ARTICLE– Analysing exchange rates – a few key concepts

This article discusses a few key concepts in the analysis of exchange rate development. The aim is to provide an introduction and background to the subsequent article "The Riksbank's exchange rate forecasts", which describes both how the Riksbank has made its assessments of the future development of the Swedish krona (SEK) and the current development work. To begin with, the article explains the difference between nominal and real exchange rates and the concept of a trade-weighted exchange rate. After that, the equilibrium real exchange rate and the most common theories for how it is determined are discussed.

Nominal and real exchange rates

The krona's *nominal exchange rate* shows the number of SEK per unit of foreign currency, for example, SEK 10.50 per euro (EUR) or SEK 9.50 per US dollar (USD). The krona's *real exchange rate* shows the relation between Swedish and foreign price levels, expressed in the same currency, according to the following formula:

$$\text{Real exchange rate} = \text{Nominal exchange rate} \times \frac{\text{foreign price level}}{\text{Swedish price level}}$$

The development of the real exchange rate is therefore determined by the nominal exchange rate and by how the price level develops in Sweden compared with other countries. Note that a *lower level signifies a stronger rate*, in exactly the same way as for the nominal exchange rate.[25]

When making economic decisions, the real exchange rate is normally most significant. Assume that a household in Sweden has the choice between buying a product in a Swedish shop or via an online store in Germany.[26] That the nominal exchange rate is, for example, SEK 10.50 per euro (EUR) does not provide much guidance for this decision. But if the product costs SEK 100 in Sweden and EUR 10 in Germany, the calculation of the real exchange rate shows that the price is SEK 105 in Germany and SEK 100 in Sweden. In this example, it would therefore appear to be more tempting to buy the product in Sweden.

It is the real exchange rate that influences the krona's purchasing power and competitiveness in an international perspective. The stronger the real krona exchange rate, the greater the krona's purchasing power, but the weaker the competitiveness of the Swedish export sector. How does this fit together?

Since 1986, The Economist has tracked the price of a Big Mac hamburger in different countries expressed in the same currency, in other words a real exchange rate for a single product. Table 3:1 below looks back in history, from 1986 to 2019. In 1986, a Big Mac cost SEK 17 in Sweden but only SEK 11 in the United States. For the price of a Big Mac in Sweden, the holder of SEK who then exchanged them for USD could therefore buy about one and a half Big Macs in the United States. In this way, the krona's purchasing power was strong. But if we toy with the idea of having exported the Big Mac from Sweden to the United States for SEK 17, demand had not been particularly high, as the price in the United States was SEK 11.[27] In this way, the strong real exchange rate meant that the competitiveness of the Swedish export sector was weak.

Table 3:1. Illustration of the nominal and real exchange rates using a Big Mac

	Nominal exchange rate, SEK/USD	Big Mac in Sweden, SEK	Big Mac in United States, USD	Big Mac in United States, SEK	Real exchange rate
1986	6,90	17	1.6	11	11/17≈0.65
1993	7.40	26	2.3	17	17/26≈0.65
2013	6.80	42	4.6	31	31/42≈0.74
2019	9.50	51	5.7	54	54/51≈1.06

Sources: The Economist and Sveriges Riksbank.

During the first year with a floating exchange rate, 1993, the nominal krona rate was somewhat weaker than in 1986.[28] But the price of a Big Mac in Sweden had risen slightly more than in the United States, so that the relation between the price in SEK in the United States and in Sweden, the real krona exchange rate, was about the same. If we quickly move

[25] A stronger rate therefore means that a certain amount of SEK can be bought with foreign currency. One should be aware that real and nominal exchange rates can sometimes be defined in the opposite way, so that the value rises when the exchange rate strengthens. The definition is based on the nominal exchange rate being measured as the number of units of foreign currency per unit of domestic currency. If the krona is 9.50 against the dollar, the nominal krona exchange rate would instead by 1/9.50 ≈ USD 0.11 per krona. The real exchange rate is defined in this example as the price level in Sweden converted into USD and divided by the price level in the United States.

[26] To facilitate the comparison, we can assume that the online store does not charge a shipping fee.

[27] In practice, it is more likely that an export product from Sweden to the United States has been priced in USD. The price of a Big Mac in Sweden was 17/6.90 ≈ USD 2.5, which is significantly higher than the price in the United States of USD 1.6. The conclusion about competitiveness is therefore the same. This method of comparing price levels follows the alternative definition of the real exchange rate in Footnote 25.

[28] The fixed exchange rate was abandoned on 19 November 1992.

twenty years forward in time to 2013, we see instead that the nominal krona exchange rate had strengthened somewhat compared with 1993. However, the price of a Big Mac had increased faster in the United States than in Sweden, so that the real krona exchange rate had nevertheless weakened somewhat.

In recent years, the krona's nominal exchange rate has weakened substantially, from SEK 6.80 per USD in 2013 to SEK 9.50 per USD in 2019. The Big Mac had gone from being SEK 11 cheaper in the United States than in Sweden in 2013 to being SEK 3 more expensive in 2019, which means that the real exchange rate has weakened substantially. The weakened purchasing power is illustrated by the fact that the price of a Big Mac in Sweden in 2019, SEK 51, would not even have bought a single Big Mac in the United States, where the price was SEK 54. If we again toy with the idea of having exported a Big Mac from Sweden to the United States for SEK 51, this would now appear to be competitive, as the price in the United States was SEK 54.

The movements in the nominal exchange rate are the most important explanation for the weakening of the real exchange rate since 2013.[29] In general, it is the case that most of the variation in real exchange rates is driven in the short term by the nominal exchange rate, as this is determined on a daily basis by financial market agents, while it takes time to change consumer prices. But as we saw in the comparison between 1993 and 2013, differences in price development can play a major role in the development of the real exchange rate over longer periods of time.

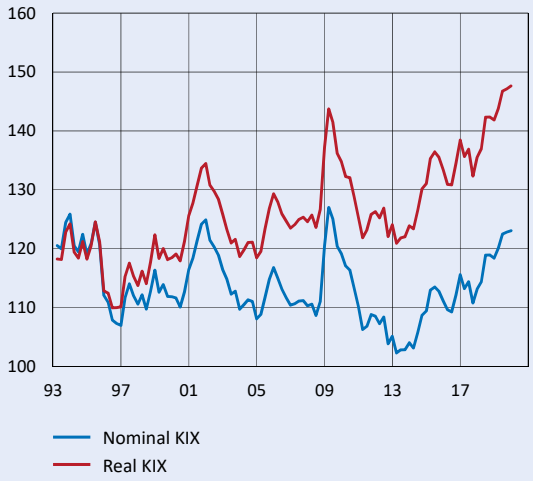
Trade-weighted exchange rate

When the Riksbank analyses and forecasts the krona exchange rate, a broad perspective is needed and not just the exchange rate against a single currency like the US dollar. For this purpose, there is the KIX krona index, which weighs together the krona exchange rate against different currencies according to the significance of the currency area for Sweden's foreign trade. The euro area is Sweden's largest trading partner and makes up about 50 per cent of the index.[30] The KIX is an example of a *trade-weighted exchange rate*, also called an effective exchange rate.[31]

To calculate the real trade-weighted exchange rate, broad price indices are used, such as the consumer price index (CPI), as a measure of the price level in the various countries. Figure 3:11 shows the krona's nominal and real exchange rate measured in terms of the KIX and the CPI during the period with a floating exchange rate, that is, from 1993 onwards. *Just as for individual currencies, a higher value of the nominal and real KIX signifies a weaker nominal and real krona exchange rate respectively.*

A few interesting observations can be made based on the figure. Just as in the Big Mac example, we see that movements in the nominal exchange rate guide movements in the real exchange rate in the short term. Another similarity is that the real krona exchange rate in 2013 was approximately the same as in 1993, and then weakened significantly, which is reflected in a rising index. We also see that the relative price level can play a significant role in the longer term and cause the nominal and real exchange rates to develop differently.[32] Compared with 1993, the nominal krona exchange rate was on approximately the same level as in 2019, while the real krona exchange rate had weakened by more than 20 per cent.

Figure 3:11. Nominal and real krona exchange rates according to the krona index (KIX)
Index, 18 November 1992 = 100



Note. The real exchange rate is calculated using the CPIF for Sweden and the CPI for the rest of the world. The KIX (krona index) is a weighted average of the currencies in the countries that are important for Sweden's international trade. A higher value indicates a weaker exchange rate.

Sources: National sources, Statistics Sweden and the Riksbank

Real equilibrium exchange rate

Exchange rates vary substantially and it is widely acknowledged that they are difficult to forecast. Although it is difficult to make a better forecast of the nominal exchange rate level in the short term than assuming the current level will also prevail in the future, the real exchange rate has a tendency to return towards a *real equilibrium exchange rate* in the longer term.[33] There are

[29] The price of the Big Mac in domestic currency increased slightly more in the United States than in Sweden. The price increase from USD 4.6 to USD 5.7 is 24 per cent while the increase from SEK 42 to SEK 51 is 21 per cent. The nominal weakening of the exchange rate was about 40 per cent.
[30] The weights are constantly updated and published on the Riksbank's website. For more information, see https://www.riksbank.se/en-gb/statistics/search-interest--exchange-rates/explanation-of-the-series/effective-exchange-rate-indices.
[31] Formally, the KIX is a competition-weighted exchange rate, that also captures the significance of export competition for Swedish products with what are known as "third-country effects". For a detailed description, see J. Alsterlind, "Effective exchange rates – theory and practice", Sveriges Riksbank Economic Review, 2006:1.

[32] A known historical example is the fixed exchange rate regime of the 1980s, when inflation in Sweden was significantly higher than abroad. This led to a real appreciation of the krona of about 25 per cent between 1983 and 1992, despite the nominal exchange rate remaining stable.
[33] The Riksbank has analysed the krona's real equilibrium real exchange rate on numerous occasions. See, for instance, Lagerwall, Björn and Nessén, Marianne, "The long-term developments of the krona", Economic Commentaries no. 6, 2009, Karolina Ekholm, "Monetary policy and the exchange rate", speech published 12 January 2010, "A long-term perspective on the krona", article in Monetary Policy Report, July 2013, and "The krona's development in the longer term", article in Monetary Policy Report, October 2018 and "Trend development of the Swedish krona", article in Monetary Policy Report, July 2019.

three fundamental theories to determine the real equilibrium real exchange rate: purchasing power parity, that the real exchange rate is stronger in richer countries, and that the real exchange rate creates balance in foreign trade.

Indisputably the most well-known theory for assessing the real exchange rate's equilibrium level is *purchasing power parity*. The theory was launched by the well-known Swedish economist Gustav Cassel about 100 years ago, although the fundamental principles of the theory go even further back.

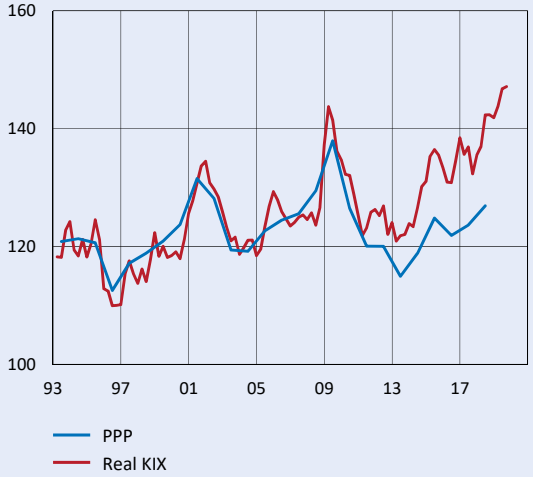
Absolute purchasing power parity is based on the law of one price, which states that a product costs the same in different countries, converted into the same currency. The idea behind the law is that if prices were to differ, so-called arbitrage opportunities would arise, i.e. a product bought in a country where it is cheap could be sold in another country where the price is higher. The Big Mac example above can therefore be seen as a test of the law of one price, and the law does not hold in this case.

When purchasing power parity is examined in general, price levels in the entire economy are compared, and these are normally measured in terms of different price indices, such as the CPI. Absolute purchasing power parity therefore means that the price level expressed in a common currency shall be the same in different countries. It is not possible to compare levels on the consumer price index in the same way as prices of identical products. The indices are just comparative figures *aimed at capturing price development over time*.[34] In addition, definitions and compositions of the indices differ among different countries. An alternative to the consumer price index is to compare identical products, like in the Big Mac example, but with a larger basket that better reflects total household consumption. Eurostat and the OECD compile such statistics, normally referred to as PPP data. In this way, an idea of the price level in Sweden compared with other countries, measured in the same currency, can be obtained. Figure 3:12 shows a calculation of the real trade-weighted krona rate calculated using PPP data, together with the earlier shown real exchange rate calculated using the CPI. We see that the different series have largely followed each other, apart from in recent years, when the depreciation of the real krona exchange rate has been significantly less according to the PPP-based calculation. A major disadvantage with the PPP statistics compared with the consumer price index, however, is that it is has a narrower base and is published less often and with a greater time lag.[35] This means that the Riksbank often focuses on the CPI-based trade-weighted real krona exchange rate in its analyses and forecasts.

An alternative concept to analyse the real exchange rate is *relative purchasing price parity*, which means that differences in the rate of price increase – i.e. inflation – between countries are matched by equally large changes in the nominal exchange rate.[36] In this case, the real exchange rate is held at a constant level. The most common definition of relative purchasing power parity in practice is that the real exchange rate shall not have a trend in any particular direction. As we saw, this seems to tally quite well for both the Big Mac and the krona's real trade-weighted exchange rate between 1993 and 2013. Figure 3:12 illustrates that the development of the PPP-based real trade-weighted krona exchange rate tallies quite well with relative purchasing power parity for the entire period since 1993.[37] If the real exchange rate does not have any trend, it will gradually return to its mean value in the long run.

Figure 3:12. Different measures of the Swedish real effective exchange rate

Index, 18 November 1992 = 100



Note. The real exchange rate is calculated using the CPIF for Sweden and the CPI for the rest of the world. The KIX (krona index) is a weighted average against currencies in the countries that are important for Sweden's international transactions. A higher value indicates a weaker exchange rate. PPP refers to annual data. The sample is limited to countries and years in which is the data available for the measures based on the PPP.

Sources: National sources, Statistics Sweden and the Riksbank

An alternative theory in order to determine the equilibrium real exchange rate is based on the assertion that *the price level measured in the same currency is higher in richer countries*. Returning to the Big Mac example, data from 2019 shows that the five most expensive Big Macs could be found in Switzerland, the United States, Sweden, Canada and Norway, all of which are among the world's 20 richest

[34] The CPI in Sweden has 1980 as its base year, which means that the value for that year is set at 100. In 2019, the value was 334, which only indicates that the price level was just over three times higher in 2019 than in 1980.

[35] For descriptions and illustrations of the krona's real exchange rate measured using PPP data, see "Trend development of the Swedish krona", article in Monetary Policy Report, July 2019 and "Development of the Swedish krona in the longer term", article in Monetary Policy Report, October 2018.

[36] Price changes can also be more difficult to compare between countries for the consumer price index than for identical products. An example of this is differences in how quality improvements are considered in calculation of the consumer price index. See O. Tysklind, "Quality adjustments and international price comparisons", Staff Memo, January 2020, Sveriges Riksbank, and the article "Inflation not fully comparable between countries", Monetary Policy Report, February 2020. Sveriges Riksbank.

[37] For a detailed analysis of Big Mac prices and purchasing power parity, see for example Pakko, M.R. and Pollard, P.S., "Burgernomics: A Big Mac Guide to Purchasing Power Parity", Federal Reserve Bank of St. Louis Review, November/December 2003, and Parsley, D.C. and Wei, S-J., "A Prism into the PPP Puzzles: The Micro-foundations of Big Mac Real Exchange Rates", Economic Journal 117, 1336-1356, 2007.

countries measured in terms of GDP per capita. In general, it is also true that countries with high GDP per capita tend to have a higher price level, measured in the same currency.[38]

One conclusion of this is that if a country's GDP per capita grows in relation to other countries, the real exchange rate should strengthen. But how does this effect arise? The Balassa-Samuelson Theory explains the differences in price developments and real exchange rates between countries. A central element in the theory is to assume that purchasing power parity applies to products traded internationally, but not to services that are not traded internationally. The thinking is that countries with high productivity growth in the goods sector have higher cost and price increases in the service sector. The box below explains how prices can develop differently for goods and services. Productivity growth in the goods sector is reflected quite well in growth in GDP per capita. The conclusion is then that countries with strong growth in GDP per capita in relation to abroad typically see a strengthening of the real exchange rate.

Price development of goods and services

According to the Baumol-Bowen theory, productivity growth is higher in the goods sector than in the services sector, which in turn means that service prices rise more quickly than goods prices. For example, a string quartet is not much more productive today than during Beethoven's lifetime. In the manufacturing industry, however, productivity has increased constantly, which means that fewer employees are required to manufacture the same amount of goods. Nevertheless, wages have risen substantially for both factory workers and musicians in string quartets since the 19th century. Cost development is normally measured in terms of unit labour costs, which corresponds to the difference between wages and productivity. The conclusion is then that the costs have increased much more for string quartets than in the industrial sector, which spills over into price development. This is the most important reason why the price of classical concert tickets rises much more than the price of industrial products.

In addition to GDP per capita, a country's relative wealth can change via its terms of trade, which reflect the difference between export and import prices. The higher the export prices in relation to import prices, the stronger the terms of trade.[39] Just as is the case with a rising GDP per capita relative to other countries, improved terms of trade would lead to a stronger real exchange rate. A simple way to understand this is to consider the goods sector in a small, open economy that is particularly focused on the export of a particular commodity. When the global market price of the commodity rises, the goods sector receives higher import revenues, which causes wages to rise.[40] This wage growth spreads to the service sector, where costs and prices also go up. The real exchange rate will therefore strengthen.[41] For a small, open economy like Sweden, the terms of trade are also significantly affected by the global market price of exports from and imports to Sweden. For example, an increase in the oil price on the global market would contribute to a deterioration in the Swedish terms of trade, as imported oil becomes more expensive.

Another theory in order to determine the equilibrium real exchange rate is to link it to the balance in foreign trade. It is normally assumed that a weaker real exchange rate increases a country's surplus in foreign trade as competition improves: Relatively speaking, exports become cheaper abroad and imports into the country become relatively more expensive. To balance foreign trade in the longer term, the real exchange rate shall therefore move in a certain direction. If a country has a large surplus in foreign trade, it indicates that the real exchange rate in the long term will strengthen so that the surplus decreases.

This conceptual framework has been a key element of the IMF's analyses of exchange rates, where the Swedish krona has often been considered undervalued in light of Sweden's large surplus in foreign trade.[42] Note that this approach requires an assessment of the long-term equilibrium in foreign trade, which does not need to be zero. Structural factors such as the design of the pension system, may justify a surplus or deficit in the long term. If an incorrect assessment has been made of the long-term foreign trade level, there is a risk of the assessment of the long-term equilibrium real exchange rate also being incorrect.[43]

Overall conclusions

The real krona exchange rate, which shows the price level in Sweden compared with other countries in the same currency, reflects the competitiveness of companies and the purchasing power of households.

For the Riksbank, the most important thing is to follow the trade-weighted krona exchange rate, as it captures the overall development of the krona in relation to the countries that are the most important for Sweden's foreign trade.

[38] When comparing prosperity levels between countries, therefore, purchasing power is normally taken into account in the exchange rate by adjusting for the difference in price level; see for example H. Gabrielsson, "How does prosperity growth in Sweden compare with other countries?", Economic Commentaries no. 10, 2019, Sveriges Riksbank.

[39] Terms of trade are measured as the ratio between the export price index and the import price index.

[40] Highly simplified, imagine that companies in the goods sector allow unit labour costs to follow the commodity price, according to the following ratio: Commodity price ≈ wage/productivity. This means that wages in the goods sector can rise not only due to increased productivity in the goods sector, as in the Balassa-Samuelson theory, but also due to an increase in the price of the commodity on the global market.

[41] The concept of *commodity currencies* is often used to denote the currency in small, open economies with substantial exports of a certain commodity, such as Norway, Canada, New Zealand and Australia. The real exchange rate is affected by changes in global market prices of the commodity, via the effect on the terms of trade. See for example Y-C Chen and K. Rogoff, "Commodity currencies", *Journal of International Economics*, pp. 133-160, 2003, and Cashin, P., L.F Céspedes and R. Sahay, "Commodity currencies and the real exchange rate", *Journal of Development Economics*, pp. 239-268, 2004.

[42] See, For example, IMF, 2018 External Sector Report: *Tackling Global Imbalances amid Rising Trade Tensions.*

[43] See for example "A long-term perspective on the krona", article in Monetary Policy Report, July 2013, Sveriges Riksbank.

The equilibrium real exchange rate is a key cornerstone in the assessment of the krona's future development. The theory on purchasing power parity says that the real exchange rate shall not have a trend in any particular direction, but shall vary around its historical mean value. Another theory is based on the assertion that the real exchange rate is stronger in richer countries. This could explain changes in the equilibrium real exchange rate. Another theory is based on the real exchange rate moving in a way that achieves balance in foreign trade.

All the concepts explained in this article have, through the years, constituted key cornerstones in the Riksbank's assessments of the future development of the krona. The next article, "The Riksbank's exchange rate forecasts" gives a closer description of these assessments and the ongoing development work.