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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

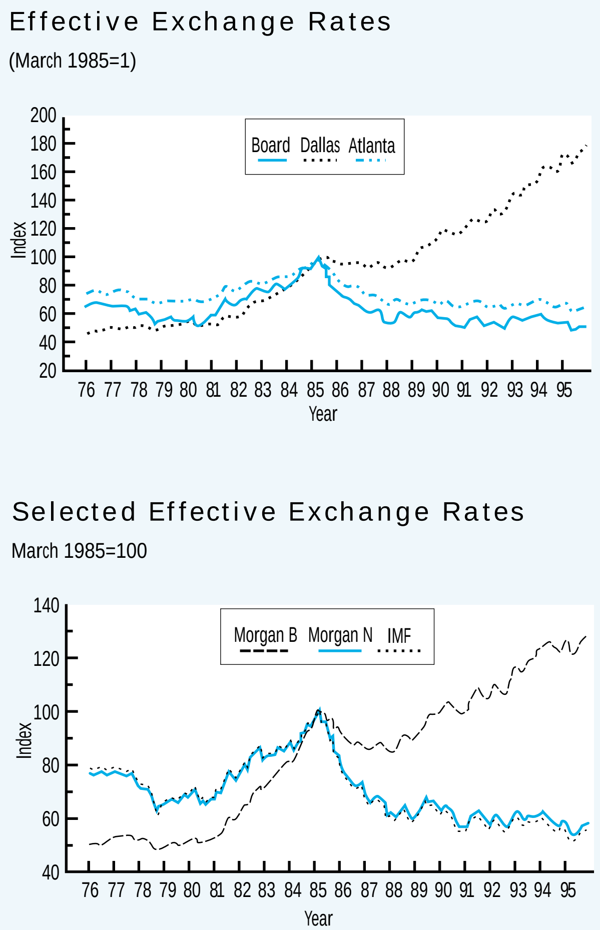
The construction of effective exchange rate indexes requires a number of decisions.[3] Because many of the decisions have more than one defensible alternative, it is not surprising that a number of effective exchange rate indexes are used. Six decisions are examined: (1) which formula is used to calculate 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



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]

[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.

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

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_{y3} 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

Year	Exchange Rates e_1	e_2	Weights w_1	w_2	Index Year 1 = 100	Year 7 = 100	Percent Change in Index 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

Year	Exchange Rates e_1	e_2	Weights w_1	w_2	Index Year 1 = 100	Year 7 = 100	Percent Change in Index 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.

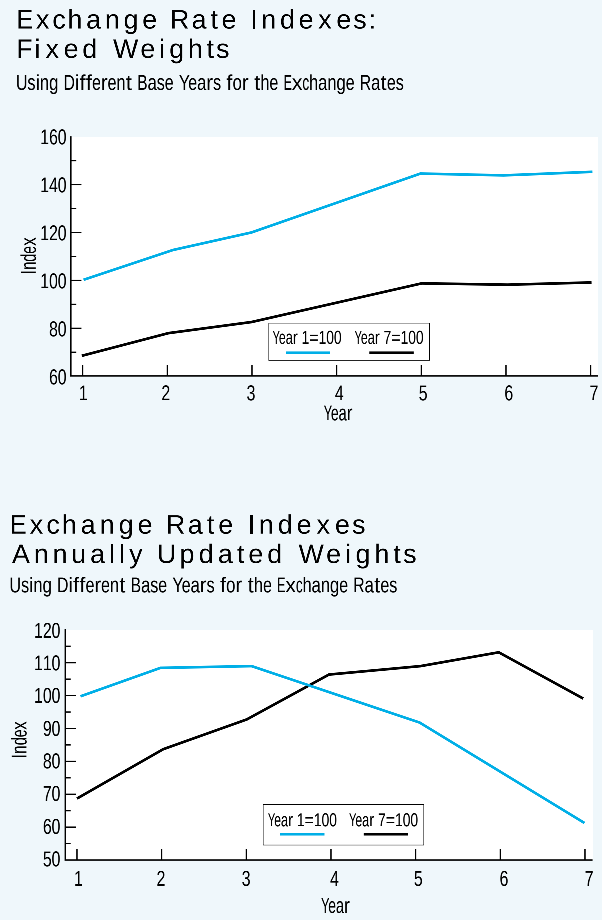
The choice of the base exchange rate period is irrelevant to the picture of the dollar's strength or weakness as measured by indexes with fixed trade weights. When the weights are updated annually, however, the calculated percentage changes in the value of the dollar become sensitive to the base period 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)

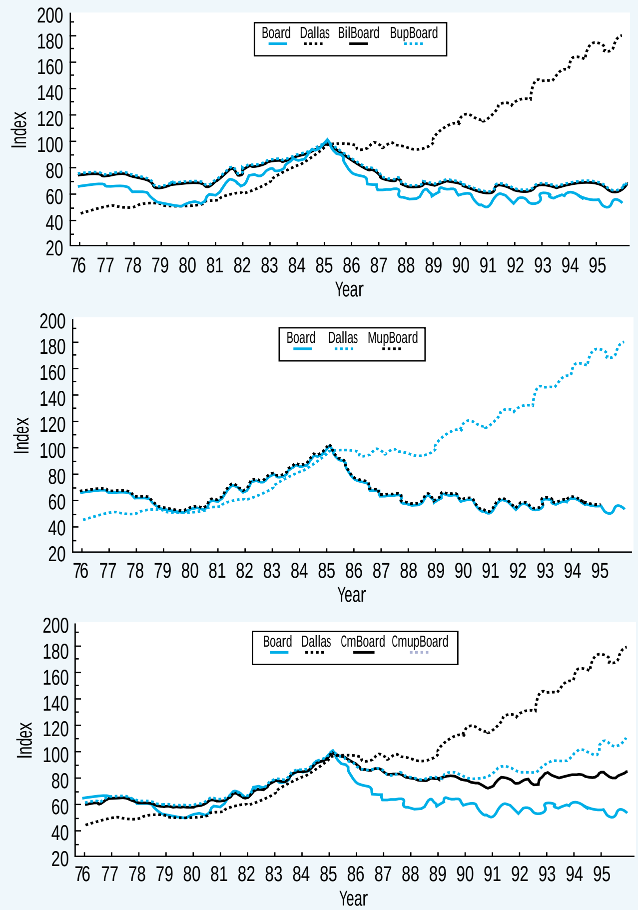
Country	1976	1985	1995
Brazil	2.3	†	†
Canada*	22.2	19.4	20.3
China	†	†	3.9
France*	2.7	2.7	2.8
Germany*	5.9	4.8	4.7
Italy*	2.8	†	†
Japan*	11.7	14.3	15
Korea	†	2.8	3.1
Mexico	4	5.7	8.1
Netherlands*	2.7	2.3	†
Saudi Arabia	†	2.6	†
Singapore	†	†	2.3
Taiwan	†	3.5	3.9
United Kingdom*	4.5	5.1	4.5
Venezuela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



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 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.

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 1976	MupBoard 1985	MupBoard 1994	BupBoard 1976	BupBoard 1985	BupBoard 1995	CmBoard	CmupBoard 1976	CmupBoard 1985	CmupBoard 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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Monetary Policy and Financial Market Expectations: What Did They Know and When Did They Know It?

Michael R. Pakko and David C. Wheelock

On January 31, 1996, the Federal Open Market Committee (FOMC) voted to ease monetary policy, which was widely reported as a lowering of interest rates. Although some interest rates fell with the Fed's action, the declines were generally small, and over succeeding months market interest rates tended to rise. The yield on the Treasury's 10-year note, for example, which had been 5.63 percent on January 30, and which closed at 5.60 percent on January 31, stood at 6.34 percent on March 29, and reached 7.03 percent by June 12. Other rates behaved similarly over this period.

Such seemingly perverse moves in market interest rates have also followed other monetary policy actions, sometimes even on the day those actions were taken. Commonly, Federal Reserve moves to raise or to lower interest rates are followed by changes in market interest rates in the same direction. On May 17, 1994, however, the Fed announced a tightening of monetary policy, which some might expect would cause market interest rates to rise. Instead, many market rates immediately *declined.*

Clearly, the statement that the Fed controls interest rates is, at best, an oversimplification. This article attempts to demystify the relationship between Federal Reserve monetary policy actions and interest rate behavior. Interest rates are set in competitive markets by factors affecting the supply of and demand for individual securities. Monetary policy actions can affect both the supply of and the demand for financial assets, and their effects depend not only on current actions but also on the public's expectations of future policy moves.

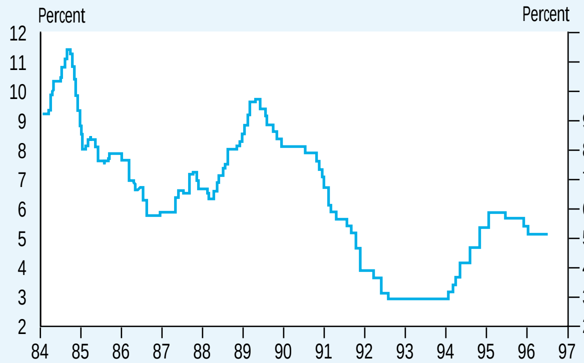
We describe in some detail the near-term behavior of government security yields following three recent Federal Reserve policy actions. On the most recent occasion, the Fed's easing action on January 31, 1996, market yields changed little immediately following the policy move, but then yields rose over succeeding months. We contrast this experience with two other events. In early 1994, Fed policy moves to raise interest rates were associated with increases in market interest rates that might be considered greater than justified by the extent of Fed actions. Then, in May 1994, market yields declined following a Fed policy action that was widely interpreted as an effort to raise interest rates. Our review of these episodes reveals how expectations of future monetary policy actions, expectations of the effect of policy on future inflation, as well as nonmonetary influences can cause market interest rates to behave in diverse ways after apparently similar Fed actions.

We begin with a brief description of how the Fed carries out open market policy and the channels through which policy might affect market interest rates. Next, we examine some recent episodes in which market interest rates responded in different ways to Federal Reserve policy moves. Finally, we conclude with a summary of how perceptions of future monetary policy actions affect the behavior

Figure 1

Federal Funds Rate Target

(1984-1996)



of market interest rates in response to current policy moves and hence complicate the assessment of the Fed's credibility as an inflation fighter.

MONETARY POLICY, EXPECTATIONS AND MARKET INTEREST RATES

Open Market Operations and Short-Term Interest Rates

Although Federal Reserve monetary policy is often described in press accounts as the manipulation of interest rates, in fact, monetary policy is carried out mainly by varying the supply of reserves available to the banking system.[1] Open market purchases of Treasury securities by the Fed supply additional reserves, whereas open market sales withdraw reserves.

Banks hold reserves to meet statutory requirements, as well as to meet the payment demands of their customers. A bank with a reserve deficiency might borrow reserves from the Fed, sell securities from its portfolio, or borrow reserves by purchasing federal funds in the interbank reserves market. Similarly, banks with surplus reserves may choose to convert their surpluses into earning assets by acquiring securities or other assets or by selling federal funds. The interest rate that clears the market for federal funds is known as the federal funds rate. The Fed can have a considerable effect on the federal funds rate because its open market operations affect the aggregate supply of bank reserves.

It is generally acknowledged that the Fed has considerable influence on the equilibrium federal funds rate, at least for relatively short periods. But do Federal Reserve operations affect other market interest rates?

The Expectations Hypothesis

The *expectations hypothesis* of interest rate determination states that long-term interest rates will reflect current and expected future yields on short-term securities. For example, the yield on two-year Treasury notes should be the average of the current yield on one-year Treasury bills and the expected yield on one-year bills whose holding period begins one year from now. Interest rate arbitrage ensures that this will occur. If, for example, the interest rate on one year securities that is expected to prevail one year from now would suddenly decrease, arbitrage would cause the current demand for two-year securities to rise. This would tend to lower the market yield on two-year securities to an average of the current one-year yield and the (now lower) one-year yield expected to prevail one year from now. Similarly, the yield on three-month Treasury bills should reflect the current and expected future path of the federal funds rate over the next three months. As a result, changes in current or expected future short-term interest rates will tend to cause similar movement all along the yield curve.[2]

Because long-term rates are linked to the current and expected future path of short-term interest rates, expectations of future Fed policy moves are important to the movements of interest rates today. It is significant therefore that changes in the Fed's target for the federal funds rate tend to be persistent, with a series of changes accumulating over time. This tendency is clearly illustrated in Figure 1, which shows how the Fed's target has evolved over the past several years.

1 The Fed also sets the discount rate, which is the rate charged banks when they borrow reserves from the Fed, and required reserve ratios, that is, the percentage of their deposit liabilities that banks are required to hold in the form of vault cash or deposits at Federal Reserve Banks. Neither is changed frequently, however, and open market policy is the principal mechanism by which the Fed conducts monetary policy.

2 See Campbell (1995) for more detail about the term structure of interest rates and empirical evidence on the expectations hypothesis.

Financial market participants are well aware of this pattern. For example, after an increase in the federal funds rate target on February 4, 1994, the *Wall Street Journal* reported, "There is little disagreement on where short-term interest rates will be going over the next year: up. The only question is how far they will rise and how fast."[3]

The persistence in federal funds rate changes causes current movements of the funds rate to provide information about future changes. When evaluating the course of short-term interest rates over several months, a current increase (decrease) can be expected to result in further increases (decreases). Because longer-term interest rates are affected by anticipated changes in short-term rates, the yield on a given security might respond to a particular change in the federal funds rate by more than the amount of the funds rate change because the security yield will incorporate the expectation of future changes in the funds rate in the same direction.

Monetary Policy, Inflation Expectations, and the Fisher Relationship

Interest rate arbitrage can explain why market interest rates often move upward when the Fed raises its federal funds target, and downward when the Fed lowers its target. Sometimes, however, market rates fall when the Fed raises its target and rise when the Fed lowers its target. Such apparently perverse changes in market rates can occur because Fed operations are not the sole influences on the supply of and demand for securities. Such changes can also happen because monetary policy is the principal determinant of the long-run rate of inflation—and inflation can have a pronounced effect on interest rates.

Because inflation erodes the purchasing power of money, an increase in inflation causes lenders to require higher interest rates as compensation for receiving future payments in money that has declined in value. Borrowers are willing to pay this *inflation premium* for the same reason. As a result, a fundamental relationship between inflation and interest rates is given by the *Fisher relationship,*

(1) $$i = r + \pi^e,$$

which states that the nominal interest rate (in dollar terms) consists of the following two components: the *real* interest rate (r) and a component that equals expected inflation (π^e).

Thus if market participants interpret a monetary policy action as providing new information about the outlook for inflation, interest rates should change accordingly. This is referred to as the *expected inflation effect* of monetary policy on interest rates. Financial market participants who are interested in the future course of inflation watch Federal Reserve actions closely. If the Fed is viewed as likely to pursue a policy that will prevent significant inflation over time, market yields will be lower. On the other hand, if the public doubts that the Fed is committed to low inflation, then financial markets will reflect fears of future inflation by incorporating an inflation premium in interest rates.

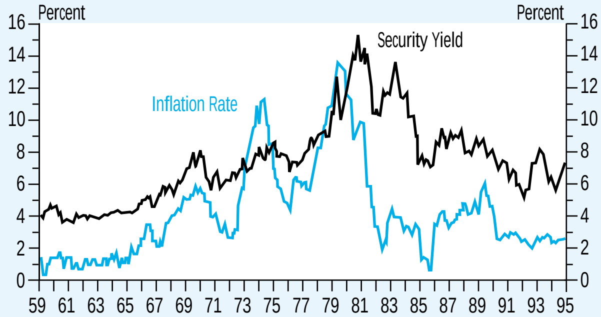
When investors are uncertain about the future course of monetary policy, and hence are uncertain about the future course of inflation, market yields might also be higher than they otherwise would be. For example, although inflation fell substantially in the early 1980s, interest rates remained high, and the difference between the level of market interest rates and the concurrent inflation rate has only recently declined to approximate the difference of the early 1960s. In other words, the *ex post* real interest rate—the difference between the market, or nominal, interest rate and the rate of inflation—was unusually high (see Figure 2).

One interpretation of the high *ex post* real interest rates of the 1980s is that, after experiencing rising inflation from 1965 to 1979, investors feared a return of high inflation and thereby demanded high nominal returns on fixed-income assets.

[3] Thomas T. Vogel, *Wall Street Journal*, February 7, 1994, p. C1.

Figure 2

Ten Year Government Security Yield and Year-Over-Year CPI Inflation
(January 1959-June 1996)



Alternately, if investors viewed the prospects for economic growth favorably, they may have simply demanded higher real returns on fixed-income investments. Still, because disinflations are often accompanied by high *ex post* real rates, both in the United States and in other countries [see, for example, Dueker (1996)], a fear of renewed inflation is a plausible explanation for high real rates in the 1980s.[4]

Carlstrom (1995) has aptly referred to this effect of Federal Reserve policy on interest rates as a monetary policy paradox. Short-term interest rates can be lowered only by increasing monetary growth, which tends to kindle inflationary expectations and higher interest rates. Lowering interest rates in the long run may require raising them in the short run.

MONETARY POLICY AND INTEREST RATES IN THE SHORT RUN

To evaluate the effect of Federal Reserve policy actions, we focus on the behavior of market interest rates on dates immediately preceding and immediately following recent actions. The Fed made no changes in its target for the federal funds rate during 1993, but on February 4, 1994, the FOMC announced that it had voted to "increase slightly the degree of pressure on commercial bank reserve positions," which it anticipated would increase market interest rates (specifically, the Fed had increased its objective for the federal funds rate by 25 basis points to 3.25 percent).

The official announcement of such a move was unprecedented, and the FOMC stated that it had made the announcement in part because this was the first tightening of monetary policy since 1989.[5] Although it was noted that such a public announcement should not be interpreted as precedent setting, after its meeting on February 2, 1995, the FOMC announced that after each future meeting it would issue a statement indicating whether there would be any change in policy.

By publicly announcing specific policy moves, the FOMC has eliminated uncertainty about its current operational stance.[6] But because the future course of policy remains uncertain, market participants continue to expend considerable effort attempting to forecast upcoming policy actions. Speculation about possible near-term actions often seems to affect the market prices and trading volumes of financial assets as much as actual moves do.

Expectations and Treasury Security Yields

Figure 3 plots the market yields on three U.S. Treasury securities on the date of each announced change in open market policy, that is, change in intended federal funds rate, and each meeting of the FOMC during 1994, 1995, and January 1996. The Fed increased its federal funds target six times in 1994 and once in 1995; the Fed reduced its target twice in 1995 and again on January 31, 1996. The change in basis points, if any, in the Fed's target is noted near the top of each vertical line corresponding to the date of a policy change or FOMC meeting. The market yields on three-month Treasury bills, one-year Treasury bills, and 10-year Treasury notes on each date are plotted, as are the yields five business days before and five business days after the central dates.

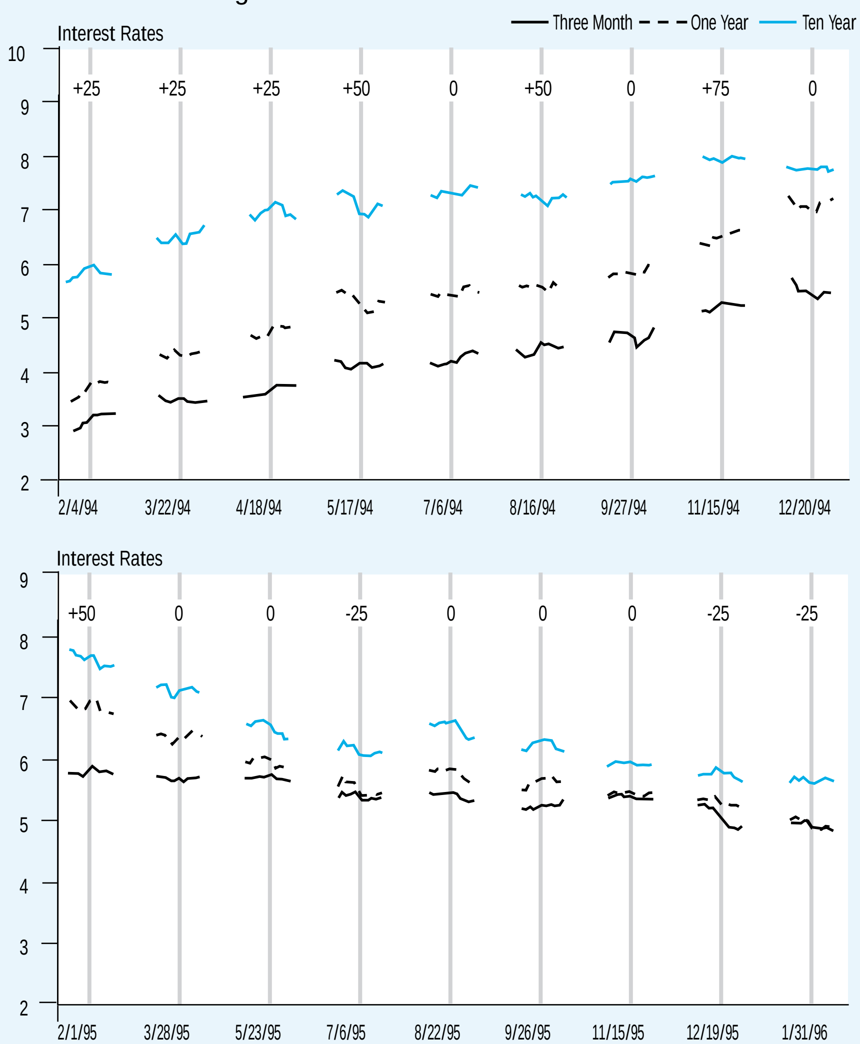
4 See Dotsey and DeVaro (1995) for empirical evidence suggesting that much of the disinflation of the early 1980s was unanticipated by the public.

5 See Pakko (1995) for a detailed description of FOMC policy moves during 1994 and Gavin (1996) for a discussion of policy moves during 1995.

6 Thornton (1996) finds that financial market volatility has been lower around the time of FOMC meeting dates since the policy of announcing federal funds rate changes was implemented.

Figure 3

The Market Response to Changes in the Fed Funds Target and FOMC Meetings



Market yields tended to rise during 1994, coincident with the Fed's target rate increases. Yields generally fell in 1995, and the differences in yields of securities with different maturities narrowed. The term structure of yields is often interpreted as revealing market expectations about the future paths of real returns and inflation. Researchers—including Fama (1990), Mishkin (1990), and Estrella and Mishkin (1995)—conclude that yield spreads contain both types of information. Long-term rates tend to be sensitive to inflation expectations, whereas short-term rates follow current and expected real short-term rates more closely. Hence the substantial narrowing in the yield spread across securities of different maturities during 1995 could reflect diminished expectations for real returns, inflation, or both.

On February 1, 1995, the Fed made the last in a series of federal funds target increases. Although market interest rates rose that day, on subsequent days they resumed a decline that had begun in late

THE FEDERAL FUNDS FUTURES MARKET†

Federal funds futures (formally known as 30-Day Interest Rate futures) have been actively traded at the Chicago Board of Trade since October 1988. The federal funds futures contract is based on the monthly average federal funds rate as reported by the Federal Reserve Bank of New York.

The contract itself calls for delivery of the interest paid on a principal amount of $5 million in overnight federal funds held for 30 days. Contracts are priced in units of 100, with the federal funds rate being 100 minus the price (for example, a price of 92.75 implies a 7.25 percent funds rate). Contracts are settled daily, with the purchaser of a contract paying the seller $41.67 (per $5 million contract) for each basis point increase in the implied federal funds rate (or each 1/100 of a point decline in the contract price) at the close of business. This tick size has been set by using a 30-day month: $5 million × 30/360 × 0.0001 = $41.67.

The following example helps explain the potential hedging use of federal funds futures. Consider a bank that is a consistent buyer of $75 million in federal funds at a current rate of 7 percent. The bank is worried that the federal funds rate will rise in the current month, raising its cost of funds. By selling 15 futures contracts (15 × $5 million = $75 million), the bank stands to profit from the futures transactions in the event that it suffers a loss from a higher cost of funds. For instance, suppose that on the first day of the month, the bank purchases the contracts at 93.00—implying a federal funds rate of 7 percent. If the funds rate immediately rises to 7.2 percent, the bank ends up paying $450,000 in interest on its federal funds purchases over the course of the month [$75 million × .0720 × (30/360)]. However, the buyer of the federal funds futures contract pays the bank $12,501 [15 contracts × 20 ticks × $41.67]. The net cost to the bank is $437,499. The bank's effective cost of funds has been locked in at 7 percent [($437,499/$75 million) × (360/30)].

In addition to banks like the one described in the preceding example—seeking to hedge positions in the federal funds market—futures trade is also carried out by speculators who are betting on a particular course of monetary policy. Each type of trader has an incentive to consider the most likely outcome of monetary policy when deciding whether to participate in a transaction, so the price of federal funds futures represents the market's best estimate of the federal funds rate over the course of the contract month.

† A more complete description of the federal funds futures market can be found in Chicago Board of Trade (1995).

1994. Security yields continued to decline throughout 1995, with the Fed lowering its funds rate target in July and December and again in January 1996.

It is apparent from Figure 3 that when the Fed changes its federal funds target, market rates sometimes, but not always, move in the same direction as the Fed's adjustment. Even when market rates do move in the same direction, they do not move by the same amount as the change in the federal funds rate. A change in expected inflation accompanying a monetary policy action could explain otherwise counterintuitive changes in market interest rates, such as a decline in market rates following a tightening of monetary policy or an increase in market rates following an easing of policy.

In the next sections we examine in more detail the behavior of market rates around three recent episodes of changes in the Fed's target federal funds rate. Knowledge of the extent to which financial market participants anticipated a policy move is important for interpreting each event. Monetary policy actions that are widely anticipated will not convey new information about future inflation, but actions that take markets by surprise may alter forecasts of future inflation. The effect of a policy move on interest rates thus depends on whether the move was expected. One source of information about market expectations of Fed policy moves is the federal funds futures market.

Information from the Federal Funds Futures Market

Since 1988, the Chicago Board of Trade has offered a market in futures contracts based on the federal funds rate. (See the shaded box, *The Federal Funds Futures Market.*) Contracts in this market are based on the monthly average federal funds rate, as reported by the Federal Reserve Bank of New York. The market is used both by financial institutions to hedge their federal funds market positions against changes in the funds rate and by speculators attempting to predict Federal Reserve monetary policy. Because the contracts are based on future monthly averages of the federal funds rate, price movements directly reflect market participants' expectations of policy actions.

Figure 4 shows the accuracy with which the federal funds futures market has predicted actual movements in the funds rate. Both the one-month ahead and two-month ahead rates track the actual funds rate closely, although the two-month ahead forecast fails to predict turning points as accurately as the one-month ahead forecast, lagging behind actual funds rate movements. Nevertheless, Krueger and Kuttner (1995) and Rudebusch (1996) find that one-month, two-month, and three-month future rates are all accurate predictors of subsequent federal funds rate movements.

Information from the federal funds futures market is used in Figure 5 to show expectations of movements in the funds rate implied by futures prices in the days leading up to and following FOMC meetings and policy changes in 1994 and 1995. The figure shows two series of futures yields. One series is the funds rate the market predicts will prevail after the meeting (see the appendix for details of the calculations). The second series is the funds rate derived from a three-month forward contract, indicating market expectations for future levels of the federal funds rate.

Figure 4

Federal Funds Futures

Actual, 1 month forward and 2 months forward through 3/96

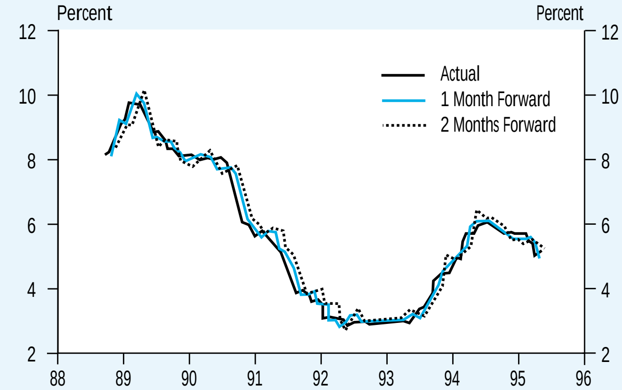
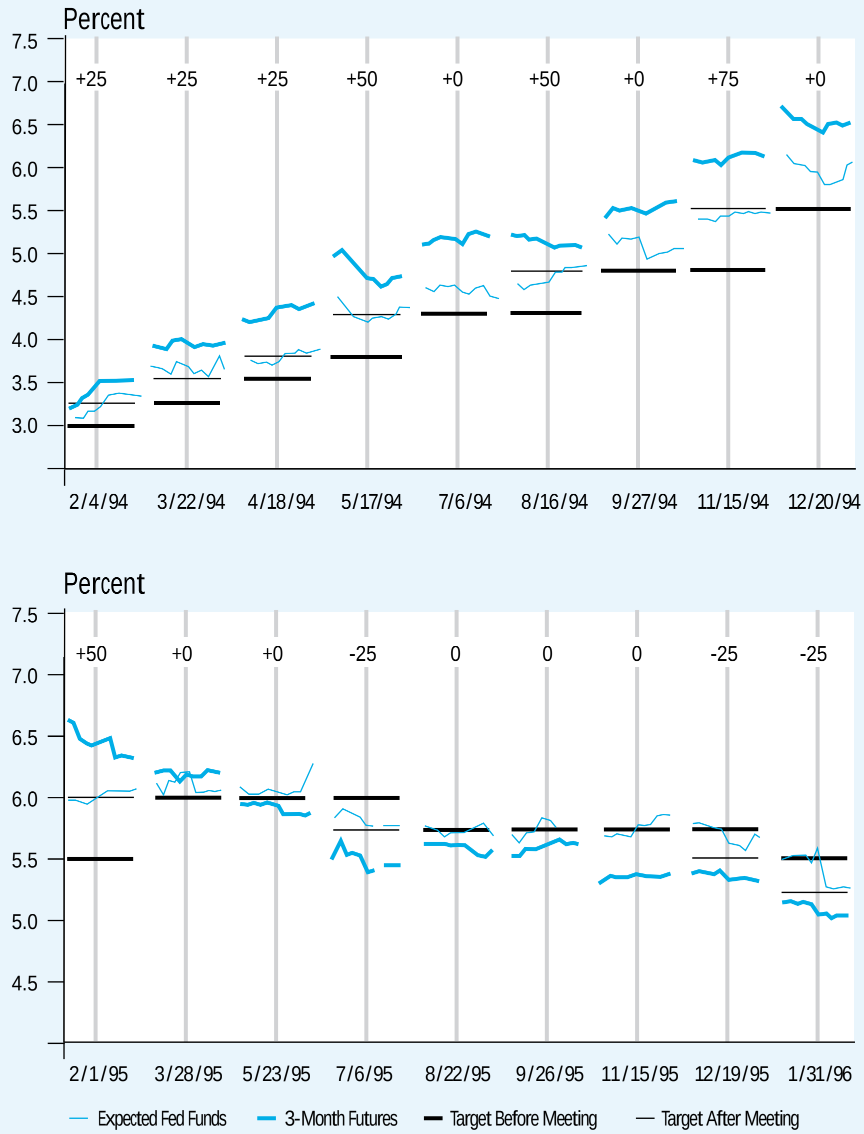


Figure 5 illustrates several notable points. First, the three-month ahead futures rate was above the one-month futures rate throughout 1994 and into early 1995. But when the Fed lowered the funds rate in July 1995, its first such move since 1992, the three-month futures rate was below both the spot rate and the current month's predicted funds rate. The market had thus correctly forecast the directional change in Fed policy.

The data in Figure 5 also show that many of the Fed's policy actions during 1994 were at least partly anticipated. That is, futures contracts were priced to reflect changes in the federal funds rate before the Fed altered its target. On occasions when it appears that funds rate changes were not fully anticipated, the three-month forward forecast moved in the same direction as the forecast funds rate for the remainder of the current month. In other words, unexpected changes in the Fed's target led market participants to expect further adjustments to the rate in the same direction as the initial move. The evidence thus indicates that, at least since 1994, the federal funds futures market has forecast specific Fed policy actions fairly well and that futures prices reflect

Figure 5

Fed Funds Expectations Derived from



the Fed's tendency to make multiple moves in one direction before reversing course.

Evaluating Market Responses to Specific Monetary Policy Actions

For both policymakers and market participants, the information about expected monetary policy and inflation embedded in interest rates would be useful. As our analysis suggests, however, the effects of monetary policy moves on interest rates can be difficult to disen-tangle. This difficulty is illustrated by a look at three specific episodes of Federal Reserve policy moves.

February 1994

On February 4, 1994, the FOMC voted

to "increase slightly the degree of pressure on reserve positions," resulting in an increase of 25 basis points in the federal funds rate. At the time, some financial analysts claimed that the move took markets by surprise. The move, however, was foreshadowed by Federal Reserve Chairman Alan Greenspan only days earlier. On January 31, 1994, the chairman stated that, "at some point . . . we will need to move [short-term interest rates] to a more neutral stance."[7] This comment was interpreted by some analysts as indicating, "It's a question of when, not whether, they will tighten."[8]

The path of federal funds rate expectations illustrated in Figure 5 makes it clear that the move was anticipated. Beginning on January 31, the expected funds rate rose gradually to the point where the 25 basis point move was almost fully anticipated on the day it occurred. Figure 3 shows that long-term interest rates rose along with the expected federal funds rate. However, bond rates tended to rise by more than the expected funds rate. From January 28 through February 4, the expected federal funds rate rose by 22 basis points, whereas the three-month, one-year, and 10-year Treasury security yields rose by 30, 35, and 26 basis points, respectively.

There are many potential explanations for the larger increases in Treasury security yields. One explanation is rather unique to this particular occasion. It holds that the Fed's policy adjustment was a preemptive move to head off a possible rise in inflation rather than a response to an already-observed increase in inflation. Yet many observers had not seen the emergence of inflation as imminent, so the move was interpreted by some as indicating that the FOMC had information or insight about inflation that was not generally available to the public. Hence inflation expectations were revised upward, and market yields rose.

A related explanation for the large increases in security yields is that the public viewed the relatively small policy move as inadequate to have much effect on incipient inflationary pressures. The market expected a more forceful move from the Fed and in the absence of such a definitive move, revised inflation expectations upward. Either explanation is consistent with the increase in market interest rates that accompanied the Fed's tight-ening move.

A third explanation—which does not involve any revision to expectations of inflation—seems more plausible, however. Because the FOMC tends to move the federal funds rate in a series of increments, the increase on February 4, 1994 led market participants to anticipate further increases. As a result, long-term rates, which reflect current and expected short-term rates, increased by more than the federal funds rate.

Figure 5 supports the notion that the 25 basis point increase on February 4 led market participants to expect further increases. At the same time that the expected funds rate for February rose in anticipation of the move on February 4, the implied three-month future yield also rose. By the time the February increase in the federal funds rate was announced, the futures market was already predicting another 25 basis point increase within the next three months. This expectation was mirrored in the comments of market analysts at the time: for example, one market observer interpreted the funds rate increase as "the first step on a journey that is going to last some time."[9]

So the behavior of market rates at the time of the Fed's first move to tighten policy could have been caused by an awakening of inflation fears, by the arbitrage effect of current and prospective increases in the federal funds rate, or conceivably by some combination of these effects.

May 1994

After two more increases of 25 basis points each in March and April, the FOMC raised its objective for the federal funds rate by 50 basis points on May 17, 1994. The response in the bond market was the reverse of previous funds rate increases. As the May FOMC meeting approached, long-term bond yields *declined.* After the funds

[7] Statement before the Joint Economic Committee, United States Congress, January 31, 1994. *Federal Reserve Bulletin* (March 1994, p. 233).

[8] Joseph Liro, chief economist at S.G. Warburg, quoted by Thomas D. Laurencella and Laura Young, *Wall Street Journal*, February 1, 1994, p. C23.

[9] John Lipsky, chief economist at Salomon Brothers, quoted by Thomas T. Vogel, *Wall Street Journal*, February 7, 1994, p. C19.

Figure 6

The Market Response to Changes in the Fed Funds Target

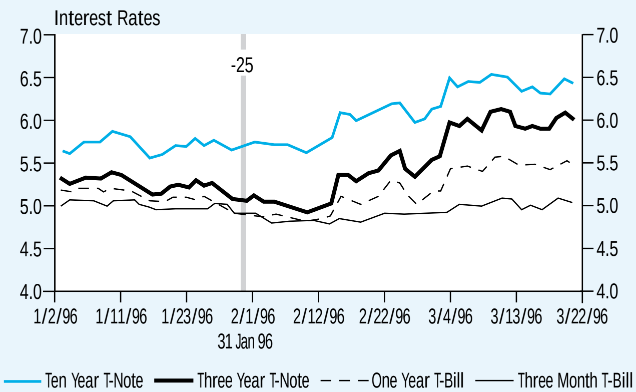
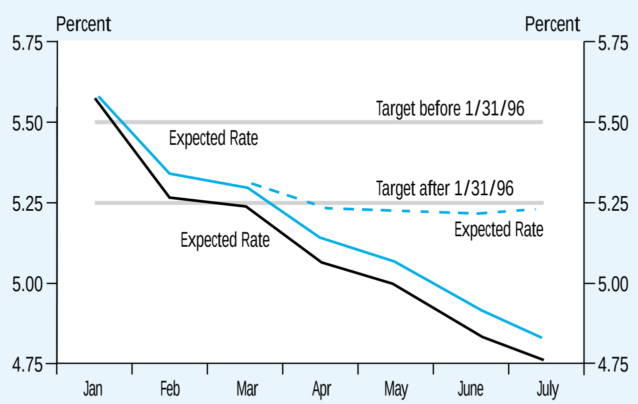


Figure 7

Fed Funds Futures Market Implied Expected Funds Rate



rate increase was announced, bond yields continued to decline. On the day of the funds rate change, the yield on 10-year Treasury notes, for example, fell by 21 basis points.

The decline in bond yields appears to have been directly related to the Fed's move. Reports in the financial press suggest that there was a great deal of uncertainty about the timing and magnitude of the policy move. On the morning of the meeting, a *Wall Street Journal* reporter noted that "several interest-rate watchers expect an increase in rates. The only question is how much?"[10] Figure 5 shows that the federal funds futures market was predicting a high probability of a 50-basis-point increase.

Did the magnitude of the funds rate increase convince market participants that the Fed's anti-inflation strategy would be successful? That is one explanation of the decline in bond yields. That conclusion, however, cannot be drawn with certainty. Once again, the expectations hypothesis suggests an alternate, though not mutually exclusive, interpretation. After the 50-basis-point increase, there was speculation that the FOMC would not have cause to raise the funds rate again in the near future. The official statement released by the FOMC following its meeting contributed to this sentiment: "These actions . . . substantially remove the degree of monetary accommodation which prevailed throughout 1993."[11] A *Wall Street Journal* writer interpreted this statement as being quite clear: "Yesterday's declaration means that the Fed now believes it is very close to neutral and doesn't expect any further rate increases soon."[12] To the extent that bond market participants lowered their expectations of further increases in the funds rate, the expectations theory of interest rates would predict a decline in bond yields, even if inflation expectations remained unchanged.

The reaction of the federal funds futures markets gives some credence to this view. As shown in Figure 5, the implied rate on three-month futures was falling for a period both before and after the meeting. Nevertheless, it continued to indicate that at least one more increase of 25 basis points was likely within the next three months. Hence it is unclear whether the bond market's reaction to the policy move on May 17, 1994, indicated a reduction in expected inflation, a change in the short-term outlook for Fed policy, or both.

January 1996

A third example serves to show the dynamic nature of market expectations and their responses to Federal Reserve policy. On January 31, 1996, the Fed voted, in effect, to reduce its target for the

[10] Dave Kansas, *Wall Street Journal*, May 17, 1994, p. C2.

[11] *Federal Reserve Bulletin*, July 1994, p. 610.

[12] David Wessel, *Wall Street Journal*, May 18, 1994, p. A3.

federal funds rate by 25 basis points, from 5.50 percent to 5.25 percent. (At the same time, the Fed lowered the discount rate from 5.25 percent to 5.00 percent.) According to the financial press, the Fed's action was widely expected and the rise in short-term security prices in preceding days reflected anticipation of the move.[13] Between January 1 and January 30, 1996, market yields on short-term Treasury securities fell some 20 to 30 basis points. The yields on government securities with maturities of seven years or more, however, did not fall over the period.

Government security yields did decline, but only modestly, after the Fed's cut in its funds rate target on January 31. Although the Fed reduced its target by 25 basis points, market yield declines ranged from eight basis points on three-month bills to just one basis point on 30-year bonds. Yields on short- and medium-term securities continued to decline through mid-February, however, but those on long-term government securities changed little—some even increased. Then, from mid-February through March, yields on all securities rose. For illustration, the daily yields on three-month, one-year, three-year and 10-year Treasury securities are plotted in Figure 6.

How might we interpret the behavior of interest rates both before and after the Fed's reduction in its funds rate target on January 31, 1996?

The modest changes in interest rates that occurred on January 31, support the press's view that the Fed's action had been widely anticipated. Further evidence of this can be seen in Figure 7, which plots the expected average federal funds rate in different months using data from the federal funds futures market. On January 30, the funds rate the market expected to prevail during February lay between the prevailing Fed target of 5.50 percent and the new target of 5.25 percent established on January 31. That the expected rate lay closer to the new target indicates that on January 30 the market believed that the Fed was more likely than not to reduce its target on January 31. When the Fed validated these expectations, the expected funds rate for February fell immediately to 5.25 percent.

The data charted in Figure 7 also illustrate that on January 30 the futures market expected not only the funds rate cut on January 31, but also further cuts from March through July. After the Fed reduced its target, these expectations only hardened.

Further evidence that the Fed's action on January 31 was widely anticipated is reflected in the lack of change in intermediate- and long-term Treasury security yields on that date. The failure of long-term yields to change significantly on the Fed's easing move is thus consistent with the behavior of short-term rates, the federal funds futures market, and the financial press, all of which suggest that the Fed's move was widely anticipated.

Between mid-February and March 31, 1996, market interest rates generally rose. As illustrated in Figure 6, rates made two especially large jumps in mid- and late February and one more in early March. Throughout the period, new data suggested that the economy was growing more quickly than some previously released indicators had suggested. Moreover, in mid-February, rising commodity prices suggested to some market participants that inflation was likely to rise, causing market security yields to rise.[14] Although yields rose across the spectrum of maturities, long-term security yields rose most. This pattern of rate changes suggests that the new information caused market participants to revise their expectations of the Fed's target for the federal funds rate upward over ensuing months, and possibly expectations of inflation as well.

Market interest rates again rose when Federal Reserve Chairman Greenspan testified before Congress about monetary policy and the state of the economy on February 20, 1996, which many analysts interpreted as confirmation that additional funds rate reductions over the near term were unlikely. Finally, the release of new employment data on March 8, 1996,

[13] See, for example, Dave Kansas, *Wall Street Journal*, January 31, 1996, p. C1.

[14] For example, see Dave Kansas, *Wall Street Journal*, February 15, 1996, p. C1.

revealing an unexpectedly large increase in employment during February is widely cited for a sharp increase in bond yields on that date. According to one report, "The carnage [in the bond market] began immediately after a stronger-than-expected employment report snuffed out hope that Federal Reserve policymakers would lower short-term interest rates anytime soon."[15]

The evolution of expectations about the course of Fed policy was reflected in the federal funds futures market. In addition to the expected future funds rate path implied by market pricing on January 30 and January 31, Figure 7 plots the implied path based on futures market data from March 8. In contrast to the earlier dates, when further funds rate cuts were expected, on March 8 the market expected the funds rate to remain at 5.25 percent through July 1996.

According to the expectations hypothesis, the rise in long-term interest rates on March 8 reflected the expectation that short-term rates would rise in the future. The increase in long-term rates could also reflect a revised anticipation of higher inflation in the future, though other explanations, such as an increase in the real interest rate, could also explain the rise. Inevitably, because many factors affect the supply of and demand for securities, any one move in market yields can have several non–mutually exclusive explanations. Nevertheless, the behavior of market rates after January 31, 1996, is consistent with, first, a period of relative calm in which markets anticipated further reductions in the Fed's interest rate target, with little apparent change in inflation expectations. Then, following new information about the health of the economy and new speculation about Fed behavior, markets changed their expectations about the near-term course of monetary policy and perhaps revised their expectations of future inflation upward.

CONCLUSION

Evaluating the credibility of monetary policy by observing bond market reactions can be difficult. Sometimes market rates rise when the Fed's target is raised, and sometimes they fall. Sometimes rates move by more than the change in the funds rate and sometimes by less. These responses can be interpreted as an amalgam of inflation expectations, anticipated future monetary policy actions, and changes in real rates of return.

Although these influences are difficult to disentangle, the information from the federal funds futures market can help identify the role of expectations in the determination of market interest rates. Specifically, with an understanding of the extent to which a Fed policy action is anticipated in financial markets, we can better interpret subsequent changes in market interest rates.

Throughout 1994 and 1995, however, the behavior of the federal funds futures market suggests that most Fed actions were at least partly anticipated. Moreover, the Fed's tendency to move its target for the federal funds rate incrementally in one direction before reversing course is built into market expectations of future policy actions, as revealed in both the spot markets for Treasury securities and the federal funds futures market. The incremental nature of Fed policy moves, along with interest rate arbitrage, likely also explains why market interest rates typically moved in the same direction as changes in the federal funds rate during 1994–95. When a policy move is widely anticipated, and particularly if it is expected to be one of many in a series of moves in the same direction, market expectations about inflation are not altered. Only surprise moves, or moves that are widely taken as turning points, will typically alter expectations about inflation.

[15] Vogelstein and Jereski, *Wall Street Journal*, March 11, 1996, p. C1.

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Appendix

CALCULATIONS UNDERLYING FIGURE 5

Figure 5 presents estimates of expected FOMC policy actions, as derived from the federal funds futures market. To isolate the funds rate that is expected to prevail *after* an FOMC meeting, some calculations are necessary. At any point during a month, the current-month federal funds futures rate (i^f) can be thought of as a weighted average of two components—the actual funds rate experienced to date (i^a), and the rate expected to prevail for the rest of the month (i^m):

$$(1) \qquad i^f = \frac{T}{N} \times i^a + \frac{N-T}{N} \times i^m,$$

where T is the number of days passed to date and N is the number of days in the month. This equation can be solved for the rest-of-month expected rate.

If there is a meeting of the FOMC, however, then the expected rate for the rest of the month can be similarly expressed as a weighted average of two components—the prevailing federal funds target, (i^*) and the rate expected to prevail after the meeting:

$$(2) \qquad i^m = \frac{M-T}{N-T} \times i^* + \frac{N-M}{N-T} \times i^e,$$

where M is the FOMC meeting date.

Combining these two expressions and solving for i^e gives the following:

$$(3) \qquad i^e = \frac{N \times i^f - T \times i^a - (M-T) \times i^*}{N-M}.$$

Hence we can find the rate expected to prevail following an FOMC meeting by taking the rate implied in the current futures contract and subtracting components related to the actual funds rate to date and the target funds rate expected to prevail between the current date and the FOMC meeting. This is the calculation underlying the expected funds rate measures illustrated in Figure 5 for days leading up to FOMC meetings. For the days following the meeting, the following for days leading up to FOMC meetings. For the days following the meeting, the following more simple formula

$$(4) \qquad i^e = \frac{N \times i^f - T \times i^a}{N-T},$$

is used.‡

‡ To prevent distortions that sometimes appear toward the end of the month (because of the nature of the futures contract), the implied funds rate from the subsequent month is used for days following FOMC meetings in cases where the meeting date falls within the last five business days of a month. See the shaded box, p. 24.

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The Giant Sucking Sound: Did NAFTA Devour the Mexican Peso?

Christopher J. Neely

At the end of 1993 Mexico was touted as a model for developing countries. Five years of prudent fiscal and monetary policy had dramatically lowered its budget deficit and inflation rate and the government had privatized many enterprises that were formerly state-owned. To culminate this progress, Mexico was preparing to enter into the North American Free Trade Agreement (NAFTA) with Canada and the United States. But less than a year later, in December 1994, investors sold their peso assets, the value of the Mexican peso plunged 50 percent against the U.S. Dollar, and Mexico was forced to borrow from the International Monetary Fund (IMF) and the United States to get through a financial crisis. In 1995, inflation in Mexico soared to 50 percent and real gross domestic product (GDP) fell by 4 percent.

Politicians and commentators like Ross Perot, Pat Buchanan, William Greider, and Robert Kuttner blamed the enactment of NAFTA for the devaluation of the peso and the ensuing economic turmoil in Mexico, with some calling for its renegotiation or even repeal. As the members of NAFTA consider expanding to encompass other Latin American nations, such as Chile, investors and policymakers should understand the link between NAFTA and the peso crisis well. Did NAFTA cause or exacerbate the devaluation of the peso? Or did NAFTA help alleviate some of the consequences of the crisis?

This article examines the relationship between NAFTA and the peso crisis of December 1994. First, the provisions of NAFTA are reviewed, and then the links between NAFTA and the peso crisis are examined. Despite a blizzard of innuendo and intimation that there was an obvious link between the passage of NAFTA and the peso devaluation, NAFTA's critics have not been clear as to what the link actually was. Examination of their arguments and economic theory suggests two possibilities: that NAFTA caused the Mexican authorities to manipulate and prop up the value of the peso for political reasons or that NAFTA's implementation caused capital flows that brought the peso down. Each hypothesis is investigated in turn.

NAFTA

NAFTA grew out of the U.S.–Canadian Free Trade Agreement of 1988.[1] It was signed by Mexico, Canada, and the United States on December 17, 1992. The legislatures of those countries ratified NAFTA, and the agreement took effect on January 1, 1994. The treaty substantially lowered national barriers to trade and investment in North America, giving consumers more choices and lower prices. In addition, the changes began to lower the cost of production and to funnel investment and labor to their most productive uses. Not surprisingly, the costs—real and imagined—of this reallocation of resources stirred the passions of those opposing the agreement.

The trade provisions of NAFTA were designed to reduce tariffs and nontariff barriers—such as quotas and import licensing—radically over 15 years. Some tariffs were reduced immediately, whereas other reductions will be phased in over a period of 10 years—15 years for certain sensitive sectors, such as agriculture and textiles and apparel.

[1] See Hufbauer and Schott (1993), Aguilar (1993), or Tornell and Esquivel (1995) for more discussion of NAFTA's provisions.

For the United States and Mexico, the trade provisions of NAFTA are expected to have their most important effects on the automobile, textile and apparel, and agricultural sectors. In agriculture, U.S. and Mexican quotas were immediately converted into equivalent tariffs and those tariffs will be phased out over 10 to 15 years. As Hufbauer and Schott (1993) note, this is a remarkable achievement given the difficulties encountered by other free trade agreements on agricultural issues.

Given the fierce fight in the United States over the agreement, it is ironic that NAFTA required more substantial changes in Mexican law—both trade and investment law—than it did in U.S. law. Average U.S. tariff levels on Mexican goods were already quite low—just four percent—on a value-weighted basis, before the introduction of NAFTA.[2] Mexican tariffs were higher, averaging 10 percent on imports from the United States. Through NAFTA, Mexico also committed itself to address other long-standing U.S. concerns, like the protection of intellectual property rights and reform of Mexico's regulation of foreign investment.

NAFTA was the culmination of a significant break with Mexico's protectionist past.[3] Until the 1970s, Mexico followed a policy of import substitution industrialization that mandated highly protected markets for manufactured goods. In that decade, preliminary reforms in the direction of freer trade were taken. The debt crisis of 1982 reversed that trend; for a short period in 1982–1983, Mexico was one of the most protected economies in the world. During the de la Madrid administration (1982–88), Mexico took important steps to move toward more liberal trade. Mexico lowered tariffs and joined the General Agreement on Tariffs and Trade (GATT) in 1986.[4] Mexico took further unilateral steps toward free trade as part of the Salinas administration's (1988–94) program of economic reform. This period is known as *la apertura* (the opening).

Despite the impressive achievements of the negotiators in crafting such a far-reaching trade agreement, NAFTA's direct economic benefit to the United States will likely be small. One representative estimate of NAFTA's annual benefits to Mexico and the United States arrives at approximately the same figure for each country;[5] however, this amounts to about 0.3 percent of 1993 U.S. GDP but more than 5.0 percent of Mexico's output. Schott (1994), Tornell and Esquivel (1995) and others have argued that the most important aspect of NAFTA's passage for the Mexican economy is that it would cement the other economic reforms in place. Krugman (1993) and Orme (1993) both contend that NAFTA is most important to the United States as a tool of foreign policy, to encourage Mexican economic and political reform.

NAFTA AND THE VALUE OF THE PESO

This section lays out the case that the peso was kept overvalued because of the politics of NAFTA and then investigates whether this argument is consistent with the facts.

The Case That the Peso's Value Was Artificially Inflated Because of the Politics of NAFTA

The most common hypothesis linking NAFTA to the peso crisis is that the politics of NAFTA caused the Bank of Mexico to systematically manipulate the value of the peso to increase support for the treaty, both before NAFTA was passed in the United States and during its first year. There are two versions of this hypothesis. The first version suggests that the value of the peso was deliberately manipulated to secure political support for NAFTA and that the devaluation—to obtain a trade advantage—was planned well in advance. The second version is less sinister. It suggests only that the Mexican authorities were sensitive to U.S. politics in setting exchange rate policy after NAFTA was passed. The following sections lay out the arguments behind each version of this hypothesis.

2 See Tornell and Esquivel (1995). Changes in value-weighted tariff schedules can be misleading, however, because there are also some quantitative restrictions.

3 See Kehoe (1995) for a review of Mexico's recent trade history.

4 The GATT was an international organization to negotiate free trade among its members. It has been superseded by the World Trade Organization (WTO).

5 Krugman (1993) and Brown, Deardorf and Stern (1992) discuss estimates of the gains from NAFTA.

Deliberate Manipulation and Planned Devaluation.

> "... the devaluation of the peso had been planned for more than a year and was openly discussed at the highest levels of the Mexican government. It was also widely known in Washington. I discussed it in my testimony before the House Committee on Small Business in March, 1993—eight months before the North American Free Trade Agreement was passed into law."
> Ross Perot, *Los Angeles Times*, January 4, 1995.[6]

Critics like Ross Perot argue that the Mexican government and the Bank of Mexico kept the value of the peso artificially high to increase political support for the treaty in the United States by creating a bilateral trade surplus with Mexico. The United States did have a trade surplus with Mexico in the early 1990s. A study by Hufbauer and Schott (1993) was frequently cited by NAFTA proponents to support the questionable notion that the *growth* of this trade surplus would create 170,000 jobs in the United States. The Clinton administration used these arguments to sell NAFTA to the U.S. Congress primarily as a jobs program, rather than as a trade agreement that would promote greater choice and lower prices for consumers and greater efficiency in production.

> "We will make our case as hard and as well as we can. And, though the fight will be difficult, I deeply believe we will win. And I'd like to tell you why. First of all, because NAFTA means jobs. American jobs, and good-paying American jobs. If I didn't believe that, I wouldn't support this agreement."
> President Bill Clinton at the signing of NAFTA Side Agreements on September 14, 1993.

President Clinton even talked about leaving NAFTA after three years if a review of the evidence at that time suggested that the treaty had cost American jobs. So there was considerable pressure to produce evidence that showed that NAFTA would create jobs in the United States.

The Mexican government was not immune to such pressure. In 1993, passage of NAFTA by the U.S. Congress was the main policy concern of the Mexican administration [see Tornell and Esquivel (1995)]. In August of that year, President Salinas even promised to raise the Mexican minimum wage to alleviate U.S. fears of cheap Mexican labor driving down U.S. wages and taking jobs. Critics charge that because of such political considerations, the Mexican government deliberately kept the peso overvalued throughout 1993 and 1994 and planned the eventual devaluation well in advance.

Sensitivity to U.S. Politics. A more reasonable hypothesis is put forward by Velasco (1995) and others. They suggest only that, after NAFTA was passed, the Mexican authorities were sensitive to the U.S. political situation and may therefore have been more reluctant to permit the peso to depreciate than they would otherwise have been. Specifically, in March 1994, the peso came under speculative pressure in the wake of the assassination of Luis Donaldo Colosio, presidential candidate of the ruling Revolutionary Institutional Party (PRI). At that time, a number of observers warned that the peso was overvalued and that a faster devaluation was warranted. Velasco suggests that because such a course of action threatened to create political problems with the United States, political exigencies may have prevented an earlier, milder correction to the value of the peso that would have avoided the drastic correction of the later crisis.

Evaluating the Case that the Peso's Value was Artificially Inflated Because of the Politics of NAFTA

Critics argue that NAFTA provided the impetus for the Mexican monetary authorities to maintain the value of the peso in

[6] See also, columnist Robert Kuttner, January 22, 1995, in the *Akron Beacon Journal* and author William Greider in *Rolling Stone*, March 9, 1995.

excess of its equilibrium value. The authorities allegedly knew that the peso was overvalued but gambled that this overvaluation could be maintained long enough to secure NAFTA's passage in the United States. Thus, this hypothesis requires that:

1. The peso was overvalued.

2. The Mexican authorities knew that it was overvalued.

3. The Mexican authorities kept it overvalued to increase or at least maintain support for NAFTA in the United States.

Although it is not possible to *test* the elements of this hypothesis, they may be examined to see whether they are consistent with the facts. This section argues that though the evidence favors the view that the peso was overvalued, *this was not obvious at the time*. Further, to the extent that the peso may have been overvalued, the overvaluation was a result of the disinflation strategy of the Mexican authorities, rather than a result of NAFTA.

Nominal and Real Exchange Rates. When discussing the value of the peso, it is important to distinguish between the *nominal exchange rate*, or the price of a peso in terms of dollars, and the *real exchange rate*, the price of Mexican goods in terms of U.S. goods. This section explains the relationship between prices and exchange rates and why the real exchange rate is the relevant measure of the proper value of the peso.

Exchange rates and prices are linked through the *law of one price*, which says that identical goods should sell for the same price when expressed in terms of the same currency.[7] In the case of oil, for example,

$$p_{oil}^{U.S.}(t) = p_{oil}^{MEX}(t) \times e(t),$$

where the variable $p_{oil}^{U.S.}(t)$ is the price of oil in dollars in the United States at time t, $p_{oil}^{MEX}(t)$ is the price of oil in pesos in Mexico at time t, and $e(t)$ is the exchange rate in dollars per peso. In other words, if a barrel of oil costs $20 in the United States and 80 pesos in Mexico, the law of one price predicts the nominal exchange rate will be $0.25 per peso. This condition must approximately hold, or people could make money by buying oil in the country where it is cheap and selling it in the country where it is expensive. Such arbitrage would tend to drive the price of oil down in the country where it is expensive and raise the price in the country where it is cheap, until the law of one price approximately holds.

If the law of one price holds for each good in a price index and the weights in the price index are the same for each country, then consumption baskets should also sell for the same price when expressed in the same currency. This is called *absolute purchasing power parity* (PPP), which can be expressed as follows:

$$p_{Index}^{U.S.}(t) = p_{Index}^{MEX}(t) \times e(t),$$

where $p_{Index}^{U.S.}(t)$ is a measure of the price level in the United States and $p_{Index}^{MEX}(t)$ is the analogous measure for Mexico. Of course, because of different patterns of consumption across countries, the presence of nontraded goods and differentiated goods, absolute PPP does not describe the relation of price levels and exchange rates very well.

A less stringent, but more realistic relation is *relative PPP*. It says that differences in countries' inflation rates should be reflected in changes in the exchange rate, so that

$$\Delta p_{Index}^{U.S.}(t) - \Delta p_{Index}^{MEX}(t) = \Delta e(t),$$

where Δ stands for the percentage change in a variable over time. This equation says that if inflation in Mexico exceeds inflation in the United States, the exchange rate will fall to reflect the difference. That is, the peso will depreciate. Why? If Mexican goods become more expensive than U.S. goods, consumers in both the United States and Mexico will tend to buy more U.S. goods. This will cause the peso to depreciate until Mexican goods are competitive again.

[7] Barriers to trade, transportation costs, and imperfectly competitive markets may prevent the law of one price from holding.

A strict interpretation of relative PPP says that the real exchange rate, or the price of Mexican goods in terms of U.S. goods, should be constant over time. At time t, the real exchange rate ($q(t)$) can be expressed as follows:

$$q(t) = \frac{p_{Index}^{MEX}(t) \times e(t)}{p_{Index}^{U.S.}(t)}.$$

For practical purposes, however, relative PPP is interpreted to mean that the real exchange rate should tend to come back to its historical average rather than be constant over time. Empirical studies suggest that this interpretation of relative PPP is useful for thinking about long-run tendencies in exchange rates, especially when inflation rates are high.

Why is the real exchange rate important? A currency has value only because of what it can purchase. The real exchange rate adjusts the nominal value of a currency for its purchasing power and so determines competitiveness in world markets. For example, a rise in the real exchange rate (as defined previously) means that the price of Mexican goods in terms of U.S. goods has risen. The price of Mexican exports to the United States rises, hurting Mexican exporters, but imports from the United States become cheaper to Mexican consumers. Therefore the relevant measure of the value of the peso is the value of the real exchange rate.

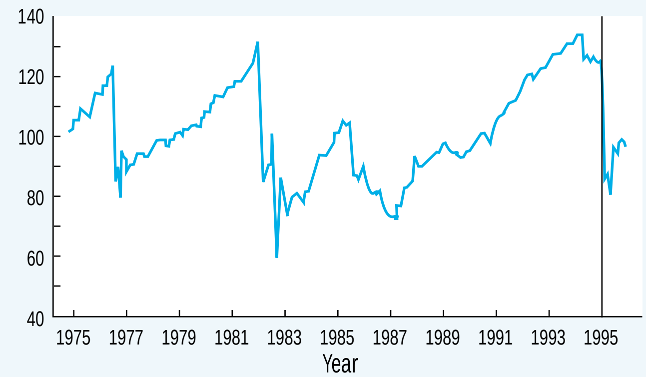
Was the Peso Overvalued? Armed with the concept of the real exchange rate, it is still difficult to determine whether the peso was correctly valued because the real exchange rate changes over time. In the case of a pegged exchange rate system like Mexico's, a real exchange rate is functionally overvalued or undervalued if the nominal exchange rate is likely to be forced to change quickly. That is, the real exchange rate should be compatible with the commitment to the pegged nominal exchange rate.

Relative PPP suggests a practical measure of whether the current real exchange rate is likely to be consistent with the peg: whether it is in line with historical values

Figure 1

Index of the Real Exchange Rate (WPI)

Mean = 100



of the real exchange rate. If the Mexican inflation rate minus the U.S. inflation rate exceeds the rate of depreciation of the peso—that is, if

$$\Delta p_{Index}^{MEX}(t) - \Delta p_{Index}^{U.S.}(t) > -\Delta e(t),$$

—then the real exchange rate rises and Mexican goods became more expensive in terms of U.S. goods; the peso becomes *overvalued*. Historical measures of the correct value of the real exchange rate are imperfect, though. The proper value of the real exchange rate can change over time because of changes in productivity, preferences, legal capital controls, or other factors. These changes are usually slow, however, leaving historical measures useful.

Respected economists like Dornbusch and Werner (1994) argued during 1993 and 1994 that the peso was overvalued because an index of the real exchange rate, as measured by the Wholesale Price Index (WPI), was high by historical standards. As illustrated in Figure 1, this index rose steadily from a level of 70 in 1987 to a peak of about 130 at the end of 1993. By this measure, Mexican goods had become almost twice as expensive in terms of U.S. goods from 1987 through 1993 and the real value of the peso was 30 percent *higher* than its historical average from 1975 through 1993. Dornbusch and Werner cautioned early in 1994 that

Figure 2

Index of Unit Labor Costs
Multilateral Real Exchange Rate
Mean = 100

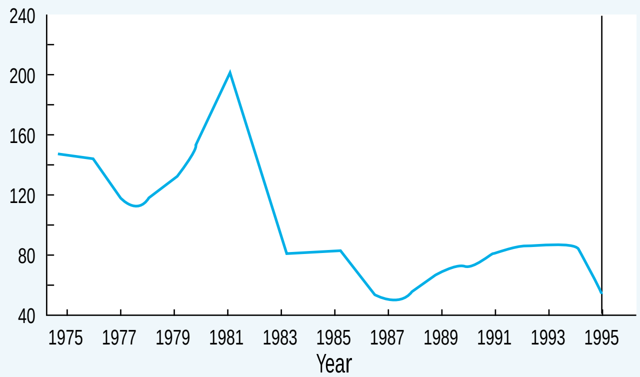
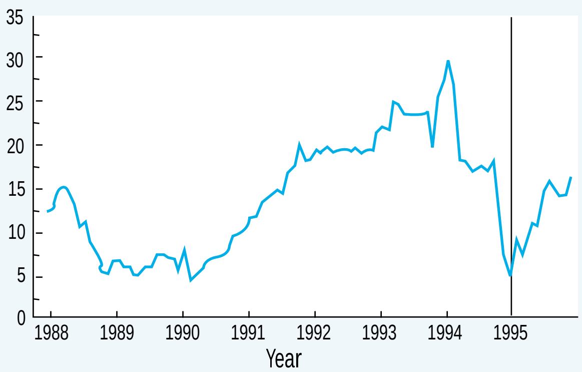


Figure 3

International Reserves
Billions of U.S. Dollars



this situation was untenable and the peso should be permitted to depreciate faster.

The hypothesis that the Mexican authorities deliberately manipulated the value of the peso requires that these authorities knew the peso was overvalued. Did they know this? In responding to Dornbusch and Werner, economists at the Bank of Mexico contended that the real exchange rate was not overvalued for several reasons. First, another measure of the real exchange rate—using unit labor costs instead of price indices—did not show the peso to be overvalued. Gil-Diaz and Carstens (1995) argue that unit labor costs are a better way to compute real exchange rates because they more closely reflect the relative cost of production in Mexico and abroad. Further, the real value of the peso for Mexico's trade depended not only on its value vs. the dollar, but also on its value vs. Mexico's other trading partners, and therefore they suggest that multilateral measure of the real exchange rate is more appropriate. Figure 2 shows that, by the beginning of 1994, the multilateral effective real exchange rate index, as measured by unit labor costs, had also risen substantially—about 60 percent—since 1987 but was still as low as it had ever been before 1986.[8] In fact, it was still slightly below its historical average for the period 1975–94. Thus Gil-Diaz and Carstens argued that this historical measure did not show the real exchange rate to be overvalued.

Second, because the proper value of the real exchange rate can change over time because of productivity changes and other factors, the Mexican authorities disagreed with Dornbusch and Werner about the relevance of historical measures. They asserted that NAFTA and other economic reforms had raised productivity and had increased the correct (equilibrium) value of the real exchange rate; that is, the equilibrium price of Mexican goods had risen.

> "The Mexicans were justifiably proud of the progress they had made in bringing down inflation, by means of the exchange rate link to the dollar, and did not want to lose it. I suspect they thought they were in a new world, as a result of the economic liberalization and NAFTA."
> Economist Jeffrey Frankel, Statement to the U.S. Senate Committee on Banking, Housing and Urban Affairs, March 9, 1995.

Also, there was very little pressure on the peso before March 1994, indicating that the markets did not believe that the peso was overvalued. In fact, the Bank of

[8] Data for the multilateral real exchange rate were taken from Gil-Diaz and Carstens (1995).

Table 1

Mexican Consumption, Savings, Output, and Inflation

	1987	1988	1989	1990	1991	1992	1993	1994
Total Consumption*	89.3	91.4	90.5	89.2	90.7	92.8	93.5	95.9
Private Consumption	78.8	81.3	80.8	79.8	80.6	81.4	81.2	82.3
Public Consumption	10.5	10.1	9.7	9.5	10.1	11.4	12.3	13.6
Total Saving*	10.7	8.6	9.5	10.8	9.3	7.2	6.5	4.1
Private Saving	NA	7.8	7.5	6.6	5.1	3.8	NA	NA
Public Saving	NA	0.8	2.0	4.2	4.2	3.5	NA	NA
Real GDP Growth	0.0	1.3	3.3	−0.9	9.3	2.8	0.4	3.8
Inflation (CPI)	159.2	51.7	19.7	29.9	18.8	11.9	8.0	7.1

* Table entries are expressed as a percentage of National Disposable Income.
Source: OCED National Accounts and DRIINTL.

Mexico had to intervene in the market to sell pesos/buy dollars to keep the value of the peso down in January 1994, accumulating foreign exchange reserves. Figure 3 shows this accumulation as the spike upwards in foreign exchange reserves at the beginning of 1994.

Finally, a fundamental measure of whether the real exchange rate is properly valued is its effect on exports. The Mexican government questioned how the real exchange rate could be overvalued when export growth was as strong as it was. Cumulative nonoil export growth from 1985 to 1994 was more than 200 percent, in the same range as such export powers as Hong Kong, Korea, Singapore, and Taiwan.[9]

To summarize: Dornbusch and Werner presented evidence that the real exchange rate, as measured by the WPI, was overvalued in 1993 and 1994. Although in retrospect it looks as if Dornbusch and Werner were correct, this was not obvious at the time. Other measures of the exchange rate showed no overvaluation, economic reform had likely made historical measures less reliable than usual, and export growth was strong.

Disinflation and the Overvalued Peso. In 1993 and 1994 many economists who supported NAFTA warned that the real exchange rate had become overvalued and could lead to a crisis.[10] These economists argued that the peso had become overvalued because Mexican officials had used the pegged exchange rate to help bring inflation down (see Table 1) from 159 percent in 1987 to 8.0 percent in 1993. This section explains the role of a pegged exchange rate in bringing down inflation and the dangers of such a policy.

To understand how the value of the peso affects inflation, consider how monetary policy, exchange rates, and prices interact. Because only the Bank of Mexico, Mexico's central bank, can issue peso currency or reserves, within very broad limits, it can control the value of the peso by controlling the supply of pesos. Similarly, the Bank of Mexico also controls Mexican inflation by increasing or decreasing the growth of the money supply. No central bank, however, can independently control both the exchange rate and inflation at the same time. The desired inflation rate may not be compatible with the preferred exchange rate. That is, if a central bank picks a level of inflation to target, it must choose the particular path for the exchange rate that is consistent with that inflation rate. By choosing a path for the exchange rate (and money growth) consistent with a low inflation rate, the Bank of Mexico could use a pegged exchange rate as a tool to help lower the inflation rate.

[9] Data taken from Gil-Diaz and Carstens (1995).

[10] See Dornbusch and Werner (1994) and Hufbauer and Schott (1993).

There are three ways in which a pegged exchange rate policy helped the fight against inflation. First, a stronger peso forced Mexican producers of tradeable goods to restrain price increases to directly compete with foreign producers. Second, in every disinflation, the credibility of the disinflation is important to breaking the momentum of the inflation with little cost in lost output. That is, people have to be convinced that inflation will fall. A pegged exchange rate helps break inflationary expectations by providing a concrete measure of the progress in fighting inflation; it gives the public an inflation-sensitive *nominal anchor*. People can see that the currency doesn't free fall against a (low inflation) foreign currency and so they come to believe that inflation is falling. Third, maintaining the exchange rate against the dollar gives the monetary authority instant feedback as to the pressure on the value of the peso.

The danger with using a pegged exchange rate to fight inflation is that the real exchange rate will become overvalued if domestic inflation exceeds the rate of depreciation of the domestic currency plus foreign inflation. Pegging the nominal exchange rate while domestic inflation exceeds foreign inflation raises the real exchange rate, and domestic goods become more expensive in terms of foreign goods. This fights domestic inflation for the reasons outlined previously, but at the cost of making domestic industries less competitive in tradeable goods. Such a situation may quickly become unsustainable.

Despite this danger, many developing countries with histories of high inflation have used restrictive monetary policy with a pegged (or crawling peg) exchange rate to control inflation. That is the course Mexico chose; from 1988 to 1994, the Bank of Mexico used the exchange rate as an instrument to bring down inflation. The peso was pegged to the dollar in March 1988. In January 1989, the peg was changed to a crawling peg and a moving target zone was introduced in December 1991.[11] The lower limit of the target zone or band was lowered (devalued) only slowly. The principle of controlling the exchange rate to restrain inflation remained the same, however.

As the preceding section concluded, it was not obvious that the peso was overvalued. To the extent that it may have been, however, creating an overvalued exchange rate by using a pegged exchange rate to bring down inflation is neither new nor unique to Mexico. Numerous authors, including Corbo and De Melo (1987), have commented on the tendency toward overvaluation in the so-called "Southern Cone" countries of Argentina, Chile and Uruguay when the exchange rate is used as an instrument to reduce inflation. Gil-Diaz and Carstens (1995) add Brazil and Finland to this list of countries that experienced overvaluation. In all of these countries, there was substantial real overvaluation but no free trade agreement to blame for it.

Other Reasons to Avoid Devaluation. Velasco (1995) discusses several reasons why the Mexican authorities wished to avoid devaluation in 1994. First, they did not wish to lose the gains they had made against inflation. Aside from the domestic consequences of loss of control of inflation, the Mexican authorities feared that a devaluation would be ineffective in changing the relative price of Mexican and foreign goods if inflation would outpace the depreciation of the peso. Such a devaluation would have been the worst of both worlds: more inflation, a loss of credibility and no improvement in the competitiveness of domestic goods. Further, to maintain their credibility with investors, the Mexican policymakers were reluctant to devalue even in the face of large shocks. They were concerned that devaluation would call into question the policymakers' commitment to other reforms and result in a loss of foreign investment.

Summary on the Value of the Peso. In 1993–1994 Dornbusch and Werner presented evidence, convincing in retrospect, that the peso was overvalued. It was not clear at the time, however, that this was the

[11] A crawling peg is a pre-announced daily rate of slow devaluation. In the target zone system, Mexican authorities pledged to keep the exchange rate with the dollar within given margins.

case. To the extent the peso may have been overvalued, it was because of the disinflation strategy pursued by Mexico, and other policy concerns. The evidence is not consistent with the claim that the government of Mexico deliberately manipulated the value of the peso and planned a devaluation years in advance or that the authorities avoided a faster rate of depreciation solely (or primarily) because of the politics of NAFTA.

NAFTA AND INTERNATIONAL CAPITAL FLOWS

This section introduces the concept of *capital flows*, lays out the hypothesis that NAFTA was responsible for the peso crisis by stimulating capital flows out of Mexico, and then shows that the evidence is not consistent with this hypothesis.

What Are Capital Flows?

Capital flows entail the buying and selling of existing assets. When foreign investors buy real or financial Mexican assets, for example, capital flows into Mexico. Real assets include factories and real estate; financial assets encompass bonds and equity. Foreign investment is divided into *foreign direct investment* (FDI) and *portfolio investment*. FDI is distinguished from portfolio investment by active control of the assets: Buying a factory is FDI, buying a bond is portfolio investment.

The *national income accounts* measure net capital flows by the balance in the *capital account*. A surplus in a nation's capital account means that more capital is flowing into the country than is flowing out; that is, the country is selling more existing assets than it is buying. Similarly, the *current account* measures trade in goods and services, net receipts on foreign investment, and unilateral transfers. A current account deficit means that a country is importing more newly produced goods and services than it exports.

Aside from measurement errors, the current account balance must be equal and opposite to the capital account balance because a country can import more than it exports only by selling foreigners claims on existing real or financial assets.[12] Thus a deficit in the current account must be balanced by an equal and opposite capital account surplus because the two accounts are the opposite sides of the same transaction. One measures the net value of the goods and services received, and the other measures the net value of the assets exchanged for the goods and services. A nation that runs a current account deficit (and, by definition, a capital account surplus) is borrowing from abroad, selling assets like bonds in exchange for new goods and services. A country running a current account surplus is lending to other countries by buying assets in exchange for exports of goods and services. In a world with balanced trade, there would be no opportunities for net international borrowing, and domestic savings would have to equal domestic investment.

Figure 4

Current Account and Capital Account Balances as a Percentage of GDP

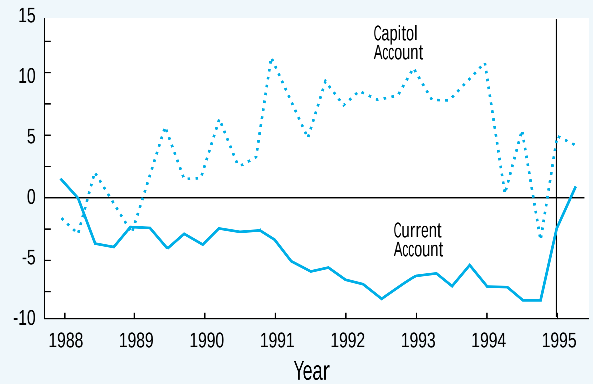


Figure 4 illustrates that Mexico ran increasing current account deficits and capital account surpluses for the period 1990–1994. In other words, it was increasingly borrowing from abroad—as much as 8 percent of its GDP by 1993. Capital inflows—a capital account surplus—are useful because they permit a nation to consume more and grow faster by borrowing

[12] The accumulation or loss of official reserves like foreign exchange, gold, or other assets permits an exception to the rule that the current and capital accounts must balance. A nation can temporarily finance a current account deficit by selling off official assets, as Mexico did in 1994. This simply amounts to a change in the way that the capital account is defined.

against future income. The sustainability of capital inflows (borrowing) is limited by the capacity of the borrower to pay back the loan. Borrowing for present consumption is not sustainable unless national income, or the capacity to pay back the loan, grows rapidly. Borrowing to invest in productive capacity, borrowing that increases future income or reduces future expenditures is more likely to be sustainable. Judging whether capital flows are sustainable is difficult, however, because consumption and investment are defined and measured imperfectly. For example, spending on education, health care, or consumer durables is counted in the national accounts as consumption, but perhaps it should be called investment.

The Case that NAFTA Was Responsible for Capital Flows that Caused the Peso Crisis

The immediate precipitating factor in the Mexican peso crisis of December 1994 was the desire of investors to get their assets, especially portfolio investment, out of pesos, which they feared would be devalued, and into dollars or other foreign currency. That is, capital was flowing out of Mexico. This section lays out the logic behind the critics' second hypothesis about NAFTA and the Mexican financial crisis—that NAFTA drove international capital flows that led to the devaluation of the peso. There are also two versions of this hypothesis. The first version requires only that NAFTA simply encouraged capital inflows—either by depressing national savings or by making Mexico a more attractive investment environment—and that capital inflows, in the form of portfolio investment, are inherently dangerous. The second version suggests that NAFTA generated political instability that sparked capital outflows and the devaluation. These hypotheses require that:

1. Either NAFTA encouraged international capital inflows, which are intrinsically destabilizing, or
2. NAFTA triggered capital outflows that led to the peso's devaluation by creating political instability.

The Case that NAFTA Generated Capital Inflows. The capital inflows to Mexico (Mexico's capital account surplus) in 1990–1994 meant that Mexico was borrowing from abroad to finance its current account deficit. A low savings rate made Mexico more dependent on international capital flows and therefore more vulnerable to shocks.[13] Critics contend that this dependence was critically worsened by passage of NAFTA. There are two ways in which NAFTA might generate capital inflows to Mexico. The first is by decreasing Mexican national savings. The second is by increasing the desirability of investment in Mexico.

Why might NAFTA reduce Mexico's savings rate? First, by directly lowering trade barriers, NAFTA made consumption of imports, especially consumer durables, cheaper and more attractive relative to saving. Given Mexico's history of protectionism, consumers may have feared that free trade was temporary and wished to buy while they could. A rise in the consumption rate must lower the savings rate because all disposable income of a nation or an individual can be classified as either consumption or savings. Second, NAFTA and other economic reforms may have increased expectations of future income, increasing Mexicans' willingness to go into debt and lenders willingness to permit this.[14] At the same time, financial reforms gave ordinary people greater access to credit markets and thus greater ability to go into debt. Finally, if NAFTA contributed to an artificially higher real value of the peso, that would have also made imported goods much less expensive and consumption more attractive.

> "... NAFTA served as a kind of 'Good Housekeeping Seal of Approval' that encouraged even more investors into Mexico."
> Anderson, Cavanagh and Ranney (1996), p. 3.

[13] A *savings rate* and a *consumption rate* are savings and consumption, respectively, as percentages of income.

[14] The Permanent Income Hypothesis, developed by economist Milton Friedman (1957), predicts that people base their consumption on their lifetime income. That is, they smooth their consumption over time by borrowing during periods of low income and saving during periods of high income.

The second form of the capital inflow hypothesis suggests that NAFTA may have generated capital inflows to Mexico by making Mexico a more attractive investment environment. This hypothesis would explain the surge, in early 1994, of capital inflows that caused the peso to appreciate. NAFTA was considered especially important to investors because an international treaty made the reforms more likely to be permanent. There is considerable reluctance to break a treaty with a foreign government.

An implicit assumption of the hypothesis that NAFTA was responsible for the peso crisis because it encouraged capital inflows is that such flows are inherently destabilizing. Portfolio investment, in particular, was frequently maligned as being a cause of the crisis. It was said to be moved on a whim with a short-term investment horizon, creating financial market volatility. Such a view requires that international capital markets be subject to fads or speculative bubbles. Critics point to the volatility of the dollar in the 1980s, the European Exchange Rate Mechanism crises of 1992 and 1993, and the recent flood of capital into emerging markets as evidence of this.

The Case that NAFTA Contributed to Capital Outflows Through Political Instability. From the Mexican view, the purpose of NAFTA was to create a more prosperous and stable Mexico. Nevertheless, even good economic policy can unintentionally create dislocations and political instability. Some have charged that NAFTA contributed to the Chiapas uprising that triggered the capital outflows that brought down the peso.

> "On January 1, 1994—the day that the North American Free-Trade Agreement (NAFTA) took effect, binding Mexico's modernizing economy to that of the United States—Indian peasants at the southern end of the country rose in armed rebellion. ... Many in Chiapas fear that NAFTA will worsen the existing divide between Mexico's prosperous north and an impoverished south."
> *The Economist*, January 8, 1994.

The uprising was soon contained by the Mexican army, but it and other political shocks concerned investors throughout the year. They engendered fears that the economic reforms in Mexico had moved too fast and would lead to social unrest that would roll back the reforms. In fact, the initial devaluation on December 20, 1994, was sparked by a run on the peso started by rumors of renewed fighting in Chiapas.[15]

These political shocks led investors to exchange pesos for dollars at the Bank of Mexico, causing a series of falls in Mexico's foreign exchange reserves, limiting its short-term ability to defend the peso.[16] Figure 3 illustrates the stepwise falls in foreign exchange reserves during 1994. By the time that rumors of renewed fighting rattled the markets on December 19, 1994, the Bank of Mexico had nearly run out of foreign exchange reserves. Without foreign exchange to defend the peso, the Bank of Mexico had to devalue.[17] Critics of NAFTA might argue that the treaty caused the peso crisis by sparking the Chiapas uprising.

Evaluating the Evidence on NAFTA and Capital Flows

This section evaluates the evidence on NAFTA and capital flows to see whether it is consistent with either of the hypotheses that NAFTA caused the peso crisis through its effect on capital flows. The first subsection examines the evidence on the extent to which NAFTA encouraged capital inflows and the next looks at the argument that capital flows are inherently destabilizing. Finally, the role of NAFTA in the Chiapas uprising and political instability is appraised.

Evidence on NAFTA and Capital Inflows. Mexico did indeed have low and falling national savings rates—4 percent of GDP in 1994, for example (see Table 1)—making it more dependent on international capital flows. Net savings fell from 10.8 percent of

[15] See Gil-Diaz and Carstens (1995) or IMF (1995) for the details of the decision to devalue.

[16] In the long run, the Bank of Mexico used its control over the money supply to determine the foreign exchange value of the peso. Over the short term, however, the Bank of Mexico defended the value of the peso by buying and selling pesos for dollars. By itself, this action would reduce the supply of pesos and push up Mexican interest rates. The Bank of Mexico, however, fully *sterilized* the purchase of pesos by buying outstanding bonds in exchange for pesos, putting the pesos back into circulation. Sterilization is intended to leave domestic interest rates unchanged after foreign exchange purchases or sales.

[17] Some suggest that the Bank of Mexico could have used its control over the domestic money supply to defend the peso, but it was reluctant to do this because of the effect high interest rates would have had on the real economy and the banking sector. Certainly by December 1994 this strategy would have imposed large costs.

GDP in 1990 to 4.1 percent of GDP in 1994.[18] This reduction in savings was driven by corresponding increases in private and government consumption, which rose 2.5 percentage points and 4.1 percentage points, respectively, over the same period.

There are several problems with the hypothesis that the declining savings was a result of NAFTA. First, it is not very plausible that NAFTA would cause a large rise in private (or government) consumption. Trade barriers cause consumers to substitute one form or source of consumption for another but change aggregate levels of consumption/saving relatively little. Thus the effect of trade liberalization on trade deficits is not likely to be very big. Also, the fact that most of the increase in consumption was caused by a rise in government consumption does not fit well with the hypothesis that NAFTA caused the fall in savings. The sluggish economy in 1993 and election year politics in 1994 were more likely than NAFTA to have played a role in this relaxation of fiscal policy. Finally, the timing of the inflows is wrong; the inflows started in 1990 with the resolution of the debt crisis and the liberalization of capital account rules to permit foreigners to hold government bonds and nonvoting equity shares in Mexican firms.[19] Figure 4 illustrates this rise in the capital account surplus; the majority of capital inflows had entered Mexico well before NAFTA was negotiated, much less enacted. Other economic reforms, like the decline in inflation and the privatization of state-owned industries, also helped drive investment.

While NAFTA was not the only or even the major causal factor for capital inflows, it probably had some marginal effect. Figure 4 shows that Mexico's capital account surplus did peak in the first quarter of 1994, coinciding with the implementation of NAFTA. The figure is somewhat deceptive in that a surge in inflows in January 1994 and February 1994 was masked in the quarterly capital account figures by a major outflow in March after the assassination of presidential candidate Luis Donaldo Colosio. Part of the capital inflow was soaked up in the form of a rapid increase and then decrease in official reserves—shown by the spike in Figure 3 at the beginning of 1994. That is, the Bank of Mexico bought up dollars in sterilized intervention to keep the price of the peso *down* in January and February 1994. The surge was not out of proportion to earlier flows, however.

To the extent that private Mexican consumption increased in the early 1990s, there are many factors aside from NAFTA to explain it. Prolonged slow growth (since 1980) had created repressed consumer demand. After growth returned in 1988, consumption spending rose along with it. Also, to the limited extent that reducing trade barriers may change savings and consumption decisions, NAFTA was not the only trade initiative. Mexico engaged in unilateral trade liberalization and trade agreements with Chile, Colombia, Venezuela, and Costa Rica. Similar to other developing countries, economic reform and financial liberalization—quite apart from NAFTA—raised expectations of increased future income and gave more Mexicans access to credit.

To summarize: the evidence does not support the argument that NAFTA drove large capital inflows to Mexico. NAFTA did increase foreign confidence and marginally increased capital inflows, but most capital inflows had entered *before* passage of NAFTA. In fact, NAFTA may have *delayed* a crisis by drawing in capital that supported the peso in early 1994.

Volatility of Capital Flows. The question of whether capital flows are excessively volatile or inherently destabilizing is difficult to answer because capital should exit a country in response to poor economic policies or other factors that reduce its productivity. This helps ensure that capital is as productive as possible and provides governments with an immediate incentive to maintain sound policies. On the other hand, it is possible that portfolio investment overreacts to information, and this volatility does create problems.

[18] Data from OECD (1995) National Accounts.

[19] See Sachs, Tornell and Velasco (1995a and 1995b).

Because capital does move rapidly out of weak currencies in moments of crisis and these movements can be destabilizing, some economists have advocated a very small tax on international financial transactions to deter short-term speculation.[20] Trying to eliminate international capital flows would be a mistake, however, because capital inflows can be quite helpful in promoting development. Also, they are not necessarily destabilizing. Rather, their volatility can depend on the soundness of macroeconomic policies followed in the recipient countries. Further, outflows occur without regard to the nationality of the investors in the presence of unsound macroeconomic policies. Domestic residents would get their money out of the domestic assets under the same conditions as international investors, if the value of these assets were threatened.

NAFTA and the Chiapas Uprising. NAFTA may have been a catalyst for, but certainly was not the cause of, the Chiapas uprising. This rebellion reflected grievances long and deeply felt by the impoverished south against the more prosperous north. Also, the uprising was only one political shock among many that Mexico endured that year, including two major assassinations, a rise in U.S. interest rates and a presidential election. If the December Chiapas uprising had not sparked the crisis, something else likely would have.

Capital Flows to Emerging Markets. Mexico is not the only developing country to experience heavy capital inflows recently. In the last 10 years capital inflows to developing countries have increased sharply because of two factors: market-oriented policy reforms and low interest rates prevailing in the developed world. These factors draw in capital because policy reforms raise the return to investment in developing countries and the low interest rates in the developed world provide a less attractive alternative for international investors. For developing countries, capital flows provide a much needed source of funds for economic growth. Ideally, international capital flows provide major advantages for both investors and recipients.

This movement of assets can also cause difficulties, however. Corbo and Hernandez (1996) studied the problems posed by this movement of assets in nine countries: Argentina, Chile, Columbia, Indonesia, Malaysia, Mexico, the Philippines, South Korea, and Thailand. They report that though the absolute level of investment in Mexico from 1986 to 1993 was very large compared with the other countries, Thailand, Malaysia, and Chile received larger capital inflows as a percentage of GDP than did Mexico. Many of these countries have also encountered problems similar to those confronted by the Mexican authorities. For example, in regimes with fixed or predetermined exchange rates, capital inflows can lower domestic interest rates, raise domestic expenditures and temporarily raise inflation, which can lead to an overvalued currency and large trade deficits.

Partly to offset the tendency toward overvaluation caused by the capital flows, all of these countries have undertaken liberalization of trade, though none of them has concluded a trade agreement comparable in importance to NAFTA. But free trade agreements are not necessary to create substantial capital inflows. The breadth and size of these capital flows to reforming countries in the developing world in the last 10 years makes it difficult to believe that NAFTA was the primary reason for the inflows to Mexico.

Capital flow volatility poses particular problems for fixed exchange rate regimes because capital outflows are synonymous with exchange rate crises. Investors who perceive a possibility of a discrete fall in the value of their assets (that is, a devaluation), will attempt to get their money out of the weak currency. *Thus crises appear suddenly when capital is easily moved.* These outflows are merely a symptom of the problem, however, not the cause.

Summary of the Evidence on NAFTA and Capital Flows. NAFTA is an unlikely culprit to blame for the quantity of capital in-

[20] See Frankel (1996) for a short discussion of the *Tobin* tax.

flows Mexico received in the early 1990s. The surge in capital flows started well before the enactment of NAFTA and had more to do with the rise in consumption by the Mexican government and the other economic reforms undertaken.

Whatever the source or timing of the inflows, however, NAFTA was *not* responsible for the outflows. It is generally acknowledged that the outflows were generated by some combination of inconsistent policies and political shocks that generated a liquidity crisis; the Mexican government had more short-term obligations—in the form of dollar-linked bonds—coming due than it had liquid assets.[21]

CONCLUSION

As Mexico entered into NAFTA at the beginning of 1994, it was widely and correctly applauded as a model of economic reform. Before the end of the year, however, it was forced to first devalue and later to allow the peso to float. In early 1995, it was forced to borrow from the IMF and the United States to get through a liquidity crisis.

Critics of NAFTA such as Ross Perot, Pat Buchanan, William Greider, and Robert Kuttner blamed the trade treaty for this crisis. This article examines two versions of this argument: that Mexican policymakers manipulated the value of the peso because of NAFTA and that NAFTA caused volatile international capital flows that brought down the peso. The evidence does not support the hypothesis that the crisis could have resulted from NAFTA's economic effects. Any peso overvaluation in 1994 resulted from the use of the exchange rate to reduce inflation, a common consequence of this strategy. Although capital inflows can present problems and aggravate instability in developing countries, they are also very useful to promote economic development. In any case, the flows to Mexico were only partially driven by NAFTA. NAFTA was not, in any sense, responsible for the devaluation, but this episode reminds us that good policies can have unintended consequences.

[21] Because the Bank of Mexico had ultimate control over the supply of pesos, it is true, *by definition*, that the devaluation was caused by insufficiently tight monetary policy. That is, the Mexican authorities' exchange rate and growth policy objectives were mutually inconsistent. For a discussion of the policy priorities of the Mexican authorities, see Gruben (1996) or Gil-Diaz and Carstens (1995). Overviews of the events leading to the crisis may be found in OECD (1995), IMF (1995) or GAO (1996). Calvo (1996) and Garber and Lall (1996) discuss the roles played by capital flows and weakness in the Mexican financial system. Sachs, Tornell and Velasco (1995a and 1995b) discuss the problems created by Mexico's dollar-linked debt instruments.

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REVIEW
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Nominal Stylized Facts of U.S. Business Cycles

Apostolos Serletis and David Krause

This paper investigates the basic nominal stylized facts of business cycles in the United States using monthly data from 1960:1 to 1993:4 and the methodology suggested by Kydland and Prescott (1990). Comparisons are made among simple-sum and Divisia aggregates using the Thornton and Yue (1992) series of Divisia monetary aggregates. The robustness of the results to (relevant) nonstochastic stationarity-inducing transformations is also investigated.

Kydland and Prescott (1990) argue that business cycle research took a wrong turn when researchers abandoned the effort to account for the cyclical behavior of aggregate data following Koopmans's (1947) criticism of the methodology developed by Burns and Mitchell (1946) as being "measurement without theory." Crediting Lucas (1977) with reviving interest in business cycle research, Kydland and Prescott initiated a line of research that builds on the growth theory literature. Part of it involves an effort to assemble business cycle facts. This boils down to investigating whether deviations of macroeconomic aggregates from their trends are correlated with the cycle, and if so, at what leads and lags.

Kydland and Prescott (1990) report some original evidence for the U.S. economy and conclude that several accepted nominal facts, such as the procyclical movements of money and prices, appear to be business cycle myths. In contrast to conventional wisdom, they argue that the price level (whether measured by the implicit GNP deflator or by the consumer price index), is countercyclical. Although the monetary base and M1 are both procyclical, neither leads the cycle. This evidence counters Mankiw's (1989) criticism of real business cycle models on the grounds that they do not predict procyclical variation in prices. Moreover, the evidence of countercyclical price behavior has been confirmed by Cooley and Ohanian (1991), Backus and Kehoe (1992), Smith (1992), and Chadha and Prasad (1994).

The cyclical behavior of money and prices has important implications for the sources of business cycles and therefore for discriminating among competing models. Initially it was argued, for example, that procyclical prices will be consistent with demand-driven models of the cycle, whereas countercyclical prices would be consistent with predictions of supply-determined models, including real business cycle models. Subsequently, however, Hall (1995) has shown that adding more detail to traditional demand-driven models can produce countercyclical prices, whereas Gavin and Kydland (1995) have shown that alternative money supply rules can generate either procyclical or countercyclical prices in a real business cycle setting.

The objective of this paper is to reexamine the cyclical behavior of money and prices using monthly U.S. data. For comparison purposes, the methodology used is mainly that of Kydland and Prescott (1990). Therefore in accordance with the real business cycle approach to economic fluctuations, we define the growth of a variable as its smoothed trend and the cycle components of a variable as the deviation of the actual values of the variable from the smoothed trend. However, we investigate robustness of the results to alternative (relevant) nonstochastic stationarity-inducing transformations.

To highlight the influence of money measurement on statistical inference [as in Belongia (1996)], comparisons are made among simple-sum and Divisia monetary aggregates (of M1A, M1, M2, M3, and L) —see Barnett, Fisher, and Serletis (1992) regarding the state of the art in monetary aggregation. The money measures employed are monthly simple-sum and Divisia indexes (from 1960:1 to 1993:4), as described in Thornton and Yue (1992), and were obtained from the Federal Reserve Economic Data (FRED) bulletin board of the Federal Reserve Bank of St. Louis.

The paper is organized as follows. Section 1 briefly discusses the Hodrick Prescott (HP) filtering procedure for decomposing time series into long-run and business cycle components. Section 2 presents HP empirical correlations of money, prices, and nominal interest rates with industrial production. In section 3 we investigate the robustness of our results to alternative stationarity-inducing transformations, and in the last section we summarize the main results and conclude.

METHODOLOGY

For a description of the stylized facts, we follow the current practice of detrending the data with the HP filter—see Prescott (1986). For the logarithm of a time series X_t, for $t = 1,2,...,T$, this procedure defines the trend or growth component, denoted τ_t, for $t = 1,2,...,T$, as the solution to the following minimization problem

$$\min_{\tau_t} \sum_{t=1}^{T} (X_t - \tau_t)^{2+\mu} \sum_{t=2}^{T-1} \left[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}) \right]^2$$

so $X_t - \tau_t$ is the filtered series. The larger the μ, the smoother the trend path, and when $\mu = \infty$, a linear trend results. In our computations, we set $\mu = 129{,}600$, as it has been suggested for monthly data. Note that the monthly cyclical components defined by $\mu = 129{,}600$ approximately average to the quarterly components defined by $\mu = 1{,}600$ which is commonly used to define business cycle fluctuations in research literature.

We measure the degree of co-movement of a series with the pertinent cyclical variable by the magnitude of the correlation coefficient $\rho(j)$, $j \epsilon \{0, \pm 1, \pm 2, ...\}$. The contemporaneous correlation coefficient—$\rho(0)$—gives information on the degree of contemporaneous co-movement between the series and the pertinent cyclical variable. In particular, if $\rho(0)$ is positive, zero, or negative, we say that the series is procyclical, acyclical, or countercyclical, respectively. In fact, for $0.23 \leq |\rho(0)| < 1$, $0.10 \leq |\rho(0)| < 0.23$, and $0 \leq |\rho(0)| < 0.10$, we say that the series is strongly contemporaneously correlated, weakly contemporaneously correlated, and contemporaneously uncorrelated with the cycle, respectively. Following Fiorito and Kollintzas (1994) in our sample of 400 observations, the cutoff point 0.1 is close to the value 0.097 that is required to reject the null hypothesis, $H_0 : \rho(0) = 0$, at the 5 percent level in a two-sided test for bivariate normal random variables. Also, the cutoff point 0.23 is close to the value of 0.229 that is required to reject the null hypothesis H_0: $|\rho(0)| \leq 0.5$, in the corresponding one-tailed test. Also, $\rho(j)$, $j \epsilon \{\pm 1, \pm 2, ...\}$—the cross correlation coefficient—gives information on the phase-shift of the series relative to the cycle. If $|\rho(j)|$ is maximum for a negative, zero, or positive j, we say that the series is leading the cycle by j periods, is synchronous, or is lagging the cycle by j periods, respectively.

HODRICK-PRESCOTT STYLIZED FACTS

In Table 1 we report contemporaneous correlations, as well as cross correlations (at lags and leads of one through six months) between the cyclical components of money and the cyclical component of industrial production. We see that all the monetary aggregates are strongly procyclical. With a minor exception for M1A, for both Divisia and simple-sum measures, the

Table 1

Correlations of HP-Filtered Sum and Divisia Monetary Aggregates with Industrial Production*

		Correlation Coefficients of Industrial Production with												
Variable, *x*	Volatility	x_{t-6}	x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}	x_{t+6}
Sum M1A	2.09	0.43	0.43	0.43	0.43	0.42	0.40	0.38	0.35	0.31	0.28	0.25	0.24	0.22
Sum M1	1.93	0.37	0.37	0.37	0.36	0.35	0.32	0.28	0.24	0.19	0.15	0.11	0.08	0.05
Sum M2	1.41	0.71	0.70	0.66	0.62	0.56	0.49	0.40	0.32	0.24	0.16	0.09	0.03	−0.03
Sum M3	1.48	0.50	0.52	0.53	0.53	0.52	0.50	0.47	0.44	0.41	0.38	0.35	0.32	0.29
Sum L	1.11	0.33	0.39	0.44	0.49	0.52	0.55	0.57	0.58	0.59	0.58	0.58	0.56	0.55
Divisia M1A	1.74	0.39	0.40	0.40	0.40	0.39	0.37	0.35	0.32	0.29	0.27	0.26	0.25	0.24
Divisia M1	1.50	0.28	0.28	0.29	0.28	0.27	0.24	0.21	0.18	0.14	0.10	0.08	0.05	0.03
Divisia M2	1.81	0.67	0.65	0.62	0.59	0.54	0.47	0.40	0.33	0.25	0.19	0.13	0.08	0.03
Divisia M3	1.78	0.68	0.67	0.66	0.64	0.60	0.56	0.50	0.45	0.39	0.34	0.29	0.25	0.21
Divisia L	1.58	0.62	0.63	0.64	0.64	0.62	0.60	0.57	0.53	0.49	0.45	0.41	0.37	0.33

* Monthly data from sample period 1960:1–1993:4.

broader the aggregate the more procyclical it is. There is also evidence that M2 money, however defined, leads the cycle by more than the other aggregates and, if anything, Sum L is slightly lagging. These results suggest the only major differences among simple-sum and Divisia monetary aggregates occur in the stronger correlation at leads for the broad Divisia aggregates, M3 and L.

We interpret these results as being generally consistent with the cyclical money behavior in the United States reported (using quarterly data) by Kydland and Prescott (1990) and Belongia (1996). Unlike Belongia, who like Kydland and Prescott, uses quarterly data and only the simple-sum and Divisia measures of M1 and M2, we find no significant differences across narrow simple-sum and Divisia monetary aggregates. We find strong contemporaneous correlations between broad-sum and Divisia money and the cyclical indicator. Divisia L, however, is leading the cycle, and Sum L is slightly lagging the cycle. This result seems to be consistent with the evidence reported by Barnett, Offenbacher, and Spindt (1984), who found that Divisia L was the best aggregate in terms of causality tests, produced the most stable demand-for-money function, and provided the best reduced-form results.

Next we turn to the statistical properties of the cyclical components of the price level (measured by the consumer price index) and two short-term nominal interest rates (to deal with anomalies that arise because of different ways of measuring financial market price information)—the Treasury bill rate and the commercial paper rate. The Treasury bill rate is the interest rate on short-term, unsecured borrowing by the U.S. government, whereas the commercial paper rate is the interest rate on short-term, unsecured borrowing by corporations. As Friedman and Kuttner (1993, p. 194) argue, the commercial paper rate is superior in capturing the information in financial prices because "the commercial paper rate more directly reflects the cost of finance corresponding to potentially interest-sensitive expenditure flows than does the Treasury bill rate."

Table 2 reports HP cyclical correlations of prices and short-term nominal interest rates with industrial production. We see that the price level is strongly countercyclical, whereas both the Treasury bill rate and the commercial paper rate are strongly procyclical and lag the cycle. These results provide strong confirmation

Table 2

Correlations of HP-Filtered Prices and Short-Term Nominal Interest Rates with Industrial Production*

Variable, x	Volatility	Correlation Coefficients of Industrial Production with												
		x_{t-6}	x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}	x_{t+6}
Consumer Price Index	1.46	−0.73	−0.71	−0.68	−0.65	−0.60	−0.55	−0.48	−0.43	−0.37	−0.31	−0.25	−0.20	−0.15
Treasury Bill Rate	1.66	−0.17	−0.09	0.01	0.11	0.22	0.32	0.40	0.44	0.46	0.47	0.47	0.48	0.48
Commercial Paper Rate	1.44	−0.12	−0.03	0.05	0.15	0.25	0.33	0.39	0.42	0.43	0.43	0.43	0.43	0.43

* Monthly data from sample period 1960:1–1993:4.

for the countercyclical price behavior in the United States reported by Kydland and Prescott (1990), Cooley and Ohanian (1991), Backus and Kehoe (1992), Smith (1992), and Chadha and Prasad (1994). They clearly support the Kydland and Prescott (1990) claim that the perceived fact of procyclical prices is but a myth.

ROBUSTNESS TO STATIONARITY-INDUCING TRANSFORMATIONS

We have characterized the key nominal features of U.S. business cycles using a modern counterpart of the methods developed by Burns and Mitchell (1946)—HP cyclical components. The HP filter is used almost universally in the real business cycle research program and extracts a long-run component from the data, rendering stationary series that are integrated up to the fourth order. HP filtering, however, has recently been questioned as a unique method of trend elimination. For example, King and Rebelo (1993) argue that HP filtering may seriously change measures of persistence, variability, and co-movement. They also give a number of examples that demonstrate that the dynamics of HP filtered data can differ significantly from the dynamics of differenced or detrended data.

Also, Cogley and Nason (1995), in analyzing the effect of HP filtering on trend- and difference-stationary time series, argue that the interpretation of HP stylized facts depends on assumptions about the time series properties of the original data. For example, when the original data are trend stationary, the HP filter operates like a high-pass filter. That is, it removes the low frequency components and allows the high frequency components to pass through. When the original data are difference stationary, however, the HP filter does not operate like a high-pass filter. In this case, HP stylized facts about periodicity and co-movement are determined primarily by the filter and reveal very little about the dynamic properties of the original data.

More recently, however, Baxter and King (1995) argue that HP filtering can produce reasonable approximations of an ideal business cycle filter. Though we believe that the results based on the HP filter are reasonably robust across business cycle filters, we believe it is useful to compare what we are doing with alternative popular methods of detrending the data. Once, however, we abstract from growth theory, we need to make some assumption about the trend. In particular, deterministic detrending will be the appropriate stationarity-inducing transformation under trend stationarity and differencing under difference stationarity.

Results reported in Koustas and Serletis (1996), based on augmented Dickey-Fuller–type regressions, indicate that the null hypothesis of a unit root in levels cannot be rejected for any of the

Table 3

Correlations of First Differences of Sum and Divisia Money with First Differences of Industrial Production*

Variable, x	Volatility	Correlation Coefficients of Industrial Production with												
		x_{t-6}	x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}	x_{t+6}
Sum M1A	0.005	0.09	0.06	0.05	0.17	0.14	0.12	0.10	0.06	−0.04	−0.08	−0.08	−0.03	−0.06
Sum M1	0.004	0.09	0.08	0.07	0.17	0.14	0.12	0.05	0.04	−0.05	−0.12	−0.08	−0.04	−0.05
Sum M2	0.003	0.25	0.23	0.21	0.27	0.23	0.16	0.11	0.04	−0.07	−0.07	−0.07	−0.05	−0.04
Sum M3	0.003	0.16	0.18	0.17	0.21	0.17	0.13	0.11	0.10	0.04	0.03	0.05	0.04	0.01
Sum L	0.003	0.10	0.11	0.07	0.12	0.10	0.14	0.15	0.17	0.11	0.11	0.11	0.08	0.09
Divisia M1A	0.005	0.04	0.03	0.01	0.14	0.11	0.09	0.04	0.02	−0.07	−0.08	−0.06	−0.02	−0.02
Divisia M1	0.004	0.04	0.05	0.03	0.14	0.10	0.08	−0.02	−0.01	−0.06	−0.10	−0.04	−0.01	−0.04
Divisia M2	0.004	0.18	0.20	0.17	0.28	0.25	0.20	0.07	0.02	−0.09	−0.10	−0.07	−0.05	−0.04
Divisia M3	0.003	0.17	0.20	0.18	0.27	0.24	0.19	0.08	0.06	−0.03	−0.04	0.00	0.01	0.02
Divisia L	0.003	0.14	0.16	0.13	0.24	0.21	0.21	0.12	0.12	0.02	0.02	0.04	0.05	0.07

*Monthly data from sample period, 1960:1–1993:4.

Table 4

Correlations of First Differences of Prices and Short-Term Nominal Interest Rates with First Differences of Industrial Production*

Variable, x	Volatility	Correlation Coefficients of Industrial Production												
		x_{t-6}	x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}	x_{t+6}
Consumer Price Index	0.003	−0.23	−0.22	−0.30	−0.23	−0.23	−0.16	−0.08	−0.07	−0.07	0.00	−0.01	−0.04	−0.07
Treasury Bill Rate	0.006	−0.10	−0.06	−0.06	−0.08	0.13	0.20	0.30	0.24	0.18	0.04	−0.00	0.02	−0.00
Commercial Paper Rate	0.006	−0.03	−0.02	−0.08	−0.04	0.14	0.21	0.23	0.23	0.11	0.03	−0.03	0.02	0.02

*Monthly data from sample period 1960:1–1993:4.

series used here, whereas the null hypothesis of a second unit root is rejected except for Sum M3, Sum L, and the price level which appear to be integrated of order 2 [or I(2) in Engle and Granger (1987) terminology]. Based on this evidence, in Tables 3 and 4 we report correlations (in the same fashion as in Tables 1 and 2) based on differenced data, keeping in mind that although differencing yields stationary series, these stationary series do not in general correspond to cyclical components. See, for example, Baxter and King (1995). These results are generally supportive of the hypothesis of acyclical money and price behavior. Nominal interest rates appear to be strongly procyclical and lagging slightly.

CONCLUSION

In this paper we investigated the cyclical behavior of U.S. money, prices, and short-term nominal interest rates, using monthly data from 1960:1 to 1993:4 and the methodology of Kydland and Prescott (1990). Based on stationary HP cyclical deviations, our results fully match recent evidence on the countercyclicality of the price level. We also found that short-term nominal interest rates are strongly procyclical and that money is in general procyclical. Furthermore, the evidence suggests that there are only slight differences across narrow simple-sum and Divisia money measures.

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