Effective exchange rates – theory and practice

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The Swedish economy is affected by movements in the krona's exchange rates with a large assortment of currencies. The value of the krona in terms of another currency is known as a bilateral exchange rate. A common way of measuring the krona's value is to use an index that includes a number of currencies. Information from bilateral exchange rates is extracted to construct an index of the effective exchange rate. This requires decisions about the bilateral exchange rates that are to be included, the weight each currency is to have and how the bilateral exchange rates are to be weighted together. These decisions naturally depend on what the exchange rate index is to be used for and what it is intended to measure. Such an index is usually constructed to measure the impact of exchange rate movements on trade in goods and services – an index of competitiveness. This article describes what an effective exchange rate index is and alternative ways of calculating it. I conclude that at present there are no sizeable differences between a conventional TCW index, a TCW index with updated weights and an index with weights derived by the Swedish National Institute of Economic Research (NIER).

What is an effective exchange rate index?

An effective exchange rate index is a weighted average of bilateral exchange rates, that is, of the krona's value in terms of other currencies.

Economic development in Sweden is heavily dependent on global economic activity. Sweden is an open economy in which foreign trade (exports plus imports) is equivalent to almost 85 per cent of GDP. It follows that the economy is affected by changes in the krona's value in terms of other currencies. The value of the krona in relation to another currency is defined as the bilateral exchange rate. The information in a number of bilateral exchange rates can be combined into a single indicator by calculating a weighted average. Such a weighted average is usually called an *effective exchange rate index*. The construction of such an index varies with what it is intended to analyse. In most cases, the purpose is to measure the exchange rate's impact on total trade in goods and services. The weights are then set to mirror the relative importance of other countries for Sweden's foreign trade. Alternatively, the index can be constructed to measure the exchange rate's impact on either imports or exports. When calculating trade volumes, relative price differences have to be taken into account. Nominal exchange rates have to be combined with relative price movements. What one wants to construct, in other words, is a *real effective exchange rate index*. The original method for calculating this type of effective exchange rate index was developed by the International Monetary Fund (IMF), using Total Competitiveness Weights (TCW). The Swedish krona's real exchange rate mirrors the price of goods and services in Sweden relative to the rest of the world, expressed in a common unit.

The real exchange rate is defined as:

$$\textit{real exchange rate} = \frac{E \times P^*}{P} \qquad (1)$$

where P^* is the price of a representative basket of goods and services in the rest of the world, P is the price of the equivalent basked in Sweden and E is the Swedish krona's nominal exchange rate with the rest of the world. Thus, the nominal exchange rate is the conversion factor whereby two countries' relative prices are expressed in a common unit. The real exchange rate can be seen as an indicator of a country's international competitiveness. A weakening of the real exchange rate means that more domestic goods and services are needed to balance a given amount of foreign products. The less it costs foreign firms and consumers to purchase Swedish goods and services, the stronger is Sweden's competitiveness. A *real effective exchange rate index* for the krona accordingly measures Sweden's total competitiveness relative to our principal trading partners.

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Applications for a nominal effective exchange rate index

It is the *nominal effective exchange rate index* that is calculated most often in practice. This is because exchange rates are quoted from day to day, whereas price statistics are available only on a monthly or quarterly basis. In an analysis of competitiveness, however, the nominal exchange rate is liable to be misleading. This is the case for periods of some length and, above all, for countries that differ in terms of inflation. Using a nominal index as a proxy for a real index may then be less appropriate. That is because inflation is high as a rule in countries where the exchange rate is depreciating. Another consequence can be that two different indices which give different paths in nominal terms may show considerably more similar developments in real terms. Countries with a currency that is depreciating/appreciating markedly and where inflation is high/low are sometimes excluded from an effective exchange rate index because they may dominate the outcome of the nominal index. A "narrower" index of this kind can be derived from a "broader" index in order to confine the calculation to countries with a similar development of inflation. That facilitates the analysis of a nominal exchange rate index.

How many and which currencies?

The number of currencies in an exchange rate index is a matter of "enough" but not "too many".

The number of countries to include in an effective exchange rate index is an open question. Every currency that in some sense is "relevant" should be included. This applies, of course, to an index for measuring competitiveness with the rest of the world. An extreme case would be to include as many currencies as possible but such an approach is not self-evidently optimal. As exchange rate movements are often correlated, including additional currencies will not necessarily improve the analysis at all substantially. Sometimes, in fact, a large number of currencies may complicate the analysis. So in practice, there are no clear criteria for the number of currencies to include in an exchange rate index; this is rather a matter of "enough" but not "too many". The choice is also limited by the availability of data. For some countries it may be difficult to find the statistics that are needed to calculate the currency's weight in the index.

The choice of currencies for an effective exchange rate index is sometimes based on arbitrary rules. An example is the criterion that a country's share of exports or imports must be more than, say, 0.5 per cent. One problem with this approach, which is used by the US Federal Reserve, the ECB and others, is that the shares may change over time, so that a country which was an important trading partner some years ago may be of no consequence today. Another complication is that a country with a small share of the bilateral trade may be a major competitor in the world market. An alternative used by the Bank of England is to assess the situation annually and include or exclude countries in accordance with the rule. The set of countries will then vary over time. Another approach is to start from geographical areas or economic groupings. The OECD calculates an exchange rate index that is limited to its member countries and the Federal Reserve prefers one of the narrower indices, limited to currencies that are considered to be important. The (TCW) exchange rate index calculated by the IMF simply includes those currencies for which statistics are available for the computation of weights. Still, there is clearly no entirely acceptable way of selecting the currencies for inclusion in an index.

Which types of goods and services?

The method for calculating weights varies with the type of goods or services for which competitiveness is to be measured.

An effective exchange rate index is used almost exclusively to measure the exchange rate's impact on trade in goods and services. The weights with which bilateral exchange rates are combined into an effective index are therefore based as a rule on trade statistics. The need for (real) effective exchange rate indices arose in the aftermath of the Bretton Woods system. These indices were designed for the simultaneous analysis of the impacts of a number of bilateral exchange rates (and relative prices) that were now free to fluctuate against each other. One of the earliest indices, the multilateral exchange rate model (MERM), was developed by the IMF and was subsequently replaced by the TCW system. The method was first described and presented in McGuirk (1987); updated versions have appeared in Zanello & Desruelle (1997) and, recently, in Bayoumi, Lee & Jayanthi (2005). In practice, the IMF's method is about constructing the weights that are used to calculate a weighted average of bilateral exchange rates.[1] Real effective exchange rate indices for many countries are calculated simultaneously in this system. Originally, a more disaggregated calculation was also made for some 20 countries, broken down into real exchange rates between different sectors of manufacturing. A majority of the exchange rate indices that exist today stem directly from this tradition. The method is reported in, for example, Zanello & Desruelle (1997) and in Bayoumi, Lee & Jayanthi (2005). As the latter authors, for instance, show, the method for calculating weights varies with the type of goods or services for which competitiveness is to be measured.

In the case of commodities, countries often compete in a single global market.

Simplifying somewhat, foreign trade can be decomposed into three main categories: commodities, manufactured goods and services. A common assumption is that commodities are homogeneous and are traded in a global market. Commodity competition between countries then occurs in a single market and a country's importance as a trading partner is determined by its share of the total market for that product. This makes the calculation of weights for homogeneous commodity groups relatively simple, as described, for example, in Zanello & Desruelle (1997).

Manufactured goods and services that are sold abroad compete in different, segmented, markets, not in a single global market.

Unlike primary products, manufactured goods and services are heterogeneous. Different makes of car from different countries, for example, are seldom perfect substitutes. Manufactured goods and services produced in Sweden for sale abroad compete in different, segmented, markets, not in a single global market. Seen from this angle, the German and the American markets are two separate markets. So in contrast to commodities, a number of markets have to be considered in the case of het-

[1] In an analysis in real terms, the same weights are used for prices as well.

erogeneous goods and services. Countries accordingly compete in many different markets and a country's importance as Sweden's trading partner therefore depends on its relative shares of these markets.

As countries compete in many different markets, it follows that the calculation of weights for an effective exchange rate index requires a large amount of data. Besides figures for each country's exports (or imports), data are needed that indicate a country's degree of openness.[2] Due to deficiencies in the availability and quality of statistics on services, weights for effective exchange rate indices are usually calculated excluding services. An exception, however, is the Bank of England's new exchange rate index, which does include trade in services.[3] While statistics on trade in services have had numerous deficiencies in the past, improvements are being made continuously, for example in far-reaching work by the OECD. As trade in services grows, so will the importance of taking this component into account.

Calculating weights

The calculation of weights for manufactured goods and services is described below because these are the major items in Sweden's foreign trade. The starting point is that heterogeneous products compete in a number of different markets. A reasonably acceptable indicator of competitiveness therefore needs to cover all the geographical areas in which the products compete. Take, for example, the competition between Sweden and Japan. For one thing, Swedish products compete with Japanese direct imports to Sweden – import competition. Similarly, Swedish products compete with Japanese in the latter's domestic market – direct export competition in Japan. Lastly, Swedish and Japanese products compete in other markets – third-market competition. The weights need to reflect both the bilateral trade and the competition in other markets. The weight for country j as regards a heterogeneous product group, for example manufactured goods, can then be written:

$$W_j = \lambda^M MW_j + \lambda^{BX} BXW_j + \lambda^{TX} TXW_j. \qquad (2)$$

2 Given an accurate valuation of all flows, imports to a country are the sum of all other countries' exports to that country. So in theory it makes no difference which flow is measured. In practice, however, measurement errors from a variety of sources lead to a discrepancy between total exports and total imports. In order to obtain consistent results, the calculation of weights is usually based on only one of the flows; the usual choice is exports, on the common assumption that export flows are easiest to measure and value correctly.

3 See Lynch & Whitaker (2004).

In this version, a country's total weight is made up of three components. The calculation of these component weights and the way in which they are weighted together are relatively complex, so further details are provided in an appendix. But an outline of the intuitive reasoning behind the formula may be of interest.

A country's total weight is made up of three components.

Swedish producers of manufactured goods compete in their domestic market with imports from other countries. The first weight, MW_j, measures the share for a country's producers of total sales in the Swedish market. This weight then represents a country's share of Sweden's total imports of manufactured goods.

The first weight measures a country's relative share of Sweden's total imports of manufactured goods.

The weight BXW_j is intended to measure a country's importance in terms of the competition Swedish producers encounter in that country's domestic market. Besides the share of Swedish exports that goes to that country, this importance has to do with the country's own producers' share of their domestic market. The importance for competitiveness of countries whose producers have a large domestic market share is greater than a weight based solely on export shares would indicate.

The second weight measures a country's importance in terms of the competition Swedish producers encounter in that country's domestic market.

The last weight, TXW_j, is intended to measure a country's importance in terms of the competition Swedish producers encounter in markets abroad. This component is measured as the sum of a country's shares of total sales in these third-country markets. The weight aims to represent the importance of, for example, a country that takes a small share of direct exports from Sweden but has large exports to countries where exports from Sweden are substantial. A case in point is Japan: direct competition between Swedish exporters and Japanese producers is small in Japan's domestic market compared with the competition between Swedish and Japanese producers in third-country markets.

The third weight measures a country's importance in terms of the competition Swedish producers encounter in third-country markets.

A country's relative importance as a competitor in Sweden's domestic market, the importance of the competition Swedish exporters encounter in that country's domestic market, and the importance of the country as a competitor in all other markets are determined by the weights λ^{M}, λ^{BX} and λ^{TX}. The competition Swedish producers encounter in their domestic market from foreign producers, MW_j, is weighted with λ^{M}, which represents the domestic market's share of Swedish output. The two different types of export competition, BXW_j and TXW_j, are weighted with λ^{BX} and λ^{TX}, which represent the shares of Swedish out put that go to markets abroad. Thus, as mentioned above, the calculation of weights is relatively complicated.

Choosing relative prices

An analysis of competitiveness can use relative export prices as well as relative costs in terms of unit labour costs.

A real effective exchange rate index commonly serves, as noted earlier, as a summary indicator of a country's international competitiveness. However, real is a somewhat ambiguous term and there are different relative prices that may be relevant in different contexts. One form of relative prices that can be used to analyse competitiveness is relative export prices. They provide information about how Swedish exporters price their products relative to exporters in other countries. There is, however, a risk of obtaining too limited a picture of a country's relative price level. The measurements concern prices of products that are actually exported, while products that, for example, are potentially tradable but not competitive are ignored. This measure of competitiveness is also affected by pricing behaviour, such as pricing to market.[4] An alternative way of measuring competitiveness is to compare costs. This is commonly done by measuring relative costs in terms of unit labour costs. It may be worth mentioning that the IMF's original method for calculating real effective exchange rate indices was designed to measure the relative level of costs in terms of unit labour costs for different sectors on manufacturing.[5]

A comparatively common approach is to use relative consumer prices expressed in a common currency.

A comparatively common approach to constructing a real exchange rate index is, however, to use relative consumer prices expressed in a common currency. The reason is that consumer prices are based on a basket that is representative of the country's pattern of consumption. The real exchange rate deflated with consumer prices therefore gives a broad measure of the relative level of prices for a representative basket of consumption. However, consumer prices include a large element of items that are not exposed to competition. Weights calculated for competitiveness are therefore usually constructed from statistics that cover as broad an aggregate of goods and services as possible.[6]

4 Briefly, this theory implies that exporters actively restrain profit margins in order to gain market share.
5 See McGuirk (1987).
6 See Zanello & Desruelle (1997).

Choosing the index's form

One of the more fundamental issues when constructing an effective exchange rate index is what type of index to use. One of the most usual ways of constructing an index is to calculate a geometrically weighted average:[7]

$$I_t^G = \prod_{n=1}^{N} \left(\frac{E_{nt}}{E_{n0}} \right)^{W_n} \qquad (3)$$

$$\sum_{n=1}^{N} W_n = 1, \quad \forall W_n \geq 0$$

The geometric form has a number of advantages, for instance that the percentage change in this form of index is independent of the particular base. The geometric form is also attractive for theory because the weights can be treated as elasticities; for a discussion, see e.g. McGuirk (1987). This is by far the most common form and is used by most central banks as well as other participants. The ECB, for instance, uses the geometric form but adjusts the weights at five-year intervals to catch any changes in competitiveness.[8] Time-varying weights can therefore be used to prevent the index from becoming increasingly out-dated. The index can then be written:

$$I_t^G = \prod_{n=1}^{N} \left(\frac{E_{nt}}{E_{n0}} \right)^{W_{nt}} \qquad (4)$$

$$\sum_{n=1}^{N} W_{nt} = 1, \quad \forall W_{nt} \geq 0$$

where the weights (W_{tn}) are now allowed to vary over time. However, this method introduces some complications. One complication with geometric weighting with variable weights concerns aggregation from daily quotations to, for example, monthly or quarterly data. Weighting the index geometrically on daily quotations and then aggregating to monthly data gives a result that differs from an index that is constructed directly on monthly averages for the bilateral exchange rates. The discrepancy, however, is usually very small. Another complication is that the value of the index may change even in the absence of a change in the ingoing

7 An arithmetic index poses the problem that the size of a percentage change varies with the base. Take, for example, an index for two currencies that each have a weight of 50 per cent; an increase of one unit in both these currencies, from 5 to 6, raises the index 20 per cent, while a one-unit increase from 6 to 7 raises the index just over 18 per cent.

8 Buldorini, Makrydakis & Thiman (2002).

exchange rates.[9] This may not be incorrect but it is not unusual for this type of index change to be considered undesirable. A simple way of overcoming this problem is to construct a chain-linked index:

$$I_t^G = I_{t-1}^G \times \prod_{n=1}^{N} \left(\frac{E_{nt}}{E_{n\,t-1}} \right)^{W_{nt}} \qquad (5)$$

$$\sum_{n=1}^{N} W_{nt} = 1, \quad \forall W_{nt} \geq 0 \quad I_0^G \ given$$

In this case, changes in weights evidently do not affect the value of the index as long as exchange rate movements are zero. This method is used by, for example, the US Federal Reserve.[10]

An exchange rate index can accordingly be constructed in various ways and there is no given way of telling which construction is most appropriate. The alternative constructions that have been presented here have different advantages and drawbacks. It can be noted, however, that most of the indices which central banks and other organisations publish are weighted geometrically. The most common reasons for this are that geometric weighting is better suited to a theoretical framework and that changes in an index are easier to interpret when the index is unaffected by the base in which the bilateral currencies are expressed. Still, the choice between a level-weighted and a change-weighted index is not self-evident. Different methods tend to give somewhat different effects, as illustrated by the following simple example, taken from Ellis (2001).[11]

TABLE 1. AN EXAMPLE WITH TWO COUNTRIES WITH VARYING WEIGHTS, USING DIFFERENT METHODS FOR CALCULATING THE INDEX

Exchange rate		Weight		Type of index	
Country B	Country C	Country B	Country C	Ordinary geometric	Chain-linked geometric
100.00	100.00	0.50	0.50	100.000	100.000
$100*(1.05)^1$	$100/(1.05)^1$	0.60	0.40	100.981	100.981
$100*(1.05)^2$	$100/(1.05)^2$	0.70	0.30	103.980	102.971
$100*(1.05)^3$	$100/(1.05)^3$	0.60	0.40	102.971	103.980
$100*(1.05)^4$	$100/(1.05)^4$	0.50	0.50	100.000	103.980

9 This is evident as the change in an index for N currencies can be written: .

$$\Delta\ln(I_t) = \sum_{n=1}^{N} \{\Delta\omega_t^n \ln(vx_{t-1}^n) + \omega_t^n \Delta\ln(vx_t^n)\}.$$

The value of the index can then change even when the currency is unchanged.

10 Loretan (2005).

11 Ellis (2001).

Table 1 presents a simple arithmetical example for an effective exchange rate index for country A, with countries B and C included in the index. Country A's exchange rate with county B is assumed to undergo a 5 per cent trendwise depreciation, accompanied by a corresponding appreciation of the exchange rate with country C. The weights are equal initially. The index weight for country B increases to begin with and then returns to the initial level. As shown in the table, the alternative methods for calculating the index give different pictures of how the effective exchange rate index develops. In this example, a chain-linked index leads to the weighted sum of the changes in the exchange rates cancelling out in the final period. The change in the value of the index in the final period is therefore zero.[12] The conventional geometric index does not have this characteristic. In the final period, the changes in weights cause the value of the index to fall back to the initial level. The example shows that the different methods give different pictures of how the index develops but says nothing about which construction is closest to the mark. It is noteworthy, however, that as a rule, central banks and other participants use a form of chain-linked index when constructing an index with variable weights.

Current indices and their purposes

As shown in Table 2, most central banks have an index that is based in some way on weights calculated internally. Moreover, time-varying weights are becoming increasingly common. The weights that most central banks calculate are akin to the IMF's principle of weighting for competitiveness but the calculations are usually simplified in certain respects.

Effective exchange rate indices for the Swedish krona are available in a number of forms and are provided by many participants, including the Riksbank. The earlier monetary policy regime with a fixed exchange rate required an official benchmark for the krona's external value. With a variable exchange rate, no such official index is needed. Under this regime, an effective exchange rate index for the krona simply serves as an instrument for economic analysis. A look at different types of index may be of interest in this context (see Table 3).

Krona indices tend to be competitiveness weighted.

Krona indices tend to be competitiveness weighted. Weights are calculated internally by many participants, which leads to differences in how

[12] Changes in a chain index mean that the change in an index for N currencies can be written: $\Delta\ln(I_t) = \sum_{n=1}^{N}\{\omega_t^n \Delta\ln(vx_t^n)\}$ when a correction is made for the effect on the base of adjusting the weights.

Table 2. Selected central bank's effective exchange rate indices

Central bank	Name	Type of weighting	No. of currencies	Calculation of weights	Other comments
US Federal Reserve	BROAD*	Weighted for competition, time-varying	26**	Internal	Sub-groups calculated
Bank of England	ERI	Weighted for competition, time-varying	Varies	Internal	Weights also calculated for services trade
Norges Bank	TWI	Trade-weighted, time-varying	25	OECD	An import-weighted index is also calculated
Bank of Canada	C-6***	Trade-weighted, constant weights	6	Internal	The USD's weight is over 80 per cent
Reserve Bank of Australia	TWI	Trade-weighted, time-varying	24	Internal	Import- and export-weighted indices are also calculated
Reserve Bank of New Zealand	TWI***	Trade-weighted, time-varying	5**	Internal	The weights also mirror the countries' GDP
ECB	EER	Weighted for competition, updated every fifth year	12	Internal	Broader indices (23 and 42 countries) are also used
Riksbank	TCW	Weighted for competition, constant weights	20	IMF	

* Two other indices (major currency index and other important trading partner (OITP) index) are also calculated.
** Here the euro is treated as one currency.
*** An index based on total competitiveness weights is also calculated.

Table 3. Effective exchange rate indices for the Swedish krona

Constructed by	Name	Type of weighting system	No. of currencies	Other comments
Goldman Sachs	TWI	Weighted for competition, time-varying weights	24	The euro area is treated as one currency
NIER (KI)	KIX	Weighted for competition, time-varying weights	29–32	Includes primary commodities
NIER (KI)	Trade-weighted	Weighted for trade, time-varying weights	14–28	Covers exports, imports and third-country effects
OECD		Weighted for competition, time-varying weights	28	
BIS	BIS index	Weighted for trade, time-varying weights	26	
IMF	TCW	Weighted for competition,	20–163	Updated weights also include commodities and services

many countries are included and in whether or not the weights are time-variable. A relevant question here is whether different indices point to different conclusions about the krona's external value. As mentioned earlier, it is real effective exchange rates that are of primary interest. For a comparison of two different indices, however, it may suffice to analyse the path of the nominal index if both indices cover the same number of currencies/countries. The weights for the TCW index in accordance with the original definition are included in Table 4. The updated weights for the countries in the original TCW calculation and for an extended country set are from Bayoumi, Lee & Jayanthi (2005). The latest (preliminary) weights calculated by the Swedish National Institute of Economic Research (NIER) are also included for comparison.[13]

TABLE 4. WEIGHTS

Country	Original TCW	Updated TCW	Updated and extended TCW	NIER's latest KIX weights
Germany	22.28	17.56	15.43	16.97
France	7.15	8.29	7.29	6.85
Netherlands	4.24	5.44	4.78	5.24
Italy	6.05	5.90	5.19	4.74
Finland	6.69	5.16	4.54	4.71
Belgium-Luxembourg	3.55	3.81	3.35	5.24
Spain	2.48	3.25	2.85	2.93
Ireland	0.77	1.69	1.49	1.35
Austria	1.71	1.39	1.22	1.29
Portugal	0.93	0.81	0.71	0.64
Greece	0.27	0.72	0.64	0.39
UK	11.56	10.34	9.09	7.52
Denmark	5.60	5.42	4.77	4.87
Poland			1.54	2.06
Czech Republic			0.57	0.81
Hungary			0.44	0.66
Slovakia			0.18	0.29
Norway	5.58	5.36	4.71	5.11
Switzerland	2.74	2.10	1.85	1.71
Turkey			0.91	0.54
Iceland			0.12	0.09
Russia			0.88	1.66
Canada	1.16	1.70	1.49	1.86
Mexico			0.97	0.93
Brazil			1.06	0.77
Japan	5.20	6.07	5.33	3.49
China			3.52	3.35
South Korea			1.31	1.27
India			0.59	0.81
Australia	0.27	1.11	0.98	0.90
New Zeeland	0.14	0.21	0.18	0.16
USA	11.63	13.67	12.02	10.81
Total	**100**	**100**	**100**	**100**

13 See Erlandsson & Markowski (2006). The preliminary calculations cover a total of 32 countries. The current KIX published by NIER includes 29 countries.

For the original TCW countries, it seems that the updating of the IMF's weights reduces the importance of Germany, for instance, and increases the importance of the United States. On the whole, there is relatively little difference between the weights on which the Riksbank's TCW index is based and the updated weights presented in Bayoumi, Lee & Jayanthi (2005) (see Figure 1).[14]

Somewhat larger differences arise, however, when additional countries are included. The difference between a 32 country set and the 20 countries in the TCW index used by the Riksbank is shown in Figure 2.

In the expanded TCW index, the countries added to the original set are Poland, Czech Republic, Hungary, Slovakia, Turkey, Iceland, Russia, Mexico, Brazil, South Korea, China and India. A nominal index with this expanded set is about 15 per cent stronger than an index based on the original TCW countries. When the currencies in an index with a given country set are weighted together with weights from different sources, however, the differences are not particularly large. Figure 3 shows an expanded TCW index and an index weighted together with NIER's latest (preliminary) calculations of KIX weights. It will be seen that the paths of these two indices are very similar. The major effect on the nominal index comes from the number of currencies.

It does not follow, however, that the construction of weights is never important for the development of an exchange rate index. Still, trade flows and production conditions change slowly and very slightly compared with movements in relative prices and nominal exchange rates. As a rule, therefore, the choice of weights is of secondary importance for the path of an effective exchange rate index.

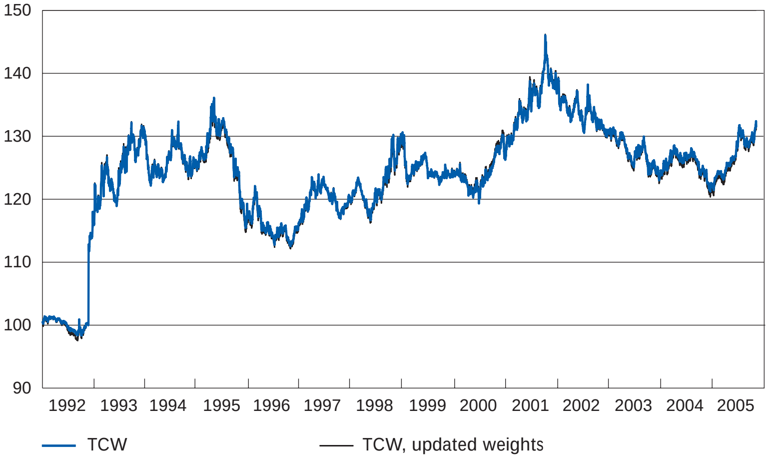
The developments presented in Figures 1–3 concern nominal effective exchange rate indices. As I have already mentioned a number of times, for economic analysis it is usually the real exchange rate that is relevant. The large differences that can occur between two nominal indices that include different numbers of currencies tend to become considerably smaller when changes in relative prices are also taken into account. Figure 4 presents real effective exchange rate indices based, respectively, on the original set of 20 countries in the TCW index and on the set of 32 countries in KIX. For both these indices, the weights have been taken from Bayoumi, Lee & Jayanthi (2005).

The picture in real terms does differ between these two indices but not all that much. One conclusion, therefore, is that the discrepancy between the nominal indices (see Figure 2) is mainly due to the high rate of inflation in the dozen additional countries in the enlarged set. The dif-

[14] The weights used in the calculation of the TCW index were published in Zanello & Desruelle (1997).

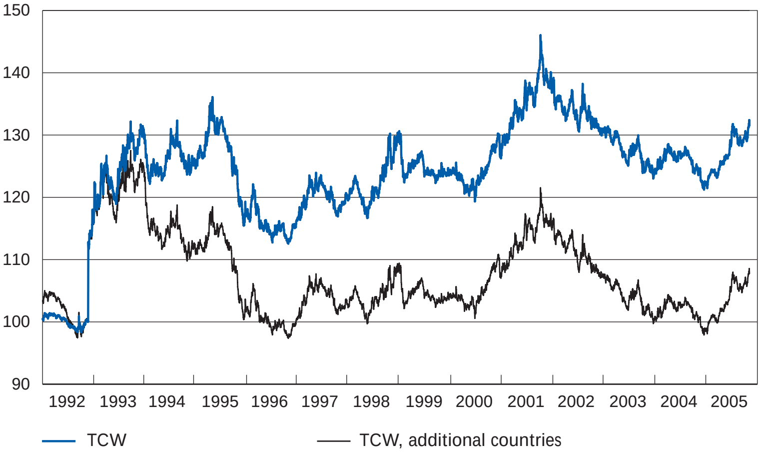
ference in real terms is therefore considerably less pronounced. It is then doubtful whether an enlarged country set in an effective index for the Swedish krona would lead to decisively different conclusions about the krona's external value.

Figure 1. Nominal effective SEK index based on initial and updated TCW weights
Index: 1992-11-18=100



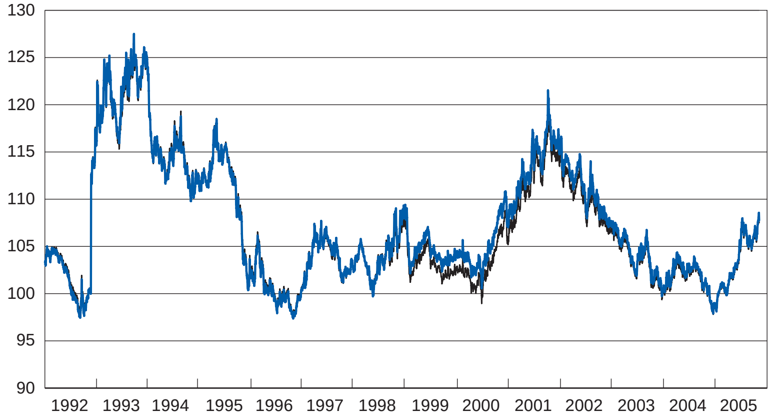
Note. The underlying bilateral SEK exchange rates are calculated with the cross rates with USD.
Sources: Reuters, IMF and the Riksbank.

Figure 2. Nominal effective SEK index based on updated TCW weights and different numbers of countries
Index: 1992-11-18=100



Note. The underlying bilateral SEK exchange rates are calculated with the cross rates with USD.
Sources: Reuters, IMF and the Riksbank.

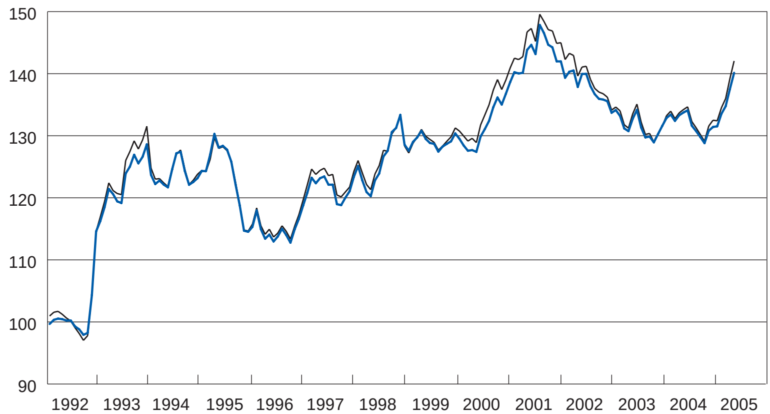
Figure 3. Nominal effective SEK index based on updated TCW weights and on NIER's (preliminary) weights
Index: 1992-11-18=100



TCW, additional countries — Index calculated with NIER's weights

Note. The underlying bilateral SEK exchange rates are calculated with the cross rates with USD. For the index based on NIER's weights the latest calculation has been used over the whole period.
Sources: Reuters, IMF, NIER (Swedish National Institute of Economic Research) and the Riksbank.

Figure 4. Real effective SEK index based on updated TCW weights and different numbers of countries
Index: 1992-11-18=100



Real TCW — Real TCW, additional countries

Note. The underlying bilateral SEK exchange rates are calculated with the cross rates with USD.
Sources: Reuters, IMF, OECD and the Riksbank.

Conclusion

The picture of the krona's external value is not decisively affected by the choice of index for the analysis.

Real effective exchange rate indices are calculated as a rule to obtain information about a country's international competitiveness. Bilateral exchange rates are therefore weighted together so that they mirror the importance of other countries as trading partners. It turns out that discrepancies can arise mainly in connection with the number of countries that are included in such an index. This seems to be due, above all, to differences in rates of inflation. The differences between real indices are therefore usually considerably smaller, regardless of how many countries are included. It can be of interest to work with a variety of indices, particularly in the event of large exchange rate movements for countries that are not currently included in the existing TCW index. At present, however, the picture of the krona's external value is not decisively affected b y the choice of index for the analysis.

Appendix: Calculating TCW weights

Most exchange rate indices use some form of the IMF's method – total competitiveness weighting (TCW) – for the calculation of weights. It may therefore be relevant to describe how the IMF constructs the weights. The method has been presented in, for example, Zanello & Desruelle (1997) and in Bayoumi, Lee & Jayanthi (2005) but some clarification may be needed. The starting-point in the IMF's method for calculating weights for heterogeneous merchandise is the construction of a matrix representing domestic output and demand as well as trade flows between k countries or markets. This can be done so that each row in the matrix describes country i's output for the domestic market and for exports to other countries. The columns show country i's demand for domestic products and imports from other countries. Clearly, demand for domestic products equals output for the domestic market. The elements in the matrix can then be normalised so that either exports and output for the domestic market or imports and domestic demand for domestic products sum to one. As a rule, normalisation of imports and domestic demand for domestic products is denoted s and normalisation of exports and output for the domestic market is denoted w. This can be represented as resulting in two matrices:

$$w = \begin{pmatrix} w_1^1 & w_1^2 & \cdots & w_1^k \\ w_2^1 & w_2^2 & & \\ \vdots & & \ddots & \\ w_k^1 & & & w_k^k \end{pmatrix} \begin{matrix} \sum 1 \\ \vdots \\ \vdots \\ \sum 1 \end{matrix} \quad \text{and } s = \begin{pmatrix} s_1^1 & s_1^2 & \cdots & s_1^k \\ s_2^1 & s_2^2 & & \\ \vdots & & \ddots & \\ s_k^1 & & & s_k^k \end{pmatrix}$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \sum 1 \quad \cdots \quad \cdots \quad \sum 1$$

In the left-hand matrix the components on the diagonal represent each country's share of the output that is intended for the domestic market and all the other components represent the share of output (in the form of exports) that is intended for all other countries. In the right-hand matrix the components on the diagonal represent each country's share of demand in the domestic market and all the other components represent the share of demand that is met by imports from other countries. As we have normalised with different bases (the sum of rows does not necessarily equal the sum of columns), it is important to note that in the normal case, $s_i^i \neq w_i^i$.

There are various expressions for the TCW weights. The most common approach is to calculate each weight, for example country j's weight for country i, as follows:[15]

$$W_{ij} = \lambda_i^M MW_{ij} + \lambda_i^{BX} BXW_{ij} + \lambda_i^{TX} TXW_{ij}$$

where

$$MW_{ij} = \frac{s_j^i}{\sum_{k \neq i} s_k^i}$$

$$BXW_{ij} = \frac{w_i^j s_j^j}{\sum_{k \neq i} w_i^k s_k^k}$$

$$TXW_{ij} = \frac{\sum_{k \neq i,j} w_i^k s_j^k}{\sum_{k \neq i} w_i^k (1 - s_i^k - s_k^k)}.$$

To construct the weights, we can define s_i^k, which denotes country i's share of market k, and w_i^k, which denotes country i's share of the supply in market k. These definitions can be used to define the component MW_{ij} as:

$$MW_{ij} = \frac{s_j^i}{\sum_{k \neq i} s_k^i}\ .$$

This weight is country j's share of market i. Country i's share of output for market i (its share of output for its domestic market) is excluded, so that these weights (for j to k countries) sum to one. MW_{ij} is then this country j's share of total imports to market i. Thus, this weight is designed to measure the competition domestic producers encounter in their domestic market in the form of imports.

The component BXW_{ij} is the share of output in country i that is sold in country j, taking into account country j's relative share of sales in its domestic market.

$$BXW_{ij} = \frac{w_i^j s_j^j}{\sum_{k \neq i} w_i^k s_k^k}.$$

As previously, country i's own output and own market shares are excluded from the calculations, so that the weights (for j to k countries) sum to one. Countries with a share of their domestic market sales that is small relative to other countries can be regarded as relatively more open, which makes them less important than a calculation based solely on export

15 See Zanello & Desruelle (1997), p. 29.

shares would indicate. If all countries have the same degree of openness, this weight is the same as the simple export share.

The last component, TWX_{ij}, represents what is known as the third-country effect (or the double-export weight) and is defined as follows:

$$TXW_{ij} = \frac{\sum_{k \neq i,j} w_i^k s_j^k}{\sum_{k \neq i} w_i^k (1 - s_i^k - s_k^k)} .$$

This component measures the importance of the competition country i encounters in the form of exports from country j in all other markets, for example the competition Swedish exporters face from Japan in the German and American markets. The component is calculated as the sum of country i's output that is exported to all other countries (except country j), taking into account country j's share of the total output (in the form of imports from country j) that meets total demand in each country. The component is normalised by subtracting the share of demand that is met by a country's domestic output plus imports from country i.

These components then have to be weighted together with weights that are calculated as follows:

$$\lambda_i^M = \frac{w_i^i (1 - s_i^i)}{\sum_k w_i^k (1 - s_i^k)}$$

$$\lambda_i^{BX} = \frac{\sum_{k \neq i} w_i^k s_k^k}{\sum_k w_i^k (1 - s_i^k)}$$

$$\lambda_i^{TX} = \frac{\sum_{k \neq i} w_i^k (1 - s_i^k - s_k^k)}{\sum_k w_i^k (1 - s_i^k)} .$$

These three expressions have the same denominator, which represents the sum of country i's shares of output in each country, taking into account the demand in a country that is not met by country i.

The numerator in λ_i^M can be read as the share of country i's output that is sold in its domestic market, taking into account the share of demand that is covered by imports. In this way, the share is closely related to the proportion of total output that is sold in the domestic market. The numerator in λ_i^{BX} is the sum of the shares of output in country i that are sold to other countries, taking into account each country's total demand for its domestic products. It is then closely related to the exported share of country i's total output. The numerator in λ_i^{TX} resembles that in λ_i^{BX}. Both these terms include the sum of the shares of output in country i that are sold in other countries. They differ in that λ_i^{TX} takes into account each country's share of the total demand that is not covered by either domestic products or by imports from country i.

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