Cletus C. Coughlin is associate director of research and Patricia S. Pollard is an economist at the Federal Reserve Bank of St. Louis. Jerram Betts provided research assistance.

A Question of Measurement: Is the Dollar Rising or Falling?

Cletus C. Coughlin and Patricia S. Pollard

In March 1985 one U.S. dollar could buy 258 Japanese yen and 0.21 Mexican pesos. In December 1995 the same dollar could buy only 102 yen, but could now buy 7.7 Mexican pesos. Though the change in the value of the dollar against each of these currencies was exceptionally large, the behavior of the dollar—rising against one currency and falling against another—was not uncommon. Over the past 10 years the dollar has appreciated against many currencies and depreciated against others. How then can one determine what has happened to the overall value of the dollar? Is the dollar stronger or weaker than it was 10 years ago? To begin answering this question, economists construct effective exchange rate indexes.

Effective exchange rates, commonly termed *trade-weighted exchange rates*, measure the average foreign exchange value of a country's currency relative to a group of other currencies.[1] Unfortunately, looking at effective exchange rate indexes may not provide a consistent answer to the preceding questions. The effective exchange value of the dollar as measured by six commonly used indexes is shown in Figure 1. According to four of these indexes, the dollar has fallen in value since March 1985, whereas two other indexes show a rise in the value of the dollar since March 1985. For example, according to the effective exchange rate index produced by the Federal Reserve Board, the U.S. dollar fell in value by 62 percent between March 1985 and December 1995.[2] In contrast, the index produced by the Federal Reserve Bank of Dallas shows the dollar rising in value by 60 percent during the same period.

Even when the indexes show the dollar moving in the same direction, they generally do not agree on the overall magnitude of that change. Why don't these indexes provide a consistent view of changes in the value of the dollar? This article answers this question by examining the way in which exchange rate indexes are constructed. We begin by exploring the basic issues of constructing effective exchange rates using the six indexes shown in Figure 1 for illustration. After discussing the differences in constructing these indexes, we examine some factors that might account for the contrasting views of the dollar by focusing on two specific indexes—the Federal Reserve Board and the Federal Reserve Bank of Dallas indexes.

CONSTRUCTING EFFECTIVE EXCHANGE RATE INDEXES

The construction of effective exchange rate indexes requires a number of decisions.[3] Because many of the decisions have more than one defensible alternative, it is not surprising that a number of effective exchange rate indexes are used. Six decisions are examined: (1) which formula is used to calculate the average, (2) which foreign currencies are used in the calculation, (3) which measure of economic activity is used as the basis for weighing the importance of individual currencies, (4) how to calculate the weights for individual currencies, (5) the base period for calculating the weights, and (6) the base period for calculating exchange rate changes. These decisions are illustrated with specific references to how six well-known effective exchange rate indexes are constructed. These indexes are identified by their producers—

[1] Effective exchange rate indexes were developed by the International Monetary Fund. The seminal work was by Hirsch and Higgins (1970).

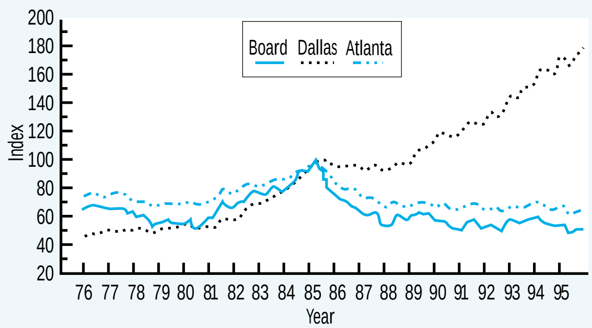
[2] For all indexes discussed in this article, percentage changes are calculated on a logarithmic basis. Thus the percentage change in an index that increases from 100.0 to 111.2 is the natural logarithm of the ratio of 111.2 to 100 or 10.6 percent.

[3] The issues involved in constructing effective exchange rate indexes have been discussed by many authors, including Rhomberg (1976), Rosensweig (1987), and Turner and Van 't dack. (1993).

Figure 1

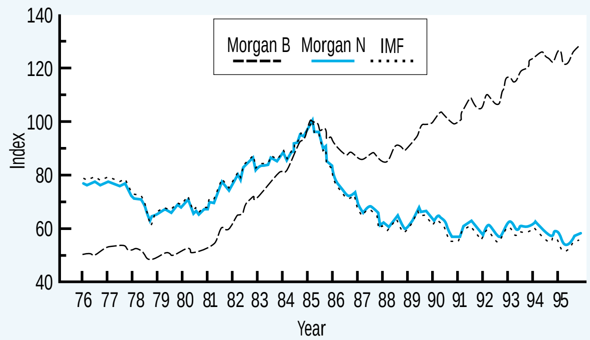
Effective Exchange Rates

(March 1985=1)



Selected Effective Exchange Rates

March 1985=100



Federal Reserve Board, J.P. Morgan (broad and narrow), International Monetary Fund (IMF), Federal Reserve Bank of Dallas, and Federal Reserve Bank of Atlanta. The movement of these indexes over time is presented in Figure 1, and a summary of their construction characteristics is provided in Table 1. In sorting through the various choices in constructing an index, it may be helpful to keep in mind a general principle: The use of the index should guide its construction.[4]

Which Formula?

Suppose the world has three currencies—the dollar, Currency *x* and Currency *y*. Further suppose that in the first year one dollar could buy 25 units of Currency *x*. In the second year one dollar could buy 50 units of Currency *x*, and in the third year a dollar could buy 100 units of Currency *x*. With respect to Currency *y*, one dollar could buy 40 units in the first year, 20 units in the second year, and 10 units in the third year. The dollar rose in value against Currency *x*—over time one dollar could buy more and more units of this currency. In contrast, the dollar fell in value against Currency *y*—over time one dollar could buy fewer and fewer units of this currency. Note that compared with the first year, one dollar could buy twice as many units of Currency *x* and half as many units of Currency *y* in the second year, and four times as many units of Currency *x* and one-quarter as many units of Currency *y* in the third year.

What happened to the overall value of the dollar? There are two methods of calculating an average value for the dollar: an arithmetic mean or a geometric mean. Each method compares the effective value of the dollar with its value in a given period, for example, relative to the first year. An arithmetic mean computes a simple average. In Year 1 the effective exchange rate using the arithmetic mean is

$$\frac{1}{2}\left(\frac{e_{x,1}}{e_{x,1}}+\frac{e_{y,1}}{e_{y,1}}\right)=\frac{1}{2}\left(\frac{25}{25}+\frac{40}{40}\right)=1 \ ,$$

where $e_{x,1}$ is the Currency *x*/dollar exchange rate in Year 1, and $e_{y,1}$ is the Currency *y*/dollar exchange rate in Year 1. In Year 2 the effective exchange rate using the arithmetic mean is

$$\frac{1}{2}\left(\frac{e_{x,2}}{e_{x,1}}+\frac{e_{y,2}}{e_{y,1}}\right)=\frac{1}{2}\left(\frac{50}{25}+\frac{20}{40}\right)=1.25 \ ,$$

where $e_{x,2}$ and $e_{y,2}$ are the Currency *x*/dollar exchange rate and the Currency *y*/dollar exchange rate, respectively, in Year 2. Similarly, in Year 3 the effective exchange rate using the arithmetic mean is

[4] Following this general principle will not necessarily mean that the constructed exchange rate measure will generate superior results when used in a specific case. See Belongia (1986) for an empirical demonstration supporting such a conclusion in the context of U.S. agricultural exports. See Deephouse (1985) and Hooper and Morton (1978) for an elaboration of the uses of effective exchange rate indexes.

Table 1

Construction Features of Effective Exchange Rates for the Dollar

Producer	Years Covered	Number of Countries	Trade-Weight Period	Weighting Scheme
Federal Reserve Board	1967–present	10	1972–1976	Multilateral
J.P. Morgan (narrow)	1970–1986	15	1980	Double (manufactures)
	1987–present	18	1990	Double (manufactures)
J.P. Morgan (broad)	1970–1986	44	1980	Double (manufactures)
	1987–present	44	1990	Double (manufactures)
International Monetary Fund	1957–present	20	1989–1991	Double (manufactures)
Federal Reserve Bank of Dallas	1976–present	128	Three-year moving average	Bilateral
Federal Reserve Bank of Atlanta	1973–present	18	1984	Bilateral

$$\frac{1}{2}\left(\frac{e_{x,3}}{e_{x,1}}+\frac{e_{y,3}}{e_{y,1}}\right)=\frac{1}{2}\left(\frac{100}{25}+\frac{10}{40}\right)=2.125\ ,$$

where $e_{x,3}$ and $e_{y,3}$ are the Currency x/dollar exchange rate and the Currency y/dollar exchange rate, respectively, in Year 3. The resulting number in each year is generally multiplied by 100 to create an easily usable index. Thus the effective exchange rate index for the three years is 100, 125, and 212.5.

The geometric mean in Year 1, again using the first year as the base year, is

$$\left(\frac{e_{x,1}}{e_{x,1}}+\frac{e_{y,1}}{e_{y,1}}\right)^{\frac{1}{2}}=\left(\frac{25}{25}+\frac{40}{40}\right)^{\frac{1}{2}}=1\ .$$

In the Year 2 the geometric mean is

$$\left(\frac{e_{x,2}}{e_{x,1}}+\frac{e_{y,2}}{e_{y,1}}\right)^{\frac{1}{2}}=\left(\frac{50}{25}+\frac{20}{40}\right)^{\frac{1}{2}}=1\ .$$

In Year 3 the geometric mean is

$$\left(\frac{e_{x,3}}{e_{x,1}}+\frac{e_{y,3}}{e_{y,1}}\right)^{\frac{1}{2}}=\left(\frac{100}{25}+\frac{10}{40}\right)^{\frac{1}{2}}=1\ .$$

Multiplying the resulting number in each year by 100 produces the following index for the three years: 100, 100, 100.

Using the arithmetic mean, the effective value of the dollar rose over the three-year period, whereas using the geometric mean, the effective value of the dollar was unchanged. The result based on the geometric mean seems more reasonable, given that the rise in the value of the dollar against Currency x is offset by the fall in the value of the dollar against Currency y. The arithmetic mean created an upward bias.[5] The Board of Governors of the Federal Reserve System, when it switched from using an arithmetic mean to a geometric mean to construct its effective exchange rate index for the dollar, noted that "as currencies diverged from each other over time, changes in currencies that rose against the dollar had a reduced impact on the index while changes in currencies that fell against the dollar had an increased impact on the index. As a result, arithmetic averaging imparted a systematic upward bias to the measurement of changes in the dollar's average exchange value."[6]

Because of the bias inherent in an index based on arithmetic averaging, all the effective exchange rate indexes shown in Figure 1 use a geometric averaging technique. Of the six decisions involved in constructing an effective exchange rate index, this choice of

[5] It is not mandatory that the direction of the bias be upward. If Year 3 had been used as the base year, the index using the arithmetic average would be 212.5, 125, 100 and the index using geometric averaging would be 100, 100, 100. In this example, arithmetic averaging would have created a downward bias.

[6] See *Board of Governors* (1978), p. 700.

a geometric average is the only one on which there is consensus.

The generic formula, using geometric averaging, for the value of the effective exchange rate index at time t is

$$(1) \qquad Index_t = 100 \prod_{i=1}^{n} \left(\frac{e_{it}}{e_{ib}} \right)^{w_{it}},$$

where Π is the product over the n foreign currencies in the index, e_{it} is the number of units of Currency i per dollar at time t; e_{ib} is the number of units of Currency i per dollar in the base period; and w_{it} is the weight assigned to Currency i at time t.

In the above example, each currency was given equal weight in each period, w_{it} = 1/2 and the base period was Year 1. In actually constructing an exchange rate index, developers must make numerous decisions involving the currencies included, the weights for the currencies, and the base periods. An elaboration of the key decisions is provided below.

Which Currencies?

Ideally, an effective exchange rate for the dollar should include all currencies for which the dollar is exchanged. Such an ideal, however, is tempered by the reality that the construction of the index requires timely, reliable data. As a result, most indexes are limited to the currencies of the principal industrial economies. Table 1 shows that most indexes use data on the dollar relative to the currencies of between 10 and 20 countries. The major exceptions are the broad index produced by J.P. Morgan that uses the currencies of 44 countries relative to the dollar and the index produced by the Federal Reserve Bank of Dallas that currently uses the currencies of 128 countries.

The index produced by the Federal Reserve Board uses data on the dollar relative to the currencies of the other nine members of the Group of Ten—Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, United Kingdom—plus Switzerland. These countries were selected for several reasons.[7] First, each country has a well-developed foreign exchange market with exchange rates that depend primarily on the supply and demand decisions of private individuals and firms. Second, these countries are involved in the majority of U.S. trade and capital flows. Third, many of the countries excluded from the index either attempt to keep their currencies pegged to an included currency or use one of the included currencies for their international transactions.

The countries whose currencies are included in the index produced by the Federal Reserve Board are located in Europe, except for Canada and Japan. Clearly, this index includes the major traded currencies and consequently allows an assessment of changes in the value of the U.S. dollar relative to the other major currencies. The other five indexes discussed here use the 10 currencies in the Board's index, but they add other currencies as well.[8] For example, the narrow index produced by J.P. Morgan adds currencies from seven European countries—Austria, Denmark, Finland, Greece, Norway, Portugal and Spain—plus Australia. The currencies of Finland, Greece, and Portugal did not appear in the index until 1987. The IMF index adds the currencies of Ireland and New Zealand to the J.P. Morgan narrow index. The IMF index therefore contains the currencies of all the major industrialized countries.[9] The Atlanta index adds the currencies of Taiwan, Hong Kong, South Korea, Singapore, and China, as well as those of Australia, Spain, and Saudi Arabia, to the Board's index. The addition of the currencies of the first five countries is justified by the shifting pattern of U.S. trade toward developing countries in Asia.[10] In addition to a narrow index for the United States, J.P. Morgan produces a broad index that uses the currencies of most member countries of the Organization for Economic Cooperation and Development plus numerous developing countries.[11] The ultimate in inclusiveness is the index produced by the Federal Reserve Bank of Dallas, which currently includes 128 currencies.[12]

7 See Hooper and Morton (1978).

8 Whether indexes with a broad range of currencies are superior to those using a small range of currencies is an empirical question. See Batten and Belongia (1987) for an empirical study of U.S. trade flows indicating that measures based on more currencies performed no better than the measures based on fewer currencies.

9 J.P. Morgan and the IMF produce effective exchange rate indexes for each of the currencies included in the U.S. dollar indexes.

10 For more on the choice of currencies in the Atlanta index, see Rosensweig (1986a and b).

11 The 26 countries included in J.P. Morgan's broad, but not its narrow, index are Ireland, New Zealand, Turkey, Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, Venezuela, Hong Kong, Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand, India, Kuwait, Morocco, Nigeria, Pakistan, Saudi Arabia, and South Africa.

12 Cox (1986) stressed that the index contained all U.S. trading partners; however, the index contains few currencies from Eastern European countries and countries that were formerly part of the Soviet Union.

Which Measure of Economic Activity?

Deciding how many countries to include in the index also requires decisions concerning how much importance should be attached to the currency from a particular country. In other words, the relative importance of a currency is determined by its weight in the average. Before determining the weight of a particular currency, researchers must decide which measure of economic activity is used in the calculation of the weights.

Because effective exchange rate indexes are most often constructed to measure changes in a country's international competitiveness, generally some measure of international trade is used to calculate the weights. For this reason, effective exchange rates are frequently termed *trade-weighted exchange rates*. International trade, however, is not the only measure of international economic activity that could be used. The exchange value of the dollar is determined by supply and demand forces involving the international exchange of goods, services, and assets. Individuals, firms, and governments demand (buy) dollars in foreign exchange markets to purchase goods, services, or assets denominated in U.S. dollars. Likewise, individuals, firms, and governments supply (sell) dollars in foreign exchange markets to purchase goods, services, or assets denominated in foreign currencies. For example, a U.S. auto dealer wanting to import BMWs must first obtain German marks and so supplies dollars and demands marks. Any country wanting to import petroleum must pay in U.S. dollars and so must first exchange its own currency for dollars, supplying its currency and demanding dollars. A Japanese investor who wants to buy U.S. Treasury securities must first obtain U.S. dollars and so supplies yen and demands dollars.

Though trade flows are used to calculate the weights given to each currency in an effective exchange rate index, based on international financial movements, one could use international capital flows to determine the weights. Both the absolute levels and the rapid growth rates of international capital flows suggest that capital flows might currently be a more important determinant of exchange rates than trade flows. Thus using capital flows, the currencies of countries with larger investment and portfolio flows are more important in the determination of the value of the dollar than are the currencies of countries with smaller investment and portfolio activity. Even though such a calculation is reasonable on theoretical grounds, no major producer of effective exchange rates uses capital flows to construct its measures.[13]

A key reason trade is used for weighting purposes is that, although trade data are subject to errors, they are much easier to obtain on a timely basis than capital flows. Different indexes, however, use different measures of international trade. Generally speaking, most indexes are constructed using total merchandise trade and do not include services, which have tended to increase rapidly in recent years. The indexes produced by J.P. Morgan and the IMF, however, use only trade in manufactures.

Which Weighting Method?

Another issue in weighting the importance of a specific currency involves the selection of a weighting scheme. If the effective exchange rate index is to reflect changes in a country's international competitiveness, then ideally the weights should be chosen to reflect the responsiveness of a country's trade flows to changes in exchange rates. A theoretically based index was previously produced by the IMF: the Multilateral Exchange Rate Model (MERM) index. In the U.S. dollar MERM index, for example, the weight given to each currency was chosen so that any combination of changes in the currencies against the dollar leading to a one percent change in the index would have the same effect on the U.S. trade balance (over a 2-3 year period) as a one percent change in the dollar against each currency in the index. Estimation of the weights required the use of an econometric model incorpo-

[13] See Ott (1987) for a more extensive discussion and illustration of a capital-weighted exchange rate.

rating information on price elasticities, exchange rate effects on domestic prices, and the policy response of the economy. Concerns about the unreliability of the model determining the weights led to the abandonment of the MERM and similarly constructed indexes.[14]

Three other methods of weighting remain in use: bilateral, multilateral, and double weights.[15] With bilateral weighting, each country is weighted by the proportion of its share of the total trade flows to and from the United States of the countries used to construct the index. Thus the weight for Country *i* is simply the sum of U.S. exports to and imports from Country *i* divided by the sum of U.S. exports to and imports from all countries included in the index. Assuming that *n* countries are used to construct the index, the weight for Country *i* is:

$$(2) \qquad w_i = \frac{USX_i + USM_i}{\sum_{i=1}^{n}(USX_i + USM_i)},$$

where USX_i is the exports from the United States to Country *i* and USM_i is the imports of the United States from Country *i*.[16]

With multilateral weighting, each country is weighted by the proportion of its share of total trade flows throughout the world. Thus the weight for each Country *i* is the sum of Country *i*'s worldwide exports and imports divided by the sum of the worldwide exports and imports of all the countries included in the index. Once again, assuming that *n* countries are used to construct the index, the weight for Country *i* is:

$$(3) \qquad w_i = \frac{WX_i + WM_i}{\sum_{i=1}^{n}(WX_i + WM_i)},$$

where WX_i is the worldwide exports of Country *i* and WM_i is the worldwide imports of Country *i*.

Neither alternative is obviously superior. The multilateral weighting approach attempts to capture the competition between two countries in countries outside of their domestic markets. For example, a change in the Japanese yen-U.S. dollar exchange rate can affect relative prices of Japanese goods, American goods, and goods from other countries besides Japan and the United States, such as Canada. The multilateral approach used in the construction of the index produced by the Federal Reserve Board seems more suitable for accounting for these third-country effects. On the other hand, it is possible that the multilateral weighting approach gives too much weight to nations that trade more extensively with each other than with the United States. For example, European Community countries that trade extensively with each other are likely to receive higher-than-warranted weights in the construction of an index for the United States. A possible result in the case of an effective exchange rate for the United States would be that Canada, the largest U.S. trading partner, would be weighted less than warranted. In this case, a bilateral weighting approach that is used in the indexes produced by the Federal Reserve Bank of Dallas and the Federal Reserve Bank of Atlanta might be more appropriate.

The double weighting method, which is used in the indexes produced by the IMF and J.P. Morgan, attempts to combine the advantages of both the bilateral and multilateral weighting schemes: recognition of competition in third markets and the strength of links between particular trading partners. In addition, the double weighting method recognizes the competitive position of domestic producers of import substitutes and therefore requires information on production for local consumption as well as on trade flows.[17] In the dollar index, the weights reflect both the competition U.S. ex-porters face from other countries' exporters and from the local countries' producers.

Which Base Period for Weights?

The fifth major issue in the construction of an effective exchange rate is the choice of a base period for the trade flows

[14] Turner and Van 't dack (1993) provide a good overview of the construction and problems associated with the MERM index.

[15] Bilateral weights were used in the original work on effective exchange rates, see Hirsch and Higgins (1970).

[16] To simplify the discussion we have omitted all references to time. Obviously, the trade flows cover a particular period and the weight for a country pertains to a particular period. As indicated by equation 1 and discussed in the next section, the weight for a country may change over time.

[17] See Hargreaves (1993) for details on how the J. P. Morgan index is constructed. Turner and Van 't dack (1993) provide a general analysis of the double weighting method.

on which the weights are based. The index may use fixed weights, weights that are updated periodically, or weights that are updated annually. For example, the Federal Reserve Board's index uses fixed weights that have remained unchanged; the J.P. Morgan indexes use different weights for the period from 1970 to 1986 and the period from 1987 to the present; and the index produced by the Federal Reserve Bank of Dallas uses a three-year moving average to continually update its weights.[18] If fixed weights are used, then researchers must decide which year or years should be used. For example, the Federal Reserve Bank of Atlanta index uses 1984 trade figures, the Federal Reserve Board index uses trade data from 1972 to 1976, and the IMF index uses trade data from 1989 to 1991.

The existence of various base periods suggests that there is no obviously superior base period. Fixing the base period for the trade weights means that the index does not incorporate the effect of changing trade patterns. Thus a shifting pattern of trade raises the possibility that a fixed-weight index becomes a less reliable exchange rate measure over time. On the other hand, a potential problem stemming from updating the weights annually is that the effects of exchange rate changes may be confounded with changes caused by shifting weights in the index. It is possible, because of shifts in trade shares, that an effective exchange rate may change even if no individual exchange rate changes.

Table 2 illustrates this point. The upper half of the table shows the results of calculating a hypothetical trade-weighted exchange rate index for the U.S. dollar assuming fixed weights for each currency based on trade shares at some point. The weight for Country 1 is 0.7, whereas the weight for Country 2 is 0.3. The lower half of the table shows the results of calculating a hypothetical trade-weighted exchange rate index for the U.S. dollar assuming that the weights given to each currency are updated annually. In the example, the weight for Country 1 declines from 0.7 in Year 1 to 0.3 in Year 7, whereas the weight for Country 2 increases from 0.3 in Year 1 to 0.7 in Year 7.

Between Year 5 and Year 6, the value of the dollar was unchanged against both currencies as 61 units of Country 1's currency and 17 units of Country 2's currency could be traded for one U.S. dollar in each year. The index calculated using fixed weights shows no change in the effective exchange value of the dollar. For example, assuming that the effective exchange rate in Year 1 equals 100, then the rate in both Year 5 and Year 6 is 144.4. When weights are updated often, however, the effective exchange value of the dollar does change. For example, assuming that the effective exchange rate in Year 1 equals 100, then the rate in Year 5 is 93.3 and the rate in Year 6 is 78.4.

Thus changes in an index with weights that are updated annually always leave doubt as to whether changes in the index reflect exchange rate changes or shifting trade weights. On the other hand, if trade patterns shift, then the use of fixed weights may cause the index to produce misleading signals. This is highly likely over long periods. A compromise is to change the weights periodically; however, it is not obvious how frequently weights should be changed.

Which Base Period for Exchange Rates?

The effective exchange rate index shown in Equation 1 calculates changes in the exchange rate of the domestic currency (for our purposes the U.S. dollar) relative to each foreign currency from a base exchange rate. The Federal Reserve Board uses the March 1973 exchange rates as the base rates.[19] The Federal Reserve Bank of Atlanta uses 1980. The Federal Reserve Bank of Dallas uses the exchange rate averages for first quarter 1985 as the base. The IMF and J.P. Morgan use the exchange rate averages for 1990 as the base. As Equation 1 indicates, the index in the base period equals 100.

The creation of effective exchange rate indexes differs from that of most price in-

[18] For example, trade data for 1992–94 is used for calculating the index in 1995.

[19] This period reflects the start of the flexible exchange rate era.

Table 2

Exchange Rate Indexes: Alternative Updating Procedures for Weights*

Fixed Trade Weights

	Exchange Rates		Weights		Index		Percent Change in Index	
Year	e_1	e_2	w_1	w_2	Year 1 = 100	Year 7 = 100	Year 1 = 100	Year 7 = 100
1	25	40	0.7	0.3	100	68.1	—	—
2	32	32	0.7	0.3	111.2	75.8	10.6	10.6
3	39	26	0.7	0.3	120	81.7	7.6	7.6
4	49	21	0.7	0.3	132	90	9.6	9.6
5	61	17	0.7	0.3	144.4	98.4	9	9
6	61	17	0.7	0.3	144.4	98.4	0	0
7	70	13	0.7	0.3	146.7	100	1.6	1.6

Annually Updated Trade Weights

	Exchange Rates		Weights		Index		Percent Change in Index	
Year	e_1	e_2	w_1	w_2	Year 1 = 100	Year 7 = 100	Year 1 = 100	Year 7 = 100
1	25	40	0.7	0.3	100	68.1	—	—
2	32	32	0.65	0.35	108.6	82.4	8.2	19
3	39	26	0.6	0.4	109.9	92.9	1.2	12
4	49	21	0.5	0.5	101.4	106.3	−8	13.5
5	61	17	0.45	0.55	93.3	108.9	−8.4	2.4
6	61	17	0.35	0.65	78.4	113.5	−17.5	4.1
7	70	13	0.3	0.7	62	100	−23.4	−12.6

* Note that e = foreign currency per dollar. Percentage changes are calculated on a logarithmic basis from the preceding year to the current year.

dexes in the use of two base periods. For example, in the consumer price index the base period for prices is exactly the same as the base period for quantities. In effective exchange rate indexes the base periods for weights and for exchange rates are generally different. The Atlanta index, for example, uses 1984 as the base period for the trade data used to construct the weights but uses first quarter 1985 as the base period for exchange rates.

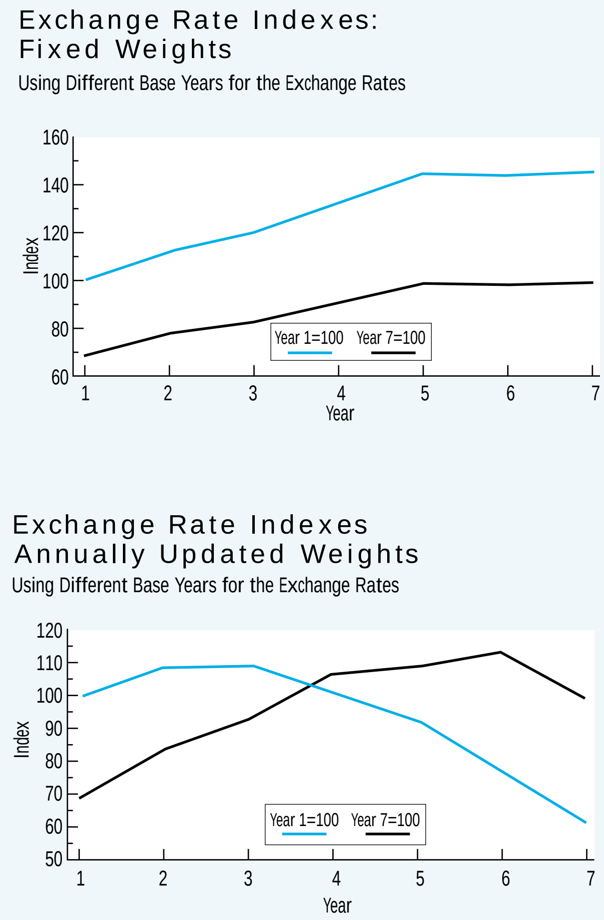
The choice of the base exchange rate period is irrelevant to the picture of the dollar's strength or weakness as measured by indexes with fixed trade weights. When the weights are updated annually, however, the calculated percentage changes in the value of the dollar become sensitive to the base period for the exchange rates.[20] The example in Table 2 can be used to illustrate this problem. Two versions of the fixed trade weights and annually updated trade weights indexes are calculated. One version uses the exchange rates in Year 1 as the base rates. The other version uses the exchange rates in Year 7 as the base rates. When the trade weights are fixed, changing the base year does not affect the percentage change in the exchange rate index. As shown in the last two columns of the top panel of Table 2, the percentage change in the effective exchange rate between any two years is the same regardless of whether Year 1 or Year 7 is used as the base year. As shown in the top panel of Figure 2 under either base year for the exchange rate index, the index indicates an appreciation of the dollar through Year 5, a

[20] This issue is explored extensively in Coughlin, Pollard and Betts (1996).

constant value of the dollar from Year 5 to Year 6, and a slight appreciation of the dollar in Year 7.

The effective exchange value of the dollar, however, is affected by the choice of the base period for the exchange rate when the trade weights are updated annually. As shown in the bottom halves of Table 2 and Figure 2, if exchange rates in Year 1 are used as a base, the effective exchange value of the dollar appreciates until Year 3 and depreciates thereafter. If exchange rates in Year 7 are used as the base, the effective exchange value of the dollar rises through Year 6 and falls in Year 7. Note that whereas the value of the dollar is constant between Year 5 and Year 6 using fixed trade weights, when the trade weights are continuously updated, the effective exchange rate index indicates either a depreciation or an appreciation of the dollar, depending on the base period for the index.

Figure 2



WHAT ACCOUNTS FOR DIFFERENCES IN THE EXCHANGE RATE INDEXES?

Because exchange rates indexes are constructed differently, it is not surprising that the picture they give of the value of the dollar may differ. The previous section explained the choices creators of effective exchange rate indexes face in designing an index. This section concentrates on two popular indexes—the Federal Reserve Board (Board) index and the Federal Reserve Bank of Dallas (Dallas) index—to illustrate which factors are the most important in accounting for differences in the behavior of the two indexes. As Figure 1 shows, these two indexes were qualitatively similar between January 1976 and March 1985 but differed sharply between March 1985 and December 1995. According to Table 3, during the early period the Board index showed a 43 percent appreciation of the U.S. dollar, whereas the Dallas index showed a substantially larger appreciation of the dollar, 77 percent. During the later period the Board index showed a 62 percent depreciation of the dollar. In sharp contrast, the Dallas index showed a 60 percent appreciation of the dollar. Over the sample period 1976–95 there was little correlation between the two indexes, as shown by the correlation coefficient of −0.27 in Table 4. In the early period the indexes were highly positively correlated (0.91), but exhibited a negative correlation (−0.50) in the later period.

The construction of the Board and Dallas indexes differs in three aspects: the method used to calculate the trade weights, the base period for the trade weights, and the choice of currencies in each index.[21] The Board index uses multilateral trade shares, whereas the Dallas index uses bilateral trade shares. The

[21] The Board and Dallas indexes also differ in their choice of base period used for their exchange rates. To eliminate any problems caused by this difference, we recalculated the Board index using the March 1985 exchange rates as the base rates.

Table 3

Exchange Rate Changes in the Various Constructed Trade-Weighted Exchange Rate Indexes (in percent)

Period	Board	Dallas	BilBoard	MupBoard*	BupBoard	CmBoard	CmupBoard
1976.01–1995.12	−19	137	−14	−17	−17	28	58
1976.01–1985.03	43	77	30	42	30	46	47
1985.03–1995.12	−62	60	−44	−59	−48	−18	11

* The data period for the MupBoard index ends in December 1994.

Table 4

Correlations Among Trade-Weighted Exchange Rate Indexes

Correlation with the Board Index

Period	Dallas	BilBoard	MupBoard*	BupBoard	CmBoard	CmupBoard
1976.01–1995.12	−0.27	0.98	1	0.97	0.52	0.11
1976.01–1985.03	0.91	0.99	1	0.99	0.97	0.97
1985.03–1995.12	−0.5	0.99	1	0.99	0.94	0.02

Correlation with the Dallas Index

Period	Board	BilBoard	MupBoard*	BupBoard	CmBoard	CmupBoard
1976.01–1995.12	−0.27	−0.39	−0.21	−0.45	0.61	0.91
1976.01–1985.03	0.91	0.93	0.91	0.93	0.97	0.97
1985.03–1995.12	−0.5	−0.51	−0.47	−0.52	−0.26	0.81

* The data period for the MupBoard index ends in December 1994.

weight assigned to each currency in the Board index is fixed, whereas the weights in the Dallas index are updated annually. Specifically, the weights used in the Board index were determined by the average trade share of each country whose currency is included in the index for the period 1972–76. In contrast, in the Dallas index, the weights used in a given year are based on the average trade shares over the prior three-year period. Last, the currencies of 10 countries are used in the Board index, whereas the currencies of 128 countries are used in the Dallas index.

This section examines the importance of each of these three aspects in accounting for the differences between the two indexes. It does so by creating five variations on the Board index—BilBoard, MupBoard, BupBoard, CmBoard, and CmupBoard—shown in Figure 3. Each variation modifies the construction of the Board index so that it is more closely in accord with the Dallas index. These new indexes are used to determine what causes the differences between the Board and the Dallas indexes.

Table 5 presents an overview of these five indexes, comparing them with the Board and the Dallas indexes. The BilBoard index is constructed using the same 10 currencies as in the Board index and the fixed weights based on 1972–76 trade shares of each country. However, whereas the Board index uses the world trade of each country to determine the weight given to its currency in the index, the BilBoard index uses only the bilateral trade flows of the 10 countries with the United States. Contrasting this index with the Board and Dallas indexes allows us to determine the importance of the multilateral/bilateral trade share choice in explaining the differences between the latter two indexes.

The MupBoard index differs from the Board index solely in the type of the base period for the weights given to each currency. Trade weights in the MupBoard index are updated annually, using a three-year moving average as in the Dallas index. The MupBoard index can be contrasted with the Board and Dallas indexes to determine the importance of the updating of weights in accounting for the differences between the latter two indexes.

The remaining difference between the Board and Dallas indexes is the choice of currencies used in each index. We created three variations on the Board index to examine the importance of currency choice. First we created BupBoard, an index that was identical to the Dallas index except that only the ten currencies used in the Board index were included in its calculation. Thus any differences in the behavior of the BupBoard and Dallas indexes could be attributed to the difference in currency choice between the Board and Dallas indexes. To further explore the importance of currency choice, we added the currencies of China and Mexico to a bilateral–trade share version of the Board index. Mexico was chosen because it has consistently been the most important U.S. trading partner excluded from the Board index. China is currently the next most important trading partner missing from the Board index. Its relative importance, as shown in Table 6, has grown substantially over the last 20 years. In 1976 the Chinese yuan received a weight of only 0.4 percent in the Dallas index, but its weight rose to 3.9 percent by 1995. Using the Chinese yuan and Mexican peso, we created two more indexes. In the CmBoard index, the weights given to each of the 12 currencies are determined by each country's share of trade with the United States. This index therefore differs from the Board index in two ways: it includes China and Mexico and uses bilateral trade shares. The CmupBoard index is constructed in the same manner as the CmBoard index except that the weights assigned to each currency are updated annually using a three-year moving average. The CmupBoard index therefore is identical to the Dallas index except that it includes only 12 currencies, not 128.

Table 5

Overview of Variations on the Board and Dallas Indexes*

Index	Trade Shares	Base Period for Weights	Currencies
Board	Multilateral	Fixed	10
BilBoard	Bilateral	Fixed	10
MupBoard	Multilateral	Updated annually	10
BupBoard	Bilateral	Updated annually	10
CmBoard	Bilateral	Fixed	12
CmupBoard	Bilateral	Updated annually	12
Dallas	Bilateral	Updated annually	128

* Note that the shaded cells highlight the differences from the Board index.

Table 6

Weights for the 10 Highest Weighted Currencies in the Dallas Index (in percent)

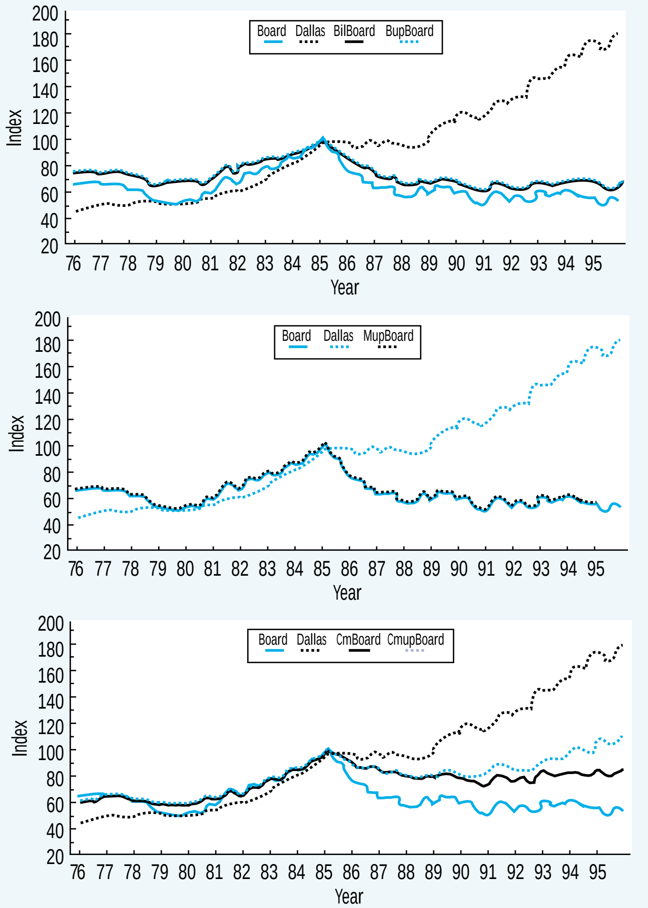
Country	1976	1985	1995
Brazil	2.3	†	†
Canada*	22.2	19.4	20.3
China	†	†	3.9
France*	2.7	2.7	2.8
Germany*	5.9	4.8	4.7
Italy*	2.8	†	†
Japan*	11.7	14.3	15
Korea	†	2.8	3.1
Mexico	4	5.7	8.1
Netherlands*	2.7	2.3	†
Saudi Arabia	†	2.6	†
Singapore	†	†	2.3
Taiwan	†	3.5	3.9
United Kingdom*	4.5	5.1	4.5
Venezuela	2.9	†	†
Total weight of top 10	61.7	63.2	68.7

* Country whose currency is included in the Board index.
† Not in the top 10 in this year.

Figure 3

Constructed Effective Exchange Rates

(March 1985=100)



yen is more than seven percentage points higher in the BilBoard index than in the Board index, whereas the other eight countries receive less weight in the BilBoard index than in the Board index.

These weight changes produce some noteworthy differences in the two indexes that are shown in the top panel of Figure 3. Table 3 reveals that between January 1976 and March 1985, the dollar appreciated 43 percent according to the Board index and 30 percent according to the BilBoard index. Accounting for this difference is relatively straightforward. The U.S. dollar rose by less against the Canadian dollar during the 1976–85 period than it did against some currencies that received higher weights than the Canadian dollar in the Board index (for example, the French franc and the British pound). With respect to the Japanese yen, the U.S. dollar fell during the 1976–85 period. Furthermore, since March 1985, the dollar has changed little relative to the Canadian dollar, falling only 1 percent. The dollar has fallen far more against the remaining nine currencies since 1985. As a result, the BilBoard index shows a less pronounced change in the dollar over the sample period than does the Board index.

The direction of the movement in the BilBoard index, however, closely matches that of the Board index as shown by the high degree of correlation between the two in Table 4. The correlation was 0.98 over the entire period. Meanwhile, the correlation between the BilBoard index and the Dallas index, even though high during 1976–85, is negative during 1985–95 and negative over the entire sample period 1976–95. In sum, the differences between the Board and the Dallas indexes cannot be primarily attributed to a difference in the method used to calculate the weights of each currency.

Bilateral vs. Multilateral Trade Shares—BilBoard

As shown in Table 7, the weights assigned to each currency in the Board and the BilBoard indexes vary substantially. For example, the weight given to the Canadian dollar is more than 30 percentage points higher in the BilBoard index than in the Board index. The reason for this difference is that although Canada is the most important U.S. trading partner, it is less important in worldwide trade. Japan also holds a higher share of U.S. trade than worldwide trade, but the other eight countries rank higher in worldwide trade rather than in trade with the United States. As a result, the weight given to the Japanese

Base Period for Trade Weights—MupBoard

The multilateral trade shares of the countries used in the MupBoard index for 1976, 1985, and 1994 are shown in Table 7.

Table 7

Trade Weights for Constructed Indexes (percent)

Country	Board	BilBoard	MupBoard			BupBoard			CmBoard	CmupBoard		
			1976	1985	1994	1976	1985	1995		1976	1985	1995
Belgium	6.4	3.4	6.4	5.9	6.3	3.5	3	2.8	3.1	3.2	2.7	2.3
Canada	9.1	39.9	9.0	8.9	7.8	39.3	35.6	37.3	37.2	36.5	31.6	30.5
China	0	0	0	0	0	0	0	0	0.5	0.6	1.8	5.9
France	13.1	4.8	12.7	12.1	12.4	4.8	5.0	5.1	4.4	4.4	4.4	4.2
Germany	20.8	10.1	20.6	19.1	21.7	10.4	8.8	8.6	9.4	9.6	7.8	7.1
Italy	9.0	4.8	9.1	9.6	9.9	4.9	4.1	3.7	4.5	4.6	3.6	3.0
Japan	13.6	21.0	13.6	17.0	15.8	20.8	26.3	27.5	19.5	19.3	23.3	22.6
Mexico	0	0	0	0	0	0	0	0	6.3	6.6	9.3	12.2
Netherlands	8.3	4.6	8.1	7.2	7.0	4.8	4.3	3.3	4.3	4.4	3.8	2.7
Sweden	4.2	1.6	4.2	3.4	2.9	1.6	1.6	1.3	1.5	1.5	1.4	1.1
Switzerland	3.6	1.9	4.6	4.7	4.5	1.9	2.0	2.0	1.8	1.8	1.8	1.7
United Kingdom	11.9	7.9	11.9	12.0	11.5	8.0	9.4	8.3	7.4	7.4	8.3	6.8

* Note that weights in the Board index are based on multilateral trade shares during 1972–76. Weights in the BilBoard and CmBoard indexes are based on bilateral trade shares during 1972-76. Weights in the MupBoard, BupBoard, and CmupBoard indexes are based on three-year moving average bilateral trade shares, updated annually. Thus, the weights in the three columns: 1976, 1985, and 1995 (1994 for MupBoard), are based on trade shares during 1973–75, 1982–84, and 1992–94, (1991–93 for MupBoard), respectively.

These trade shares did not change substantially over time. As a result, the MupBoard index closely mimics the Board index, as shown in the middle panel of Figure 3. Both indexes show the same percentage appreciation of the dollar between January 1976 and March 1985 and nearly the same depreciation from March 1985 through 1994.[22] Likewise, the two indexes were nearly perfectly correlated. Thus one can conclude that the frequency of updating weights is not the driving force for differences in the Board and Dallas indexes.

Currency Choice—BupBoard, CmBoard and CmupBoard

The top panel of Figure 3 shows that the BupBoard index closely mimics the behavior of the BilBoard index, particularly in the 1976–85 period when the weights for the two indexes, listed in Table 7, are similar. In the 1985–95 period, as Japan's share of U.S. trade rises, the BupBoard index shows a slightly larger depreciation of the dollar than the BilBoard index. This result follows from the fact that during this period the U.S. dollar fell by more against the yen than against any of the other currencies included in the index.

The behavior of the BupBoard index resembles that of the Board index. For example, Table 3 shows a 17 percent depreciation of the dollar using the BupBoard index from January 1976 to December 1995, whereas the Board index shows a 19 percent depreciation of the dollar. During this period the Dallas index shows the dollar appreciating by 137 percent. These results are reinforced by the correlation coefficients shown in Table 4. The BupBoard index is highly correlated with the Board index in the 1976–95 period (0.97) but negatively correlated with the Dallas index (−0.45). Changing the manner and frequency with which the weights are calculated to accord with the Dallas index did not create an index that resembled the Dallas index. Thus the primary cause of the differences between the two indexes must be the selection of countries in each index.

The CmBoard index allows us to further explore the importance of country choice. In the CmBoard index, the weights given to each currency are determined by that country's share of trade with the

[22] Worldwide trade data for some of the countries used in the index were not available for 1994; therefore, the MupBoard index ends in 1994.

United States.[23] This index therefore differs from the Board index in two ways: its inclusion of China and Mexico and the use of bilateral trade shares. The behavior of the CmBoard index, shown in the bottom panel of Figure 3, is similar to the Board index over the January 1976–March 1985 period. As shown in Table 3, the CmBoard index appreciated 46 percent, whereas the Board index appreciated 43 percent. A greater difference between the CmBoard and the Board indexes occurs over the period from March 1985 to December 1995. The CmBoard index shows an 18 percent trade-weighted depreciation of the dollar during this period, while the Board index shows a 62 percent depreciation. The CmBoard index, however, does not show an appreciation of the dollar as the Dallas index does during this period. That the changes embedded in the CmBoard index cause it to become more similar to the Dallas index and less similar to the Board index is reinforced by the correlation coefficients in Table 4. For the entire period, the correlation of the CmBoard index with the Board index is much lower than the Bilboard, MupBoard, and BupBoard indexes, whereas its correlation with the Dallas index is positive rather than negative.

The CmupBoard index, which also includes China and Mexico, still does not show the magnitude of the appreciation of the dollar in the bottom panel of Figure 3 that the Dallas index indicates in the January 1976–March 1985 period. In contrast, however, to all of the previously constructed indexes, it does show an appreciation of the dollar during the March 1985–December 1995 period, although this appreciation is less than that indicated by the Dallas index. For the entire period, the CmupBoard index shows little correlation with the Board index but is highly correlated with the Dallas index.

The CmBoard and the CmupBoard indexes illustrate two key points. The first is that the Dallas index differs from the Board index primarily because the Dallas index includes currencies whose behavior, particularly during the March 1985–December 1995 period, was in sharp contrast to the behavior of the currencies included in the Board index. Specifically, the Dallas index includes currencies against which the dollar appreciated substantially during this period. Between March 1985 and December 1995, the dollar rose by 362 percent against the Mexican peso. In contrast, the dollar fell against all of the currencies included in the Board index during this period.

The second point is that in an index in which there are sharp differences in the behavior of the currencies (such as the Dallas index), the weights assigned to each currency matter. In the Board index the behavior of the currencies was relatively similar: The dollar rose against all 10 currencies with the exception of the Japanese yen during the early period and fell against all 10 currencies during the later period. Given such similarities in the behavior of the currencies, the manner in which the weights were calculated—bilateral or multilateral trade shares—and the frequency of updating of the weights had little effect on the behavior of the indexes. However, when the behaviors of the currencies in the index differ greatly, as evidenced by the enormous appreciation of the dollar against the Mexican peso during the same period in which the dollar was depreciating against the currencies of the major industrialized countries, the method of calculating the weights assigned to each currency increases in importance.

This latter point is illustrated by the differences in the CmBoard and the CmupBoard index. The dollar appreciated against the Chinese yuan by 107 percent between March 1985 and December 1995. This appreciation, however, has little effect on the trade-weighted value of the dollar when the weight assigned to the yuan is based on China's share of U.S. trade over the 1972–76 period (as in the CmBoard index). With annual updates of the weights, as in the CmupBoard index, the growth in China's share of U.S. trade places increased importance on the appreciation of the dollar against the yuan.

[23] We were unable to construct an index using multilateral trade shares that included China and Mexico because world trade data for China before 1982 are unavailable.

Likewise, the appreciation of the dollar against the peso is given greater weight in the index with annual updates. If the weights used in the CmBoard index had been based on the 1992–94 trade shares, the index would have shown a sharper appreciation of the dollar than that evidenced by the CmupBoard index.

The difference between the Board and the Dallas indexes does not simply result from the fact that the Dallas index includes more countries than the Board index. Two factors make the country choice important: (1) the Board index excludes (the Dallas index includes) countries that account for a significant share of U.S. total merchandise trade; and (2) the behavior of the excluded currencies against the dollar has been substantially different since 1985 from that of the currencies included in the Board's index. The importance of the first factor has increased over time. In 1976, as shown in Table 6, seven of the 10 currencies that constitute the Board index were among the 10 most heavily weighted currencies in the Dallas index. By 1995, only five of the countries included in the Board index also were in the top 10 of the Dallas index.

Our analysis indirectly identifies an important consideration in using trade-weighted exchange rate indexes as a measure of international competitiveness. Generally speaking, changes in real (that is, nominal exchange rates adjusted for inflations difference), rather than nominal exchange rates, are commonly used for assessing changes in international competitiveness. Since the inflation experience of the countries whose currencies are in the Board index has been roughly similar over time, the nominal Board index mimics its real counterpart. The Dallas index, however, includes countries that have experienced periods of hyperinflation. As a result of this hyperinflation, the currencies of these countries depreciated sharply against the dollar during these periods, driving the appreciation of this index between 1985 and 1995. After adjusting for the inflation differences, the real Dallas index declines between 1985 and 1995.

CONCLUSION

Our examination of effective exchange rates reveals the many decisions underlying their construction. These decisions can produce substantially different views of changes in the average foreign exchange value of a currency. The actual effect of these decisions was investigated by comparing the Board index with the Dallas index.

The difference between the Board index and the Dallas index is driven primarily by the choice of currencies. This does not mean, however, that issues such as the determination of trade shares and the frequency with which weights are updated are unimportant. What makes these latter factors unimportant in the Board index is the similarity in the behavior of the currencies that make up the index. This also illustrates why all of the trade-weighted exchange rate indexes covered in this article show an appreciation of the dollar between 1976 and 1985. During this period, and particularly after 1980, the dollar was appreciating against most other currencies. Since 1985, the behavior of the dollar has been markedly different against the currencies of the industrialized countries from its behavior against the currencies of the developing countries. Thus even though we have not provided a definitive answer to the question posed in the title of this article, the reasons for the measurement differences have been illuminated.

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