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Evaluating Alternative Measures of the Real Effective Exchange Rate

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Bank of Canada



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The views expressed in this paper are those of the authors. No responsibility for them should be attributed to the Bank of Canada.

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Abstract

This paper discusses the merits and shortcomings of alternative price indices used in constructing real effective exchange rate indices and examines the effects of different weighting schemes. It also compares selected measures of the real effective exchange rate in terms of their ability to explain movements in Canadian net exports and real output. The paper argues that, although different weighting schemes may at times provide useful and complementary information, the choice of a weighting scheme does not, in general, significantly affect on measures of Canada's competitiveness. The choice of a price index is usually the critical factor. In particular, real effective exchange rate indices that are computed using unit labour costs explain movements in Canadian net exports and real output significantly better than those based on consumer price indices.

Résumé

Les auteurs analysent les mérites et les lacunes de différents indices de prix utilisés dans l'élaboration de mesures du taux de change réel effectif ainsi que l'incidence du choix du mécanisme de pondération. Ils comparent également la capacité de certaines de ces mesures d'expliquer l'évolution des exportations nettes et de la production réelle au Canada. Selon eux, le recours à divers mécanismes de pondération peut parfois fournir des renseignements additionnels pertinents; toutefois, en règle générale, le choix du mécanisme de pondération n'influence pas de façon sensible la mesure de la compétitivité canadienne. Dans la plupart des cas, le facteur décisif est plutôt l'indice de prix retenu. Plus précisément, les mesures du taux de change réel effectif calculées à partir des coûts unitaires de main-d'oeuvre expliquent beaucoup mieux les variations des exportations nettes et de la production réelle au Canada que celles reposant sur les indices de prix à la consommation.

1. Introduction

Real effective exchange rate (REER) indices measure how nominal exchange rates, adjusted for price differentials between a country and its trading partners, have moved over a period of time. These measures are used as indicators of a country's overall international competitiveness—a decrease in the REER would normally lead, *ceteris paribus*, to an improvement in the country's real trade balance over time.¹ A REER index basically has three components: the range of foreign countries covered, their relative weights, and the price indices to be compared.²

This paper discusses the merits and shortcomings of alternative price indices used in constructing real effective exchange rate indices and examines the effects of different weighting schemes. It also compares the ability of selected measures of the real effective exchange rate to explain movements in Canadian net exports and real output. The paper argues that, in general, the choice of a weighting scheme does not significantly affect measures of Canada's competitiveness, even though different weighting schemes may at times provide useful and complementary information. The choice of a price index is usually the critical factor. In particular, real effective exchange rate indices that are computed using unit labour costs explain movements in Canadian net exports and real output significantly better than those based on consumer price indices.

Three factors motivated the writing of this paper. First, concerns have been expressed about the Bank of Canada's reliance on a relatively narrow effective exchange rate measure—the G-10 index—to monitor the evolution of monetary conditions.³ Some observers believe that the index should include a larger group of countries. If the G-10 index misrepresents the evolution of Canada's international competitiveness, there may be important implications for assessing the stance of monetary policy with the monetary conditions index.

Second, the emerging market economies in Asia are increasingly important in world trade, but, since mid-1997, a number of these countries have experienced sharp currency depreciations. This situation has raised the issue of whether this could lead to a major redistribution of competitiveness gains and losses across countries. While the Asian countries in crisis represent only a small fraction of Canada's overall trade, their firms compete in certain sectors with Canadian producers in third markets, notably the United States. Thus, an issue for consideration is

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1. International competitiveness is defined as the relative price of domestic tradable goods in terms of foreign tradables (see Turner and Golub 1997). Based on this definition, a decline in the relative price of a country's tradable good represents an improvement in international competitiveness.
 2. More formally: $REER = P / ((P_1 E_1)^{w_1} \cdot (P_2 E_2)^{w_2} \dots (P_n E_n)^{w_n})$ where P represents an index of domestic prices; $P_1 \dots P_n$ represent price indices of competitor countries; $E_1 \dots E_n$ represent the respective bilateral exchange rates; and $w_1 \dots w_n$ represent the relative weights of the foreign countries in the index.
 3. For instance, Carmichael (1998) argues that the Bank of Canada's focus on the G-10 index has led it to underestimate the extent to which the Canadian dollar has appreciated in real terms on an effective basis since the beginning of 1997.

the importance that should be given to competition in third markets when the country weights are determined in a real exchange rate index.

Third, various price indices have been suggested as possible candidates to construct real effective exchange rate indices (see Edwards 1989). Since each index has advantages and disadvantages, and real effective exchange rate measures differ depending on the price index used, it is necessary to determine which of them is more appropriate for analyzing changes in Canada's international competitiveness.

The paper is organized as follows. Section 2 discusses the relative merits of broad versus narrow REER measures in terms of country coverage and alternative weighting schemes. Section 3 reviews the advantages and disadvantages of alternative price measures. In Section 4, a number of selected REER measures for Canada are compared. To evaluate the ability of different measures to capture changes in competitiveness, Section 5 presents a simple test to estimate how different REER measures are related to aggregate demand and net exports. Section 6 concludes.

2. Country coverage and weighting schemes

This section discusses the scope of effective exchange rate measures and the relative merits of alternative weighting schemes.

In principle, it is desirable to include in REER measures all foreign countries whose firms compete with domestic producers either directly or indirectly through third markets. In practice, limitations in data availability and quality tend to restrict the number of countries that can be considered. Moreover, the value of using broad rather than narrow indices will depend on the extent to which they provide a different picture of a country's international competitiveness. For Canada, however, the breadth of country coverage does not matter much, given the high concentration of its trade with the United States. (See Section 4.)

Another issue relates to the nature of the goods and services that should be considered in computing country weights. Ideally, one would want to use data on all goods and services exposed to international competition (conceptually known as tradables). Tradables are not easily defined, however, so real exchange rate measures are usually based on actual trade data.

There are different methods of computing international competitiveness weights using international trade data. The total international competitiveness of any country consists of both import and export competitiveness. An import competitiveness indicator measures a country's competitive position in its home market, while an indicator for export competitiveness measures a country's competitive position in its export markets.

In most open economies, policy-makers are more interested in the total international competitive position of their countries. In this case, appropriate REER measures should include

both import and export weights. Computing import weights is fairly straightforward and is based on bilateral imports. However, there are various ways to compute export weights, including bilateral, multilateral, and double export weighting schemes.

In the bilateral export weighting system, the weights are derived based on bilateral trade patterns. They take into account direct trade and competition between a country and its trading partners. However, they do not consider indirect competition between two trading partners in third markets, thereby understating the degree of competition faced by domestic producers in external markets.

Under the multilateral export weighting system, the weight attached to each competitor in a given country's export competitiveness index is the relative weight of that competitor's exports in world trade. Multilateral weights incorporate competition in third markets by assuming that all countries compete equally in the global market. The main limitation of this approach, however, is that it does not take account of countries' specific export markets. In particular, this approach may overstate the relative importance of small countries that have large export sectors and trade mainly among themselves.

The double export weighting system is a much more acceptable method of computing competitiveness weights. Under this approach, the export competitiveness weight for any country is derived as a combination of two components: a bilateral export weight, which accounts for direct competition between exporters and domestic producers in a particular export market; and a third-market export weight, which captures competition between exporters from two different countries in a third market.⁴

The multilateral exchange rate model (MERM) developed by the International Monetary Fund (IMF) provides a different method of computing competitiveness weights. MERM was designed to estimate the medium-term effects of changes in the exchange rates of industrial countries on their trade balances.⁵ Simulations of the model are used to derive competitiveness weights. Country coverage is limited to selected industrial countries, however, and the model is rather dated. The IMF has not published MERM-based exchange rate measures for a number of years.

All things considered, the double export weighting approach would seem to be the most appropriate way to account for foreign competition in a broad spectrum of markets.

4. Although these approaches are conceptually different, there are circumstances in which the measures of export competitiveness derived using the various approaches will be the same. For instance, the bilateral export weighting system will yield similar weights as the double export weighting system if a country faces competition in each export market only from domestic producers in those markets. Similarly, the multilateral export weighting system will yield the same result as the double export weighting system if international competition only takes place between exporters in global markets.

5. For a description of the main features of the multilateral exchange rate model, see Artus and McGuirk (1981).

3. Price indices

A major problem in designing a relevant real exchange rate index is the choice of domestic and foreign price indices. In principle, they should cover a representative basket of traded goods and services that are comparable across countries.⁶ Moreover, price measures should try to reflect underlying trends rather than temporary movements associated with “pricing to market” or other short-term influences.

Available measures of international competitiveness, however, often fail to meet these criteria. These measures include export and import unit values, consumer price indices (CPI), wholesale and producer price indices (WPI, PPI), GDP deflators, and unit labor costs (ULC). Each of these measures has its strengths and weaknesses.

Relative export and/or import unit values provide the most direct measure of the prices of goods actually traded. However, the type of goods included may differ substantially from one country to another. Export and import unit values may be heavily influenced by short-run pricing to market as firms may be setting prices to preserve market share in the short run; this results in prices that do not reflect costs at normal profit levels. They may also be heavily weighted with prices of primary products whose prices are determined in world markets.⁷ Moreover, they are not available for many countries.

The main problem shared by consumer price indices, producer price indices, and GDP deflators is that they include non-traded goods as well as traded goods. Traded and non-traded goods prices may diverge over time due to differential sectoral productivity growth. Thus, aggregate price indices could be very misleading indicators of the prices of traded goods. Producer price indices cover more of the tradable goods sector than export prices, but their coverage, method of construction, and weighting vary substantially from country to country. GDP deflator-based measures are basically comparable across countries. However, they include price developments in non-traded goods and services such as construction and the government sector.

Consumer prices, while broadly comparable across countries, have a number of drawbacks as indicators of international competitiveness. They reflect changes in the prices of non-traded items such as housing and services; they cover only consumer goods; and they may incorporate a large component of imported goods, thereby understating an improvement in competitiveness following a depreciation of the currency.

6. One might consider excluding primary products, however, as their prices cannot diverge much internationally even if underlying competitiveness changes.

7. This is particularly a problem for Canada, given the relative importance of its commodity exports. For instance, when commodity prices are generally declining, Canada’s REER based on export unit values tends to show a disproportionate improvement in international competitiveness (see Lafrance 1988).

Relative unit labour costs indices, in a common currency, are often used as indicators of international competitiveness. ULC indices provide a broad indication of domestic costs of production.⁸ Labour costs are, however, only one element of the production process and they do not take account of the cost of capital or material inputs. However, while capital and intermediate goods are traded in international markets, labour remains largely immobile internationally. Thus, labour costs are likely to diverge much more across countries than do other costs of production and therefore play a disproportionately important role in competitiveness.

What can be concluded about the most appropriate indicator of international price or cost competitiveness? To the extent that a competitiveness index seeks to capture a country's ability to sell its products in international markets, it would seem preferable to focus on domestic cost considerations associated with tradable goods. In this respect, relative unit labour cost measures—particularly if restricted to the manufacturing sector as more representative of tradable goods—would seem to be the most relevant indicators of competitiveness.

There are severe limitations, however, with respect to data availability and quality of ULC measures for emerging markets. Recent studies by the OECD and the IMF have noted that data series for these countries are typically available only with a 1- to 2-year lag. Thus, to monitor Canada's international competitiveness with a broader country set including emerging market economies, one may have to rely on indices, such as the CPI, that appear to be highly correlated with unit labour costs. (See Section 4.)

4. Comparing alternative REERs for Canada

While economic theory can provide some guidance on the most relevant REER measures, perceived differences may be academic if most measures trace the same picture of Canada's international competitiveness. In this section, we compare selected REER measures to ascertain whether differences in country coverage, weighting schemes, and the choice of price indices matter. Table 1 provides background information on country weights for selected REER measures. The measures calculated by the IMF and the Bank for International Settlements (BIS) use double export weighting schemes, while J.P. Morgan and the Bank of Canada (BoC) measures use bilateral trade weights.⁹ The countries that are included differ, depending on the measure, as do the reference years for the trade data used in the calculations: IMF (1988–1990 averages), BIS and Morgan (1990), and Bank of Canada (1996).

8. The unit labour cost is the ratio of the cost of a unit of labour to its productivity. As the measured productivity of labour can exhibit wide swings in the course of the business cycle, notably through labour hoarding in downturns, it is preferable to use a unit labour cost index that has been corrected for cyclical effects, by means of various filtering techniques. The appropriate choice of filters is also an issue that needs to be examined.

9. The "IMF REER measures" were in fact calculated by us based on IMF weights.

First, we compare a number of narrow and broad indices with different country coverages and weighting schemes, using CPI prices. Sample period and end points are determined by data availability. In the 1990s, the indices have moved broadly together (Figure 1) and are highly correlated (Table 2). This is not surprising given the dominant position of the United States in all the weighting schemes. Differences are apparent, however, in specific periods. For instance, indices that give the United States a lower weight indicate more depreciation of the Canadian dollar in real terms in 1995, but greater appreciation more recently (Figure 2), reflecting the appreciation of the Canadian dollar against Asian currencies. These results suggest that the breadth of country coverage and the nature of weighting schemes are generally of secondary importance for a country such as Canada whose external trade is highly concentrated. However, in specific episodes, country coverage can make a difference.

Second, we compare three BIS indices with the same weights but different types of price indices (Figure 3).¹⁰ Judged by the experience of the 1990s, the choice of price indices matters. Canada seems highly competitive recently, based on CPI data, but much less so when producer prices are used to calculate real effective exchange rates.

10. The BIS uses interpolation techniques to provide an up-to-date ULC-based REER series for manufacturing.

Table 1: Country coverage and weights of alternative REER indices (%)

| COUNTRY | IMF | BoC-G43 | BoC-G24 | BoC-G10 | Morgan | BIS ^a |
|-------------------------------|-------|---------|---------|---------|------------------|------------------|
| US | 58.65 | 77.70 | 79.48 | 87.29 | 68.6 | 69.9 |
| UK | 3.03 | 1.98 | 2.02 | 2.22 | 2.4 | 2.5 |
| BELGIUM | 0.71 | 0.47 | 0.48 | 0.53 | 0.6 | 0.6 |
| FRANCE | 2.02 | 1.03 | 1.06 | 1.16 | 1.8 | 1.9 |
| GERMANY | 4.04 | 1.62 | 1.66 | 1.82 | 3.6 | 3.6 |
| ITALY | 1.82 | 0.82 | 0.84 | 0.93 | 1.6 | 1.6 |
| NETHERLANDS | 0.81 | 0.51 | 0.53 | 0.58 | 0.7 | 0.7 |
| SWEDEN | 0.91 | 0.29 | 0.30 | 0.33 | 0.7 | |
| SWITZERLAND | 0.81 | 0.38 | 0.38 | 0.42 | 0.8 | |
| JAPAN | 10.82 | 4.21 | 4.31 | 4.73 | 8.3 | 8.7 |
| NORWAY | 0.20 | 0.73 | 0.75 | | 0.1 | |
| AUSTRIA | 0.30 | 0.21 | | | 0.3 | |
| DENMARK, FINLAND | 0.50 | 0.22 | | | 0.5 | |
| GREECE, PORTUGAL, TURKEY | 0.20 | 0.18 | | | 0.5 | |
| IRELAND | 0.30 | 0.16 | | | 0.2 | |
| SPAIN | 0.40 | 0.23 | | | 0.3 | 0.4 |
| AUSTRALIA | 0.40 | 0.46 | 0.47 | | 0.3 | |
| NEW ZEALAND | 0.10 | 0.11 | | | 0.1 | 0.4 ^b |
| SOUTH AFRICA | 0.10 | 0.13 | | | 1.8 | |
| ARGENTINA, BRAZIL, CHILE | 1.01 | 0.70 | 0.73 | | 0.7 | |
| COLOMBIA, PERU, VENEZUELA | 0.20 | 0.45 | | | 0.1 | |
| MEXICO | 1.92 | 1.43 | 1.46 | | 1.5 | |
| TAIWAN, HONG KONG, CHINA | 5.16 | 2.92 | 2.98 | | 2.8 ^c | |
| INDONESIA | 0.20 | 0.30 | 0.31 | | 0.2 | |
| KOREA | 2.53 | 1.10 | 1.13 | | 1.9 | |
| MALAYSIA, SINGAPORE, THAILAND | 1.71 | 1.10 | 1.13 | | 1.3 | |
| INDIA, BANGLADESH | 0.40 | 0.22 | | | 0.3 | |
| ISRAEL, POLAND, HUNGARY | 0.40 | 0.18 | | | | |
| PHILIPPINES | 0.30 | 0.16 | | | 0.2 | |

- a. Other European countries have a combined weight of 2.1 in the BIS index. Taiwan, Hong Kong, South Korea, Singapore, and Mexico have a combined weight of 7.0.
- b. Combined Australia and New Zealand weight.
- c. Does not include China.

Table 2: Correlation of year-over-year growth rates for CPI-based measures
(1991Q1 to 1998Q1)

| | BoC-G10 | BoC-G24 | BoC-G43 | IMF | Bilateral | BIS |
|------------------|----------------|----------------|----------------|--------------|------------------|--------------|
| BoC-G10 | 1.000 | 0.997 | 0.997 | 0.963 | 0.979 | 0.981 |
| BoC-G24 | | 1.000 | 1.000 | 0.969 | 0.975 | 0.984 |
| BoC-G43 | | | 1.000 | 0.972 | 0.972 | 0.987 |
| IMF | | | | 1.000 | 0.894 | 0.996 |
| Bilateral | | | | | 1.000 | 0.926 |
| BIS | | | | | | 1.000 |

Table 3: Correlations between measures of the Canadian-U.S. real exchange rate
(year-over-year growth rates for the period: 1991Q1 to 1998Q1)

| | ULC-based | CPI-based | Deflator-based | PPI-based |
|-----------------------|------------------|------------------|-----------------------|------------------|
| ULC-based | 1.00 | 0.878 | 0.964 | 0.740 |
| CPI-based | | 1.00 | 0.950 | 0.680 |
| Deflator-based | | | 1.00 | 0.767 |
| PPI-based | | | | 1.00 |

Figure 1

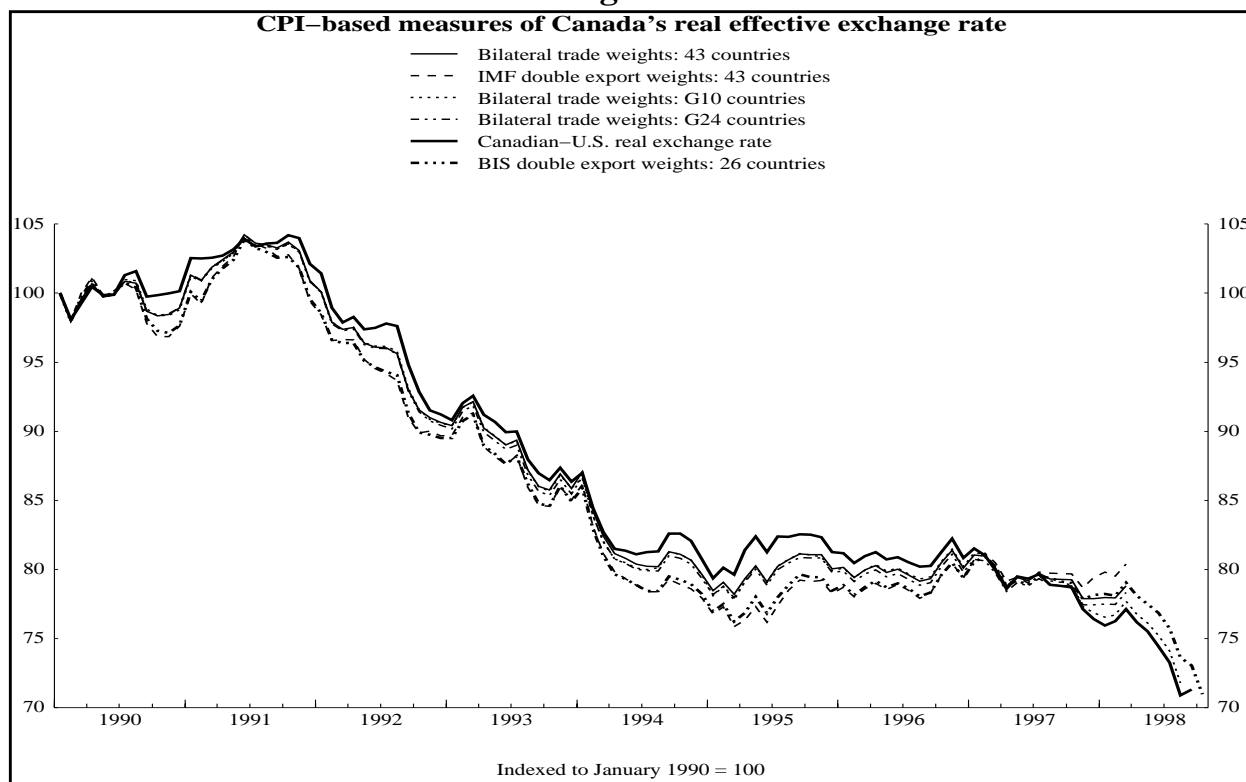


Figure 2

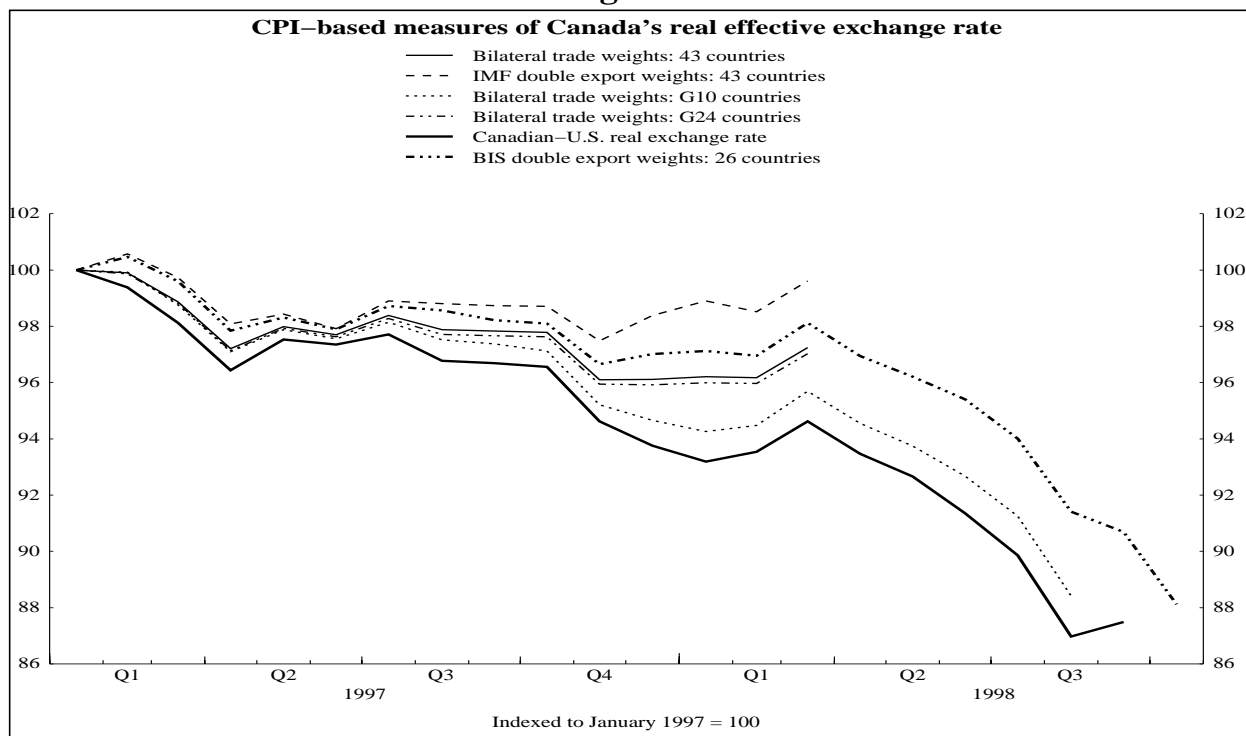


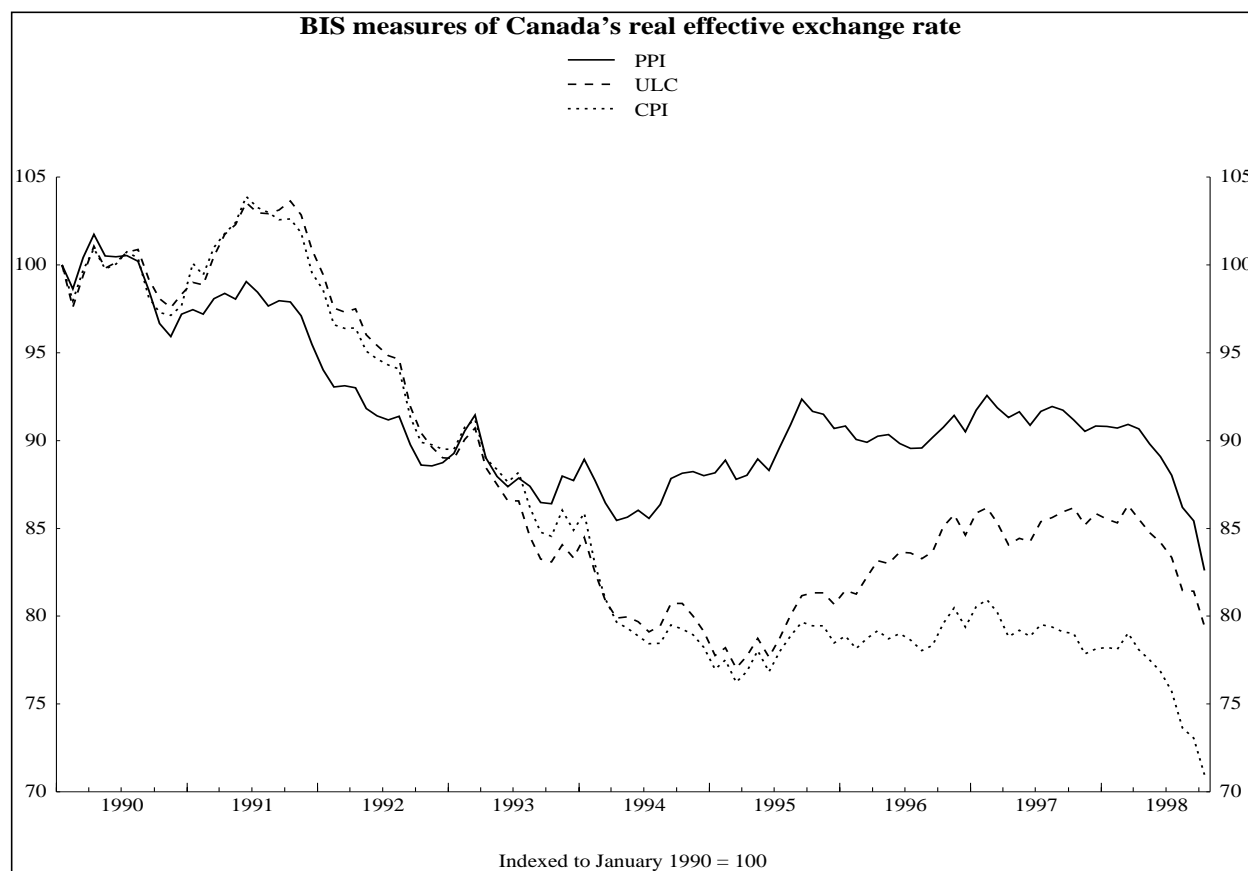
Figure 3

Figure 4, which focuses on Canada's position relative to that of the United States, confirms this view.¹¹ Since 1992, producer prices have risen much faster in Canada than in the United States, while the opposite has been true for consumer prices (Figure 5). The sharp depreciation of the Canadian dollar in the early 1990s might account for part of the difference. Many products whose prices are included in the PPI index are denominated in U.S. dollars (the index includes a large share of export prices). Thus, the depreciation is likely to have had more impact on PPI than on CPI prices. It is not surprising to find that, in general, the correlation between the series with different prices indices (Table 3) is much weaker than that between series with the same price indices but different weighting schemes (Table 2). It is also interestingly that the PPI index is the one least correlated with the others.

11. We noted different trends in the ULC-based BIS and bilateral REER measures, however, particularly in the 1970s. This could be due to data quality problems. Proxies were used in the BIS series over certain periods.

Figure 4

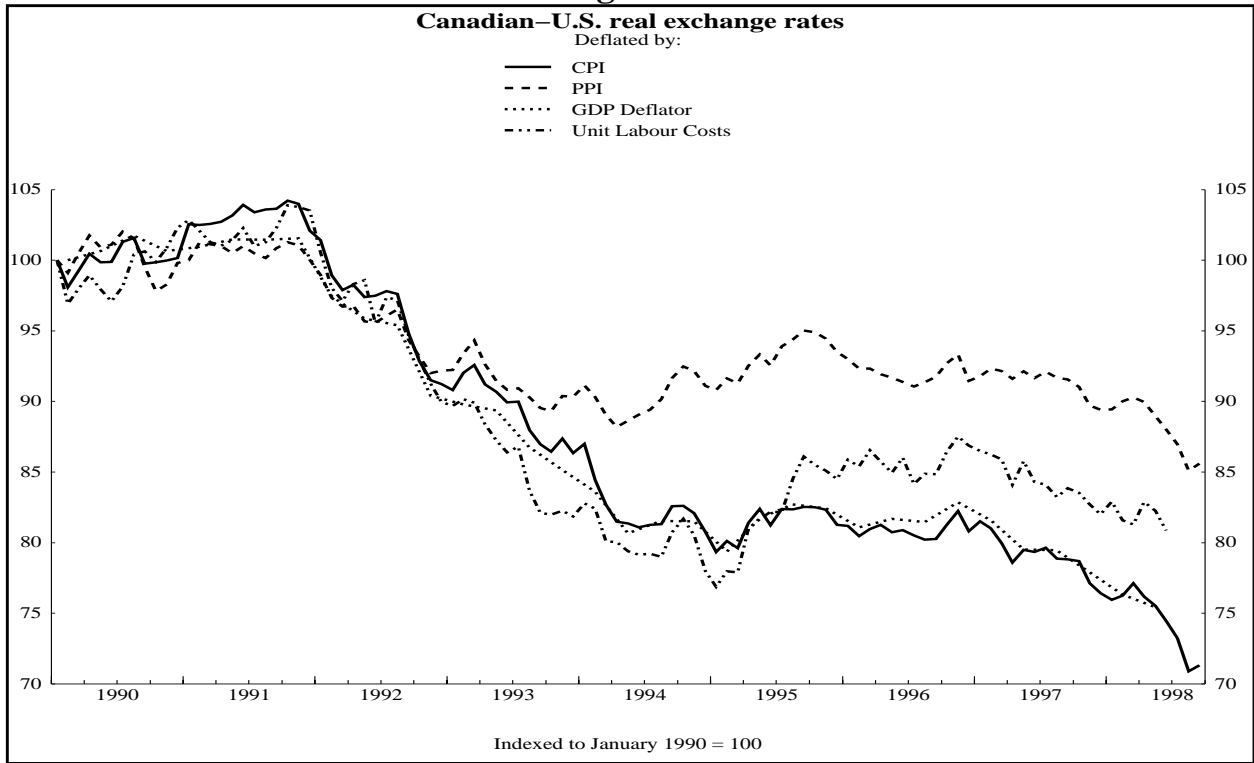
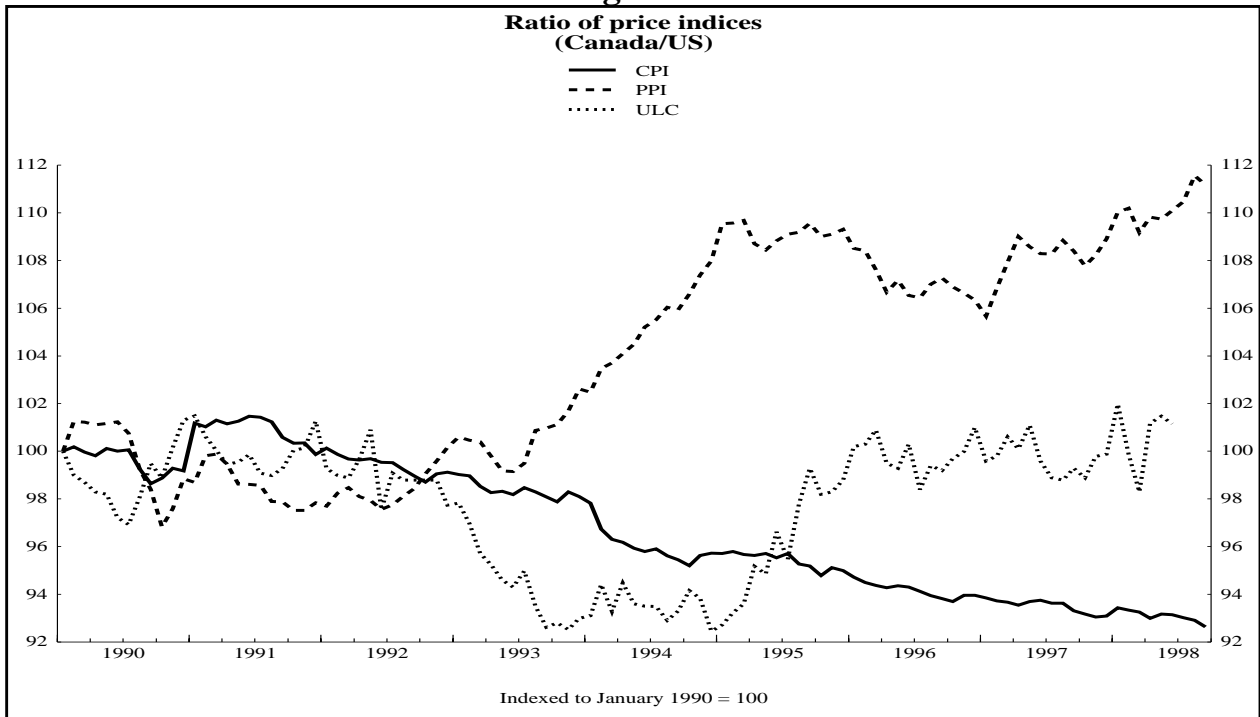


Figure 5



5. The relationship between measures of the REER and aggregate demand

The exchange rate is a channel through which monetary policy can affect aggregate demand and inflation. It is thus of interest to study the possible relationship between different REER measures and aggregate demand, either directly or indirectly through the trade balance. We carry out Granger-causality tests to determine which REER measure provides better leading information on net real exports and real GDP.

Granger (1969) causality refers to predictability. Variable x_i causes variable x_j if adding x_i in the information set used to determine x_j improves the latter's forecast.

Assume that $x_t = (x_{1t}, \dots, x_{Kt})'$ is a stationary process for which there exists an autoregressive representation of order p :

$$x_t = \sum_{k=1}^p \Pi_k x_{t-k} + u_t$$

where u_t is second-order stationary and normally distributed. The hypothesis that x_i does not cause x_j corresponds to testing the following constraints:

$$\pi_{ji,k} = 0 \text{ for } k = 1, \dots, p.$$

In this paper, we are primarily interested in assessing how much leading information on real net exports and real GDP there is in different measures of the REER. Geweke (1984) discusses the following statistic designed to measure the degree of linear feedback between variables x_j and x_i in the context of a VAR system:

$$\text{linfeed} = \log(\text{var}(u_i^c) / \text{var}(u_i))$$

where u_i^c corresponds to the case where the coefficients of x_j , a REER measure, in the x_i (real net exports or real GDP) VAR equation are constrained to be zero. If there were absolutely no causality, *linfeed* would be equal to zero. The larger *linfeed* is, the more information there is in the measure of the REER being considered.

We first look at bivariate VARs with a REER measure and either real GDP or real net exports. The number of lags that are included in the VARs is determined by the Akaike criterion. Net real exports, which correspond to real exports minus real imports, are assumed to be stationary in levels. Real GDP and the different measures of the REER are assumed to be stationary in first differences. These assumptions are consistent with the unit root tests presented in Appendix 1, except for ULC-based REER measures that could be stationary in levels. Real net exports are difficult to pin down, however. The unit root is rejected at the 10 per cent significance level but not at the 5 per cent level. We assume that this series is stationary in levels.

In Tables 4 and 5, we examine the relationship between four bilateral real exchange rate measures and net real exports and real GDP, with samples determined by data availability. The tables report the number of lags included in the VAR, the marginal level of significance of the test that the lags of the REER in the real net exports or the real GDP equation are jointly zero (i.e., that Granger-causality is rejected), and the *linfeed* statistic.

Table 4: Causality tests and linear feedback with 2-variable VARs using different measures of the Canadian-U.S. real exchange rate and real net exports
(Sample: 1964Q1 to 1997Q4)

| Real exchange rate | Number of lags | Marginal level of significance | <i>linfeed</i> |
|------------------------|----------------|--------------------------------|----------------|
| CPI | 5 | 0.294 | 0.051 |
| Deflator | 5 | 0.157 | 0.066 |
| PPI | 1 | 0.551 | 0.004 |
| ULC (first-difference) | 6 | 0.111 | 0.088 |
| ULC (level) | 5 | 0.291 | 0.051 |

Table 5: Causality tests and linear feedback 2-variable VARs using different measures of the Canadian-U.S. real exchange rate and real GDP
(Sample: 1961Q1 to 1997Q4)

| | Number of lags | Marginal level of significance | <i>linfeed</i> |
|------------------------|----------------|--------------------------------|----------------|
| CPI | 1 | 0.755 | 0.001 |
| Deflator | 1 | 0.616 | 0.002 |
| PPI | 1 | 0.708 | 0.001 |
| ULC (first-difference) | 2 | 0.043 | 0.045 |
| ULC (level) | 1 | 0.004 | 0.059 |

The results are consistent with the points made in Section 3 as they indicate that the ULC-based measure provides the most linear feedback with real net exports and real GDP. In the latter case, the ULC-based measures clearly dominate. The other measures are not significant. In the

case of real net exports, no measure is significant at conventional significance levels. In terms of linear feedback, the ULC-based measure in first differences is the best performer. In all cases, the PPI-based measure performs poorly.

Since exchange rates are considered jointly with short-term interest rates movements in the Bank of Canada's monetary conditions index, we performed causality tests with 3-variable VARs, adding real interest rates to the mix.¹² The real interest rate, which is unobserved, is proxied by the overnight rate (see Armour, Engert, and Fung 1996) minus current CPI inflation (annualized quarterly growth rates). It is assumed to be stationary in first differences (see Appendix 1). The results in Tables 6 and 7 below are broadly consistent with those presented in Tables 4 and 5.

Table 6: Causality tests and linear feedback statistics estimated with 3-variable VARs using real net exports, interest rates, and measures of the Canadian-U.S. REER (Sample: 1964Q1 to 1997Q4)

| REER | Number of lags | Marginal level of significance | linfeed |
|------------------------|----------------|--------------------------------|---------|
| CPI | 1 | 0.206 | 0.0497 |
| Deflator | 3 | 0.112 | 0.0631 |
| PPI | 1 | 0.450 | 0.0044 |
| ULC (first-difference) | 4 | 0.188 | 0.0517 |
| ULC (level) | 4 | 0.081 | 0.0698 |

We noted above that, because of the preponderance of the U.S economy in all weighting schemes, bilateral and multicountry measures tend to be highly correlated. Nevertheless, it might be interesting to see if including more countries in the index improves the information content of a REER measure sufficiently to make a significant difference empirically. Unfortunately, multicountry measures are not available before 1970. The results presented in Tables A2 and A3 of Appendix 2 are thus based on shorter samples for all measures for which data is available. ULC-based measures are again generally the best performers in 2-variable VARs.¹³ It is difficult, however, to draw conclusions concerning weighting schemes. This could reflect the dominance of the U.S. economy in Canada's trade or poor quality in the some of the data.

12. See Freedman (1995) for a discussion of the role of the exchange rate in the Bank of Canada's monetary conditions index.

13. Results for the 3-variable case (not reported) were similar but in general more favourable to the bilateral ULC-based index.

Table 7: Causality tests and linear feedback statistics estimated with 3-variable VARs using real GDP, interest rates, and measures of the Canadian-U.S. REER (Sample: 1961Q1 to 1997Q4)

| Real exchange rate | Number of lags | Marginal level of significance | <i>linfeed</i> |
|------------------------|----------------|--------------------------------|----------------|
| CPI | 1 | 0.808 | 0.0004 |
| Deflator | 1 | 0.600 | 0.0020 |
| PPI | 1 | 0.684 | 0.0012 |
| ULC (first-difference) | 2 | 0.046 | 0.0447 |
| ULC (level) | 1 | 0.004 | 0.0589 |

6. Conclusions

The analysis presented in this paper suggests the following conclusions:

- The literature provides only limited guidance on what price indices should be used for calculating REERs. However, to the extent that a competitiveness index seeks to capture a country's ability to sell its products in international markets, it would seem preferable to focus on domestic cost considerations associated with tradable goods. In this respect, relative unit labour cost measures—particularly if restricted to the manufacturing sector as more representative of tradable goods—would seem to be the most relevant indicators of competitiveness.
- In principle, it is preferable to include a relatively broad set of countries in REER measures, with weights that reflect competition in third markets. As we noted, the double export weighting approach would seem to be the most appropriate way to account for foreign competition in a broad spectrum of markets. Broad measures that incorporate third-country competition may provide useful information at times, the recent Asian financial crisis being a case in point.
- There is a trade-off, however, between country coverage and timeliness. REER indices that include a large number of emerging markets are typically dated and not particularly useful for monitoring purposes.¹⁴ Data quality for price indices for some of these countries may also be an issue. Moreover, historical samples for broad measures tend to be rather short, limiting empirical work with these series to a large extent.

14. While these series could be updated by using forecast measures, forecasting errors are likely to seriously limit their usefulness for monitoring purposes.

- In practical terms, for Canada, the choice of representative price indices is more critical than is the question of country coverage or weighting scheme. The dominant position of the U.S. economy in Canada's trade is such that various REER measures that differ only on the basis of country coverage or weighting schemes tend to move in a roughly similar fashion. In contrast, we noted that real exchange rate measures that were based on different price indices could differ markedly over relatively short periods.
- Granger-causality tests indicate that there is, in general, a closer relation between both real net exports or real GDP and unit labour cost REER measures than with the other measures that were considered. However, it is difficult to draw conclusions concerning the different weighting schemes on the basis of these tests.

Can we identify a preferable REER measure? While broader measures that incorporate third-country effects and focus on factor cost comparisons would be preferable, data limitations lead us to consider second-best options. Moreover, broad indices of Canada's competitiveness usually will not differ much from narrower ones due to the predominant weight put on the U.S. economy. Still, we would recommend monitoring a broader range of REER measures to give some perspective to exchange rate movements. Overall relative unit labour cost measures seem to be best suited to the task. In the case of broader indices, CPI-based measures should be adequate for monitoring purposes. We would not recommend using PPI-based indices because comparability may be limited, the data may reflect to a large extent past movements in the exchange rate, and there is no apparent relationship between these REER measures and real net exports in Canada's case.

Appendix 1: Unit root tests

Table A1 shows the results of the augmented Dickey-Fuller test of the null hypothesis of non-stationarity for real net exports and different measures of the REER. The results support the hypothesis that real net exports are stationary in levels while the various REER measures are stationary in first differences. The only exceptions are the ULC-based measures of the REER, which appear to be stationary in levels. Of course, these results are to be taken with caution since unit root tests are known for having both power and, for some data generating processes, level problems.

Table A1: Unit root tests^a

| | Number of lags | Test statistics |
|----------------------------|----------------|-----------------|
| Real net exports | 6 | -2.670 |
| Real GDP | 3 | -3.295 |
| CPI-based (bilateral) | 3 | -1.480 |
| Deflator-based (bilateral) | 7 | -2.035 |
| PPI-based (bilateral) | 6 | -2.392 |
| ULC-based (bilateral) | 3 | -2.953 |
| BIS (CPI-based) | 4 | -1.261 |
| BIS (PPI-based) | 1 | -2.118 |
| BIS (ULC-based) | 7 | -3.494 |
| J.P. Morgan (PPI-based) | 7 | -2.051 |
| Bank of Canada G-10 | 4 | -1.050 |
| Real interest rates | 3 | -2.442 |

- a. The sample used for the Bank of Canada, J.P. Morgan, and BIS indices is 1972Q1 to 1997Q4. The sample for the other series is 1964Q1 to 1997Q4. The number of lags was chosen using the recursive procedure suggested by Ng and Perron (1993). All tests, except for the test on real GDP, assume that there is no linear deterministic trend in the series. The critical value for the no-trend case is approximately -2.57 at a 10 per cent significance level and -2.89 at a 5 per cent level. The corresponding values in the trend-case are -3.15 and -3.45. Bold figures indicate that the unit root is rejected at the 5 per cent level.

Appendix 2: Causality tests and linear feedback

Table A2: Causality tests and linear feedback statistics estimated with 2-variable VARs using real net exports and alternative measures of the REER
(Sample: 1972Q1 to 1997Q4)

| REER | Number of lags | Marginal level of significance | linfeed |
|-----------------------------------|----------------|--------------------------------|---------|
| CPI-based (bilateral) | 1 | 0.647 | 0.0086 |
| Deflator-based (bilateral) | 1 | 0.399 | 0.0137 |
| PPI-based (bilateral) | 1 | 0.674 | 0.0082 |
| ULC-based (bilateral) | 1 | 0.494 | 0.0112 |
| ULC-based (bilateral) (in levels) | 4 | 0.136 | 0.0761 |
| BIS (CPI-based) | 1 | 0.543 | 0.0102 |
| BIS (PPI-based) | 1 | 0.574 | 0.0097 |
| BIS (ULC-based) | 1 | 0.209 | 0.0225 |
| BIS (ULC-based) (in levels) | 1 | 0.004 | 0.0593 |
| J.P. Morgan (PPI-based) | 1 | 0.349 | 0.0153 |
| Bank of Canada G-10 (CPI-based) | 1 | 0.584 | 0.0095 |

Table A3: Causality tests and linear feedback statistics estimated with 2-variable VARs using real GDP and alternative measures of the REER
(Sample: 1972Q1 to 1997Q4)

| REER | Number of lags | Marginal level of significance | linfeed |
|-----------------------------------|----------------|--------------------------------|---------|
| CPI-based (bilateral) | 1 | 0.643 | 0.0022 |
| Deflator-based (bilateral) | 1 | 0.509 | 0.0042 |
| PPI-based (bilateral) | 1 | 0.350 | 0.0089 |
| ULC-based (bilateral) | 2 | 0.024 | 0.0239 |
| ULC-based (bilateral) (in levels) | 4 | 0.047 | 0.1057 |
| BIS (CPI-based) | 1 | 0.826 | 0.0005 |
| BIS (PPI-based) | 1 | 0.612 | 0.0018 |
| BIS (ULC-based) | 4 | 0.339 | 0.0498 |
| BIS (ULC-based) (in levels) | 1 | 0.703 | 0.0015 |
| J.P. Morgan (PPI-based) | 1 | 0.922 | 0.0000 |
| Bank of Canada G-10 (CPI-based) | 1 | 0.752 | 0.0010 |

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