Is Purchasing Power Parity a Useful Guide to the Dollar?

By Craig S. Hakkio

Some academic and business economists use the concept of purchasing power parity to help predict the foreign exchange value of the dollar. *Purchasing power parity* (PPP) is a measure of the dollar's equilibrium value—the exchange rate toward which the dollar moves over time. Because the value of the dollar is currently below its PPP value, PPP advocates argue that the dollar is undervalued and therefore likely to rise.

Other economists acknowledge that PPP may help forecast the value of the dollar over the long run but doubt its usefulness as a short-run guide. They often cite the 1970s, when the dollar frequently strayed from its PPP value and sometimes took years to return. They also note that economic and political forces regularly buffet the dollar, keeping its value away from equilibrium. Thus, even though the dollar is currently below its PPP value, these economists maintain there is no guarantee it will rise in value in the near term.

This article argues that PPP is a useful guide to the dollar in the long run and—to a lesser extent—in the short run. The first section of the article defines the concept and discusses why most economists believe it is a useful long-run guide. The second section shows the dollar generally moves toward its PPP value in the long run. The third section shows that in the short run the dollar generally moves toward its PPP value only when deviations from PPP are unusually large. Because today's dollar is not unusually low relative to PPP, the measure says little about whether the dollar will rise in the near term.

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WHAT IS PURCHASING POWER PARITY?

Economists use three concepts of purchasing power parity to explain why goods in one country should cost the same as identical goods in another country. The *law of one price* relates exchange rates to prices of individual goods in different countries. *Absolute PPP* relates exchange rates to overall price levels. And *relative PPP* relates exchange rates to inflation rates. While the law of one price and absolute PPP are intuitively appealing as theories of exchange rates, relative PPP is more useful empirically.

The law of one price

The law of one price is the simplest concept of PPP. It states that identical goods should cost the same in all countries, assuming it is costless to move goods between countries and there are no impediments to trade, such as tariffs or quotas. Before the costs of goods in different countries can be compared, however, prices must first be con-

verted to a common currency. Once converted at the going market exchange rate, the prices of identical goods from any two countries should be the same. After converting pounds into dollars, for example, a sweater bought in the United Kingdom should cost the same as an identical sweater bought in the United States.

In theory, markets enforce the law of one price. Specifically, the pursuit of profits tends to equalize the price of identical goods in different countries. Suppose the sweater bought in the United States was cheaper than the sweater bought in the United Kingdom after converting pounds into dollars. A U.S. exporter could make a profit by buying the U.S. sweater and selling it in the United Kingdom. Such profit opportunities would persist until the law of one price held. Exploiting these opportunities should ensure that the price of the sweater eventually equalizes in both countries, whether prices are expressed in dollars or pounds.[1]

In practice, however, the law of one price does not always hold. International trade is far more complicated than suggested by simple economic theories. For example, the cost of transporting goods from one country to another limits the potential profit from buying and selling identical goods with different prices. In addition, tariffs and other impediments to trade potentially drive a wedge between the prices of identical goods in different countries. As a result, instead of focusing on a particular good or service when applying the PPP concept, most analysts focus on market baskets consisting of many goods and services. Hence, the concept of absolute PPP.

Absolute PPP

Absolute PPP extends the law of one price to general price levels. It argues that a basket of goods and services should cost the same in all countries after converting prices to a common currency. If the law of one price holds "on average" for all goods and services and if price levels in different countries are constructed in exactly the same way, absolute PPP should hold. The pursuit of profits, which caused the law of one price to hold, would also cause PPP to hold.

Absolute PPP provides an equilibrium measure of exchange rates—the PPP exchange rate. This hypothetical exchange rate equalizes the prices of identical market baskets in two different countries. More precisely, the PPP exchange rate equals the ratio of overall price levels in two countries (see box).[2] For example, the PPP exchange rate between the dollar and the pound is the ratio of the overall price level in the United Kingdom to that in the United States. This ratio reflects the purchasing power of the dollar in the United States relative to the purchasing power of the pound in the United Kingdom.

As an equilibrium concept, the PPP exchange rate provides a measure of a currency's long-run foreign exchange value. When the foreign exchange value of the dollar equals its PPP value, there should be no tendency for the dollar's value to rise or fall. In contrast, when the dollar diverges from its PPP value, market forces should push it back. Most economists believe the PPP exchange rate equals the market exchange rate only in the long run. In the short run, the actual exchange rate can deviate from its equilibrium level. Thus, at any particular moment, the dollar is likely to differ from its PPP value. But over time the dollar is likely to gravitate toward PPP.

While absolute PPP has considerable appeal as a theory of exchange rates, in practice it generally fails for two reasons. First, the law of one price does not always hold—even "on average." Second, price levels in different countries are calculated using imperfect price indexes. These indexes are based in different years, include different market baskets of goods and services, and weight the various components of the market baskets differently. As a result, the simple ratio of price levels may not be an adequate measure of equilibrium exchange rates.

Relative PPP

A better measure of equilibrium exchange rates is relative PPP. While absolute PPP asserts that exchange rates depend on the ratio of price levels in different countries, relative PPP asserts that exchange rate changes depend on differences in inflation rates. Thus, relative PPP is simply the concept of absolute PPP expressed in growth rates. Relative PPP says that the foreign exchange value of a currency tends to rise or fall at a rate equal to the difference between foreign and domestic inflation. For example, if U.K. inflation exceeds U.S. inflation by five percentage points, the purchasing power of the dollar rises 5 percent relative to the pound. Therefore, the foreign exchange value of the dollar should rise 5 percent per year.

Because relative PPP follows directly from absolute PPP, relative PPP clearly holds if absolute PPP holds. But relative PPP may hold even if absolute PPP does not. Even if the exchange rate is not *equal* to the ratio of foreign to domestic price levels as required under absolute PPP, it may be *proportional* to the ratio. If this proportion is fixed, relative PPP holds.[3] This condition is less restrictive than the condition that exchange rates precisely equal the ratio of foreign to domestic price levels. As a result, relative PPP is more likely to hold than absolute PPP. For this reason, most economists study relative, rather than absolute, PPP. And this article tests PPP using the relative PPP concept.[4]

Although relative PPP is more likely to hold than absolute PPP, relative PPP is still controversial. Economists disagree about how exchange rates are determined. While some theories of exchange rate determination suggest PPP holds, other theories do not.[5] These other theories generate equilibrium exchange rates that differ from PPP exchange rates.

In addition, common sense suggests that relative PPP is unlikely to hold over very short periods of time. Finding that the market exchange rate temporarily deviates from the PPP rate would not be surprising for two reasons. First, exchange rates fluctuate minute by minute because they are set in financial markets. Price levels, in contrast, are sticky and adjust slowly. Because exchange rates move quickly while prices move slowly, deviations from PPP will arise. However, deviations from PPP should disappear as prices have time to adjust.

The exchange rate may also deviate from its PPP rate during periods of fixed exchange rates, such as the Bretton Woods regime of 1948 to 1973. During such periods, the market exchange rate usually remains fixed even though inflation differentials among countries change. Thus, at any single point in time, the exchange rate is unlikely to equal its PPP rate. But a fixed exchange rate regime does not mean exchange rates never change. History is rife with examples of currency devaluation and revaluation. When deviations from PPP develop, the exchange rate can be adjusted through a devaluation or revaluation. In this way, deviations from PPP may be eliminated through a change in government policy rather than through market forces. Thus, PPP might hold over long periods of time even during periods of fixed exchange rates.

IS PPP A USEFUL GUIDE TO THE LONG-RUN VALUE OF THE DOLLAR?

Many economic decisions require predicting the value of the dollar over the next few years. Businesses contemplating building a factory overseas, for example, must look years ahead in evaluating whether the project is viable. The future value of the dollar is one key factor affecting the project's viability. A large rise in the value of the dollar five years from now could sharply reduce the value of profits repatriated to the United States.

Similarly, policymakers must look years ahead in planning monetary policy. A long-term decline in the value of the dollar, for example, could make achieving price stability more difficult by steadily raising the dollar price of imported goods and services. Thus, for both businesses and policymakers, a reliable guide to the long-run

value of the dollar, such as PPP, would be helpful.

For PPP to be a useful long-run guide, the dollar must generally move toward its PPP rate over time. While the dollar might differ from its PPP rate in the short run, it must tend back toward its PPP rate in the long run. This section shows that PPP does hold in the long run. While deviations of the exchange rate from PPP generally result in exchange rate movements back toward PPP, achieving PPP generally takes a long time. Three types of evidence support this conclusion. First, simple charts comparing actual exchange rates with PPP exchange rates over long periods of time suggest that PPP holds in the long run. Second, statistical tests show that deviations from PPP eventually result in exchange rate movements back toward PPP and that the likelihood of such movements increases over time. Finally, statistical examination shows that it generally takes several years to achieve PPP.

Actual and PPP exchange rates

Actual and PPP exchange rates tend to move together over long periods of time. From the turn of the century to today, the value of the dollar against other major currencies has generally moved in concert with the dollar's PPP exchange rate on a yearly average basis. Looking at annual data over long periods focuses attention on long-run movements in exchange rates, minimizes the influence of purely short-run factors, and reveals long-term relationships.

A typical relationship is the long-term link between the pound/dollar exchange rate and its PPP rate (Chart 1, panel A). The rise in the pound/dollar exchange rate throughout the period from 1900 to 1990 generally mirrored the rise in the pound/dollar PPP rate. Similar long-term relationships (not shown) are apparent for the value of the dollar against the yen, mark, and Canadian dollar.

In addition to moving in similar directions, actual and PPP exchange rates have tended to converge over time. Although exchange rates have deviated from PPP—often for long periods—these deviations have always tended to disappear (Chart 1, panel B).[6] For the pound/dollar exchange rate, the deviations have been large, ranging between plus and minus 30 percent. The deviations have also persisted for long periods. For example, the dollar was below its PPP rate from 1911 to 1927 and above its PPP rate from 1946 to 1962. But the dollar eventually fell whenever it was above its PPP rate and eventually rose whenever it was below its PPP rate. Although the deviations have at times been large, for the period as a whole the average deviation was only -2 percent. Thus, with deviations of the exchange rate from its PPP rate diminishing over time, PPP appears to hold in the long run.

Likelihood of convergence to PPP

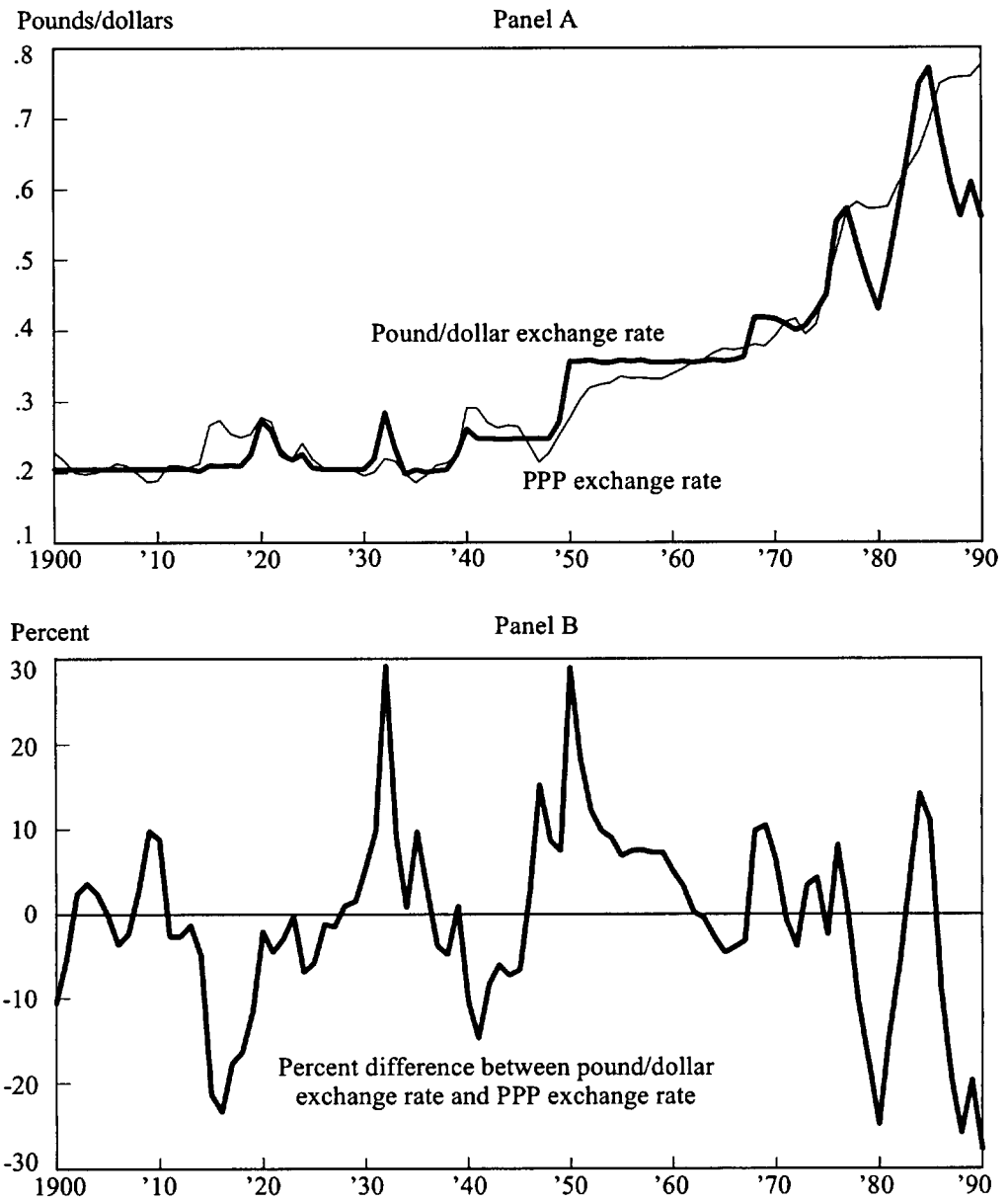
Various statistical tests can be used to determine more rigorously whether PPP holds in the long run. One approach is to estimate the probability that an exchange rate moves toward its PPP rate over a given time period. For example, what is the probability that the dollar will fall over the next year or two if it is currently above its PPP rate? Calculating such probabilities accounts for the uncertainty inherent in predicting future movements in the dollar and provides a test of long-run PPP.

For PPP to hold in the long run, the probability of the dollar moving closer to PPP over long periods should be greater than the probability of it moving away from PPP. For example, the probability of the dollar moving toward PPP in the next year might be 55 percent and the probability of the dollar moving away from PPP might be 45 percent. As the time period gets longer, the probability of moving toward PPP increases. Over the next five years, for example, the probability of the dollar moving toward PPP might rise to 75 percent, while the probability of it moving away from PPP might fall to 25 percent.

For PPP to be useful, the probability that the exchange rate moves toward its PPP rate must be

Chart 1

PPP and the Pound/Dollar Exchange Rate



Source: Lee (1978).

greater than 50 percent.[7] To see why, suppose the exchange rate is currently above its PPP exchange rate. A probability of 50 percent means there is a 50-50 chance the exchange rate will rise and a 50-50 chance the exchange rate will fall. In other words, for predicting the future exchange rate, flipping a coin is as reliable as using PPP. As a result, in this case, the PPP exchange rate conveys little useful information.[8] In contrast, a probability of 90 percent means an analyst could be confident that the exchange rate would fall. In this case, the PPP exchange rate conveys useful information about the long-run value of the exchange rate.

Based on estimated probabilities of convergence of actual exchange rates to PPP exchange rates, PPP is a useful long-run guide to the value of the dollar against the pound, yen, mark, and Canadian dollar (Table 1).[9] The probability that any of the four exchange rates will move closer to their PPP rate in the next one to six years is between 54 and 79 percent. Averaging across all four currencies, the probability that the exchange rate will move toward its PPP rate in the next year is 59 percent.

At all time horizons, the pound/dollar exchange rate has a higher probability of moving closer to PPP than the other dollar exchange rates. The probability that the pound/dollar exchange rate moves closer to its PPP rate in the next year is 64 percent and increases to 79 percent in six years. Probabilities for the other exchange rates, while somewhat smaller, are still over 50 percent. They increase over time from an average of 57 percent in one year to 66 percent in six years. Because all estimated probabilities indicate a greater than 50-50 chance of moving toward PPP, they imply that PPP may be useful as a long-run guide to the dollar.

Length of time to convergence

Another way to test the value of PPP as a long-run guide is to estimate the length of time required to achieve PPP when the exchange rate deviates from PPP. If it takes decades to eliminate a deviation, PPP may have limited appeal as a guide to even the long-run value of the dollar. However, if PPP is generally achieved in a matter of years rather than decades, PPP may have considerable appeal as a long-run guide.

Several years are generally required for the pound/dollar exchange rate to equal its PPP rate (Chart 2). The number of years it takes for the pound/dollar exchange rate to reach its PPP rate is shown on the chart's horizontal axis. The height of the bar at a given number of years shows the percentage of time it took that many years or less for the pound/dollar exchange rate to equal its PPP rate. For example, about 20 percent of the time, it took one year or less for the exchange rate to equal its PPP rate. About 40 percent of the time, it took two years or less. And about 50 percent of the time, it took three years or less. Because about half of the time three years or less were required to eliminate a deviation from PPP, three years is an estimate of the average time needed to achieve PPP.

For the other currencies, it generally took about six years for the exchange rate to equal its PPP rate. Specifically, the average time to eliminate a deviation was nine years for the yen, five years for the mark, and six years for the Canadian dollar. While five years may seem like a long time, businessmen and policymakers frequently have planning horizons of five or more years. As a result, information about the value of the dollar five years hence is generally useful. Because PPP provides such information, it is potentially a useful long-run guide to the dollar.

IS PPP A USEFUL SHORT-RUN GUIDE?

Businesses and policymakers would also like a guide to the value of the dollar over the next few months. Such a guide would help businesses determine when they should repatriate profits. And policymakers could use a short-run guide to the

Table 1

PPP As a Long-run Guide to the Dollar

Probability that the exchange rate moves toward the PPP exchange rate in:	Yen	Mark	Pound	Canadian dollar
1 year	60	54	64	57
2 years	60	65	70	64
3 years	66	61	72	60
4 years	65	60	72	60
5 years	66	64	78	65
6 years	64	65	79	68

Note: The sample period is from 1900 to 1989; the base period is 1900–13. Probabilities are reported as percentages. The probability of moving toward *PPP* in k periods is calculated as:

$$\frac{NOBS_{PPP}}{NOBS_{TOTAL}} \times 100,$$

where $NOBS_{PPP}$ is the number of times the exchange rate moves toward the *PPP* exchange rate in k periods, and $NOBS_{TOTAL}$ is the total number of observations.

More formally,

$NOBS_{PPP}$ = Number of observations where $[e_{t+k} < e_t$ and $e_t > PPP_t] +$
Number of observations where $[e_{t+k} > e_t$ and $e_t < PPP_t]$,

$NOBS_{TOTAL}$ = Number of observations where $e_t \neq PPP_t$,

e_t = exchange rate at time t, and

PPP_t = *PPP* exchange rate at time t.

dollar as one of many variables providing information about the appropriate stance of monetary policy over the short run.

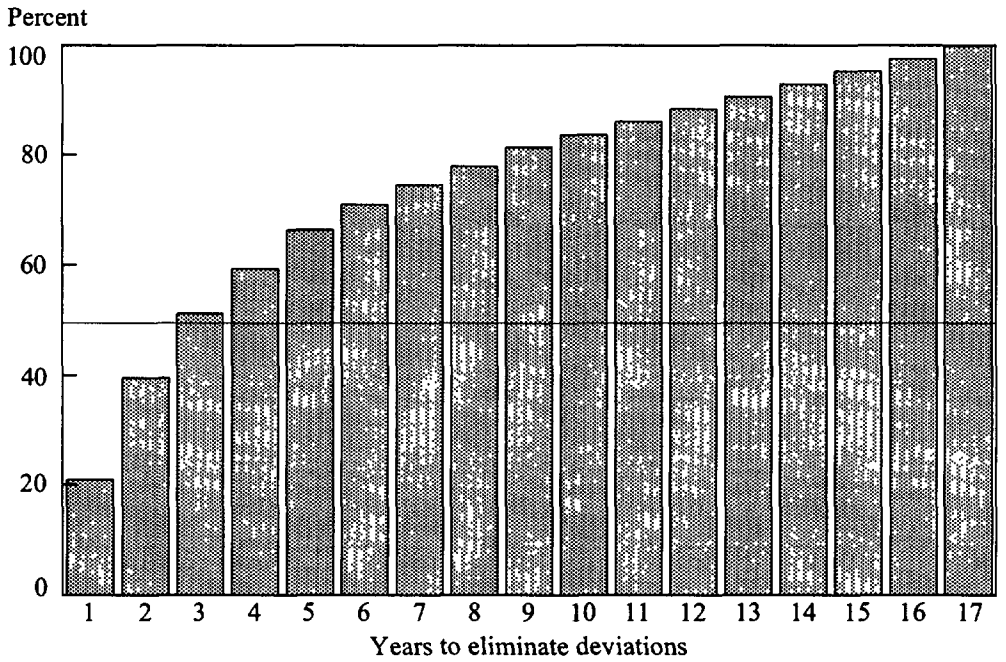
The usefulness of PPP as a short-run guide is tested by examining monthly exchange rate movements from January 1974 to July 1991, the period of the current floating exchange rate regime. First, the same methodology used to examine long-run PPP is used to test short-run PPP. Not surprisingly, PPP fails these stringent tests for usefulness. Then, the usefulness of PPP is examined using less-stringent tests. These tests show that, under certain circumstances, PPP may be a useful guide to short-run movements in the dollar.

Stringent tests for the short-run usefulness of PPP

Market exchange rates and PPP rates do not move together from month to month nearly as closely as they do over longer horizons. For example, the relationship between the pound/dollar exchange rate and its PPP rate from 1974 to 1991 was weak (Chart 3, panel A).[10] While both rates

Chart 2

Years Before Pound/Dollar Equals PPP Rate



rose during the period, the short-run relationship between the pound/dollar exchange rate and its PPP rate was much weaker than the long-run relationship.

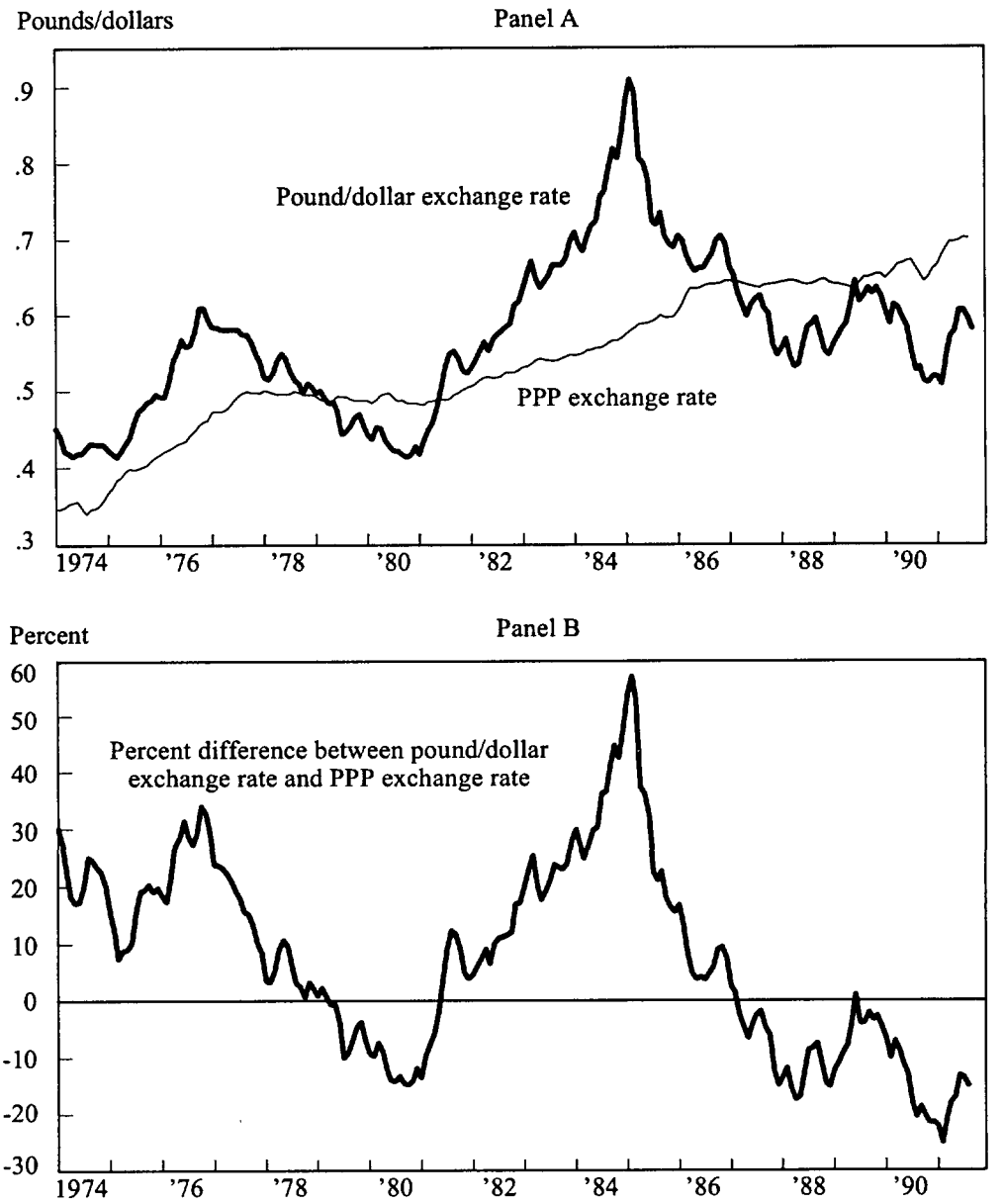
Although the pound/dollar exchange rate occasionally equaled its PPP rate during the period, deviations from PPP were large and persistent (Chart 3, panel B). Each time the dollar rose above its PPP rate, it eventually declined; and each time it dipped below its PPP rate, it eventually rose. Still, the pound/dollar rate often far exceeded its PPP rate. For example, in March 1985 the dollar was overvalued 57 percent relative to PPP. And for almost $5\frac{1}{2}$ years, from June 1981 to February 1987, the dollar stayed above its PPP rate. Thus, as a guide to month-to-month movements in the pound/dollar exchange rate, the PPP rate is highly suspect.

PPP is also unreliable as a guide to short-run movements in the value of the dollar against the yen, mark, and Canadian dollar (Table 2). Based on the 1974-91 experience, the probability that the exchange rate moves toward its PPP rate within six months ranged from 45 percent for the mark to 60 percent for the Canadian dollar. In the case of the mark, a 45 percent probability implies that the exchange rate moved in the wrong direction relative to PPP 55 percent of the time. For the yen and Canadian dollar, the results are only slightly stronger. The probability that the yen/dollar exchange rate moves toward its PPP rate ranged from 54 percent (for one month) to 58 percent (for six months). The probability that the Canadian dollar/U.S. dollar exchange rate moves toward its

Chart 3

PPP and the Pound/Dollar Exchange Rate

January 1974 - August 1991



Source: Board of Governors.

Table 2

PPP As a Short-run Guide to the Dollar

Probability that the exchange rate moves toward the PPP exchange rate in:	Yen	Mark	Pound	Canadian dollar
1 month	54	44	54	52
2 months	54	42	53	49
3 months	56	45	50	57
4 months	57	44	51	57
5 months	57	45	50	59
6 months	58	45	51	60

Note: The sample period is from 1974:1 to 1991:7; the base period is 1980:1–1982:12. The probabilities are calculated as in Table 1.

PPP rate ranged from 52 percent (for one month) to 60 percent (for six months).

The time required for exchange rates to equal their PPP rates casts further doubt on PPP as a useful short-term guide to the dollar during the 1974-91 period (Chart 4). About 10 percent of the time, four months were needed for the pound/dollar exchange rate to equal its PPP rate. About 80 percent of the time, up to 47 months were needed. And about 50 percent of the time—the "average" time required to achieve PPP—about 23 months were needed.

The average time required for the other exchange rates to return to their PPP rates varied widely. The average time was 19 months for the Canadian dollar, 22 months for the Japanese yen, and 53 months for the German mark.

Less stringent tests for the short-run usefulness of PPP

Testing whether the exchange rate always moves toward its PPP rate within six months, however, may be too stringent. Many economists believe that the margin of error in estimating the PPP exchange rate is 10 percent (Levich, p. 15). If true, it is not surprising that the dollar fails to move toward the estimated PPP exchange rate when it differs only slightly from the estimated rate.

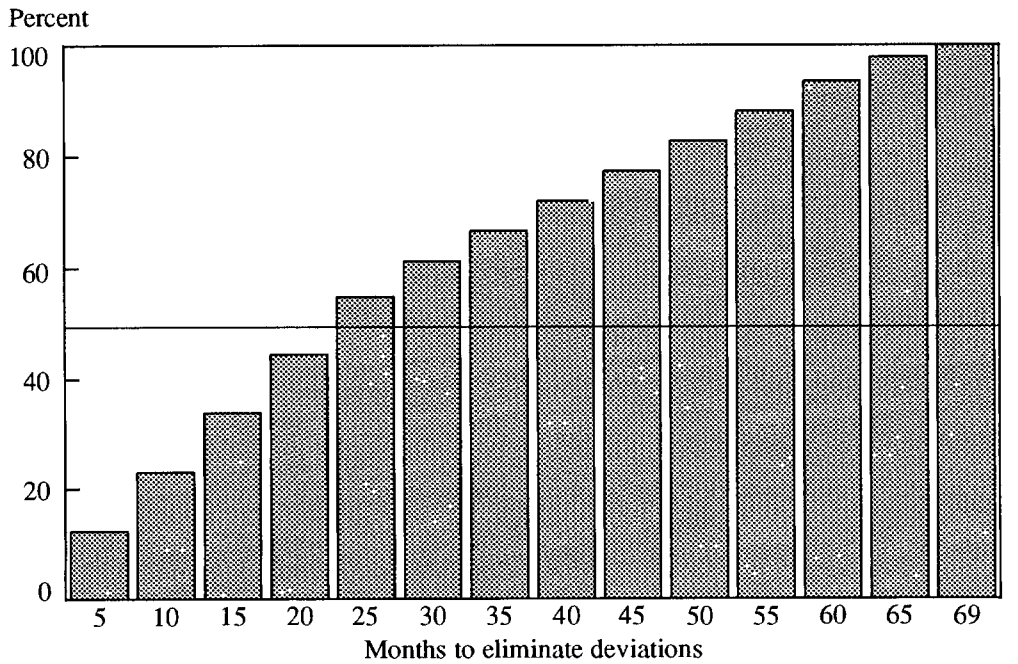
Figure 1 illustrates the margin of error problem. In the figure, the thin solid line is the estimated PPP exchange rate and the two dotted lines represent the band of uncertainty in estimating the PPP rate. In other words, all that investors and policymakers really know is that the "true" equilibrium rate lies somewhere between the two dotted lines. The heavy solid line is the actual exchange rate. Consider the exchange rate at point A. At point A, the exchange rate is above the estimated PPP rate but within the band of uncertainty. If the true equilibrium value is given by the thin solid line, then a rising exchange rate is inconsistent with PPP. However, if the true equilibrium value is given by the upper dotted line, then a rising exchange rate is consistent with PPP. Therefore, changes in the exchange rate when it is between the dotted lines may or may not be consistent with PPP.

Another reason the previous tests may be too stringent is that there may be a zone in which PPP

Chart 4

Months Before Pound/Dollar Equals PPP Rate

January 1974 - July 1991

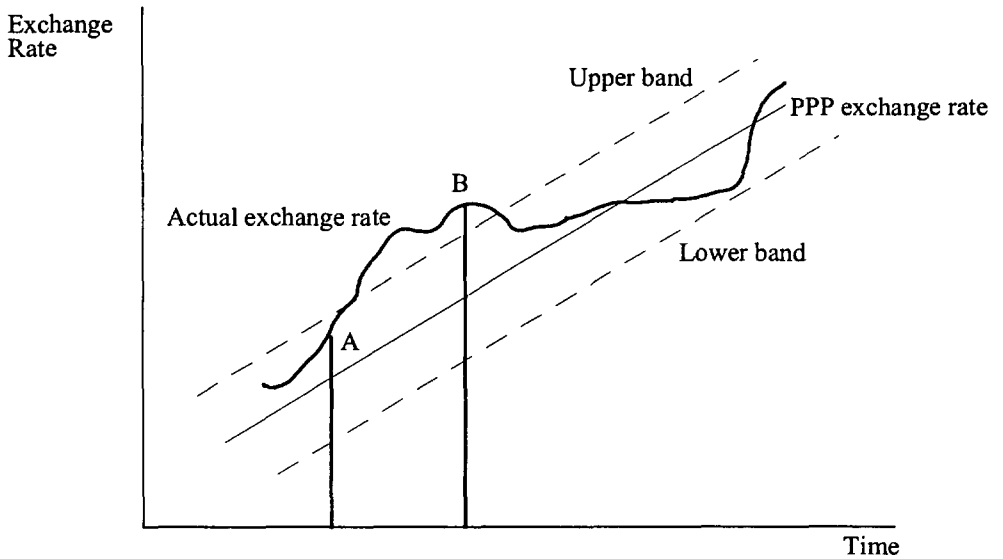


forces are weak. Many political and economic events cause the dollar to rise or fall, independent of what PPP implies. For example, news in 1990 that the United States attacked Iraq put upward pressure on the dollar. More recently, news that West Germany tightened monetary policy put downward pressure on the dollar. When events like these happen, movements in the dollar depend on how far the dollar is from PPP. When the dollar is far from PPP, market forces are likely to push the dollar toward PPP. But when the dollar is near PPP, market forces can push the dollar in either direction.

Figure 1 illustrates this argument. Suppose that policymakers were certain that the thin solid line was the true equilibrium value of the dollar. The two dotted lines now represent the band of weak PPP forces. Even though the exchange rate is above its PPP rate at point A, other forces can dominate PPP forces so that the exchange rate may rise or fall. However, if the exchange gets too far out of line, such as at point B, then PPP forces are likely to cause the exchange rate to decline.

It is possible to test for a band of uncertainty or a band of weak PPP forces. The tests are similar to those performed previously. Now, however, the question is whether the exchange rate falls when it is above a threshold level and rises when it is below a threshold level. Suppose the threshold in Figure 1 encompasses 75 percent of the deviations from PPP.[11] The question then becomes: What is the probability that the exchange rate will fall, given that it is above the top dotted line (at a point such as B) and that it will rise, given that the

Figure 1
Less-Stringent Tests of PPP



exchange is below the bottom line?

Statistical tests show that when the exchange rate is far from its estimated PPP value (outside the band of uncertainty or the band of weak PPP forces), it is likely that the exchange rate will move toward its PPP rate in the near term (Table 3). The probability of moving toward the band in one month is fairly strong for the value of the dollar relative to all currencies except the mark. While the probability for the mark is only 50 percent, the probability for the other exchange rates ranges from 55 percent for the pound/dollar exchange rate to 63 percent for the yen/dollar exchange rate. Furthermore, the probability of the rates moving toward the band in six months is even higher, ranging from 63 percent for the mark to 80 percent for the Canadian dollar.[12]

CONCLUSIONS

Evidence presented in this article suggests purchasing power parity is a useful long-run guide to the dollar. With the dollar currently estimated to be about 20 percent below its PPP value against the mark and the yen, the dollar is likely to rise against these currencies over the next several years.

It is also found that PPP is less useful as a short-run guide to the dollar. Only when deviations from PPP are unusually large is the dollar more likely to move toward PPP than away from PPP in the short run. Current estimates of the dollar's value relative to PPP suggest the near-term outlook for the dollar is uncertain. This uncertainty stems from possible measurement error in

Table 3

A Narrow Version of PPP As a Short-run Guide to the Dollar

Probability that the exchange rate moves toward the PPP exchange rate in:	Yen	Mark	Pound	Canadian dollar
1 month	63	50	55	61
2 months	61	54	58	57
3 months	61	59	59	65
4 months	69	61	62	70
5 months	69	62	63	74
6 months	70	63	75	80

Note: Boundary set so that 75 percent of the observations are within the boundary. The sample period is from 1974:1 to 1991:12; the base period is 1980:1–1982:12. The probabilities are calculated as in Table 1, but using only those observations that fall outside the 75 percent boundary.

estimating the dollar's PPP rate. In addition, the current 20 percent deviation of the dollar from PPP is not clearly outside the zone of weak PPP forces. As a result, while the value of the dollar is likely to rise over the next few years, the dollar's outlook over the near term remains uncertain.

BOX

The PPP Exchange Rate

The relation between the U.S. price level and the PPP exchange rate can be seen mathematically. In the case of the pound/dollar exchange rate, the PPP exchange rate is defined as follows:

$$PPP = \frac{P^{UK}}{P^{US}} \quad (1)$$

where

PPP = the PPP exchange rate,

P^{UK} = the UK price level, and

P^{US} = the $U.S.$ price level.

If all prices in the United States double, P^{US} doubles. The purchasing power of the dollar falls by half because the U.S. basket of goods now costs twice as much in dollar terms. Holding U.K. prices fixed, the pound/dollar PPP exchange rate falls by half. Since the purchasing power of the dollar is half what it used to be, a foreigner will pay only half as much for a dollar. That is, the PPP exchange value of the dollar falls by half.

The equation also demonstrates the equal value, under absolute PPP, of identical baskets of goods and services in the United States and United Kingdom. Recall that the U.S. price level in equation 1 is the dollar value of a basket of U.S. goods. Multiplying both sides of the equation by the U.S. price level yields:

$$PPP \times P^{US} = P^{UK}.$$

The left-hand side of the equation is now the pound value of the U.S. basket of goods, and the right-hand side is the pound value of the U.K. basket of goods. When both baskets are valued in the same currency at the PPP exchange rate, the values are equal. This equality reflects the law of one price, which says that the price of a specific good in the United States and the United Kingdom should be the same when expressed in pounds.

Absolute PPP can be viewed as an extension of the quantity theory of money to an international economy. According to the quantity theory of money, an increase in the supply of money leads both to an increase in the price level and to a decline in the exchange rate. An increase in the U.S. price level means a dollar purchases fewer goods; a decline in the exchange rate means a dollar purchases fewer units of foreign currency. For both reasons, the increase in the money supply reduces the purchasing power of money. According to PPP, the increase in the price level and the decline in the dollar are equal. Equation 1 reflects this equality.

ENDNOTES

[1] The law of one price provides that each good potentially has its own exchange rate. For example, the exchange rate for sweaters equals the price of U.K. sweaters divided by the price of U.S. sweaters. If the U.S. price of sweaters is $100 and the U.K. price of sweaters is £50, the exchange rate for sweaters equals £50/$100 or £0.50/$. If the law of one price holds strictly, this PPP exchange rate for sweaters equals the market exchange rate.

[2] Price levels, in turn, may be measured by a number of indexes, including the consumer price index, producer price index, and the fixed-weight and implicit GDP deflators. Because there are only a handful of price indexes, there are only a few possible ways to measure absolute PPP exchange rates.

[3] If there is a constant factor of proportionality, PPP can be written as:

$$e^{PPP} = \theta * \frac{pUK}{pUS}.$$

Taking the growth rate of both sides yields relative PPP

because the growth rate of the constant term is zero. Kenichi Ohno (1990) estimates this factor of proportionality.

[4] Testing relative PPP first requires computing the relative PPP exchange rate. While the concept of relative PPP provides a formula for computing changes in the PPP exchange rate, it does not provide a means for computing the levels. An initial PPP exchange rate is therefore needed to serve as an anchor in converting changes in the PPP exchange rate to levels. Once an initial exchange rate is known, PPP exchange rates can be calculated for all other time periods. But how is the initial exchange rate chosen?

One way to choose an initial exchange rate is to assume that PPP held in some base year. For example, suppose PPP held in 1980, so that the PPP exchange rate in 1980 equaled the actual exchange rate. In the case of the pound/dollar exchange rate, the assumption could be written mathematically as:

$$e_{1980} = e^{PPP} = \theta * \frac{P^{UK}}{P^{US}}$$

According to relative PPP, the change in the PPP exchange rate between 1980 and 1981 would equal the inflation differential between the United States and the United Kingdom. Knowing the PPP rate in 1980 and the change in the PPP rate between 1980 and 1981 provides an estimate of the PPP rate in 1981. Continuing in this way leads to a time series of PPP exchange rates.

Choosing a different base year yields a different PPP exchange rate. Since it is impossible to say with certainty that PPP held in some particular base year, there is no such thing as *the* PPP exchange rate. By choosing several different base years, the results are not prejudiced by this base-year problem.

[5] If shocks are always money shocks, then most theories suggest that PPP is correct. However, if shocks are also real shocks that lead to changes in relative prices, then PPP would be incorrect.

[6] To make the deviation in 1900 comparable to the deviation in 1980, the chart plots the percentage deviation between the exchange rate and the PPP rate.

[7] The probability that the exchange rate moves toward PPP plus the probability that it moves away equals 100 percent. Therefore, if the probability of moving toward PPP is greater than the probability of moving away, the probability of moving toward PPP must be greater than 50 percent.

[8] If the probability is less than 50 percent, then a deviation from PPP is most likely going to get larger. But the calculation only says that the deviation will get larger; it does not say how large. Therefore, the PPP exchange rate contains little useful information.

[9] As in Chart 1, the base period is 1900-13. The results using other base periods are similar.

[10] The base period for calculating PPP was 1980-82 because several economists have argued this was a period of equilibrium. See Krugman and others.

[11] The choice of 75 percent is arbitrary—60 percent or 90 percent would also have been possible. If one believes that 25 percent of the deviations from PPP are "large," then a 75 percent band is appropriate.

[12] In addition, the exchange rate quickly moves to the edge of its band. It takes from three to six months for the exchange rate to return to the edge of its boundary whenever it is above the upper boundary or below the lower boundary. Of course, this information is limited. The exchange rate quickly moves to the edge of its band, but the band is wide—covering 75 percent of the exchange rate observations.

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