivity has changed

Relative productivity growth has had a prominent role in the empirical research literature that aims, with the Balassa-Samuelson hypothesis as a starting point, to find explanations for lasting changes to real exchange rates. In this context, the way productivity is defined and measured is crucial. The Balassa-Samuelson hypothesis basically suggests that the real exchange rate is determined by how productivity in internationally-traded production relative to productivity in the production of domestic market goods can be compared to

²³ See Balassa (1964) and Samuelson (1964).

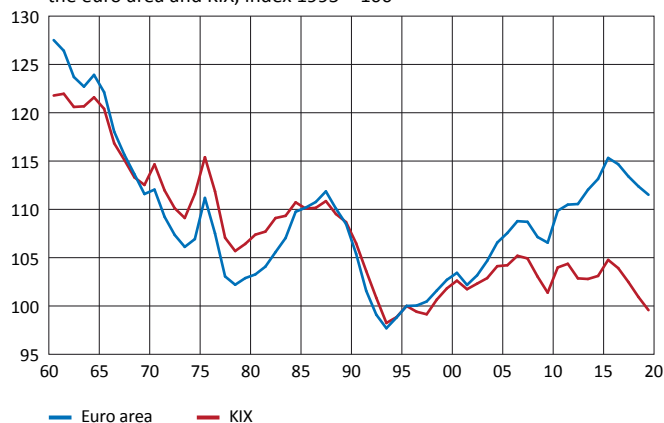
²⁴ See, for example, Neary (1988), Chen and Rogoff (2003), and Berka et al. (2018).

the same relationship in other countries. This means that, if we wish to know to which extent productivity growth can explain how a real exchange rate has developed, we need to have access to comparable sector-specific productivity data for the home country as well as for all countries included in the index calculation. This is a high demand. Nevertheless, a number of attempts of this kind have been made and, in most cases, they provide support for the hypothesis.²⁵ However, if we are interested, as we are in our case, in explaining the development of an effective real exchange rate that includes emerging market economies and, furthermore, wish to be able to illustrate developments over a longer period, there are limited possibilities for obtaining the necessary data. In practice, one must instead rely on one measure of productivity for the entire economy in the hope that productivity growth mainly takes place within internationally-traded production, which is an assumption used and also empirically supported already by Balassa (1964).

Figure 11 uses GDP per inhabitant aged 15–64 to measure productivity. This lets us create a KIX-weighted index starting in 1960.²⁶ In the figure, we can see that productivity measured in this way increased more slowly in Sweden than abroad in the years between 1960 and 1993. This can be expected to have contributed to weakening the real krona exchange rate during this period. After this, there followed a period of relatively strong Swedish productivity growth until 2006, which has, however, fallen again in recent years. Relative to the euro area, Sweden's productivity growth has followed a similar pattern but it weakened slightly more until 1993, followed by a slightly larger strengthening afterwards. One conclusion of this is that it is possible to explain, to a certain extent, the depreciation of the real krona exchange rate until about 1993 through productivity growth, but not afterwards.

Figure 11. Sweden's productivity relative to other countries

Sweden's GDP per inhabitant between the ages of 15–64, relative to the euro area and KIX, index 1995 = 100



Note. Annual data.

Sources: OECD, Penn World Table, World Bank

6.2 Worsened terms of trade may have contributed to the depreciation

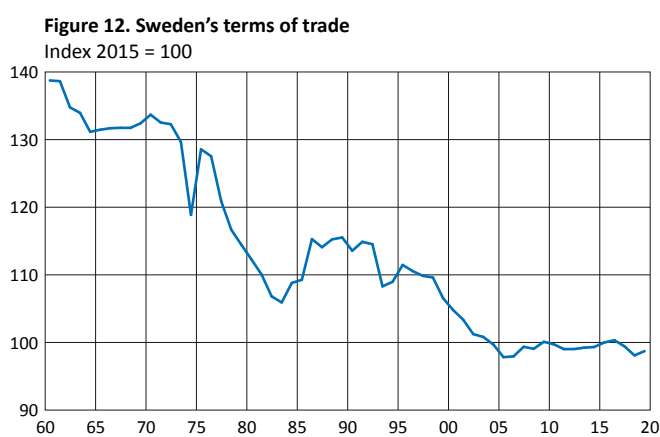
Terms of trade have also frequently been included in empirical studies that have attempted to explain real exchange rate movements. More favourable terms of trade are not just equivalent to higher productivity in the production of internationally-traded goods and services (as this means that one and the same amount of work in the production of export

²⁵ See Gubler and Sax (2019) for an overview.

²⁶ A smaller investigation of how Sweden's productivity in internationally-traded production in relation to productivity in production of domestic market goods compares to the corresponding relative productivity in the euro area over the period 1995–2018 points to a development closely resembling that for relative GDP per inhabitant aged 15–64.

goods allows a larger volume of imports), which may be expected to affect the real exchange rate positively by pushing up prices for domestic market goods. They may, in addition, have a direct effect on relative consumer price levels and thereby the real exchange rate if there is a so-called home bias in consumption.²⁷

In Figure 12, we can see a negative trend in the Swedish terms of trade, measured as the relationship between export prices and import prices in the national accounts, until about 2005. This can be presumed to have contributed to the trend depreciation of the real krona exchange rate over the same period. Among the product groups playing an important role within Swedish international trade, price growth for petroleum products, as well as pulp and paper, seem to have contributed to worsened terms of trade.²⁸ After 2005, it becomes more difficult to explain a depreciation of the real exchange rate on the basis of the development of the terms of trade.



Note. Annual data.
Sources: European Commission, DG ECFIN, AMECO

6.3 Other possible factors behind the development of the real exchange rate

Alongside productivity in relation to other countries and the terms of trade, there are a number of other factors that are mentioned in the research literature and that could contribute towards explaining the depreciation trend in the real krona exchange rate. These can be divided into factors that, like productivity in relation to other countries, affect how rich a country is in relation to other countries, and into factors that more directly affect the relationship between prices for domestic market goods and internationally-traded goods.

The net external position, which is to say the difference between claims on and liabilities to other countries, reflects a country's wealth in comparison to the rest of the world and has therefore been highlighted as potentially important for a country's real exchange rate.²⁹ The net external position depends partly on the historical development of the current account and partly on changes in the market values of the securities that make up the country's assets and liabilities. Unfortunately, there are significant measurement problems here, which make it difficult to determine how this variable has developed for Sweden's part.³⁰ However, a dataset that is often used in this context and which was developed by Lane and Milesi-Ferretti (2018), the current level lies very close to the 1970 level. Even if Sweden were to have undergone a major change in its net external position, Christopoulos et al. (2012)

²⁷ See Berka et al. (2018).

²⁸ According to the export and import price indices published by Statistics Sweden.

²⁹ See, for example, Lane and Milesi-Ferretti (2004).

³⁰ See Blomberg and Östberg (1999) and Blomberg and Falk (2006) for discussions of measurement problems and difficulties in making accurate comparisons further back in time.

show that this should not affect the real krona exchange rate as there are no restrictions on Sweden's access to foreign capital.

Factors that more directly affect the relationship between prices on the domestic market and internationally-traded goods should also be able to affect the real exchange rate. In a comprehensive analysis of 48 countries' effective real exchange rates, Ricci et al. (2008) find that three such factors exert a certain influence on real exchange rates: public consumption since it can affect total demand in the direction of domestic market production, protectionism since it can drive up domestic prices above world market prices and price controls since they can keep prices below their market levels. However, a review of how these variables have developed in Sweden and among our most important trading partners indicates that the relative changes have been so minor that they could only have had a marginal influence on the trend development of the real krona exchange rate.

In summary, it seems that, for a number of decades, there have been trends in certain key variables, more specifically in Sweden's productivity relative to other countries and in the terms of trade, that could explain a trend depreciation of the real krona exchange rate, at least up until 2005. However, how much these variables may have contributed to the trend of the real exchange rate and what can explain the variations around this trend, remain to be determined. In the next section, I show how this can be done using an empirical model.

7 A model estimate and the development and current level of the long-run real exchange rate

Belfrage et al. (2020) describe an empirical model to explain the trend in the real krona exchange rate and how this relates to the central explanatory variables that I have presented above. This is a time series model with time-varying equilibrium levels. We interpret the long-run real exchange rate as the trend level obtained from the model and which we assume is a linear combination of estimated trends in the measures of relative productivity and terms of trade that I discussed in section 6.³¹ In one and the same estimate, we can then use so-called Bayesian methods to calculate the long-run real exchange rate and the variations in the difference between the actual and long-run real exchange rate, known as the real exchange rate gap. In turn, the short-term variations in the real exchange rate gap are explained by the variations around the trends in relative productivity, the terms of trade and the current account, variations in the interest rate differential against the rest of the world (based on the hypothesis that the exchange rate is affected by how the return on investments differs from the rest of the world) and the VIX index (which reflects uncertainty over developments on the financial markets and thus demand for assets in currencies such as the krona that are considered less liquid), as well as a real exchange rate shock.

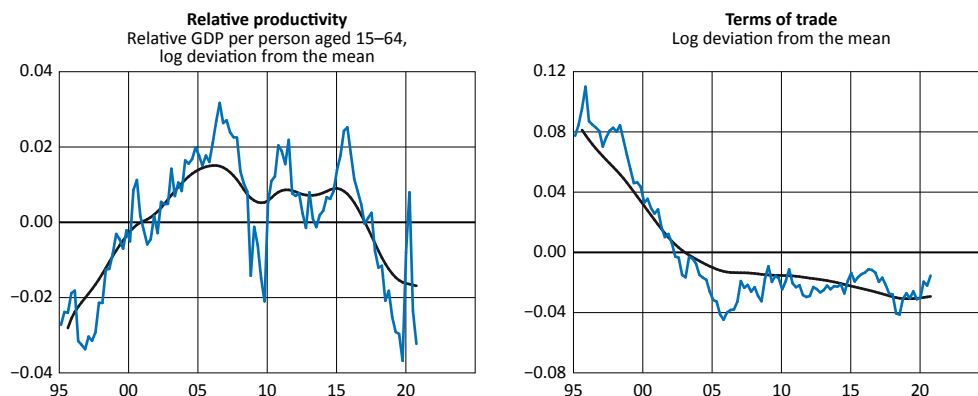
Figure 13 shows outcomes and estimated trend levels for Sweden's relative productivity and terms of trade, while Figure 14 shows the model's estimate of the long-run level of the real KIX since 1995.³² We can see that, between 1995 and 2005, there is a trend increase in Sweden's productivity compared with the rest of the world, which itself suggests an appreciation of the long-run real exchange rate. At the same time, however, there is a powerful trend deterioration of the terms of trade, which itself suggests a depreciation of the long-run real exchange rate. In the model estimate, we can say that the effect of the worsened terms of trade dominates, as the estimated long-run real exchange rate depreciates over the period in which the trends of the explanatory variables move in different directions. After this, it is almost unchanged until 2015, after which a certain

³¹ See Lane and Milesi-Ferretti (2004) for a theoretical model that gives rise to such a link.

³² Limited access to more frequent data (here, quarterly data) and the fact that the dynamics of the real exchange rate also changed in conjunction with the transition from fixed rate to floating exchange rate at the end of 1992 explain why the model estimate restricts itself to the period from 1995.

depreciation takes place as the trend levels fall for both relative productivity and the terms of trade.

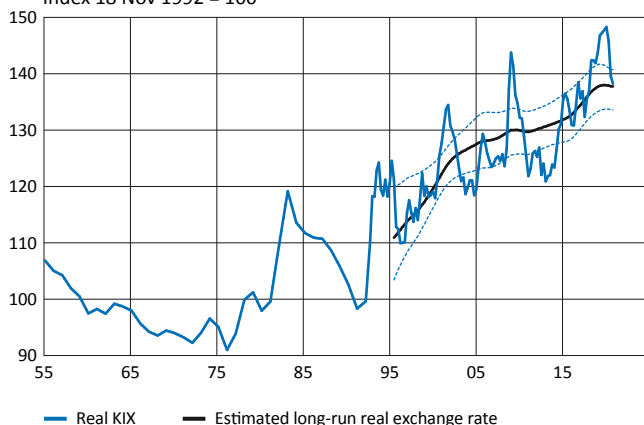
Figure 13. Outcomes and estimated trend levels for central explanatory variables



Note. Quarterly data.
Sources: BIS, National Institute of Economic Research, Macrobond, national sources, Statistics Sweden, Sveriges Riksbank and own calculations

Figure 14. Long-run real KIX according to estimate using the TVE-VAR model

Index 18 Nov 1992 = 100



Note. Annual data until end of 1992, quarterly data from 1993 to 2020. Up to and including 1994, KIX weights from 1994 have been used in aggregation. The CPIF has been used as price index for Sweden from 1980 on, and the CPI before this. The dotted lines show the 95 per cent posterior coverage interval for the model estimate.
Sources: BIS, National Institute of Economic Research, Macrobond, national sources, Statistics Sweden, Sveriges Riksbank and own calculations

The krona can be said to have been weak over the periods in which the actual real exchange rate exceeded the estimated long-run level, and strong when the opposite was true. For example, the Swedish krona was weak during the most intensive phase of the global financial crisis 2009–2010, which was a period of clearly elevated uncertainty surrounding the world economy in general and developments on the financial markets in particular. The krona was subsequently strong over the years 2011–2014, when Swedish monetary policy was less expansionary than it was abroad, and may therefore have contributed to a stronger krona exchange rate by affecting the interest rate differential against the rest of the world.³³ Between 2018 and 2020, the krona has been weak again. Bacchetta and Chikani (2021) also

³³ The model explains the real exchange rate gap through the included variables' deviations from their respective trend levels, but without making further assumptions it is unfortunately impossible to identify the contributions made by each variable.

attempt to explain the development of the real krona exchange rate with largely the same set of variables but with a different method of estimation. They obtain a similar picture of the development of the real exchange rate gap.³⁴ Unfortunately, the reasons for the deviations from the long-run level cannot be identified, either in their model or in the model presented here. Further analysis is needed to gain deeper insights into this.

8 Conclusions

The effective real krona exchange rate – measured using the consumer price index – seems to have been stationary over most of the 1900s. However, in recent decades, it has undergone a clear trend depreciation that is almost unique in an international comparison in terms of size and duration. The real krona depreciation has taken place against all trading partners of significance, albeit to varying degrees. Even when the real exchange rate is calculated using alternative measures of price levels, such as the OECD and Eurostat's comparative price level indices and unit labour costs, a depreciation trend is visible. However, these calculations also give a slightly less dramatic picture of the development of the real krona exchange rate, particularly after 2008. The trend depreciation can, at least partially, be explained by weaker productivity growth in Sweden than abroad and a trend weakening of Sweden's terms of trade.

³⁴ They use dynamic OLS regressions, in one variant on quarterly data from 1975 to 2018 and in another variant on annual data from 1970 to 2018. Their analysis does not relate trend levels but the variables' actual levels. In their model, the exchange rate gap is therefore simply the residuals from the regression.

References

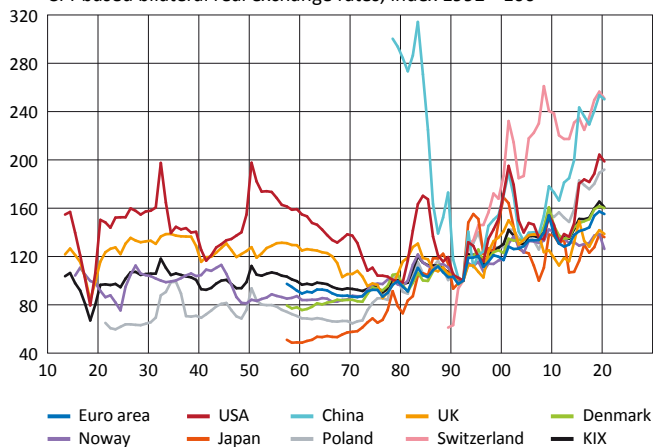
- Bacchetta, Phillippe and Pauline Chikhani (2021), 'On the weakness of the Swedish krona', *Sveriges Riksbank Economic Review*, no. 1.
- Balassa, Bela (1964), 'The Purchasing-Power Parity Doctrine: A Reappraisal', *Journal of Political Economy*, vol. 72, no. 6, pp. 584–596.
- Belfrage Carl-Johan, Paolo Bonomolo and Pär Stockhammar (2020), 'A time-varying equilibrium VAR model of the long-run real exchange rate', Staff Memo, Sveriges Riksbank.
- Berka, Martin, Michael B. Devereux and Charles Engel (2018), 'Real Exchange Rates and Sectoral Productivity in the Eurozone', *American Economic Review*, Vol. 108, no. 6, pp. 1543–1581.
- Blomberg, Gunnar and Maria Falk (2006), 'How do large current-account surpluses co-exist with a weak international investment position?', *Sveriges Riksbank Economic Review*, no. 1.
- Blomberg, Gunnar and Johan Östberg (1999), 'Market evaluation of external position – a new picture of Sweden's international dependence', *Sveriges Riksbank Economic Review*, no. 2.
- Bordo, Michael D., Ehsan U. Choudri, Giorgio Fazio and Ronald MacDonald (2017), 'The real exchange rate in the long run: Balassa-Samuelson effects reconsidered', *Journal of International Money and Finance*, vol. 75, pp. 69–92.
- Cassel, Gustav (1918), 'Abnormal Deviations in International Exchanges', *The Economic Journal*, vol. 28, no. 112, pp. 413–415.
- Ca' Zorzi, Michele, Marcin Kolasa and Michał Rubaszek (2017), 'Exchange rate forecasting with DSGE models', *Journal of International Economics*, vol. 107, pp. 127–146.
- Chen, Yu-chin and Kenneth Rogoff (2003), 'Commodity Currencies', *Journal of International Economics*, vol. 60, no. 1, pp. 133–160.
- Christopoulos, Dimitris K., Karine Gente and Miguel A. León-Ledesma, 'Net foreign assets, productivity and real exchange rates in constrained economies', *European Economic Review*, vol. 56, pp. 295–316.
- Deaton, Angus and Bettina Aten (2017), 'Trying to Understand the PPPs in ICP 2011 Why Are the Results So Different?', *American Economic Journal: Macroeconomics*, vol. 9, no. 1, pp. 243–264.
- Dornbusch, Rudiger (1985), 'Purchasing power parity', *NBER Working Paper Series*, no. 1591.
- Erlandsson, Mattias and Alek Markowski (2006), 'The Effective Exchange Rate Index KIX – Theory and Practice', Working Paper No. 95, National Institute of Economic Research.
- EU and OECD (2012), *Eurostat-OECD Methodological Manual on Purchasing Power Parities*.
- Froot, Kenneth A. and Kenneth Rogoff (1995), 'Perspectives on PPP and long-run real exchange rates', chapter 32 of *Handbook of International Economics* vol. 3, G. Grossman and K. Rogoff (eds.), Elsevier Science.
- Gubler, Matthias and Christoph Sax (2019), 'The Balassa-Samuelson effect reversed: new evidence from OECD countries', *Swiss Journal of Economics and Statistics*, vol. 155, no. 3.
- Lane, Philip R. and Gian M. Milesi-Ferretti (2004), 'The transfer problem revisited: net foreign assets and real exchange rates', *The Review of Economics and Statistics*, vol. 86, no. 4, pp. 841–857.
- Lane, Philip R. and Gian M. Milesi-Ferretti (2018), 'The External Wealth of Nations Revisited: International Financial Integration in the Aftermath of the Global Financial Crisis', *IMF Economic Review*, vol. 66, pp. 189–222.
- Meese, Richard A. and Kenneth Rogoff (1983), 'Empirical Exchange Rate Models of the Seventies: Do they fit out of sample?', *Journal of International Economics*, vol. 14, pp. 3–24.
- Neary, Peter (1988), 'Determinants of the Equilibrium Real Exchange Rate', *American Economic Review*, vol. 78, no. 1, pp. 210–215.

- OECD (2016), 'Estimation of annual PPPs before 2013 in the Eurostat-OECD PPP Programme', www.oecd.org/sdd/prices-ppp/Estimation-of-annual-PPPs-before-2013-in-the-Eurostat-OECD-PPP-Prog.pdf, accessed 16 February 2021.
- Ravaillon, Martin (2018), 'An exploration of the changes in the international comparison program's global economic landscape', *World Development*, vol. 105, pp. 201–216.
- Samuelson, Paul A. (1964), 'Theoretical Notes on Trade Problems', *The Review of Economics and Statistics*, vol. 46, no. 2, pp. 145–154.
- Statistics Sweden (2017), 'Statistics Sweden measures inflation – the difference between the CPI, the CPIF and the HICP', www.scb.se/hitta-statistik/artiklar/2017/Sa-mater-SCB-inflation--skillnaden-mellan-KPI-KPIF-och-HIKP, accessed 18 May 2021.
- Sveriges Riksbank (2019), 'Development of Swedish labour costs in an international perspective', article in *Monetary Policy Report*, February.
- Sveriges Riksbank (2020), 'Historical time line', www.riksbank.se/sv/om-riksbanken/historia/historisk-tidslinje, accessed 4 December 2020.
- Taylor, Alan M. and Mark P. Taylor (2004), 'The Purchasing Power Parity Debate', *Journal of Economic Perspectives*, vol. 18, no. 4, pp. 135–158.
- The Economist (2020), 'Burgernomics: The Big Mac index', www.economist.com/news/2020/07/15/the-big-mac-index, accessed 21 December 2020.
- Tysklind, Oskar (2020), 'Quality adjustments and international price comparisons', Staff Memo, Sveriges Riksbank.
- World Bank (1970), *Annual Report 1970*, pubdocs.worldbank.org/en/815631586875431072/IBRD-Financial-Statements-June-1970.pdf, accessed 6 January 2021.

Appendix

Figure A1. Bilateral real exchange rates against the currencies that have contributed most to the depreciation of the KIX-weighted real exchange rate

CPI-based bilateral real exchange rates, index 1992 = 100



Note. Annual data. The bilateral real exchange rates shown are those that have made a contribution of more than 2 percentage points to the depreciation of the KIX-weighted index since 1957, 1970 or 1992. Up to and including 1994, KIX weights from 1994 have been used.

Sources: BIS, Macrobond, Sveriges Riksbank and own calculations