

Federal Reserve Bank of Cleveland

The Growing Significance of Purchasing Power Parity

by Ben Craig

Under the skin of any international economist lies a deep-seated belief in some variant of the PPP theory of the exchange rate.

—Rudiger Dornbusch
and Paul Krugman (1976)

Recently, trade diplomats from many countries met in Ecuador to discuss whether the Chinese currency was at “the appropriate level.” The underlying tool that was used in the debate was the concept of purchasing power parity (PPP), or the idea that the changes in exchange rates should balance the price of a basket of traded goods in a foreign country so that it roughly equals the price of the same basket in the United States, once the foreign prices are converted to American dollars at the exchange rate. This concept constitutes a major pillar of the economics of exchange rates.

Indeed, even the most naïve tourist, when confronted with a cup of coffee that costs the equivalent of \$200 in some (admittedly hypothetical) foreign country, would conclude one of three things: either there is a scam, this is extremely good coffee, or the foreign currency in that country is overvalued. At some point in the future the price of that currency in terms of dollars can be expected to fall.

Faith in PPP is so strong that many economists regard it as consistent with long-term equilibrium in the exchange market, claiming that the dollar is overvalued or undervalued, as the case may be, whenever the dollar deviates substantially from its PPP value. While exchange rates do seem to revert to their PPP values over long periods of time, they need not remain there. Large deviations from PPP are common and fully

consistent with equilibrium in the foreign exchange market.

PPP is central to the theoretical underpinnings of our analysis of many trade issues, but how empirically supportable is it? Attempts to use PPP to predict future exchange rates have not been successful, suggesting that PPP might not be empirically relevant. Up until 2000, in fact, researchers could find scant empirical support for PPP even in the long run. Recent research has confirmed that PPP is not so useful to forecasters trying to predict short-term movements in the exchange rate, but it has begun to demonstrate that PPP is quite tenable to use in economic models that analyze medium- or long-range policies.

■ The Law of One Price

The idea behind PPP evolved from the law of one price, the idea that arbitrage will ensure that the same good sold both here and abroad will have the same price when that price is expressed in a common currency. If the same price were not to hold, then someone could make a quick profit by buying the good where it was cheaper and selling it where it was more expensive. The price of the good could be expected to rise in the place where it was cheaper and fall where it was more expensive, and the foreign exchange rate would also be expected to adjust to make goods in the cheaper country relatively more expensive. PPP is the mechanism through which the exchange rate adjusts to the aggregated changes in the prices of tradable goods in two countries to reflect the law of one price.

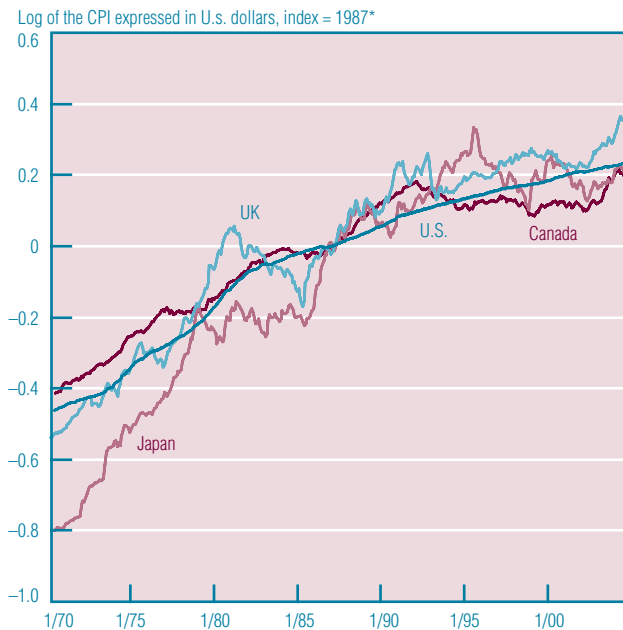
Although the idea of the law of one price seems reasonable enough, a quick look at actual examples immediately points up why a single price might not apply in practice. First, even fairly homogeneous

The principle of purchasing power parity is central to the theoretical underpinnings of the analysis of many trade issues, but up until recently, there was little evidence that PPP held in the long run. Current research has changed that. The key to finding the evidence was realizing how to test for a long-run effect given the fact that exchange rates adjust to their long-run levels in a nonlinear way.

goods differ. Coffee differs in quality and taste; wheat and corn come in different varieties. Second, an item, even one which is rigorously controlled to be the same good, is still different once it is sold in different places. Consider the difference between the same radio sold in Hong Kong and Des Moines. The Chinese radio is sold in a shop that pays higher property fees, and it is sold by salesmen who must, themselves, pay higher rent in order to live. The act of retailing a traded good ends up packaging the tradable good with a nontraded good, that is, the service of selling it. Thus, even with many traded goods, their prices reflect a combination of the good and a nontraded service.

Third, even if the radio in Iowa were exactly the same item as a radio sold in Hong Kong, it might not make much sense to buy cheap radios in Iowa and ship them to China. It might cost too much to find out the relatively expensive prices, ship the cheaper radios to China, set up distribution networks to sell them, and so forth. These transactions costs might mean that price differences between goods that are the same can

FIGURE 1 CONSUMER PRICES IN U.S. DOLLARS



*Prices were calculated by converting each country's CPI into U.S. dollars (dividing by the exchange rate) and then taking the logarithm.

SOURCE: The International Monetary Fund.

persist. This is true in the short run—even when firms can find ways to reduce the transactions costs with new container ships, say—or in the longer run, where they can reduce costs with new distribution networks. Deviations from the law of one price can be arbitrated away only as long as they are larger than these transactions costs. Studies of price differences of known standard commodities show that the differences tend to be larger with greater distances between points of sale. Given that transactions costs can be expected to grow with distance (all else equal), this is not surprising. What is interesting about the results of this research is that merely sending a good across an international border results in a large additional deviation from the law of one price. Some researchers interpret this as a strong preference for domestically produced goods, a “home bias,” although another interpretation is that crossing a border imposes a large additional transaction cost.

■ Purchasing Power Parity (PPP)

It is a long way from the law of one price to PPP, for the law of one price is a statement about a single tradable good, whereas PPP says that exchange rates change to reflect the change in prices of all tradable goods between countries. How does one test the validity of PPP? Doing so requires first that

all prices within a country are aggregated in such a way that they are consistent with a statement of PPP. The aggregation should capture the underlying price level and not distort cross-country differences in prices because of the way relative price shocks of individual items are included in the index.

Typically, time series of price indexes in two or more countries are used, along with exchange rate data, to measure the validity of PPP. Some of the measurement problems that have been encountered when testing PPP center on the use of these price indexes. Different countries weight their goods differently when measuring price changes, so that even choosing a different base year will yield different weights. It is fairly easy to demonstrate several anomalies that occur in the measurement of PPP simply because of cross-country differences in the weighting of the component prices that constitute the price indexes.

In a perfectly measured world, PPP could be applied to say that the average price of a bundle of goods from some foreign country, multiplied by the exchange rate (that is, the amount of domestic currency bought by one unit of the foreign currency), should equal the average domestic price of the same bundle. However, when different weights are used in constructing the

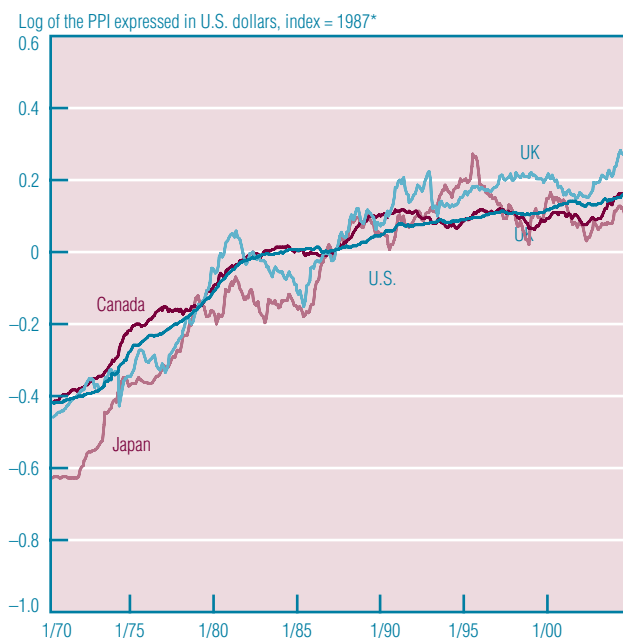
average (as is usually the case), this identity will not hold, even when the law of one price holds for all of the individual component prices. It is more common to see a relative form of PPP being applied in practice, which holds that the percentage change of the foreign price index plus the percentage change in the exchange rate should equal the percentage change in the domestic price index. This will hold if all of the components of the price index change by the same percentage amount (as in a purely monetary inflation). However, if the price components change at differing rates, then, once again, the relation does not hold. The relative form of PPP is what researchers actually test when they test the validity of PPP.

Another reason that PPP is tested using its relative form is that some economists base the principle of PPP on interest rate differences rather than the law of one price. Briefly, the idea is that interest rates within a country are composed of inflation plus a “real rate,” or the natural return that would accrue if the prices of future goods did not reflect inflation. Because of trade, the real rate in the long run is often assumed to be the same for all countries, so that the only difference in interest rates is the expected inflation component. Arbitrage of international interest rates gives a version of PPP that balances changes in the relative price indexes with changes in the exchange rate.

Figures 1 and 2 show some patterns that are relevant to PPP. These figures take several price indexes from postwar Britain, Canada, and Japan and convert them to U.S. dollars at the contemporary exchange rate. The corresponding U.S. price index is also shown. If these indexes measured the respective countries' underlying price levels accurately, and if PPP held perfectly, these lines would coincide. The first pattern to note is that the producer price indexes (PPI), when converted to dollar amounts, move slightly more closely together than do the consumer price indexes (CPI).

Although the differences between the consumer and producer price series are admittedly slight, they may be due to the fact that more of the components of the PPI are tradable than those in the CPI. CPI components such as housing are not easily traded across countries, so it is hard (if not impossible) to take advantage of price differences in two different

FIGURE 2 PRODUCER PRICES IN U.S. DOLLARS



*Prices were calculated by converting each country's PPI into U.S. dollars (dividing by the exchange rate) and then taking the logarithm.

SOURCE: The International Monetary Fund.

countries to make a profit. Further, the consumer price indexes have services in their baskets of goods, some of which are tradable, some of which are hard to trade. A rise in the relative price of nontradable to tradable components will cause a failure of relative PPP. Producer prices, on the other hand, have more components that are likely to be tradable, and thus provide more opportunities for profit if they deviate from a single price in the two countries. However, the differences are small, and in practice economists often test PPP with differences in the relative CPIs.

Another pattern to note is that both price series do not move exactly the same for all countries. There are instances in the short term in which the U.S. price index grows more quickly than a foreign one, or vice versa. The data in figures 1 and 2 provide a hint that transactions costs are responsible for this short-term failure of PPP. Recall that transactions costs would explain deviations from the law of one price (and thus PPP) in the short run, while allowing for the possibility that it might hold in the long run. The hint is to be found in the fact that the Canadian price series move more closely to the American series than do the British and Japanese series, a fact which is consistent with the lower transactions costs inherent in the smaller distance between the

two North American countries. How strong is the statistical evidence that PPP holds in the long run? And how quickly do exchange rates return to the PPP position once they are off the PPP path? These questions have been the subject of considerable controversy and are just now being resolved.

■ Solving PPP Puzzles

Research up until 2000 had found little evidence that PPP held in the long run. Most of the research also found that the rate at which exchange rates returned to the PPP position was very slow. Thus, until about four years ago, the consensus among researchers seemed to be that PPP might exert a weak pull on exchange rates, but the relationship between exchange rates and PPP was so statistically weak and took place over such a long time, that it was empirically irrelevant. These findings were obtained even when the researchers were careful to measure the prices of tradable goods. It was puzzling that such seemingly strong results should be found against the existence of a single price, an idea that has a great deal of intuitive appeal. Many economic models relied on some form of PPP—for which so little support could be found—as a foundation for modeling the international sector, yet these models were successful in characterizing the behavior of this sector. What was going on?

Resolution of these puzzles began when researchers focused on one of the assumptions that had always been made when adjustment to PPP over time was studied. The assumption concerns the notion of a half-life. A half-life represents the amount of time that elapses before a discrepancy between the PPP level and the current exchange rate is half its current size. Thus, if the exchange rate were one dollar above the PPP value, and if the half-life were three months, then, after one-quarter year, the discrepancy would be 50 cents; after one year, it would be slightly over 6 cents, and so forth. Calculating the half-life is equivalent to answering the question: How much of the discrepancy will be left after one year? In this example, only about 6 percent of the discrepancy will remain after one year—the exchange rate has adjusted by 94 percent to its PPP level. Further, if PPP did not hold even in the extreme long run, then there would be no adjustment after one year. The half-life would be infinite.

Research into this question found a half-life of between three and six years, which suggested a very slow rate of adjustment. In fact, there is only weak evidence that the half-life is not infinite, and in part, the process of testing whether this number is infinite or not leads to technical difficulties that make the tests less convincing. Research that attempts to account for these technical difficulties suggests that the half-life might be even larger and that exchange rates adjust the difference between their current position and the rate implied by PPP at the speed of between ten percent per year and nothing.

Up until a few years ago, researchers had always assumed that the half-life stays the same, no matter what the distance is from PPP. But there is strong reason to think that this would not be true. Consider the transactions costs that cause a persistent difference in prices for the same good. If the difference in the price is small and largely reflects the transactions costs, then merchants might not be very motivated to correct the difference by setting up sales in the markets with the more expensive good. However, if the difference is great, many merchants will be motivated to take advantage of the profit opportunity, and the price will become the same much more quickly.

What this suggests is that the half-life period for adjustment may vary, depending on whether the difference between the exchange rate and PPP is large or small. Estimation techniques that are based on this idea find a very different set of results. First, there is strong evidence that PPP holds in the long run. Second, the half-life of the period of adjustment is much smaller. For small deviations from PPP, the half-life of the difference is under three years. For larger differences, it is even smaller, from less than a year to 18 months.

■ **The Relegitimization of PPP**

Current research suggests that PPP is not only relevant in the long run, but also that convergence to PPP happens on average in a short time horizon that it is both empirically and theoretically relevant. It is just important to acknowledge the role that the nonlinear nature of the adjustment of exchange rates to their long-run levels plays when testing whether the long-run level is relevant, and in estimating the speed at which the adjustment occurs.

As a predictive mechanism (where economists are trying to explain day-to-day fluctuations in exchange rates, for example), PPP is not a particularly useful predictive concept. This makes sense because the arbitrage trading of goods across borders, which enforces PPP, takes some time to work. PPP evolves slowly in many economic models because information about the basics of the model percolates into the decision making slowly. In any case, the fact that PPP is not instantaneously observed at each point in time is completely consistent with these economic models.

■ **Recommended Reading**

Alan M. Taylor, and Mark P. Taylor, 2004. "The Purchasing Power Parity Debate." National Bureau of Economic Research, Working Paper no. 10607.

The opening quotation comes from

Rudiger Dornbusch, and Paul Krugman. 1976. "Flexible Exchange Rates in the Short Run." Brookings Papers on Economic Activity 3, pp. 537–75.

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