

## Revision of the Weights for Calculation of the Nationalbank's Effective Krone Rate Index

by Erik Haller Pedersen, Economics Department

### *Introduction*

Danmarks Nationalbank regularly publishes an index of the development in the strength of the krone, called the effective krone-rate index. Changes in trading patterns make it necessary from time to time to recalculate the weights at which the individual exchange rates are weighted together when the index is calculated. This took place most recently in 1992 using a set of weights based on trade in manufactured goods in 1989<sup>1)</sup>. As from June 2, 1998 the Nationalbank will publish an effective krone-rate index calculated using weights based on trade in manufactured goods in 1995.

The new index is linked to the previous index as of May 30, 1997, i.e. the krone-rate index has been recalculated for the last year. There are no changes in the published index prior to the date of linkage.

The new set of weights includes four new countries, South Korea, Poland, the Czech Republic and Hungary, bringing the number of countries up to 25. No other changes have been made to the basic method of calculating the index.

As a consequence of the revision, at the beginning of May 1998 the krone-rate index using the new weights was approximately  $\frac{3}{4}$  per cent higher than the previously published index, primarily due to the depreciation of the South Korean currency, the won, against the previous year.

### *What is an effective exchange rate?*

In the currency market a large number of currencies are traded directly or indirectly against the Danish krone. Often the krone will strengthen against certain currencies while simultaneously weakening against others. By weighting the exchange rates together the effective krone rate provides an overall measure of the development in the international value of the krone as a consequence of fluctuations in the individual bilateral exchange rates. This requires a set of weights which shows the relative importance of each currency. How these weights are to be calculated is not determined beforehand since it depends on the problems to be studied.

---

<sup>1)</sup> See "The Effective Krone Rate and Competitiveness" by Christian Ølgaard, Danmarks Nationalbank, *Monetary Review* - February 1992.

Table 1 *Weights for the Nationalbank's effective krone-rate index*

	Double-weighted export weights	Bilateral import weights	95 weights	89 weights	83 weights
	60.3	39.7	100		
Germany (DEM) . . . . .	26.6	28.6	27.4	25.6	24.8
Sweden (SEK) . . . . .	6.7	13.7	9.4	11.7	12.4
UK (GBP) . . . . .	8.3	9.2	8.6	9.8	10.6
USA (USD) . . . . .	9.5	4.3	7.5	8.7	9.0
France (FRF) . . . . .	7.6	6.0	7.0	6.8	6.5
Japan (JPY) . . . . .	7.5	3.5	5.9	6.7	7.8
Netherlands (NLG) . . . . .	3.9	8.0	5.5	4.6	5.2
Italy (ITL) . . . . .	5.1	5.7	5.4	5.3	4.9
Belgium (BEF) . . . . .	3.3	4.5	3.8	3.5	3.2
Norway (NOK) . . . . .	4.1	3.0	3.7	3.9	5.3
Finland (FIM) . . . . .	2.9	3.3	3.1	3.6	3.0
Switzerland (CHF) . . . . .	2.5	2.2	2.4	2.7	2.8
Spain (ESP) . . . . .	2.3	1.1	1.8	1.8	1.2
Austria (ATS) . . . . .	1.7	1.4	1.6	1.7	1.5
Portugal (PTE) . . . . .	0.6	1.5	0.9	1.0	0.5
Ireland (IEP) . . . . .	0.9	1.1	0.9	0.7	0.6
Canada (CAD) . . . . .	0.8	0.2	0.5	0.7	0.7
Australia (AUD) . . . . .	0.8	0.0	0.5	0.5	...
Greece (GRD) . . . . .	0.3	0.2	0.3	0.4	...
Iceland (ISK) . . . . .	0.2	0.0	0.1	0.2	...
New Zealand (NZD) . . . . .	0.1	0.0	0.1	0.1	...
Poland (PLN) . . . . .	1.6	1.4	1.5	...	...
South Korea (KRW) . . . . .	1.9	0.5	1.4	...	...
Czech Republic (CZK) . . . . .	0.5	0.4	0.4	...	...
Hungary (HUF) . . . . .	0.3	0.2	0.3	...	...

Note: The weighting together of the export and import weights to the total set of weights is to more decimal places than shown in the table.

The basis for the Nationalbank's effective krone rate is the international price competitiveness of Danish industry. It is assumed that the costs of Danish and foreign manufacturers, including wage costs, are to a great extent determined in national currencies. Since domestic manufacturing enterprises sell their products in competition with foreign enterprises the exchange rate is of central importance to the relative competitiveness of the Danish enterprise.

However, fluctuations in the effective krone rate can only be taken to indicate an equivalent change in Danish industry's competitiveness if costs in Denmark rise in step with those of our competitors. Otherwise adjustment must be made for the development in the relative wage costs in the same currency. This is the role of the real effective exchange rates. But it should

also be emphasized that an index of effective exchange rates by no means reflects all aspects of competitiveness as a concept.

Effective exchange rates are overall measures which do not express the change in the competitive situation of an individual company. Relevant bilateral exchange rates are often more suited to this purpose.

In the following the new set of weights is first presented and then the principles behind the Nationalbank's choice of methodology are outlined. The more technical aspects of the calculation can be found in the Appendix.

#### *The new krone-rate weights*

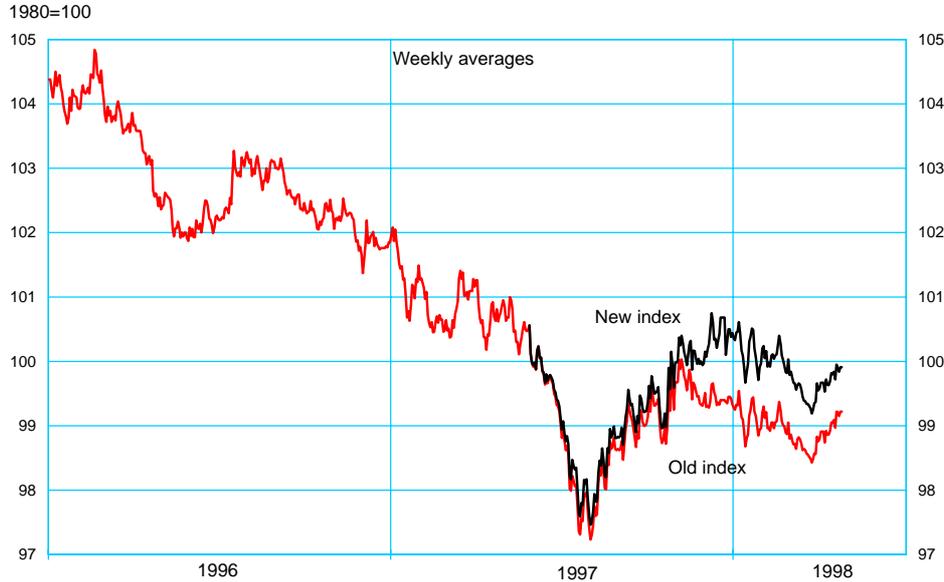
In order to arrive at the final weights, as before a set of export weights (double-weighted export weights) is weighted together with a set of import weights (bilateral import weights), with greatest weighting given to the export side. The double weighting of the export weights reflects that competition with a given country not only concerns that country's domestic market, but also international markets. This is described further in the Appendix.

The set of weights based on trade in manufactured goods in 1995 is presented in Table 1. The general picture is of slightly more pronounced changes in the weights this time than on the last revision of the weights. During the intervening period all EU trade statistics have been re-organized in connection with the introduction of the EU single market in 1993. This has given rise to data quality problems.

The inclusion of additional countries will naturally entail an underlying trend for the weights for the individual countries to be reduced from the 89 set of weights. For some countries, however, the weights have decreased considerably more than can be attributed solely to the inclusion of the additional countries. This applies in particular to Sweden, the UK and the USA, but this is merely a continuation of a historical trend, cf. the Table. With regard to Sweden the entire decrease lies by and large on the export side, which quite certainly also reflects the economic downturn in Sweden at the beginning of the 1990s, and thereby low demand for foreign goods. The weighting of the Japanese yen has also diminished. This is due exclusively to a decrease in the import share, while the export weight is unchanged from the last revision of the weights.

The relatively large decrease in the weights for the four aforementioned countries is counteracted by a comparatively strong increase in the weights for Germany and the Netherlands. In the case of Germany this e.g. reflects the consequences of the German reunification. The increase in exports to

Chart 1 *Previous and new effective krone-rate indices*



Germany has an extra strong impact on the overall krone-rate weighting, since in the 95 set of weights the export side is weighted more strongly on calculation of the final weighting than was the case in the 89 set of weights (60.3 per cent against 53.1 per cent). This reflects that exports are becoming increasingly more important to Danish industry.

In the new set of weights the overall weighting for the countries participating in the euro is just below 60 per cent. With the addition of countries which can be presumed to seek to maintain a generally stable exchange rate against the euro bloc the percentage reaches more than 70. This entails considerable cushioning of the future fluctuations in the effective krone rate. The possible inclusion of the four new countries, whose total weighting is 3.6 per cent, is a counteracting factor. In the event of very strong exchange-rate fluctuations this weighting is sufficiently high to have a marked impact on the overall index.

Comparing the development in the previous and new krone-rate indices the latter is approximately  $\frac{3}{4}$  per cent higher at the beginning of May 1998, cf. Chart 1. This reflects among other things the depreciation of the South Korean won during the period, cf. also the breakdown in Table 2. Even though the South Korean currency is included with only a moderate weighting its very strong depreciation still has a marked impact on the overall index.

Table 2 *Contributions to the change in the effective krone rate during the period June 2, 1997 to May 1, 1998*

	Index points
Currencies of the core countries .....	- 0.12
Pound sterling .....	- 0.63
US dollar .....	- 0.41
Swedish krona .....	- 0.47
South Korean won .....	0.49
Other currencies .....	0.49
Change in effective krone rate .....	- 0.65

- reflects a strengthening of the currency against the krone.

The inclusion of countries with strongly depreciating currencies in an effective exchange-rate index is not without its drawbacks, since usually such countries also have a high price- and wage-increase rate. Even in the short term this can make the value of the nominal effective exchange rate a problematic indicator of the development in competitiveness since the index will tend systematically to show relatively poorer development in competitiveness than is actually the case.

In order to make adjustment for the deviating development in the relative prices and wages in the same currency real effective krone rates with the four new countries have been calculated, including the two real krone-rate indices which are published regularly by the Nationalbank with respectively consumer prices and hourly wages in manufacturing as deflator<sup>1)</sup>.

The real effective krone rate with prices as deflator shows the same overall development as the nominal index, cf. Chart 2, but the rate of price increases in South Korea has doubled during the last six months and the price-increase rate in the three eastern-European countries included in the krone-rate index is also rather high (10-20 per cent).

It must be concluded overall that the revision of the krone-rate index does not significantly change the picture the index gives of the development in the competitiveness of Danish industry in recent years, not even with further retrocative projection of the date of linkage.

#### *The basis for calculation of the Nationalbank's effective krone rate*

When effective exchange rates are calculated a number of choices must be made - both operational and concerning issues of principle. The most

<sup>1)</sup> See "Real Effective Exchange Rates" by Erik Haller Pedersen, Danmarks Nationalbank, *Monetary Review* - May 1996 for a more detailed account of different real effective krone rates.

Chart 2 *Real effective krone rate*



important are the delineation of which countries to include in the index, the choice of base year, and the goods composition. Moreover, the date of linkage with the previous index must be determined.

Since the effective krone-rate index is designed to measure the development in industry's competitiveness, the weights in the index should reflect the breakdown by country of trade in manufactured goods. In practice, the trading pattern does not change significantly from year to year, but considerable shifts may take place over a period, calling for revision of the weights. Ultimately the weights could be updated every year, although this might make interpreting the index more difficult, since a given change might now be due to both the exchange rate and/or changes in the weights. The choice of 1995 as the base year for the Nationalbank's index was made exclusively on pragmatic grounds, since it is the last year covered by the OECD trade statistics at the required level of detail.

Compared to previously, in recent years the importance of regions outside the group of industrialized countries to trade in manufactured goods has also grown steadily<sup>1)</sup>. However, as before, the delineation of countries has been limited to the OECD countries. Since the last revision of the weights the OECD has been enlarged to include South Korea, Poland, the

<sup>1)</sup> For further discussion see OECD (1994) Economic Outlook No. 56, pages 38-49.

Czech Republic and Hungary, and these countries are thus included in the calculation of weights. Mexico and Turkey are also OECD members, but are excluded since they are both characterized by strongly depreciating currencies and high inflation. Countries outside the OECD group are not included on operational grounds, i.e. problems in obtaining data with a sufficient level of detail and of a sufficiently high quality, and also for reasons of principle. In this regard two factors are involved. If countries with high inflation and continuously depreciating currencies are included a nominal exchange-rate index will be distorted, as previously described, and there is more focus on the real exchange-rate index, which in practice is more difficult to calculate and will only be available after a certain delay. Secondly, it is problematic to include countries with an industrial structure which differs significantly from Denmark's, i.e. actual low-wage countries. This aspect is discussed in more detail in the Appendix. In reality, there is no clear distinction between which countries to include and which not.

As stated, the basis for the calculation of weights is trade in manufactured goods. Denmark's substantial agricultural exports are thus not included. The reason is not a lack of statistics, but rather the extensive subsidy schemes and quantitative restrictions in this area which make the impact of exchange-rate fluctuations more difficult to isolate, since prices are not fully market-determined. The growing international trade of services is not included either. However, this is due to a lack of data. Manufactured exports constitute approximately 70 per cent of total Danish goods exports and 50 per cent of total exports. The proportions on the import side are a little higher.

In relation to some of Denmark's trading partners it is vital whether all trade in goods is included, or only trade in manufactured goods. This applies for example to trade with a country such as Russia. Measured in terms of total trade of goods this country is one of Denmark's largest trading partners in eastern Europe and the previous Soviet area. However, if only trade in manufactured goods is included, exports to Russia constitute only 1/3 of manufactured exports to e.g. Poland. The difference is even greater on the import side.

The inclusion of South Korea in the set of weights is the basis for the recalculation of the index for the most recent year, in contrast to the procedure last time the weights were changed. In autumn 1997 the Korean currency depreciated strongly in line with a number of other South-east-Asian currencies. It is the assessment that in South Korea's case at any rate this depreciation far exceeded what could be attributed to the real

economic situation. Inclusion of the won only after the depreciation took place will make the krone-rate index biased when the currency begins to re-appreciate. If the weaker level of the won proves to be longstanding this will not present any problem in relation to the krone-rate index. However, in recent months the won has already recovered some of its former strength.

The single currency, the euro, will be introduced by a number of European countries as of January 1, 1999. This raises the question of the weighting given to the euro area in the krone-rate index. One possibility is to add together the new weights for the participating countries, another to calculate a new set of weights covering the euro area as one. This would eliminate the inter-regional trade flows in the euro area. The two methods do not give quite the same set of weights, which is a small disadvantage of the double-weighting methodology. In the first instance the Nationalbank intends to use the first-mentioned procedure in view of the wish to continue to use the price and wage statistics from the individual countries in the euro area to calculate real effective krone rates.

## Appendix

Danish companies face competition from companies abroad on both the domestic and export markets. The breakdown of this competition by country cannot be determined precisely, but when effective exchange rates are calculated it is normally assumed that competition on individual export markets and on the domestic market is directly proportional to each country's market share. The starting point is thus trade flows, whereas normally which currency the trade is invoiced in is without significance.

As a starting point two sets of weights are calculated, one representing the distribution of competition on export markets (double-weighted export weights) and one for the domestic market (bilateral import weights).

### *Double-weighted export weights*

Calculation of a set of double-weighted export weights assumes that each country's market share is known, including its domestic market share, i.e. the diagonal in the matrix. The calculation is based on a trade matrix for manufactures (SITC 5-9), as illustrated below.

From country	To country				
	1	2	...	25	RoW
1	a <sub>1,1</sub>			a <sub>1,25</sub>	a <sub>1,26</sub>
2					
...					
25	a <sub>25,1</sub>			a <sub>25,25</sub>	a <sub>25,26</sub>
Total	1			1	1

Note: RoW stands for "Rest of World".

$a_{i,j}$  indicates the export share of manufactures from country "i" to country "j". The basis is thus the export statistics, which are normally considered to be more correct than the import statistics.

The diagonal elements in the matrix indicate total deliveries to the domestic market from country "i"'s industry in relation to the total inflow of manufactures to country "i", i.e. including imports from other countries:

$$a_{i,i} = \frac{PV_i - X_i}{PV_i - X_i + M_i}$$

$PV_i$  = Production value in manufacturing sector in country "i"

$X_i$  = Value of manufactured exports from country "i"

$M_i$  = Value of manufactured imports to country "i"

One of many problems with regard to the layout of the matrix is that national accounts and foreign-trade statistics must be collocated.

It should be noted that there is no row for "Rest of World" (RoW). The underlying assumption is that where RoW includes industry it does not compete with industry in Denmark or the other 25 countries, for example because it manufactures other categories of goods which are not close substitutes for products from industrialized countries. This is a simplified assumption for calculation purposes.

On the other hand, there is a column for RoW comprising the 25 countries' export shares to RoW. Here the assumption is that Danish manufacturers' exports to RoW compete solely with exports from the 25 countries, but not with industry in RoW.

The aforementioned assumptions are, as stated, necessary for the calculation, but at the same time do have a certain relevance. The greater the divergence between the stages of industrial development of the countries included, the more difficult it becomes to interpret changes in the effective exchange rate as reflecting any change in competitiveness, since often there is no close substitution between the manufactured goods. This problem is *inter alia* discussed in the OECD (1994)<sup>1)</sup> and emphasizes that an effective exchange-rate index will not necessarily be "better" simply because many countries are included in the calculation. Nonetheless, the international development is towards including new countries in the calculation of weights, as more and more newly industrialized countries become players in the world market for manufactured goods. The Southeast-Asian countries' share of world trade in manufactured goods has thus doubled from 1985 to 1995, and now constitutes almost 25 per cent. However, this is partly offset by a decrease in the share of other non-OECD countries, so that the OECD countries' total share of world trade has declined only moderately during the period.

The matrix of market shares describes the extent to which Danish manufactured exports compete with the 25 other countries in the 26 markets where RoW is considered as one. To gain an overall impression of competition with each country the shares on the individual markets must be weighted together. This is based on the collocation of Danish manufactured exports distributed by country, i.e. using bilateral export weights ( $b_j$ ).

---

<sup>1)</sup> Op. cit.

The double-weighted export weight for country "i" ( $w_i^x$ ) is generated as follows:

$$w_i^x = \sum_{j=1}^{26} a_{i,j} \cdot b_j$$

If "i" is e.g. Germany, the double-weighted export weight is Germany's share of the US market multiplied by the share of Danish exports to the USA, plus Germany's share of the Japanese market multiplied by the share of Danish exports to Japan ....., plus Germany's domestic-market share multiplied by the share of Danish exports to Germany, plus Germany's share of the market in RoW multiplied by the share of Danish exports to RoW.

Since industry's production value in country "i",  $PV_i$ , to a certain extent comprises output sold to the domestic market but in real terms does not compete with imports from other countries (a case in point is newspapers), in practice the domestic-market share is overestimated. In other words, the double-weighted export weights entail a bias towards bilateral export weights not subject to simple adjustment.

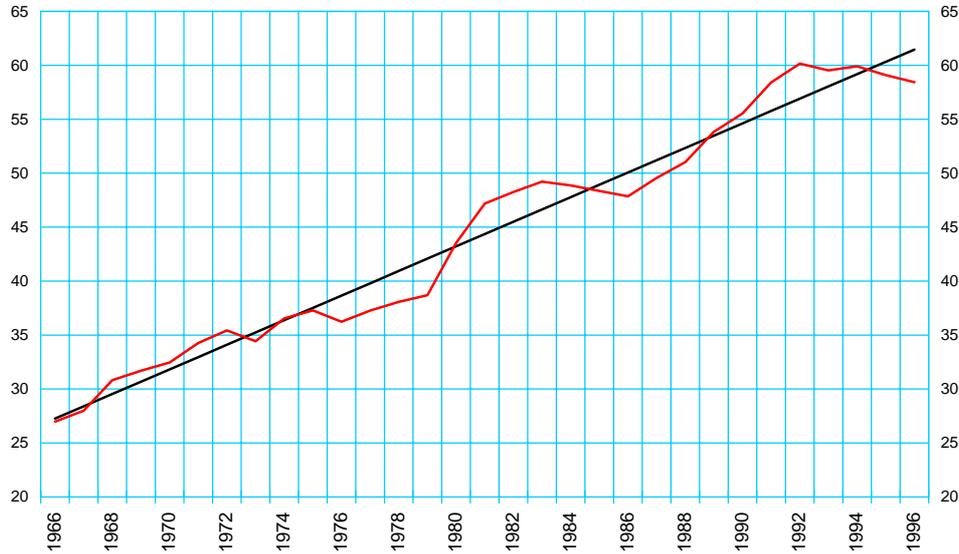
#### *Bilateral import weights*

Danish industry's domestic-market sales take place in competition with foreign companies, as is the case for the export markets. Equivalent to the treatment on the export side, competition on the domestic market from each country is assumed to be directly proportional to that country's share of Danish manufactured imports. The impact of foreign competition on the domestic market is therefore represented by a set of bilateral import weights ( $w_i^m$ ). RoW is not included in the set of weights on the import side due to the assumption that industry in RoW does not compete with either Danish enterprises or enterprises in the other 25 countries.

#### *Overall set of weights*

In order to obtain an overall set of weights the double-weighted export weights ( $w_i^x$ ) and the bilateral import weights ( $w_i^m$ ) must be weighted together. The method is not determined beforehand. The Nationalbank has chosen to weight the export side with the proportion of the value of manufactured output which is exported. As a consequence of the greater international division of work this proportion has been increasing in historical terms, but with fluctuations over time, inter alia as a consequence of varying cyclical development in Denmark and abroad. The actual trend, cf. Chart 3, is therefore used. It might be argued that a similar adjustment should be made on calculating the market-share matrix and the bilateral

Chart 3 *Export share of value of manufactured output*  
Per cent



sets of weights. However, it is the assessment that the greater uncertainty this will entail for the calculation exceeds the advantages.

The total set of weights for country "i" is now:

$$w_i = a^e \cdot w_i^x + (1 - a^e) \cdot w_i^m$$

where  $a^e$  is the trend-determined export share in the base year, i.e. 1995. This is estimated at 60.3 per cent. The resulting set of weights is shown in Table 1.

#### *Calculation of the effective krone-rate index*

Given the set of weights as calculated above, the nominal effective krone-rate index (NEER) is now:

$$\text{NEER} = 100 \cdot \prod_{i=1}^{25} \left( \frac{S_i(t)}{S_i(t_0)} \right)^{w_i}$$

where  $\sum_{i=1}^{25} w_i = 1$ , and  $S_i()$  is the bilateral krone rate vis-à-vis currency "i" compiled as foreign currency per krone to time  $t$  and basis time  $t_0$ .

In other words the effective krone-rate index is calculated by weighting indices for the value of one krone vis-à-vis the various currencies using the calculated weights. An effective exchange rate is therefore born as an index and has no meaning in absolute terms at any given time, since only the

development over time can be subject to interpretation. An increase in the effective krone-rate index reflects a strengthening of the krone. It will be seen that a geometrical weighting is used. The advantages of this are described in the Box.

The index is linked to the old index as of May 30, 1997, when the value was 100.563246, so that 1980 is still equal to 100. Effective krone rates from before June 2, 1997 are thus unchanged.

The real effective exchange rate (REER) is as follows:

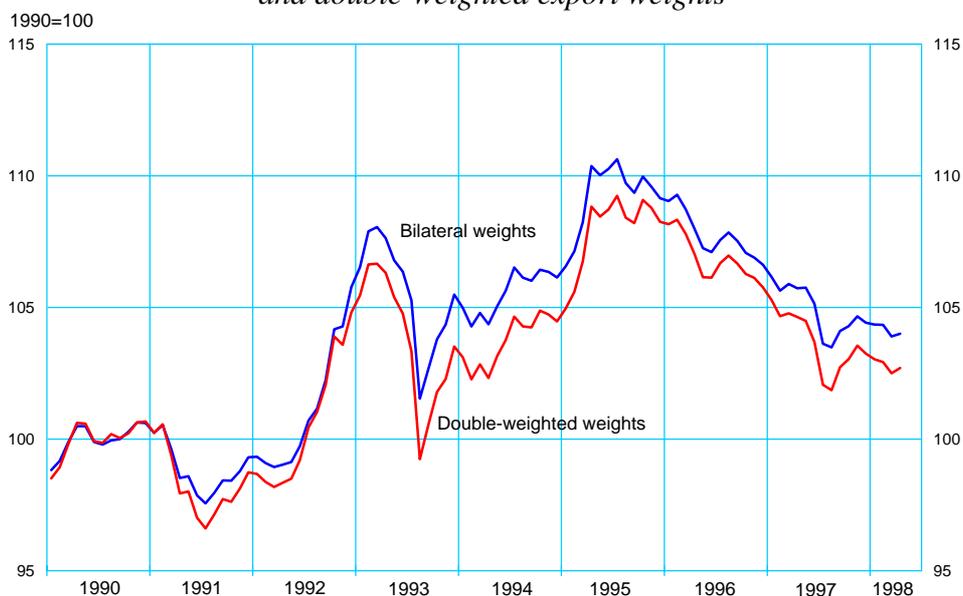
$$\text{REER} = \text{NEER} \cdot \frac{P_{\text{DK}}}{P_{\text{abr}}}$$

where  $P_{\text{abr}} = \prod_{i=1}^{25} P_i^{w_i}$  and  $P_{\text{DK}}$  is a price index for Denmark, and  $P_i$  equivalently a price index for country "i".

#### *The consequences of not double weighting the export weights*

While calculation of an effective krone rate based on bilateral weights can apply Danish data exclusively, double weighting requires detailed statistics from all countries involved, which makes it more difficult to involve many countries and to construct up-to-date weights. On the other hand the advantage is that the theoretical basis for double-weighted export weights

Chart 4 *Effective krone rate calculated with respectively bilateral and double-weighted export weights*



## Box

*Background to the use of a geometrical average*

It is assumed that we wish to construct an effective exchange-rate index with only three countries, Denmark and two others. It is also assumed that the two foreign countries carry equal weight in the index. This assumption is not decisive for the result, but makes the calculation easier. It is assumed that in the chosen base year one Danish krone can buy 100 units of the currency of country x, in the next year 200 units and in the third year 400 units. Vis-à-vis country y the equivalent figures are 40, 20 and 10 units in the three years. The krone thus strengthens continuously vis-à-vis the currency of country x and weakens against the currency of country y. From year one to year two, one krone can buy twice as many units of the currency of country x, but only half as much of the currency of country y. How has the krone's overall strength developed? The intuitive result must be that since the two countries carry equal weighting, the overall strength of the krone is unchanged. This is exactly the result given by geometrical weighting, but not by the usual arithmetical weighting.

Using an arithmetical average the effective krone rate is calculated as a simple average of the krone's fluctuation vis-à-vis each of the two currencies in relation to a chosen base year as follows:

$$\text{Year 1 } \frac{1}{2} \cdot (100/100 + 40/40) \cdot 100 = 100$$

$$\text{Year 2 } \frac{1}{2} \cdot (200/100 + 20/40) \cdot 100 = 125$$

$$\text{Year 3 } \frac{1}{2} \cdot (400/100 + 10/40) \cdot 100 = 213$$

However, with geometrical weighting the result is:

$$\text{Year 1 } (100/100 \cdot 40/40)^{1/2} \cdot 100 = 100$$

$$\text{Year 2 } (200/100 \cdot 20/40)^{1/2} \cdot 100 = 100$$

$$\text{Year 3 } (400/100 \cdot 10/40)^{1/2} \cdot 100 = 100$$

The conclusion is that the arithmetical average entails a bias in relation to the geometrical average. In the example shown the bias is very great due to the huge changes in the exchange rates. The basis for this bias is that on using an arithmetical weighting currencies which strengthen against the krone will achieve greater and greater weighting on calculation of the index (even though their formal weight is unchanged) in relation to currencies which weaken. The latter will be gradually "crowded out". The greater the exchange-rate fluctuations, the greater these effects.

Another advantage of a geometrical average is that the index gives the same increase between two dates, irrespective of the base year chosen.