

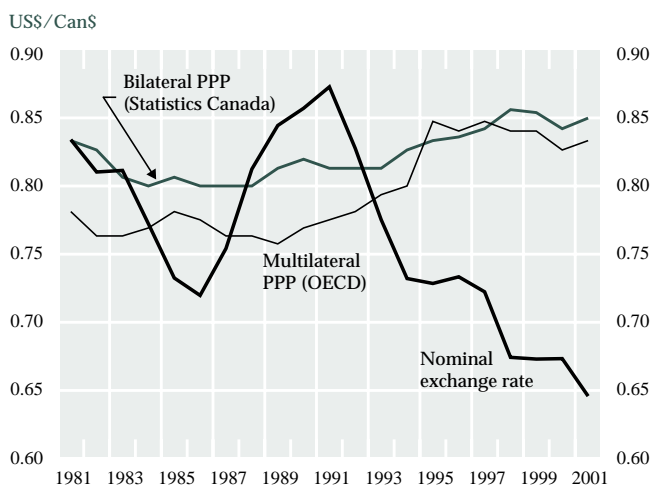
Purchasing-Power Parity: Definition, Measurement, and Interpretation

Robert Lafrance and Lawrence Schembri, International Department

- *The concept of purchasing-power parity (PPP) has two applications: it was originally developed as a theory of exchange rate determination, but it is now primarily used to compare living standards across countries.*
- *From the perspective of exchange rate determination, PPP is useful as a reminder that monetary policy has no long-run impact on the real exchange rate. Thus, countries with different inflation rates should expect their bilateral exchange rate to adjust to offset these differentials in the long run. The exchange rate, however, can deviate persistently from its PPP value in response to real shocks.*
- *To compare living standards across countries, PPP exchange rates are constructed by comparing the national prices for a large basket of goods and services. These rates are used to translate different currencies into a common currency to measure the purchasing power of per capita income in different countries. A PPP exchange rate constructed in this manner is not, however, an accurate measure of the equilibrium value of the market-determined exchange rate.*

It has been argued that the Canadian dollar is undervalued because its current market value is below the purchasing-power-parity (PPP) exchange rate calculated by the Organisation for Economic Co-operation and Development (OECD) and Statistics Canada (Chart 1). While the deviation of the value of the Canadian dollar from its purchasing-power-parity rate has been growing in recent years, this article argues that this deviation cannot be interpreted as implying that the Canadian dollar is undervalued by a comparable amount. Instead, this deviation indicates that the prices of goods and services are, on average, lower in Canada than in the United States, when measured in the same currency at the prevailing exchange rate.

Chart 1
Canada's PPP Exchange Rate



PPP as a Theory of Exchange Rate Determination

While the origins of the PPP concept can be traced back to the Salamanca School in 16th-century Spain, its modern use as a theory of exchange rate determination begins with the work of Gustav Cassel (1918), who proposed PPP as a means of adjusting pre-World War I exchange rates or parities for countries intending to return to the gold standard system after hostilities ended.¹ Some adjustment was necessary because countries that left the gold standard in 1914 experienced significantly different rates of inflation during and after the war.²

As a theory of exchange rate determination, the simplest and strongest form of PPP (absolute PPP) is based on an international multi-good version of the law of one price (Box 1). Absolute PPP predicts that the exchange rate should adjust to equate the prices of national baskets of goods and services between two countries because of market forces driven by arbitrage. Under absolute PPP, the exchange rate is simply equal to the ratio of the domestic to the foreign price of a given aggregate bundle of commodities, but this implies that the real exchange rate is constant.³

In practice, however, absolute PPP does not hold for a number of reasons, and these undermine its usefulness as a theory of the determination of the level of the exchange rate.⁴ The most important are

- the existence of non-traded goods and services that preclude arbitrage
- the presence of significant transactions costs for traded goods, including transport costs, tariffs, taxes, information costs, and other non-tariff trade barriers that make arbitrage costly⁵

1. Dornbusch (1987) provides a historical overview and insightful discussion of PPP.

2. Like Cassel, Keynes believed that the exchange rate needed to be adjusted for inflation differentials because he recognized that wages and prices were too sticky to adjust. Unfortunately, Winston Churchill, as Chancellor of the Exchequer, decided to return the United Kingdom to its pre-war parity in 1925. This move proved disastrous; exports fell and unemployment increased sharply.

3. The real exchange rate is defined here as the exchange rate deflated by the ratio of the domestic to the foreign price index.

4. Perhaps the strongest criticism of the absolute version of PPP is by Paul Samuelson (1964, p. 153). "Unless very sophisticated indeed, PPP is a misleadingly pretentious doctrine, promising us what is rare in economics, detailed numerical prediction."

5. Rogoff (1996) surveys evidence that the law of one price does not hold for most traded goods and services; he concludes that international markets for these items are much less integrated than domestic markets.

- the composition of the basket of goods and services included in measures of national price levels differs across countries, especially for producer-based as opposed to consumer-based price indexes, and
- the fact that the real exchange rate is not constant in the short run because aggregate price levels are sticky and the exchange rate is affected by money or asset market shocks, or in the long run because of persistent real shocks

In practice . . . absolute PPP does not hold for a number of reasons, and these undermine its usefulness as a theory of the determination of the level of the exchange rate.

A weaker version of PPP, known as relative PPP, implies that the exchange rate between two countries should eventually adjust to account for differences in their inflation rates. That is, countries that follow monetary policies with different inflation-rate objectives should expect to see this difference manifest itself in an exchange rate movement. To illustrate the circumstances where relative PPP may provide useful explanatory power, consider Table 1, which compares the cumulative inflation and exchange rate experiences of Canada and Mexico relative to the United States over the period 1975–2001. The table clearly shows that, for Canada, the exchange rate movement over the period is largely due to a depreciation of the underlying real exchange rate because the cumulative inflation differential with the United States is only 6 per cent of the total exchange rate movement. The opposite is true for

Table 1
Relative Inflation and Exchange Rates, 1975–2001

Country	(1) CPI in 2001 1975=1	(2) Price ratios ^a	(3) Exchange rates ^b 1975=1	Contribution of relative inflation ^c
Canada	3.38	1.03	1.52	6%
Mexico	2260	687	747	92%
United States	3.29	1	1	na

a. Canadian and Mexican price levels relative to the U.S. price level in 2001

b. Units of domestic currency per U.S. dollar

c. Proportion of exchange rate depreciation relative to the U.S. dollar that is explained by higher rates of inflation in Canada and Mexico

Box 1

Absolute and Relative Purchasing-Power Parity

Absolute PPP is obtained by extending the law of one price to multiple commodities in an international setting. This “law” implies that, in the absence of transactions costs, competitive arbitrage should force the same good to sell for the same price, expressed in a given currency, across countries.

To illustrate the law of one price, let P_i and P_i^* be the domestic and foreign currency prices of commodity i (a good or service) and E the exchange rate (expressed as the price of foreign exchange). Thus, the law of one price implies that

$$P_i = EP_i^*. \quad (1)$$

To extend this illustration to PPP, let P and P^* be the domestic and foreign price levels, which are constructed by taking a weighted average of the prices of n commodities in the national production or consumption baskets:

$$P = \sum_{i=1}^n w_i P_i \text{ and } P^* = \sum_{i=1}^n w_i^* P_i^*, \quad (2)$$

where w_i and w_i^* represent the weights of commodity i in the basket. If it is further assumed that the weights are identical and the law of one price holds for all commodities, then

$$EP^* = P \quad (3)$$

or

$$E = P/P^*. \quad (4)$$

As a theory of exchange rate determination, absolute PPP, given by equation (4), predicts that the exchange rate will adjust to equalize price levels. Note that absolute PPP assumes that the real exchange rate—the nominal exchange rate adjusted for differences in national price levels—is constant: $EP^*/P = 1$.

In practice, absolute PPP does not hold because of obstacles to international trade. If these trade frictions, denoted by k , are assumed to be relatively constant, then (4) can be modified as

$$E = k \cdot P/P^*, \quad (5)$$

and taking the ratio between time t and time o gives

$$\frac{E_t}{E_o} = \frac{P_t/P_o}{P_t^*/P_o^*}. \quad (6)$$

Equation (6) represents a weaker version of PPP (relative PPP) that predicts that the exchange rate will adjust to offset inflation differentials between two countries over time. Thus, if most of the shocks affecting the exchange rate are monetary rather than real, then relative PPP will be able to explain a substantial portion of the exchange rate movement between two countries.

Mexico, where the cumulative inflation differential represents 92 per cent of the exchange rate movement relative to the United States. Therefore, relative PPP is useful in explaining exchange rate movements only when monetary, not real, shocks predominate.⁶

6. Keynes was perhaps the first to recognize this point; although he appreciated the value of PPP as a rough benchmark, he also understood its weaknesses (1923, p. 80). “If, on the other hand, these assumptions are not fulfilled and changes are taking place in the ‘equation of change,’ as economists call it, between the services and products of one country and those of another, either on account of movements of capital, or reparation payments, or changes in the relative efficiency of labour, or changes in the urgency of the world’s demand for that country’s special products, or the like, then the equilibrium point between purchasing power parity and the rate of exchange may be modified permanently.”

PPP and Standard-of-Living Comparisons

To compare living standards between countries, it is necessary to translate per capita income or expenditure values measured in the local currency into a common currency, normally the U.S. dollar. This presents the problem of determining the appropriate exchange rate to use for the currency translation. One could use the nominal bilateral exchange rate with the U.S. dollar, but this ignores the often large differences in the prices of a broad set of goods and services that are not reflected in the value of the exchange rate

(i.e., absolute PPP does not hold). For example, travelers are sometimes surprised by the differences in the prices of certain goods and services across countries. They expect exchange rates to adjust to equalize these prices. But many goods and services are not traded (e.g., fast food and dry cleaning), and these tend to be more expensive in Western European countries than in Canada, and less expensive in emerging-market countries. To a large extent these price disparities reflect the differences in the cost of non-traded inputs, chiefly labour and land. These large discrepancies in the price levels across countries for which the exchange rate does not adjust imply, as noted above, that absolute PPP is a poor theory of exchange rate determination. Nonetheless, the concept of absolute PPP can be used to compute a PPP exchange rate that accounts for differences in prices across countries and, thus, for differences in the local purchasing power of national currencies.

Because . . . PPP exchange rates reflect differences in the national prices of both non-traded and traded goods, they are very useful for international comparisons of standards of living.

In this case, a PPP exchange rate is defined as the ratio of prices for a representative basket of final goods and services in two countries, with the prices expressed in the two national currencies. At this exchange rate, the purchasing power of the different currencies is equal (or has parity) in terms of the specific quality of a specific bundle of goods or services that can be purchased. Because these PPP exchange rates reflect differences in the national prices of both non-traded and traded goods, they are very useful for international comparisons of standards of living.

Although the construction of a PPP exchange rate may seem straightforward, in practice it is very difficult. As a result, only two comprehensive measures of the PPP exchange rate are available for the Canadian dollar. One measure, based on multilateral comparisons, is published by the OECD. The other is based on a Canada-U.S. comparison and is published by Statistics Canada. Both measures are based on very similar methodologies. (The more widely known Big Mac index periodically

reported in *The Economist* boils down the whole comparison to one very specific good: a McDonald's Big Mac.)

To compute these measures of PPP exchange rates, the prices of individual goods and services of comparable quality are compared across countries and then aggregated. For example, for the 1999 benchmark year, the OECD's PPP measures, which are compiled in collaboration with Eurostat (the Statistical Office of the European Community) reflect price quotations of a basket of about 3,000 comparable and representative goods and services in various categories of expenditure included in the gross domestic product.⁷ Within the consumption categories, the breadth of this sample of goods and services is, however, generally less than that of national CPI bundles because of the need to use commodities that are common to the majority of countries in the sample. The OECD measures are calculated for certain benchmark years. These are available on an annual basis for the European OECD countries. For the other countries, estimates between benchmark years are based on relative inflation rates for the underlying GDP components. PPP exchange rates are calculated for different aggregates of final demand expenditure; those for GDP are the most widely quoted.

For Canada-U.S. comparisons, the bilateral study is judged to be more appropriate, because it relates expenditure and price data from only the two countries involved, rather than from all the OECD countries (Kemp 1993, 2000). Moreover, the specifications of the items to be priced are more precisely matched.

Actual and PPP Exchange Rates

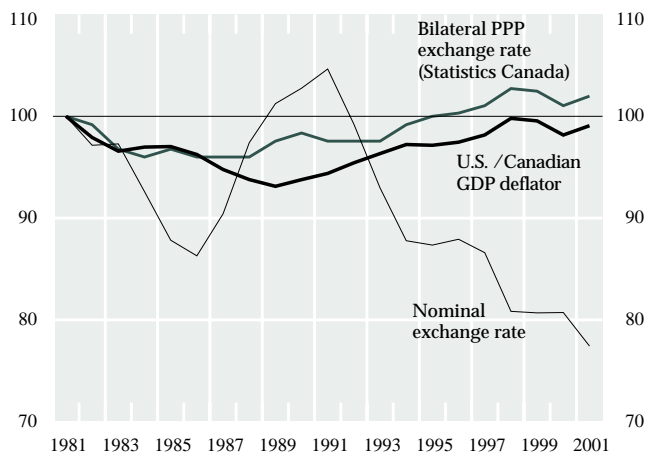
The OECD and Statistics Canada measures of Canada's PPP exchange rate are displayed in Chart 1 along with the bilateral exchange rate. The most striking observation is that the PPP exchange rates are much less volatile than the market-determined exchange rate; hence, deviations from absolute PPP are frequent and persistent. The relative stability of these estimates of the PPP exchange rate is due to three main factors: first, as a result of comparable monetary policies in the two countries, the evolution of price levels in Canada and the United States has been similar over this period (Chart 2); second, most of the goods and services in

7. The methods used by the OECD to weight and aggregate the price ratio across countries to construct PPP exchange rates are complex and are described in detail in OECD (2002).

Chart 2

Relative Prices and Exchange Rates, Canada and the United States

1981 = 100



GDP (roughly 65 per cent to 70 per cent) are non-traded, and therefore, their prices are not directly influenced by the exchange rate; and third, the extent to which firms pass through exchange rate movements into the domestic prices of traded goods is often not very large because it is costly to adjust their prices in response to short-run exchange rate fluctuations.

Sizable deviations of exchange rates from PPP rates have been the norm for most major industrialized countries over the last 20 years.

Sizable deviations of exchange rates from PPP rates have been the norm for most major industrialized countries over the last 20 years (Chart 3). Compared with other G-7 countries and with other commodity exporters (Chart 4), however, Canada's deviation from PPP has been the least volatile over the sample period.

As noted earlier, deviations in the exchange rate from the absolute PPP measures represent short- and long-run movements in the real exchange rate. These deviations can occur for a wide variety of reasons and can

Chart 3

Percentage Deviations of G-7 Exchange Rates from OECD PPP Exchange Rates

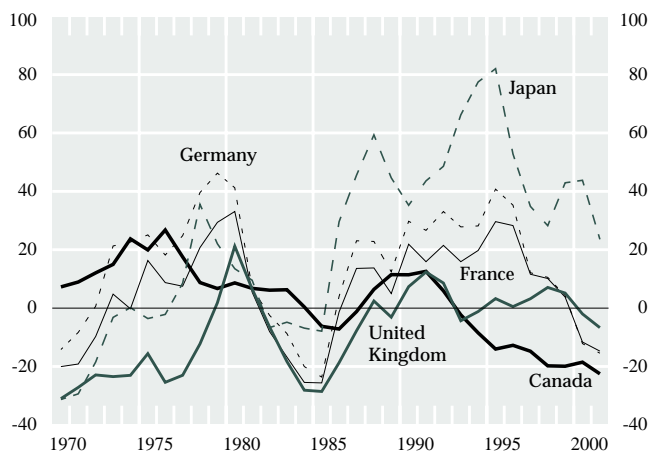
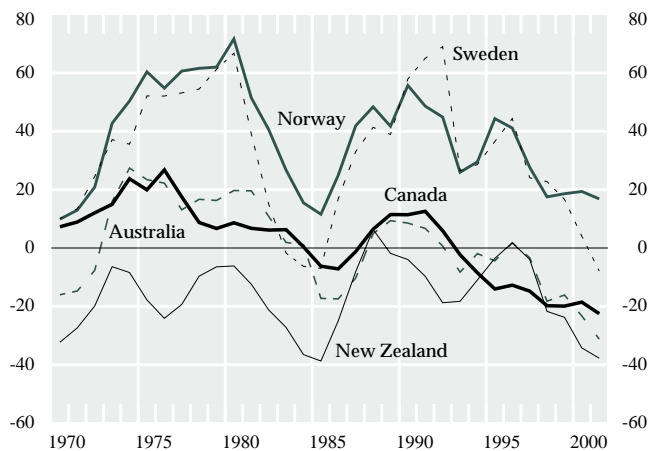


Chart 4

Percentage Deviations of the Exchange Rates of Commodity-Exporting Countries from OECD PPP Exchange Rates



be very persistent.⁸ PPP performs well as a theory of exchange rate determination when monetary policies

8. Econometric tests of PPP examine whether the real exchange rate tends to revert to an average level. For very long samples, 75 years or more, these tests indicate that the real exchange rate does slowly revert to its mean. The results imply that monetary factors have a stronger influence on exchange rate determination than real factors in the long run and that the value of the real exchange rate is bounded, although perhaps widely, by the degree of substitution in production and consumption in the domestic economy and in the economies of its trading partners. See Froot and Rogoff (1995) for a survey of these issues and Johnson (1993) for Canadian evidence.

produce different inflation rates across countries, but it does not take into consideration the fact that the real exchange rate may need to adjust to real shocks.⁹

In theory, the real exchange rate will adjust in the long run to equalize the relative demand and supply of domestic and foreign goods to ensure that the demand for domestic goods equals the supply. Any factor that would affect the relative demand or supply of domestic and foreign goods would affect the equilibrium real exchange rate. Thus, shifts in fiscal policy, changes in domestic or foreign tastes, capital flows that influence aggregate domestic spending, exogenous changes in the terms of trade, and movements in relative productivity could all affect the real exchange rate and, at a given relative price level, cause the exchange rate to deviate from the PPP rate. In addition, short-run deviations may be the result of money or asset market shocks, such as portfolio shifts or unexpected events (“news”) that may cause the exchange rate to move and also generate (given sticky national price levels) movements in the real exchange rate.

The deviation of the exchange rate from the PPP exchange rate in Canada has increased since the early

1990s. While this is partly the result of the strength of the U.S. dollar, it is also due to the fact that the equilibrium real exchange rate has likely depreciated because of lower commodity prices, relatively weak domestic demand for Canadian non-traded goods (e.g., lower fiscal spending as a percentage of GDP), and the lower rates of labour productivity growth in the Canadian manufacturing (i.e., traded goods) sector (the Balassa-Samuelson effect).¹⁰

Conclusion

Although the current deviation of the exchange rate from the PPP rate indicates that Canadian goods and services are relatively inexpensive by historical standards when compared with those in the United States or in other OECD countries, this deviation from PPP cannot be interpreted as indicating that the Canadian dollar is undervalued by a comparable amount. Fundamentally, exchange rates are influenced by real, as well as monetary, factors. Consequently, the equilibrium value of the exchange rate need not equal its PPP rate.

9. Between 1991 and 2001, the average values of the Canada-U.S. PPP exchange rate and the actual exchange rate were US\$0.82 and US\$0.73, respectively. Movements in the exchange rate over this period are well explained by shifts in the prices of non-energy commodities and by the Canada-U.S. interest rate differential. See Lafrance and van Norden (1995) and Laidler and Aba (2002) for more details.

10. See Lafrance and Schembri (1999) for a discussion of the Balassa-Samuelson effect. Balassa (1964) and Samuelson (1964) both argued that PPP would not hold in the long run because of different rates of productivity growth in the traded-goods sector across countries. Relatively high rates of productivity growth would raise wages in the economy, push up the relative prices of non-traded goods, and cause the real exchange rate to appreciate because of the higher overall price level.

Literature Cited

- Balassa, B. 1964. “The Purchasing-Power Parity Doctrine: A Reappraisal.” *Journal of Political Economy* 72 (6) (December): 584–96.
- Cassel, G. 1918. “Abnormal Deviations in International Exchanges.” *Economic Journal* 28 (112) (March): 413–15.
- Dornbusch, R. 1987. “Purchasing Power Parity.” In *The New Palgrave Dictionary of Economics: Volume 3, 1075–85*. Edited by J. Eatwell, M. Milgate, and P. Newman. New York: Stockton Press.
- Froot, K. and K. Rogoff. 1995. “Perspectives on PPP and Long-Run Real Exchange Rates.” In *Handbook of International Economics: Volume 3, 1647–48*. Edited by G. Grossman and K. Rogoff. Amsterdam: North-Holland.
- Johnson, D. 1993. “Unit Roots, Cointegration and Purchasing Power Parity: Canada and the United States, 1870–1991.” In *The Exchange Rate and the Economy, 133–98*. Proceedings of a conference held at the Bank of Canada, June 1992. Ottawa: Bank of Canada.

- Kemp, K. 1993. "International Price and Quantity Comparisons: Purchasing Power Parities and Real Expenditures, Canada and the United States." In *National Income and Expenditure Accounts, Annual Estimates, 1981-1992*. Statistics Canada Catalogue No. 13-201.
- . 2000. "Purchasing Power Parities and Real Expenditures, United States and Canada—An Update to 1998." In *National Income and Expenditure Accounts, Third Quarter 1999*. Statistics Canada Catalogue No. 13-001-XPB.
- Keynes, J.M. 1923. *A Tract on Monetary Reform*. London and New York: Macmillan and St. Martin's Press for the Royal Economic Society, 1971.
- Lafrance, R. and L. Schembri. 1999. "The Exchange Rate, Productivity, and the Standard of Living." *Bank of Canada Review* (Winter): 17-28.
- Lafrance, R. and S. van Norden. 1995. "Exchange Rate Fundamentals and the Canadian Dollar." *Bank of Canada Review* (Spring): 17-33.
- Laidler, D. and S. Aba. 2002. "Productivity and the Dollar: Commodities and the Exchange Rate Connection." C.D. Howe Institute *Commentary* No. 158. Toronto: C.D. Howe Institute.
- Organisation for Economic Co-operation and Development. 2002. *Purchasing Power Parities and Real Expenditures: 1999 Benchmark Year 2002 Edition*. Paris: OECD.
- Rogoff, K. 1996. "The Purchasing Power Parity Puzzle." *Journal of Economic Literature* 34 (2) (June): 647-68.
- Samuelson, P. 1964. "Theoretical Notes on Trade Problems." *Review of Economics and Statistics* 46 (2) (May): 145-54.

