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Alternative Measures of the Swedish Real Effective Exchange Rate

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Svensk resumé på sidan 2

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Abstract

This study presents alternative measures of the Swedish real effective exchange rate (REER), based on three alternative weighting schemes and three alternative price indices. Pros and cons of alternative measures are discussed in the context of the REER as an indicator of competitiveness. Bivariate VAR-models are estimated in an effort to conclude whether or not the alternative REER measures contain leading information on real GDP, real investments and real net exports. The results may be interpreted as empirical support for the supposition that REERs based on export prices reflect competitiveness primarily for internationally traded goods and services, while REERs based on consumer prices serve as a broader indicator of competitiveness.

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Svensk Resumé

Syftet med studien är att diskutera olika sätt att mäta den reala effektiva växelkursen och hur dessa mått speglar konkurrenskraft, samt att presentera och utvärdera ett antal mått på den reala effektiva växelkursen för Sverige. Tre olika viktsystem (MERM, TCW och bilaterala handelsvikter) och tre olika prisindex (konsumentprisindex, exportenhetspriser och enhetsarbetskostnader) används, vilket ger totalt sett nio olika mått på den svenska reala effektiva växelkursen. I studien används halvårsdata för perioden 1975 till 1998.

De olika måtten ger i stora drag samma bild av den reala effektiva växelkursen, vilken har varierat ganska mycket under perioden. De olikheter som finns beror främst på skillnader mellan de olika prisindexen och endast i mindre utsträckning på skillnaderna mellan de olika viktsystemen. De mått som baseras på konsumentprisindex och exportenhetspriser har utvecklats förhållandevis likartat, med den skillnaden att de förra har haft en något starkare deprecierande trend och en något högre variabilitet. En tänkbar förklaring till den något starkare deprecierande trenden i den reala effektiva växelkursen som baseras på konsumentprisindex kan vara att Sverige haft lägre tillväxt än omvärlden under perioden, och att detta mått på den reala växelkursen därför deprecierats till följd av den s.k. Balassa-Samuelson effekten. En trolig förklaring till varför den reala effektiva växelkursen som baseras på exportenhetsvärden uppvisar jämförelsevis mindre variabilitet är att förändringar i den nominella växelkursen ej tillåts slå igenom fullt ut på exportpriserna till följd av den internationella konkurrensen, åtminstone inte på kortare sikt. De mått på den reala effektiva växelkursen som baseras på enhetsarbetskostnader skiljer sig från de övriga i det att de har uppvisat en större variabilitet. En möjlig förklaring är att en real effektiv växelkurs baserad på enhetsarbetskostnader inte speglar förändringar i kapitalintensiteten i produktionen. Därigenom tenderar den att överskatta de förändringar i konkurrenskraften som följer en förändrad kapitalintensitet i produktionen, *ceteris paribus*.

Under antagandet att den reala effektiva växelkursen speglar konkurrenskraft kan den förväntas ha en inverkan på den aggregerade efterfrågan och några av dess komponenter, som t.ex. investeringar och nettoexport. Vid tester av s.k. Granger-kausalitet i bivariata VAR-modeller framkommer att de reala effektiva växelkurserna som baseras på konsumentprisindex innehåller ledande information för real BNP, reala investeringar och real nettoexport, medan de reala effektiva växelkurserna som baseras på exportenhetsvärden innehåller ledande information endast för real nettoexport. Resultaten för de reala effektiva växelkurser som baseras på enhetsarbetskostnader är något osäkra, men tyder på att de innehåller ledande

information för real BNP och reala investeringar men ej real nettoexport. Undersökningen bidrar till att klargöra bilden av de olika måtten av den reala effektiva växelkursen. Förväntningen att en real effektiv växelkurs baserad på exportpriser först och främst speglar konkurrenskraften för internationellt handlade varor och tjänster får empiriskt stöd, liksom förväntningen att en real effektiv växelkurs baserad på konsumentpriser speglar konkurrenskraften i ett bredare perspektiv.

1. Introduction

A country's nominal exchange rate is the price of its currency in terms of another currency. The value of the nominal exchange rate will be affected by a number of nominal variables, e.g. the interest rate, the inflation rate, the money growth rate, and expectations concerning these rates. The real exchange rate, considered as the real counterpart of the nominal exchange rate, is defined as a ratio of the price levels between countries, expressed in a common numeraire. In a longer time perspective, the real exchange rate is usually thought of as being determined by real variables only.

Comparing the real exchange rate and its medium to long-run *equilibrium* value gives an indication of over- or undervaluations (misalignments) of the real exchange rate. In turn, this provides insights into the future development of both the real exchange rate and the nominal exchange rate, although the link between the two is not straightforward. For example, with a floating exchange rate regime, adjustments in the real exchange rate are likely to take place primarily through changes in the nominal exchange rate. For other, less flexible exchange rate regimes, adjustments in relative prices are likely to play a more significant role. Still, the real exchange rate is perhaps the most important tool when trying to predict the future development of the nominal exchange rate in a longer run.

Before one can start to analyse the real exchange rate, one has to decide how to actually measure it. Since a country trades and competes with a number of other countries in the international markets, the real exchange rate is (usually) constructed as a multilateral, or *effective*, index. To compute the real effective exchange rate (REER) index one has to decide what countries the REER should cover, how to measure these countries' relative weights, and what price indices to use. The purpose of this study is to compute and evaluate a number of alternative REER indices for Sweden. We make use of three different weighting schemes and three alternative price indices, resulting in nine REER indices.

In Section 2, some conceptual issues on real exchange rates are revisited. In particular, alternative definitions of real exchange rates and the equilibrium real exchange rate are discussed. Section 3 discusses pros and cons of various weighting schemes and various price indices. In Section 4, alternative Swedish REER indices are presented and compared.

Under the assumption of a constant *equilibrium* REER (Purchasing Power Parity), changes in the REER can be interpreted as changes in a country's competitive stance. The REER may thus be expected to provide information on future aggregate demand and some of its components, such as net exports and investments. Section 5 presents a basic test to evaluate

to what extent the alternative REER indices contain such leading information, thus providing a way, albeit simplistic, to evaluate the REER indices. Finally, Section 6 summarises and concludes.

2. Some Conceptual Issues on REERs and the Equilibrium Real Exchange Rate

Two Alternative Definitions of the REER

The real exchange rate is commonly defined as a (geometrically weighted) index of the price level abroad relative to that at home:

$$\ln REER = \sum_{i=1}^{n} w_i \cdot \ln(E_i \cdot P_i / P) \qquad (1)$$

where w_i is the relative weight attached to country *i* (trading partner / competitor), E_i is the nominal exchange rate vis-à-vis country *i* measured as domestic to foreign currency, P_i is the relevant price index in country *i*, measured in foreign currency, and *P* is the relevant domestic price index measured in domestic currency. Defined in this way, the REER is nothing but a ratio of foreign to domestic prices expressed in a common numeraire. Various price indices have been used for computing REERs, e.g. consumer prices, export prices, producer prices, and unit labour costs. All of them have their strengths and weaknesses, as will be discussed in Section 3 below.

An alternative way of defining the REER, often used in the theoretical literature,[1] is as the price of tradables relative to that of non-tradables:

$$\ln REER = \sum_{i=1}^{n} w_i \cdot \ln(E_i \cdot P_i^T / P^N) \qquad (2)$$

where P_i^T is the price of tradables (a composite of export and imports), expressed in foreign currency and thought of as being determined in the international market and exogenously given, and P^N is the domestic price of non-tradables. With this definition, the REER

[1] See e.g. Corden (1994), Edwards (1989) and Elbadawi (1994).

corresponds to the ratio of the price of tradables, converted to domestic currency via the nominal exchange rate, over the price of domestic non-tradables. The main feature of this definition of the REER is that it directly captures the incentives that guide resource allocation between the tradables and non-tradables sectors. A depreciation of the REER increases the relative profitability of producing tradables, thereby inducing resources to move from the non-tradables to the tradables sector, while an appreciation of the REER has the opposite effect.

One major disadvantage of defining the REER as the relative price of tradables to non-tradables is that it lacks a straightforward empirical counterpart. In the literature, trading partners' wholesale price indices have been argued to serve as a reasonable proxy for the price of tradables, while the domestic consumer price index serves as a reasonable proxy for the domestic price of non-tradables.[2] Since both price indices are a mix of prices of tradables and non-tradables they are arguably somewhat deficient for this purpose.

Although the two above definitions of the REER are conceptually quite different, they do, under certain assumptions, come close to each other. Consider the case when the real exchange rate, computed according to equation (1), is based on price indices that include both tradables and non-tradables. In Appendix A it is shown that under the assumption of purchasing power parity for tradable goods, the REER defined as the relative price of tradables to non-tradables merely becomes a simplification of the REER defined as the price level abroad relative to the price level at home. The main difference is that the REER defined as the price level abroad relative to the price level at home reflects not only the domestic relative price of tradables to non-tradables, but also the foreign relative price of tradables to non-tradables. Hence, as argued by e.g. Williamson (1994), the price level abroad, relative to the price level at home generally serves as a broader and more comprehensive measure of the real exchange rate.

The Equilibrium Real Exchange Rate

As was discussed above, the real exchange rate is merely a ratio between foreign and domestic prices expressed in a common numeraire. Short-run changes in the real exchange rate are often dominated by variations in the nominal exchange rate and therefore more or less impossible to predict. In a longer run the real exchange rate has a tendency to converge towards its equilibrium value. Deviations of the real exchange rate from its equilibrium value, generally

[2] See e.g. Harberger (1986).

referred to as misalignments, may thus be taken as an indication of how the real exchange rate will evolve in a longer run.

The most traditional approach to the equilibrium real exchange rate is the theory of *Purchasing Power Parity* (PPP). This theory holds that the equilibrium real exchange rate remains constant over time. The cornerstone of PPP is the law of one price, which states that homogeneous goods should cost the same in all countries when expressed in a common numeraire. The absolute version of the PPP relates to the overall price level and postulates that the same basket of goods should cost the same in all countries when expressed in a common numeraire. Although intuitively appealing, the theory of absolute PPP is undermined by trade costs and other impediments to international trade. A weaker, and perhaps more realistic, version is the relative PPP, which states that the rate of change in the nominal exchange rate should equal the difference between the domestic and foreign rates of inflation for equivalent baskets of goods.

The mechanism behind PPP is that international (free) trade should tend to equate goods prices across countries. Hence, the theory of PPP is essentially a theory for internationally traded goods. High transportation costs and other trade impediments may prevent goods from being traded internationally. Moreover, most services are not traded on the international market. For such non-tradables there need not be any tendency for arbitrage to equate prices across countries.[3]

Although widely used, the theory of PPP has received much critique for not adequately reflecting the equilibrium real exchange rate. Empirical studies have frequently rejected the theory of PPP, but some recent studies that have focused on industrialised countries, narrow price indices covering mostly tradables, or longer time periods have found support for PPP.[4]

From a theoretical standpoint there are several reasons why the exchange rate may deviate from its PPP value. Temporary deviations of the exchange rate from its PPP value may arise if there is a tendency for inertia in international trade, i.e. trade flows do not (fully)

[3] However, under the assumptions of identical production functions across countries, internationally perfectly mobile capital and perfectly mobile labour within economies (but not necessarily between them), free international trade will tend to equate factor prices across countries. In its turn, factor price equalisation will tend to equate the price of nontraded goods across countries. Hence, from a theoretical standpoint, PPP may hold under certain assumptions even when allowing for nontraded goods. For a model along these lines, see e.g. Obstfeld and Rogoff (1996), Chapter 4.

[4] For a survey of empirical evidence on PPP, see e.g. Froot and Rogoff (1995) and Boucher Breuer (1994).

respond to changes in the nominal exchange rate due to adjustment costs.[5] In the presence of such adjustment costs only large or sustained changes in the nominal exchange rate have an impact on exporters' pricing decisions. Hence, there may be little tendency for short-run variations in the nominal exchange rate to be offset by changes in the price of traded goods, thus causing the real exchange rate to deviate from PPP. A related explanation for temporary deviations from PPP stems from the "sticky-price" model of exchange rates.[6] This model suggests that prices of goods react sluggishly in the short run to unanticipated changes in monetary conditions, causing the exchange rate, which reacts much more rapidly, to deviate from its PPP value.

Even though the above examples explain why the exchange rate may deviate from its PPP value temporarily, they do not invalidate PPP as a theory of the equilibrium real exchange rate in a longer run. There are, however, other reasons why the equilibrium real exchange rate need not remain constant over time.

The first reason is the imperfect substitutability among traded goods, which implies that relative prices of various traded goods may be subject to change as their supply and demand changes. Shifts in supply and demand may occur for a number of reasons, such as changes in taste, differences in export and import elasticities with respect to income, and differences in growth rates. Since countries do not export and import identical bundles of goods, such changes will affect export and import prices differently across countries, thereby causing changes in the terms-of-trade, which in turn will alter the real exchange rate *and* its equilibrium value.[7]

Another reason why the equilibrium real exchange rate may change over time arises when non-traded goods are included in the real exchange rate. Differences in total factor productivity (TFP) growth rates between the tradables and non-tradables sectors, and across countries, may then cause the equilibrium real exchange rate to change. This is the so-called Balassa-Samuelson effect.[8] The common explanation assumes a small country, constant returns to scale in production of both tradables and non-tradables, and that the law of one price prevails on the market for tradables and in the capital market. Then, if TFP increases (faster) in the tradables sector, the marginal productivity of labour will tend to increase (faster) in this

[5] See e.g. Dixit (1989) for a model on hysteresis in international trade.
[6] See Dornbusch (1976).
[7] The effects of changes in the terms-of-trade on the real exchange rate and its equilibrium value depends among other things on whether the changes are temporary or permanent and if non-tradables are included in the analysis. See e.g. Ostry (1988) and Edwards (1989).

sector as well. This will be matched by a rise in wages so that, with perfect labour mobility across sectors, the price of non-tradables will increase accordingly. In its turn, this will lead to an appreciation of the real exchange rate and its equilibrium value, *ceteris paribus*. An extension to a case with two countries is straightforward. The country that experiences the most rapid TFP growth in the tradables sector relative to the non-tradables sector will face an appreciating (equilibrium) real exchange rate.

The above arguments imply that the theory of PPP may be inappropriate as a guideline for the equilibrium real exchange rate, even in a longer run. In contrast to the PPP approach, the so-called "underlying balance approach" to the equilibrium real exchange rate accounts for changes in the economic structure and recognise that such changes may lead to changes in the equilibrium real exchange rate. A number of alternative models based on the underlying balance approach have been developed during the last two decades.[9] These models have in common that the equilibrium real exchange rate is defined as the real exchange rate that is consistent with simultaneous internal and external equilibria in the economy.[10] Moreover, the equilibrium real exchange rate is a function of underlying determinants, so-called fundamentals, and changes in these fundamentals will affect the equilibrium real exchange rate. A number of fundamentals have been suggested in the literature.[11] Differences between countries' TFP growth rates in the tradables and non-tradables sectors, and changes in terms-of-trade were discussed above. The accumulation of foreign assets, exogenous capital flows, tariffs and trade restrictions, the level and composition of government expenditure, and the level and composition of investments are examples of other fundamentals suggested in the literature.

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[8] See Balassa (1964).

[9] See e.g. Edwards (1989), Williamson (1994) for the Fundamentals Equilibrium Exchange Rate (FEER) approach, Bayoumi et al. (1994) for the Desired Equilibrium Exchange Rate (DEER) approach, and Stein et al. (1995) for the Natural Real Exchange Rate (NATREX) approach.

[10] The definitions of internal and external equilibria differ somewhat between the models. However, they all come close to the definition by Nurkse (1945). Nurkse defined internal equilibrium as an economy with full employment and a sustainable level of inflation (NAIRU), and external equilibrium as the case when present and future current accounts are compatible with long-run, sustainable capital flows.

[11] See e.g. Edwards (1989), Williamson (1994), and Stein et al. (1995) for a discussion on real exchange rate fundamentals.

3. Constructing Real Effective Exchange Rate Indices

Before calculating REERs one has to decide which countries should be included, what their relative weights should be, and which price indices to use. In this section we will discuss these issues.

Country Coverage and Weighting Schemes

A major issue when constructing REERs is the choice of countries to include and their relative weights. In principle, all countries that compete with domestic producers, directly or indirectly in third markets, should be considered. In practice, data limitations tend to restrict the number of countries that can be considered. However, the inclusion of countries with small relative weights most likely affects the real exchange rate index only marginally and as long as major trading partners and competitors are included the issue of country coverage should be of subordinate importance.

A more complicated issue is how to compute the relative weights of the countries included in the REER. The most straightforward way is to use trade shares. Since one typically would like the REER to reflect the competitiveness on both the import market and the export market, the weights should preferably be based on total trade flows rather than export flows or import flows alone. However, a weighting scheme based on pure trade weights suffers from the drawback that it does not account for indirect competition from trading partners in third markets, thereby understating the degree of competition faced by domestic producers. The International Monetary Fund's (IMF) Total Competitiveness Weights (TCW) are based on bilateral trade flows, but they also account for competition by third countries on the domestic and foreign markets and may therefore better reflect the competitiveness situation. Previously, IMF also used their Multilateral Exchange Rate Model (MERM) to calculate competitiveness weights.[12] The model's country coverage is however more limited than the TCW scheme and, moreover, the MERM weights have not been published for some time.

[12] For a description of the Multilateral Exchange Rate Model, see Artus and McGuirk (1981).

Price Indices

Another problem is the choice of domestic and foreign price indices. Various price indices have been suggested in the literature, e.g. export and import prices, consumer prices, wholesale prices, GDP deflators and unit labour costs.[13]

A REER based on export prices may serve as a useful indicator of a country's external competitiveness, but it suffers from sampling bias. Export price indices include only goods that are traded at the current exchange rate and not those that potentially could be traded at a more favourable exchange rate. Export price indices thus tend to be a function of the exchange rate itself. Other price indices, too, suffer from this sort of sampling bias, but the bias decreases if nontraded goods are included. Furthermore, an export price based REER is likely to understate the variations in competitiveness. The reason is that exporters can "price to market" so that short-run variations in the nominal exchange rate are not passed on to the buyers in foreign currency, but rather are allowed to affect the export price expressed in domestic currency and thus the profit margin.

REERs based on aggregate price deflators, such as the consumer price index (CPI), are more comprehensive. For example, because a CPI-based REER index reflects the relative prices of tradables and non-tradables at home and abroad, a change in this index reflects either a change in competitiveness in the market for tradables and/or an incentive to shift resources between the tradables and non-tradables sectors. However, this index also includes indirect taxes and, more importantly, the price of imported goods. In addition to consumer prices, other broad REER indices may be constructed from e.g. GDP-deflators, value added deflators and wholesale prices. Data on the latter two are often available only with a substantial delay and, moreover, wholesale prices tend to suffer from a lack of comparability across countries.

REER indices are sometimes defined in terms of relative unit labour costs, typically in manufacturing. Such a measure compares the relative profitability of non-labour factors producing manufactured goods at home and abroad. Implicit in this measure is that the real exchange rate operates to equilibrate the rate of return of non-labour factors across countries. Defined this way, the REER index reflects the incentives to reallocate non-labour factors internationally and domestically. An advantage of a unit labour cost-based REER index is that it does not pick up temporary fluctuations in profit margins and thus better reflects competitiveness than REERs based on CPIs, GDP-deflators, export prices, import prices and wholesale prices.

REER indices based on unit labour costs have a couple of drawbacks. One is related to the capital to labour ratio in the production. Consider for example a shift towards a more capital-intensive production. This may lead to a lower total production cost per unit, and thus a gain in competitiveness. However, the associated fall in the unit labour cost will overstate this gain in competitiveness since unit labour costs fall relatively more than total costs do per unit. Changes in unit labour cost-based REER indices may thus originate not only in changes in competitiveness, but also in changes in the capital to labour ratio that are not related to competitiveness. Yet another problem with unit labour costs is relatively large errors of measurement and long publication lags.

4. A Comparison of Alternative Real Effective Exchange Rates for Sweden

In this section we compare some REER indices for Sweden in order to evaluate the importance of alternative weighting schemes and price indices. REERs for Sweden are computed according to equation (1) in Section 2.

Table 1 provides background information on the country coverage and country weights for the real effective exchange rate indices for Sweden. Three different sets of weights are used to calculate effective real exchange rates: the MERM weights, TCW, and bilateral trade weights.[14] The MERM weights come from the data used in the *Multilateral Exchange Rate Model* of the IMF and are based on trade flows and supply and demand elasticities for the period 1980-1983. The TCW also come from the IMF. These weights are based on bilateral trade flows of manufactured goods, averaged over the period 1989-1991, but also reflect competition by third countries on the domestic and foreign markets. The bilateral trade weights are own computations, based on bilateral trade flows (exports plus imports) for 1992, between Sweden and the same set of countries as covered by the TCW scheme.

According to Table 1, the MERM weighting scheme differs markedly from the two other weighting schemes. First, the MERM weighting scheme covers 17 OECD countries while the TCW and the bilateral trade weighting schemes comprise 20 OECD countries. Second, in the MERM weighting scheme Canada, U.S. and Japan have much larger weights

Table 1. *Country coverage and weights in alternative weighting schemes for Sweden* (*percentage points*).

[13] For a discussion, see e.g. IMF Occasional Paper 115 (1994).
[14] The MERM weight schemes and the TCW schemes were obtained from Sveriges Riksbank (1995), p.16.

Country	MERM Weights	Total Competitiveness Weights (TCW)	Bilateral Trade Weights
Canada	4.25	1.16	0.98
U.S.	25.56	11.63	9.88
Japan	8.46	5.20	4.01
Australia	1.78	0.27	0.94
New Zealand	-	0.14	0.13
Austria	1.48	1.71	1.67
Belgium	2.74	3.55	4.54
Denmark	4.19	5.60	8.65
Finland	5.75	6.69	6.56
France	6.96	7.15	6.35
Germany	12.68	22.28	19.30
Greece	-	0.27	0.44
Ireland	0.68	0.77	0.80
Italy	7.27	6.05	4.80
Netherlands	3.03	4.24	5.78
Norway	6.69	5.58	8.92
Portugal	-	0.93	1.17
Spain	1.90	2.48	2.14
Switzerland	1.40	2.74	2.30
U.K.	5.18	11.56	10.64
Sum	100	100	100

Note: For real effective exchange rates based on Unit Labour Costs the weight for Ireland was set to zero due to lack of data. The weights for the remaining countries were recalculated so that they still sum to 100.

than in the other two weighting schemes, while Germany and U.K. have correspondingly smaller weights. The TCW and bilateral trade weighting schemes come relatively close to one another, the main difference being that the former places somewhat larger weights on the larger countries.

In Diagrams 1 to 4 we compare a number of REER indices for Sweden. An increase in the index corresponds to a depreciation of the REER. The indices are based on semi-annual data for the period 1975:1 to 1998:1. As to the choice of semi-annual data, availability of unit labour cost statistics has been the constraining factor. Diagram 1 presents three MERM weighted REER indices based on consumer prices, export unit values and unit labour costs, respectively. Diagrams 2 and 3 present the corresponding REER indices based on TCW and bilateral trade weights. Finally, Diagram 4 compares consumer price-based real effective exchange rates for the three alternative weighting schemes.

From Diagrams 1 to 3 it is evident that the Swedish REER has fluctuated substantially over the period. The alternative definitions of the REER give roughly the same picture. During the 1975 to 1981 period the REER was fairly stable. A sharp depreciation followed in 1981

and 1982 as a consequence of the devaluations during these years. The real exchange rate then appreciated gradually during the following decade. A sharp depreciation of the REER took place in late 1992 when the krona was floated and the nominal exchange rate depreciated sharply. After the immediate depreciation, the real exchange rate has shown no clear trend but a fair amount of variability.

The tendency of alternative REER indices to move together may be explained by the fact that nominal exchange rate variations tend to dominate the price movements. In the case of Sweden, this explanation is particularly relevant for the period after 1992. Consumer price and export unit value-based real exchange rates have moved relatively closely together throughout the period of the study, with a slightly more depreciating trend in the former and a somewhat higher degree of variability in the latter. The higher rate of depreciation in the consumer price-based REER indices may possibly be explained by the relatively low growth rates of the Swedish economy during the period of the study. Due to the so-called Balassa-Samuelson effect, countries with relatively low (productivity) growth rates tend to have less rapid increases in consumer prices, thus facing a depreciating real exchange rate over time.

The unit labour cost-based REER indices differ from the others in that they show a much larger depreciation in the 1990s. They exhibit a seasonal pattern in the 1980s, probably due to different ways of allowing for summer vacation costs in different countries.

An explanation of why the REER indices based on unit labour costs have varied more than the other REER indices could be that the price of tradables may be “sticky” in foreign currency due to hysteresis effects in international trade, as described in Section 2. It follows that variations in the nominal exchange rate may be expected to feed through relatively less into the price index-based REER than to the unit labour cost-based ones, thereby making the latter more variable.

Another explanation could be that changes in unit labour cost-based REER indices may reflect not only changes in competitiveness, but also changes in the capital to labour ratio in production. As domestic production becomes relatively more capital intensive, unit labour

Diagram 1. Swedish Real Effective Exchange Rates calculated with semi-annual data for the period 1975:1 to 1998:1, using the MERM weights and different price indices. 1990=100.

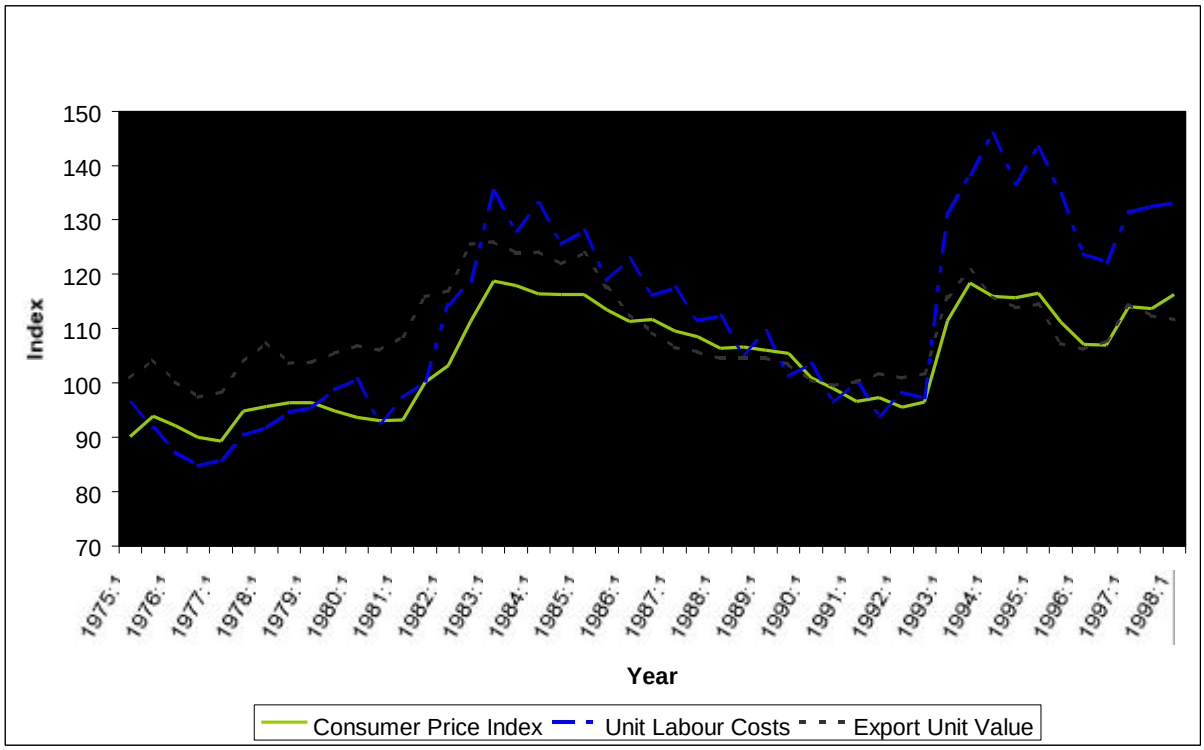


Diagram 2. Swedish Real Exchange Rates calculated with semi-annual data for the period 1975:1 to 1998:1, using the TCW and different price indices. 1990=100.

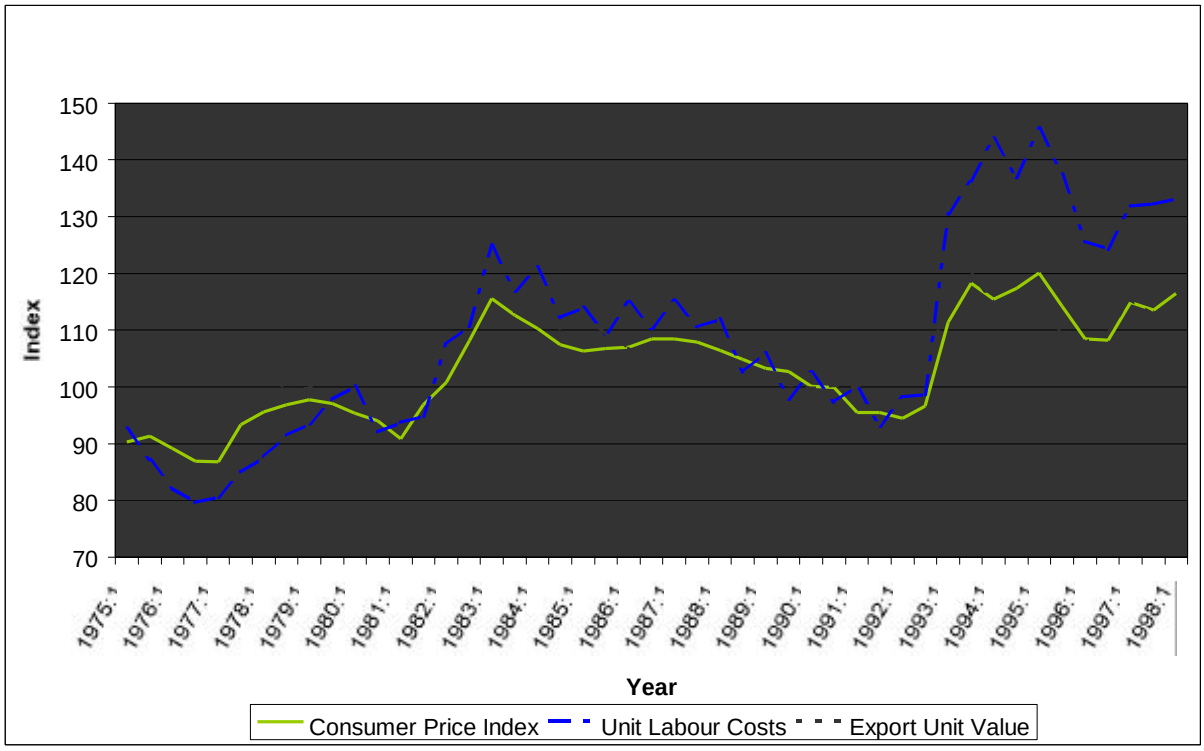


Diagram 3. Swedish Real Exchange Rates calculated with semi-annual data for the period 1975:1 to 1998:1, using the bilateral trade weights and different price indices. 1990=100.

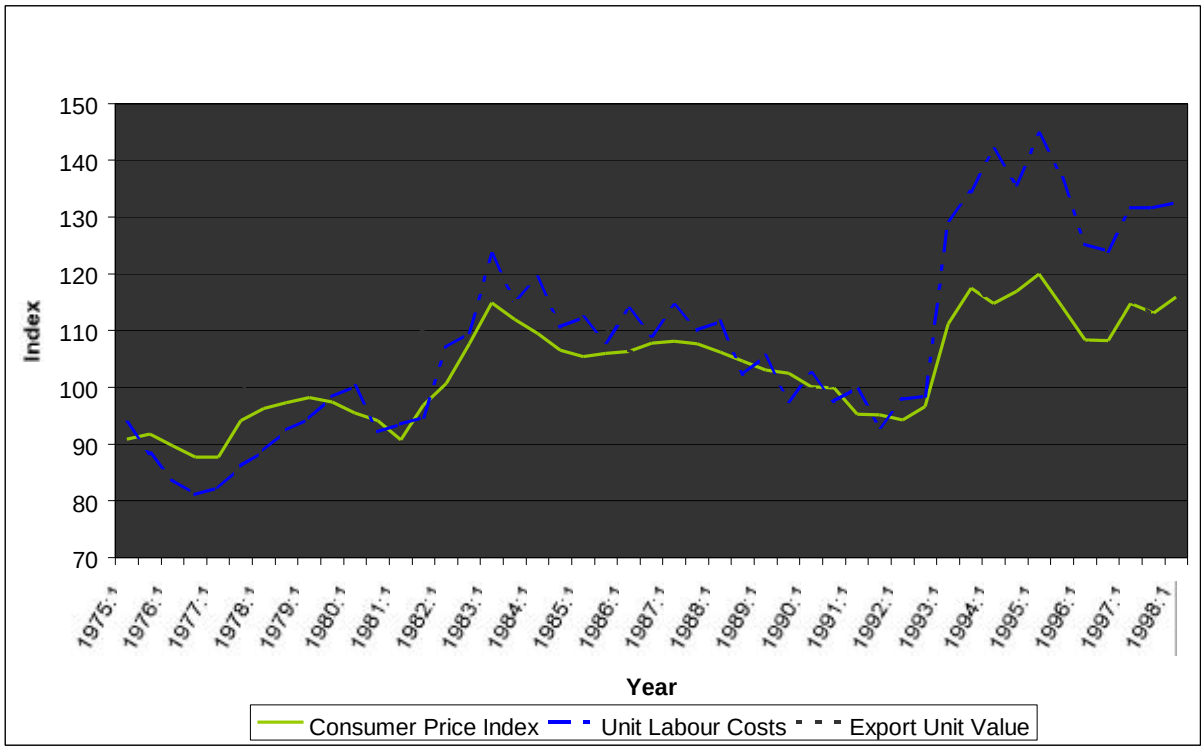
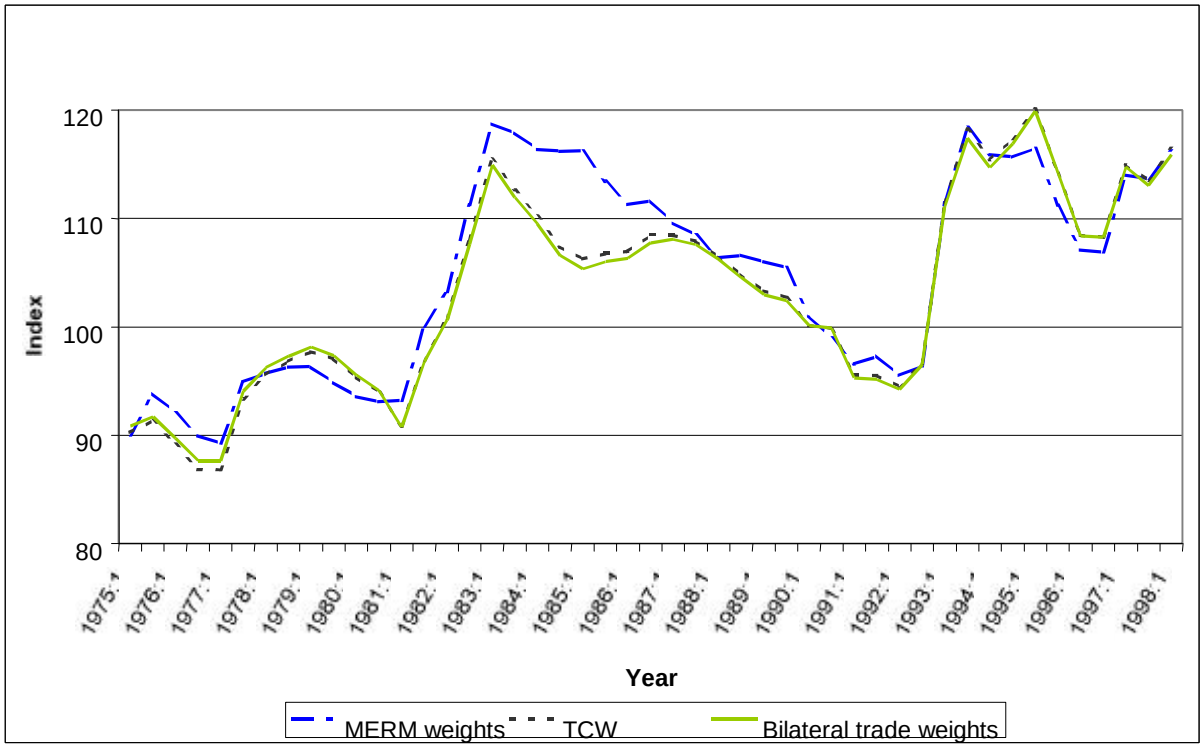


Diagram 4. Swedish Real Exchange Rates based on consumer prices, calculated with semi-annual data for the period 1975:1 to 1998:1 using MERM, TCW and bilateral trade weights. 1990=100.



costs will tend to decrease relatively more than the associated gain in competitiveness. The depreciation of a unit labour cost-based REER will thus tend to overstate the gain in competitiveness. Consider for example the period from late 1992 to early 1993. As the Swedish krona started to float, the nominal effective exchange rate depreciated by around 20 percent. The export unit value and consumer price-based REER indices depreciated by somewhat less, roughly 10 and 15 percent, respectively. As for the unit labour cost-based REER, it depreciated by more than 30 percent, i.e. the real depreciation exceeded the nominal depreciation by more than 10 percentage points. To the extent that wages (and related taxes) did not fall during this period, the additional depreciation of the unit labour cost-based REER can only be explained by an increase in the capital/labour ratio. Indeed, this supposition is supported by the rapid increase in Swedish unemployment rates during this period. Thus, as far as the fall in unit labour cost reflected a shift towards a relatively more capital-intensive production, the depreciation of the unit labour cost-based REER seems to have overstated the gain in competitiveness during this period.

Diagram 4 presents consumer price-based real effective exchange rates calculated using all three alternative weighting schemes. The three indices follow each other quite closely, particularly those based on TCW and bilateral trade weights. [15] The main exception is a period of seven years during the middle of the 1980s, when the MERM weighted index remained more depreciated than the indices based on TCW and bilateral trade weights. This is explained by the exceptionally high value of the U.S. dollar during this period and by the fact that the U.S. dollar is given an approximately twice as high weight in the MERM weighting scheme.

Taken together, diagrams 1 to 4 suggest that the choice of the weighting scheme is of subordinate importance in relation to the choice of price index. This is corroborated by the coefficients of correlation between the alternative real effective exchange rate indices. For real effective exchange rates with a common weighting scheme but different price indices, the correlation coefficients range from 0.752 to 0.949, whereas for real effective exchange rates with a common price index, but with different weighting schemes, the correlation coefficients range from 0.872to 0.999 (see Appendix B, Table B3).

[15] This is a common finding and e.g. Edwards (1989) argues that effective exchange rates usually are not very sensitive to the choice of weighting scheme.

5. Leading Information in the Real Effective Exchange Rate

As noted in Section 2, changes in the REER may not only reflect changes in a country's competitive stance, but also in the underlying fundamentals. If e.g. a depreciation of the REER originates in a decrease in the terms-of-trade, the depreciation of the REER need not reflect a gain in competitiveness but rather a restoration of it. The reason is that less favourable terms-of-trade are likely to depreciate the equilibrium REER. On the other hand, for a given equilibrium REER (i.e. given the fundamentals) a depreciation of the real exchange rate implies a gain in competitiveness. Changes in competitiveness should thus be measured by the changes in the REER in relation to the equilibrium REER, rather than by the variation of the REER itself.

In this section, we will carry out a basic test to analyse the extent to which the deviations of the alternative REER indices from their corresponding equilibrium REER Granger cause aggregate demand and some of its components. We do so in an effort to gain some additional insights of how well the various REER indices reflect competitiveness. The results may be interpreted as an indication of the relevance of the alternative REER indices.

Since the equilibrium REER is not directly observable we rely on a proxy. An assumption of PPP would imply that the equilibrium REER is constant. However, as was argued in Section 2, there are several theoretical arguments why PPP need not prevail, and the empirical evidence in favour of PPP is limited. In this study we make the assumption that the equilibrium REER may be approximated by a linear trend. Implicitly, this amounts to assuming that changes in underlying fundamentals of the equilibrium REER, e.g. relative growth rates and terms-of-trade, have changed the equilibrium REER at a constant rate. This assumption may be criticised for being too simplistic. Still, it may serve as a first approximation. Under this assumption, deviations of the real exchange rate from the trend value may be interpreted as changes in competitiveness. In turn, such changes can be expected to affect aggregate demand and some of its components. For example, an appreciation of the real exchange rate *relative to its equilibrium value* most likely lowers exports and raises imports, thereby lowering net exports. Investments may also be affected. An appreciation of the real exchange rate relative to its equilibrium value is likely to reduce investment incentives in the tradables sector by lowering expected future profits. Moreover, it may divert demand for non-tradables towards now relatively cheaper imports, thereby reducing investment incentives also in the non-tradables sector.

First, bivariate Vector Auto Regressions (VARs) consisting of a REER index, deterministic variables, and either real net exports, real investments, or real GDP are estimated. Granger causality tests are then carried out to analyse to what extent the alternative REER indices provide leading information on the other variables.

Granger Causality and Linear Feedback

Consider a bivariate VAR-system

$$\begin{aligned} x_{1,t} &= \sum_{l=1}^{p} p_{11,l} x_{1,t-l} + \sum_{l=1}^{p} p_{12,l} x_{2,t-l} + e_{1,t} \\ x_{2,t} &= \sum_{l=1}^{p} p_{21,l} x_{1,t-l} + \sum_{l=1}^{p} p_{22,l} x_{2,t-l} + e_{2,t} \end{aligned} \qquad (2)$$

where x_2 and x_1 are the two variables included in the VAR, p are coefficients and e are independently and identically distributed error terms with expected value zero and a constant variance-covariance matrix. The variables are assumed to be stationary and to have an autoregressive representation of order p. Granger causality from x_2 to x_1 implies testing the null hypothesis:

$$p_{12,l} = 0 \quad \text{for} \quad l = 1,...., p.$$

If the hypothesis that the estimated parameters are zero can not be rejected, it is concluded that x_2 does not Granger cause x_1 (Symmetrically, x_1 does not Granger cause x_2 if the null hypothesis $p_{21,l} = 0,\ l = 1,...., p.$ can not be rejected). Additional information on how much leading information there is in one variable about another can be obtained by analysing the degree of *linear feedback*, as discussed in Geweke (1984). The degree of *linear feedback from* x_2 *to* x_1 is estimated as:

$$linear\ \ feedback = \log(\text{var}(e_1^c)) - \log(\text{var}(e_1))$$

where (e_1^c) is the vector of restricted residuals ($p_{12,l} = 0,\ l = 1,...., p.$) and (e_1) is the vector of unrestricted residuals. The more feedback there is from x_2 to x_1, the larger will the feedback statistic be. If there is no feedback at all, the statistic will be close to zero.

Estimation

The bivariate VARs are estimated using semi-annual data for the period 1975:1 to 1998:1 (for a description of the data, see Appendix B). Real net exports can not be log-transformed since it takes on both positive and negative values. The VARs including real net exports are therefore estimated with non-transformed variables, while the VARs including real investments and real GDP are estimated both with non-transformed variables and in logs. Moreover, since it may be argued that changes in the REER should affect real investments and real net exports in relation to the real GDP, the VARs including real investments and real net exports are also estimated with real investments and real net exports expressed as shares of real GDP. It turns out, however, that the results of the VARs with log-transformed variables and the VARs with variables as shares of real GDP differ little from the results of the VARs with non-transformed variables, which are the ones reported here.

The first step in the estimation procedure is to carry out Augmented Dickey-Fuller unit root tests for all variables to determine their order of integration. The test procedure proposed by Enders (1995) is applied. The results of unit root tests are presented in Appendix B, Table B1. All series are integrated of order one with no drift term. Dividing real net exports and real investments with real GDP or log-transforming the variables (with real net exports as the exception) does not affect the result (tests not reported). Furthermore, adding a dummy variable to account for the shift in the exchange rate regime in late 1992 does not affect the results either (tests not reported).

Since all variables are I(1), the VARs are estimated in first differences. It is possible that the variables in the bivariate VARs cointegrate. If so, the cointegrating vector should be included when estimating the VAR. Engle-Granger cointegration tests were carried out for the VAR systems, but in no case could the hypothesis of no cointegration be rejected (see Appendix B, Table B2). Hence, all VARs are estimated in first differences without any cointegrating vector. A constant is included to allow for possible drift in the model, thus accounting for the equilibrium real exchange rate which is assumed to be a linear trend for the

model in levels. Seasonal effects are accounted for by including a seasonal dummy variable. The number of lags included in each VAR is determined by the likelihood ratio tests (tests not reported). Lag lengths up to six lags have been considered.

In view of the shift in the exchange rate regime in late 1992, a Chow test was performed for each VAR to test for a potential structural break. Due to the limited number of observations in the 1993:1 to 1998:1 sub-sample, the 1975:1-1992:2 sub-sample was tested against the full sample. In no case could the hypothesis that the parameters were equal be rejected, thus suggesting no structural break.

Estimated residuals are tested for the presence of serial correlation (Ljung-Box Q-tests; not reported) and for ARCH effects (Engle-tests; not reported). In no case can we reject the hypotheses of no serial correlation and no ARCH effects. The residuals are also tested for skewness and kurtosis. The results indicate that there are problems with non-normality of the residuals in some of the VARs. However, these problems refer only to the equation with the REER as the dependent variable (tests not reported). Since we do not perform inference testing on this equation, the problem with non-normality should be of little concern.

Table 4 presents results for the Granger causality tests with the alternative REER indices and the real GDP. The table reports the number of lags implied in the likelihood ratio tests, the significance level of the test that the lags of the real effective exchange rate in the real GDP equation are jointly zero (no Granger causality), and the linear feedback statistic. The likelihood ratio tests suggest that two lags should be included in the VARs. However, as a sensitivity analysis we also present results for the arbitrarily chosen lag length of four. The results indicate that the REERs based on consumer prices perform best. The Granger causality tests yield p-values close to 0.01 both when two and four lags are included in the VARs and the linear feedback statistics are clearly the highest. For REERs based on unit labour costs the results are quite sensitive to model specification.

Granger causality tests yield p-values below or around one percent for the VARs with two lags, but for the VARs with four lags the p-values are above the ten-percent level. The linear feedback statistic is lower than for the consumer price-based REERs, not only for the VARs with four lags, but also for the VARs with two lags. Finally, there is little evidence that the REERs based on export unit values Granger-cause real GDP. The p-values of the Granger causality tests are all above the ten-percent level, except for the MERM-weighted

*Table 4. Causality tests and linear feedback for bivariate VARs, using alternative real effective exchange rates and **Real GDP**. Sample: 1975:1-1998:1.*

Real Effective Exchange Rate	No. lags LR-test	Significance Level Granger Causality 2 lags p-value	4 lags p-value	Linear Feedback 2 lags	4 lags
Consumer price, MERM weights	2	0.000484	0.0159	0.413	0.382
Consumer price, TCW	2	0.00187	0.00785	0.340	0.433
Consumer price, bil. trade weights	2	0.00250	0.00789	0.324	0.433
Unit Labour Cost, MERM weights	2	0.00635	0.158	0.273	0.207
Unit Labour Cost, TCW	2	0.0105	0.178	0.246	0.197
Unit Labour Cost, bil. trade weights	2	0.0104	0.160	0.247	0.206
Exp. Unit Value, MERM weights	2	0.0959	0.734	0.127	0.0629
Exp. Unit Value, TCW	2	0.125	0.542	0.112	0.0968
Exp. Unit Value, bil. trade weights	2	0.171	0.692	0.0954	0.0700

*Table 5. Causality tests and linear feedback for bivariate VARs, using alternative real effective exchange rates and **Real Net Exports**. Sample: 1975:1-1998:1.*

Real Effective Exchange Rate	No. lags LR-test	Significance Level Granger Causality 1 lag p-value	4 lags p-value	Linear Feedback 1 lag	4 lags
Consumer price, MERM weights	1	0.0456	0.176	0.101	0.198
Consumer price, TCW	1	0.0307	0.108	0.118	0.238
Consumer price, bil. trade weights	1	0.0292	0.111	0.120	0.235
Unit Labour Cost, MERM weights	1	0.185	0.567	0.0445	0.0922
Unit Labour Cost, TCW	1	0.225	0.681	0.0372	0.0719
Unit Labour Cost, bil. trade weights	1	0.230	0.697	0.0365	0.0692
Exp. Unit Value, MERM weights	1	0.00524	0.0128	0.197	0.398
Exp. Unit Value, TCW	1	0.00224	0.00800	0.237	0.432
Exp. Unit Value, bil. trade weights	1	0.00201	0.00641	0.241	0.447

*Table 6. Causality tests and linear feedback for bivariate VARs, using alternative real effective exchange rates and **Real Investments**. Sample: 1975:1-1998:1.*

Real Effective Exchange Rate	No. lags LR-test	Significance Level Granger Causality 2 lags p-value	4 lags p-value	Linear Feedback 2 lags	4 lags
Consumer price, MERM weights	2	0.00300	0.120	0.314	0.229
Consumer price, TCW	2	0.00227	0.0488	0.329	0.299
Consumer price, bil. trade weights	2	0.00273	0.0497	0.319	0.297
Unit Labour Cost, MERM weights	2	0.00429	0.169	0.295	0.201
Unit Labour Cost, TCW	4	0.00466	0.144	0.290	0.214
Unit Labour Cost, bil. trade weights	4	0.00508	0.144	0.286	0.214
Exp. Unit Value, MERM weights	2	0.0755	0.616	0.140	0.0833
Exp. Unit Value, TCW	2	0.0884	0.532	0.131	0.0986
Exp. Unit Value, bil. trade weights	2	0.130	0.633	0.110	0.0802

REER index in the VAR with two lags, where the p-value is just below the ten-percent level. The results are supported by the low linear feedback statistics.

Table 5 reports the results for the VARs with real net exports. Likelihood ratio tests indicate that only one lag should be included in the VARs. The evidence that real exchange rates Granger cause net exports is strongest for the export unit value based REER indices. The Granger causality tests yield p-values below or around one percent both when one and four lags are included in the VARs and the associated linear feedback statistics are by far the highest. The result is somewhat weaker for REERs based on consumer prices. The Granger causality tests yields p-values below the five-percent level in the one-lag VAR models, while the p-values are just above the ten-percent level in the four lag models. Furthermore, the linear feedback statistics are roughly around half the magnitude of those for the export unit value-based REERs. As for the unit labour cost-based REERs, the p-values of the Granger causality test are all by and large above the ten percent level and the linear feedback statistics are very low.

Finally, Table 6 presents the results for the relationship between the alternative REERs and real investments. Likelihood ratio tests suggest that two lags should be included in the VARs for the REERs based on consumer prices and export unit values. For the REERs based on unit labour costs the model specification is less clear-cut. Results are reported both for two and four lags, even though the likelihood ratio tests suggest that four lags should be included in the VARs with REERs based on TCW and bilateral trade weights. The reason is that the additional lags are only just significant in the likelihood ratio tests and that the results of the VARs are highly sensitive to the choice of lag-length.

The results for the VARs with real investment s are highly reminiscent of those reported for the real GDP. The results clearly indicate that the consumer price based REERs Granger cause real investments. As for the unit labour cost based REERs the evidence is somewhat less clear and highly sensitive to model specification. Furthermore, the difficulties in discriminating between the two-lag model and the four-lag model call for a cautious interpretation of the results. Finally, there is little evidence that export unit value-based REERs Granger cause real investments.

Summing up the results, we have that the weighting scheme generally matters little. We find that consumer price-based REERs contain leading information on real net exports, real investments, and real GDP. As for unit labour cost based REERs they contain leading

information on real investments and real GDP. However, p-values of Granger causality tests are generally more statistically significant and linear feedback statistics are correspondingly lower in comparison with the results of the consumer price based REERs and the results are much more sensitive to the model specification. Furthermore, there is no indication that unit labour cost-based REER indices contain any leading information on real net exports. In contrast, export unit value based REER indices contain leading information on real net exports, where they clearly perform better than consumer price-based REER indices. They do not, however, contain any leading information on either real investments or real GDP.

The findings of this study contradict the common view that a unit labour cost-based REER index is the best indicator of a country's competitive stance. For example, in a study that comes close to this one, Lafrance *et al*. (1998) find that unit labour cost-based REER indices perform better than REERs based on other price indices in the case of Canada. Lafrance *et al*. find evidence that unit labour cost-based REER indices Granger-cause real GDP, while no effects are found on net exports. In contrast, REERs based on other price indices are not found to Granger-cause either real GDP or net exports.

6. Summary and Concluding Remarks

This study has analysed alternative measures of the Swedish real effective exchange rate (REER). When constructing the REERs, one generally prefers weighting schemes that include a relatively broad set of countries with weights that reflect both direct trade flows and competition in third markets. A first conclusion of this study is that in the case of Sweden the choice of the weighting scheme is of subordinate importance. This is an expected result, confirming the findings for other countries. [16]

The choice of the price index used to construct the REER indices is by far more important. In this study we have considered consumer prices, export unit values and unit labour costs in manufacturing. The three alternative price indices are all associated with advantages and disadvantages and the literature provides only limited guidance as to the choice of price index.

If a REER index reflects a country's competitive stance, one would expect it to contain leading information on the aggregate demand and some of its components, perhaps most notably on net exports and investments. In a basic attempt to evaluate the relative merits

of the alternative REER indices we have estimated bivariate VARs, including a REER index and either real net exports, real investments, or real GDP. The results from the Granger-causality tests indicate that the REER indices based on consumer prices provide leading information on all three variables. As for the unit labour cost-based REER indices, they contain leading information on real investments and real GDP, but they do not perform quite as well as the consumer price based REER indices. Moreover, they do not contain any leading information on real net exports. As expected, the evidence of Granger-causality on real net exports is strongest for the export unit value based REER indices. However, there is little evidence that the latter Granger cause real investments and real GDP.

The simplistic specification of the VARs calls for a cautious interpretation of the results. Still, the results help in clarifying the picture of the alternative REER indices. The results confirm that REERs based on unit labour costs are associated with some degree of uncertainty. Furthermore, the supposition the REERs based on export unit value reflect primarily the competitiveness for internationally traded goods and services while REERs based on consumer prices reflect a broader measure of a country's competitive stance gets empirical support.

[16] See e.g. Edwards (1989) and Lafrance *et al*. (1998).

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Appendix A

Two alternative ways to define the real exchange rate are commonly used in the literature. Perhaps the most traditional way to define the real exchange rate is as a ratio of price levels between countries, expressed in a common numeraire. Recent theoretical work often defines the real exchange rate as the price ratio of tradables to non-tradables. Below, we will clarify the relation between these two alternative definitions.

To start with, consider the more traditional way to define the (domestic) real exchange rate

$$RER^{Dom} = S \cdot \frac{P^*}{P^{Dom}} \tag{A1}$$

In equation (A1), S is the nominal exchange rate expressed as domestic to foreign currency, P^* is the foreign price index in foreign currency, and P^D is the domestic price index in domestic currency. In practice, price indices used to compute real exchange rates typically include prices of both tradables and non-tradables (e.g. consumer prices, wholesale prices and the GDP deflator). For expositional purpose, assume that the foreign and domestic price indices are linear, homogeneous Cobb-Douglas functions of tradables (P_T) and non-tradables (P_N). The domestic and foreign price indices can then be written as

$$P^D = (P_N^D)^b \cdot (P_T^D)^{1-b} \tag{A2}$$

$$P^* = (P_N^*)^g \cdot (P_T^*)^{1-g} \tag{A3}$$

Making use of these aggregate price indices, the real exchange rate of equation (A1) may be rewritten as

$$\begin{aligned} RER^D &= S \cdot \frac{P^*}{P^D} \\ &= \frac{(S \cdot P_N^*)^g \cdot (S \cdot P_T^*)^{1-g}}{(P_N^D)^b \cdot (P_T^D)^{1-b}} \\ &= \left(\frac{P_T^D}{P_N^D}\right)^b \cdot \left(\frac{P_T^*}{P_N^*}\right)^{-g} \cdot \left(\frac{S \cdot P_T^*}{P_T^D}\right) \end{aligned} \tag{A4}$$

Under the assumption that absolute PPP holds for tradables, so that $P_T^D = S \cdot P_T^*$, the real exchange rate in equation (A4) may be further rewritten as

$$RER^D = \left(\frac{S \cdot P_T^*}{P_N^D} \right)^b \Big/ \left(\frac{P_T^*}{P_N^*} \right)^g \tag{A5}$$

Equation (A5) highlights the relationship between the real exchange rate defined as a ratio of price levels between countries and the real exchange rate defined as the relative price of tradables and non-tradables. The latter can be written as

$$\begin{aligned} RER_{T/N}^D &= \frac{P_T^D}{P_N^D} \\ &= S \cdot \frac{P_T^*}{P_N^D} \end{aligned} \tag{A6}$$

The major difference between RER^D and $RER_{T/N}^D$ is that the former includes the foreign price of non-tradables. The relation can be clarified further by writing

$$RER^D = \left(RER_{T/N}^D \right)^b \Big/ \left(RER_{T/N}^* \right)^g \tag{A7}$$

Equation (A7) shows that the definition of the real exchange rate as the relative price of tradables and non-tradables is merely a special case of the broader definition of the real exchange rate as the ratio of price levels between countries.

Appendix B

Data

The study makes use of semi-annual data for the period 1975:1 to 1998:1. Nominal exchange rates and consumer price indices have been obtained from *Ecowin* as monthly data. Figures on real investment, real net exports and real GDP have been computed from quarterly data obtained from *Statistics Sweden*. Export unit values and unit labour costs in manufacturing have been obtained from the *OECD Economic Outlook* as semi-annual data. When necessary, semi-annual data have been generated as average means of higher frequency data.

Real effective exchange rates are geometrically weighted, using data on nominal exchange rates and various price indices. MERM weights and TCW have been obtained from *Sveriges Riksbank* (1995). Bilateral trade weights (BTW) have been calculated using trade data from *IMF Direction of Trade Statistics*. The following variables are used in the study:

Euvmerm	Real effective exchange rate based on export unit values and MERM weights
Euvtcw	Real effective exchange rate based on export unit values and TCW
Euvbtw	Real effective exchange rate based on export unit values and BTW
Cpimerm	Real effective exchange rate based on consumer prices and MERM weights
Cpitcw	Real effective exchange rate based on consumer prices and TCW
Cpibtw	Real effective exchange rate based on consumer prices and BTW
Ulcmerm	Real effective exchange rate based on unit labour cost in manufacturing and MERM weights
Ulctcw	Real effective exchange rate based on unit labour cost in manufacturing and TCW
Ulcbtw	Real effective exchange rate based on unit labour cost in manufacturing and BTW
NetExp	Net exports
Invest	Investments
Real GDP	Real GDP
D1	Seasonal dummy variable

Testing for Stationarity

Test equations for Augmented Dickey-Fuller unit root tests:

1. Constant and trend: $\Delta y_t = \alpha_0 + \gamma y_{t-1} + \alpha_2 t + \sum \beta_i \Delta y_{t-1} + \varepsilon_t$

2. Constant, no trend: $\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum \beta_i \Delta y_{t-1} + \varepsilon_t$

3. No constant, no trend: $\Delta y_t = \gamma y_{t-1} + \sum \beta_i \Delta y_{t-1} + \varepsilon_t$

The tests were carried out as suggested in Enders (1995: pp. 257). A sufficient number of lags was added in each equation to get rid of serial correlation (Ljung-Box tests, not reported). Critical values (5% level, 50 observations) are as follows (see Enders (1995: pp. 419-421)):

Constant and trend: t-stat = 3,50; F-stat(ϕ_2) = 5,13; F-stat(ϕ_3) = 6,73

Constant, no trend: t-stat = 2,93; F-stat(ϕ_1) = 4,86

No constant, no trend t-stat = 1,95

Table B1. Results of augmented D-F tests. Figures significant at 5 percent level in bold.

		Constant and trend						Constant, no trend				No constant, no trend	
		lags	*Const* t-stat	*y(t-1)* t-stat	*trend* t-stat	*fi(2)* F-stat	*Fi(3)* F-stat	lags	*Const* t-stat	*y(t-1)* t-stat	*fi(1)* F-stat	lags	*y(t-1)* t-stat
LEVELS	Euvmerm	1	2,12	-2,12	0,11	1,51	2,25	1	2,15	-2,14	2,32	1	0,0437
	Euvtcw	1	2,42	-2,39	1,15	2,02	2,87	1	2,13	-2,10	2,35	2	0,727
	Euvbtw	1	2,30	-2,28	0,81	1,83	2,86	1	2,17	-2,14	2,43	2	0,664
	Cpimerm	1	2,50	-2,48	1,28	2,14	3,08	1	2,15	-2,11	2,36	1	0,299
	Cpitcw	1	3,11	-3,08	1,95	3,29	4,75	1	2,35	-2,31	2,84	1	0,365
	Cpibtw	1	3,16	-3,13	1,98	3,40	4,93	1	2,39	-2,35	2,93	1	0,361
	Ulcmerm	7	2,58	-2,55	1,49	2,39	3,27	7	2,10	-2,03	2,37	7	0,530
	Ulctcw	6	1,76	-1,70	1,44	1,64	1,46	6	1,06	-0,90	1,38	6	1,28
	Ulcbtw	6	1,70	-1,66	1,47	1,62	1,41	6	0,955	-0,800	1,30	6	1,30
	NetExp	1	-0,461	-0,91	1,37	1,98	0,985	1	1,41	0,305	1,99	1	1,39
	Invest	2	2,88	-2,89	0,915	2,83	4,24	2	2,75	-2,77	3,83	2	-0,288
	Real GDP	2	3,13	-3,08	3,07	4,55	4,80	2	0,605	-0,386	1,74	2	1,80
FIRST DIFF.	Euvmerm							0	0,193	**-5,21**	**13,6**	0	**-5,27**
	Euvtcw							0	0,529	**-5,53**	**15,3**	0	**-5,56**
	Euvbtw							0	0,493	**-5,66**	**16,0**	0	**-5,69**
	Cpimerm							0	0,477	**-4,63**	**10,8**	0	**-4,65**
	Cpitcw							0	0,554	**-4,65**	**10,8**	0	**-4,65**
	Cpibtw							0	0,545	**-4,69**	**11,0**	0	**-4,69**
	Ulcmerm							4	0,925	**-3,52**	**6,20**	1	**-2,05**
	Ulctcw							4	1,20	**-3,63**	**6,61**	4	**-3,41**
	Ulcbtw							4	1,20	**-3,64**	**6,64**	4	**-3,42**
	NetExp							1	1,79	**-4,17**	**8,74**	1	**-3,68**
	Invest							2	-0,077	**-3,07**	4,74	2	**-3,12**
	Real GDP							2	2,26	**-3,33**	**5,56**	2	**-2,33**

Testing for Cointegration

Engle-Granger cointegration tests are described in e.g. MacKinnon (1991). MacKinnon also provide critical values for rejecting the hypothesis of no cointegration. With two variables and a constant but (no trend) in the test equation, the critical value equals –3,47(-4,14) at the 5(1) percent level for a sample size of 47.

Table B2. Results of Engle-Granger cointegration tests.

Variables	Net Exports			Investments			Real GDP		
	Lags	Engle-Granger test-stat.	Ljung-Box Q-stat(10)	lags	Engle-Granger test-stat.	Ljung-Box Q-stat(10)	Lags	Engle-Granger test-stat.	Ljung-Box Q-stat(10)
Euvmerm	0	-2,24	0,928	0	-2,06	0,916	1	-2,18	0,795
Euvtcw	0	-2,35	0,914	0	-1,90	0,940	1	-2,49	0,888
Euvbtw	0	-2,24	0,928	0	-2,03	0,960	1	-2,38	0,894
Cpimerm	1	-2,23	0,845	1	-2,04	0,470	1	-2,65	0,555
Cpitcw	1	-3,06	0,933	1	-2,25	0,731	1	-3,07	0,884
Cpibtw	1	-3,21	0,910	1	-2,29	0,771	1	-3,12	0,888
Ulcmerm	0	-2,24	0,509	2	-2,17	0,577	1	-2,69	0,628
Ulctcw	1	-2,62	0,300	2	-1,97	0,701	1	-2,83	0,798
Ulcbtw	1	-3,18	0,276	2	-1,92	0,748	1	-2,80	0,814

Coefficients of Correlation

Table B3. Correlation coefficients of the various real effective exchange rate indices.

	Euvmerm	Euvtcw	Euvbtw	Cpimerm	Cpitcw	Cpibtw	Ulcmerm	Ulctcw	Ulcbtw
Euvmerm	1,00								
Euvtcw	0,872	1,00							
Euvbtw	0,921	0,989	1,00						
Cpimerm	0,793	0,874	0,839	1,00					
Cpitcw	0,678	0884	0,825	0,953	1,00				
Cpibtw	0,667	0,878	0,819	0,945	0,999	1,00			
Ulcmerm	0,752	0,910	0,866	0,938	0,954	0,951	1,00		
Ulctcw	0,607	0,871	0,804	0,867	0,949	0,951	0,971	1,00	
Ulcbtw	0,589	0,861	0,792	0,854	0,944	0,946	0,965	0,999	1,00