The new dollar indexes are no different from the old ones

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The continued deterioration in the international trade balance of the United States, despite the dramatic decline in the foreign exchange value of the dollar during the past two years, has prompted analysts to reexamine the traditional aggregate measures of the international value of the dollar. As a result, a number of new aggregate exchange rate indexes have been developed in the hope of providing insight into the changes in the international competitive position of the United States. The expectation was that such insight would shed light on why the trade account has not to date turned around.

We too joined the fray. But early on in our analysis, it began to appear that the question of the relative value of the various trade-weighted dollar indexes was, in some ways, trivial. Certainly, there are conceptual differences between the indexes, but from a practical perspective the differences appear to be minor. In those cases where a marked departure from the norm occurs, the departure largely seems to be explained by what we consider to be flaws in the index.

In this paper we discuss the background of aggregate indexes and the key conceptual issues in the construction of such indexes. In addition, we examine 12 of the indexes available in the literature. Those included are: the Federal Reserve Board's trade-weighted dollar indexes (nominal and real), the Morgan Guaranty 15-country (nominal and real) and 40-country (real) indexes, the OECD's (Organization for Economic Cooperation and Development) effective exchange rate index, the IMF's (International Monetary Fund) Multilateral Exchange Rate Model-based effective exchange rate index, the Atlanta Fed index, the Dallas Fed indexes (nominal and real), and the Chicago Fed indexes (nominal and real). In addition, as a part of our analysis we construct nominal and real "minimal" five-currency indexes that are used as benchmarks in the analysis of the other indexes.

The analysis covers the period 1971-Q1 through 1986-Q4. Composition of the examined indexes spans considerable breadth. The number of countries included range from 10 to 131. Trade-weighting schemes range from simple bilateral export-plus-import trade of the United States with the index countries to complexly derived trade weights based on a structural model of world trade. The base periods for the trade weights range from fixed values set in the mid-1970s to a 12-quarter moving average of bilateral U.S. trade updated each quarter. Seven indexes are nominal and five are real, incorporating an adjustment for change in relative prices. Three of the real indexes use relative consumer prices as the real adjustment deflator, and two use relative wholesale/producer prices for manufactured goods (excluding food and fuels). There is, in sum, considerable conceptual variation in the construction of the 12 indexes.

The analysis is based primarily on exploring the degree of correlation between the indexes—both in levels and growth rates. How much difference does the variation in the number of countries included in an index, the variation in weighting schemes, and the selection of different base periods make? Not much! The indexes, with modest exception, show a remarkable consistency in behavior.

We sympathize with the arguments which hold that in the construction of an aggregate exchange rate index it is analytically preferable to 1) use a large number of countries in the base in order to obtain as broad a measure of the trade relationship as is possible; 2) adopt a trade-weighting scheme that takes into account third-country relationships; and 3) select a base period that takes into account structural changes in international relationships. However, these factors appear to be of little practical significance.

Has then all the energy spent on the aggregate dollar indexes been misspent? We

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think not. To date, the work has provided analysts with a better understanding of the issues involved. We suggest, however, that as far as the aggregate (world-wide) indexes are concerned, it is time to move on to potentially more productive concerns.

Our specific conclusions are:

1) The major distinguishing characteristic of the indexes is whether they incorporate a "real" or relative price adjustment. Indexes that take relative price movement into account, including the broad indexes, are remarkably similar. While the absolute levels of the indexes vary substantially, other measures—such as "recovery ratios," which measure the decline in the dollar index since 1985-Q1 against the increase recorded since the early 1980s, and high correlations between index levels and growth rates—indicate that for the most part there is relatively little to distinguish between them.

2) The one index that departs markedly from the norm is the Dallas X-131, a nominal index. Its inclusion of countries with high rates of inflation, without adjustment for that fact, produces changes in the series that have little to do with competitiveness and risks an interpretation of the international value of the dollar that is inconsistent with the economic consequences of developments in those countries vis-à-vis those in the United States.

Background

The emergence of floating exchange rates in 1973 following the breakdown of the Bretton Woods Agreement and the long-standing regime of fixed exchange rates opened a new era of inquiry into the components of international competition. In a span of less than two years—from August 1971 when the United States officially abandoned its gold-for-dollars convertibility to the abandonment of fixed exchange rates in March 1973—the world economy shifted from an environment of rigid price controls on relative currency values to one of market-determined values for relative currency values (albeit market-determined within a framework dictated by the economic policies pursued by the various governments).

Following the dollar float, two major aggregate exchange-rate indexes were developed and routinely published—one by the Morgan Guaranty Trust Company of New York and one by the Board of Governors of the Federal Reserve System.[1] These indexes were later followed by a plethora of other aggregate exchange rate indexes, including, among others, published series developed by the IMF, the OECD, additional and more detailed indexes by Morgan Guaranty, and several indexes from the regional Federal Reserve Banks, including Atlanta, Dallas, and Chicago.

Intensified interest in aggregate exchange rate indexes emerged in the mid-1980s. After four years of appreciation against major currencies the dollar peaked in the first quarter of 1985. Thereafter it declined against many of the major currencies. Still, during 1985 and 1986 U.S. international trade continued to deteriorate.

The current account balance, which on average was in surplus by about $300 million during the 12 years 1970-1981 and recorded a $6 billion surplus as recently as 1981, deteriorated rapidly as the exchange value of the dollar rose during the first half of the 1980s. By 1984 the current account recorded a deficit of $106 billion. Despite the turnaround in the exchange value of the dollar in early 1985 the current account balance continued to deteriorate, recording deficits of $118 billion in 1985 and $140 billion in 1986.

Observers impatient to see a reduction in the current account deficit during 1985-1986, given what appeared to be a substantial depreciation in the exchange value of the dollar, began to question whether the aggregate indexes of the dollar's value were providing an accurate and appropriate measure of its international value.[2]

Aggregate measure of a currency's value: The rationale

Exploratory work during the development of an aggregate exchange rate index at the Chicago Fed in early 1986 indicated that different constructions of aggregate indexes showed more similarities than differences. Given the many indexes that have been developed, and the criticism leveled against some of them, it seemed appropriate to examine several key issues relating to the construction of such

indexes. First of all: What is the rationale for the construction of such indexes and what are the general strengths and weaknesses of the components undergirding such indexes. Secondly, the issue alluded to above: Are the various aggregate indexes really that different? Do the numerous variations in weighting schemes, country inclusion, and adjustment for relative prices make a difference? To these issues we now turn.

International transactions make up a broad matrix of relationships among countries. When a currency appreciates or depreciates within a floating exchange rate regime it does so against numerous currencies, with varying rates of change against those currencies. Thus, a change in a bilateral exchange rate is of only limited use in exploring the consequences of a currency-value change on international competitiveness. It was this limitation that led analysts to form an aggregation of exchange rates in the form of an index that incorporates changes in the relative values of specified currencies against a base currency over some relevant time period—an aggregate exchange rate index, e.g., the "trade-weighted dollar."

The intention implicit in the development and construction of an aggregate currency index is that the resulting index should provide a reliable measure of the change in the "international value" of the base currency (in effect, a measure of relative competitiveness) against the rest of the world—a change that is attributable to movements in exchange rates.

Index construction issues

The worth of any index depends upon the appropriateness of its construction and the trustworthiness-of-measure of its individual components. In the case of an aggregate exchange rate index we are concerned with three primary issues:

1) The number and selection of currencies that should be included in order to obtain a reliable index.

2) The weighting scheme, that is, the relative importance to be attributed to each currency in the index. Integral issues include the selection of the economic variables that are most appropriate to determine the relative importance of the individual currencies, the methodology for applying those weights, and the base period on which those weights rest.

3) The impact on the index of relative changes in inflation between the countries included in the weighting scheme and the index-defined currency, that is, the difference between a nominal or a real index.

Countries/currencies—a broad range of choice

With respect to the number of currencies included in an index there is a diversity of view among researchers that is nearly as broad as the number of aggregate indexes that have been developed. For the most part the differences are relatively minor, with the sample of currencies included in the index typically ranging between 10 and 22 in number. The value of U.S. merchandise trade accounted for by the countries included in these indexes ranges from about one-half to more than four-fifths. Several expanded-base indexes have also been developed (ranging up to 131 currencies) that include the currencies of countries that account for nearly all of U.S. merchandise trade.

The argument for the inclusion of additional countries in an aggregate index rests on the premise that the broader the coverage the more accurately the weighting scheme will represent the importance of the various countries in the international activities of the base country. In part, it is argued that the relative values of numerous countries' currencies that were excluded from the indexes formulated during the mid-to-late 1970s, especially the currencies of the newly industrializing countries of the Far East and Latin America, have changed with respect to the U.S. dollar in a pattern that is different from that observed with most of the currencies included in those earlier indexes. It is also argued that the exclusion of even a few of these countries from an index ignores a substantial, and over time, an increasingly important portion of U.S. trade (see Table 1, column 3).

Some of the currencies that are typically excluded from the exchange rate indexes have been closely tied to the U.S. dollar and as a result have not experienced the variability against the dollar that has been observed in the European currencies, for example. Other cur-

Table 1
Inflation and U.S. trade with the 22 largest trading partners of the United States[1]

Country	Export/import rank in 1986	Total U.S. trade by country	Percent of total U.S. trade	Rate of inflation by country and by area	
				1971-1980	1981-1986
(arranged by geographic area)		*(bil. $)*	*(1986 trade)*	*(average annual % change in CPI)*	
Canada	1	114.0	18.9	9.0	6.9
Europe					
Germany	3	36.7	6.1	5.1	3.2
United Kingdom	5	27.4	4.5	14.3	6.6
France	8	17.8	3.0	10.2	8.4
Italy	9	16.1	2.7	15.0	12.5
Netherlands	11	12.2	2.0	7.3	3.6
Bel-Lux	13	9.6	1.6	7.7	6.1
Switzerland	16	8.4	1.4	4.8	3.7
Sweden	20	6.5	1.1	13.9	8.2
Spain	21	5.6	0.9	14.2	11.7
(Area total)		(140.3)	(23.3)	(9.8)[2]	(6.4)[2]
Latin America					
Mexico	4	30.0	5.0	18.0	66.4
Brazil	12	11.2	1.9	38.3	152.3
Venezuela	15	8.5	1.4	9.6	11.0
(Area total)		(49.7)	(8.3)	(21.1)[2]	(76.3)[2]
Japan	2	112.4	18.6	9.4	2.9
Pacific rim					
Taiwan	6	26.8	4.4	12.0	4.1
South Korea	7	19.9	3.3	16.8	6.5
Hong Kong	10	12.5	2.1	9.5	7.8
Singapore	17	8.3	1.4	7.2	2.5
Malaysia	22	4.2	0.7	6.5	4.0
(Area total)		(71.7)	(11.9)	(12.1)[2]	(5.2)[2]
Australia	14	8.5	1.4	10.9	8.5
China	18	8.3	1.4	—	—
Saudi Arabia	19	7.5	1.2	13.7	−1.0
22-country total[3]		512.4	84.8	(11.0)[2]	(12.4)[2]
United States		604.1	100.0	8.3	4.9

[1]Inclusion is based on the trading partners' ranking within the top 25 countries for U.S. exports-to and imports-from. A total of 22 countries met both criteria in 1986.

[2]The average rate of inflation for the geographic area total is weighted by U.S.-area trade contributions by country to the total area trade with the United States.

[3]China is not used in the 22-country CPI weighting scheme because of an incomplete CPI series.

rencies not included in the indexes depreciated relative to the U.S. dollar throughout the 1980s, even during the 1985-1986 period when most major currencies recorded substantial appreciation against the U.S. dollar.

As the relative importance of the newly industrializing countries in the international environment increased during the 1980s, the continued exclusion of their currencies from an aggregate measure of the dollar might be ex-

pected to result in an increasingly distorted picture of the international value of the dollar. It is primarily this development that during the last two years has brought about the renewed interest among economists in aggregate measures of the international value of the dollar. It has also resulted in the inclusion of additional countries/currencies in the more recently developed indexes. (Table 2 provides a summary of the characteristics of the various indexes examined in this paper.)

The relative importance of different currencies

Determination of which currencies can be appropriately included in any particular index must be followed with a determination of how the relative importance of each currency is to be assigned within the index. Generally, measures of economic interaction rely on measures of international trade, in most cases merchandise trade. Several indexes adjust the value of trade to include only manufactured goods or to exclude certain types of trade that are deemed to be insensitive to exchange rate changes. Table 3 sets out the trade weights, by major geographic area, for the individual indexes.

The simplest procedure for incorporating international trade as an index weight is to assign currency weights based on the value of the bilateral trade—exports plus imports—between the index base country (in this case the United States) and the other countries included in the index.[3] This in fact is the manner in which most of the published indexes assign trade weights.

Economic interaction between two countries does not exist in a vacuum, however; it has an impact on third-country relationships. Consequently, changes in relative exchange rates between two countries will result in changes in their economic/trade relationships with third countries in accordance with the cross-elasticities of demand for the relevant markets.

There is diversity of view among economists as to the importance of these third-country effects and whether they should be somehow accounted for in the weighting scheme. Indeed, the diversity is not so much whether third-country effects should be accounted for but rather whether the statistical gain from the inclusion of third-country effects is sufficiently great to offset the increased cost and complexity associated with their inclusion. Nevertheless, several indexes have undertaken approaches that attempt to take into account third-country effects.

Conceptually, an ideal methodology to take into account third-country relationships would be through a structural model of the world economy from which one could determine the relative weights to be applied to each currency—an undertaking of considerable magnitude. The International Monetary Fund utilizes this complex approach in its Multilateral Exchange Rate Model.

Another approach to the interaction of third-country relationships is characterized by multilateral trade weights such as those used in the Federal Reserve Board's trade-weighted dollar. This aggregate exchange rate index incorporates multilateral international trade weights based on the relative importance of total world trade of the countries in the index. As compared with the structural model this approach has the appealing empirical advantage of being more simply executed.

At the same time, multilateral trade weights in this form have the disadvantageous characteristic of applying extraordinarily heavy weights to geographical regions within which a great deal of intercountry trade takes place. This is especially true of those countries which in many respects function as an economic unit but which are political entities with individual currencies—such as, the European Economic Community and its European Free Trade Association neighbors.

Trade among these Western European countries is substantial. Consequently, several of these countries weigh relatively heavily in total world trade. As a result, they carry substantial weight in a multilateral index (see for example, Table 3, FRB-TWD). At the same time they may be considerably less important in terms of their bilateral trade with the United States than are Canada or Japan (see Table 1, column 3). Such distortions presumably could be corrected by aggregating the intraregional trade of these countries—the European Community's trade with the rest of the world—and using some common *numeraire,* such as the European Currency Unit, to obtain the foreign currency/dollar relationship. In effect, our minimal index, which is used in the analy-

Table 2
Summary characteristics of selected aggregate exchange rate indexes for the U.S. dollar

Index name	Index characteristics: Number of currencies	Weighting scheme: Trade-weight period	Weighting scheme: Multilateral/bilateral	Relative price adjustment (nominal or real)
Federal Reserve Board (FRB-TWD)	10	1972-1976	Multilateral	Nominal
Morgan Guaranty (M-G15n)	15	1980	Bilateral (trade in manufacturers)	Nominal
Chicago Fed (7-Gn)	16	Moving average, 12 quarters	Bilateral	Nominal
IMF effective (IMF)	17	1972 (years through 1974); 1977 (years 1975 on)	Multilateral (Multilateral Exchange Rate Model)	Nominal
Atlanta Fed (ATLANTA)	18	1984	Bilateral	Nominal
OECD effective (OECD)	22	Moving average, annual	Bilateral (double-weighted, based on manufactured goods production and trade)	Nominal
Dallas Fed (X-131)	131	Moving average, annual	Bilateral	Nominal
Federal Reserve Board (FRB-TWDr)	10	1972-1976	Multilateral	Real, CPI-based
Morgan Guaranty (M-G15r)	15	1980	Bilateral (trade in manufacturers)	Real, wholesale prices of manufactured goods, excluding food and fuels
Chicago Fed (7-Gr)	16	Moving average, 12 quarters	Bilateral	Real, CPI-based
Morgan Guaranty (M-G40)	40	1980	Bilateral (modified to take into account U.S. competitiveness in foreign markets for trade in manufacturers)	Real wholesale prices of manufactured goods, excluding food and fuels
Dallas Fed (RX-101)	101	Moving average, annual	Bilateral	Real, CPI-based
Minimal (MIN_n)	5	Moving average, 12 quarters	Bilateral	Nominal
Minimal ($MINr_c$)	5	Moving average, 12 quarters	Bilateral	Real, CPI-based
Minimal ($MINr_w$)	5	Moving average, 12 quarters	Bilateral	Real, wholesale prices of manufactured goods excluding food and fuels

sis presented later, uses a regional grouping technique although it retains bilateral trade weights.

Morgan Guaranty and the OECD have recently adopted a modified approach to the bilateral weighting scheme that attempts to take into account third-country interactions. In effect, they use a double weight, first determining a measure of the competitiveness of the dollar against other major competitors in each

Table 3
Trade weights by index

Index name[1] *(trade-weight period)*	Canada	Japan	Western Europe	Pacific rim developing countries[2]	Other	Total
FRB-TWD nominal and real (1972-76)	0.091	0.136	0.773	—	—	1.000
M-G15 nominal and real (1980)	0.303	0.232	0.441	—	0.024	1.000
7-G[3] nominal and real (1985)	0.298	0.215	0.322	0.144	0.021	1.000
IMF nominal (1977)	0.203	0.213	0.535	—	0.049	1.000
ATLANTA nominal (1984)	0.288	0.213	0.298	0.157	0.044	1.000
OECD[3] nominal (1985)	0.287	0.337	0.363	—	0.013	1.000
M-G40 real (1980)	0.207	0.185	0.381	0.089	0.138	1.000
RX-101[3] real (1985)	0.210	0.171	0.253	0.142	0.224	1.000
X-131[3] nominal (1985)	0.207	0.168	0.252	0.137	0.236	1.000
MIN[3] nominal and real (1985)	0.305	0.219	0.328	0.148	—	1.000

[1] The published indexes are ordered by the number of countries (low to high) included in the index.
[2] Includes one or more of the following countries: Taiwan, South Korea, Hong Kong, China, Singapore, Indonesia, Malaysia, Thailand.
[3] The trade weights for these indexes change over time. The weights shown are for 1985.

specific foreign market in the index and then averaging these weights in proportion to U.S. bilateral trade with those markets. Morgan Guaranty uses this procedure with its 40-country real index.[4]

The structure of world trade is constantly changing

Another factor that must be taken into account in the weighting scheme is the selection of an appropriate base period upon which the index weights are set. The worrisome nature of this issue centers on the perennial index number problem of the reliability of an index if the economic structure underlying the index is changing while the weighting mechanism is fixed in time.[5] Nonetheless, most of the aggregate dollar indexes in the literature utilize fixed-weight bases. For some of the indexes the bases are periodically updated so as to utilize recent weights that more accurately reflect the current trade structure. Still these suffer from the structural change distortions imposed by longer-term analysis.

Indexes developed at the OECD and more recently at the Federal Reserve Banks of Chicago and Dallas have approached this issue by adopting moving weights, but not without some cost. While an accounting of the influence of structural change on exchange rates over time is realized, a moving weight makes it more difficult to interpret period-to-period changes. The analytical advantage of a constant and known frame of reference is lost.

A nominal or a real index

The third major hurdle that confronts the construction of an aggregate exchange rate index is the issue of relative changes in price levels between countries. An exchange rate is a measure of the nominal "price" of one currency in terms of another. In the short term a change in the relative price between two currencies does not necessarily reflect an equivalent divergence in the economic relationships between those countries. When the price relationship between currencies is changing, the relationships between other economic variables—real and nominal—are also changing, but not necessarily in tandem. Consequently, an understanding of the real economic impact of a change in exchange rates also requires an understanding of what is happening in the real sectors.

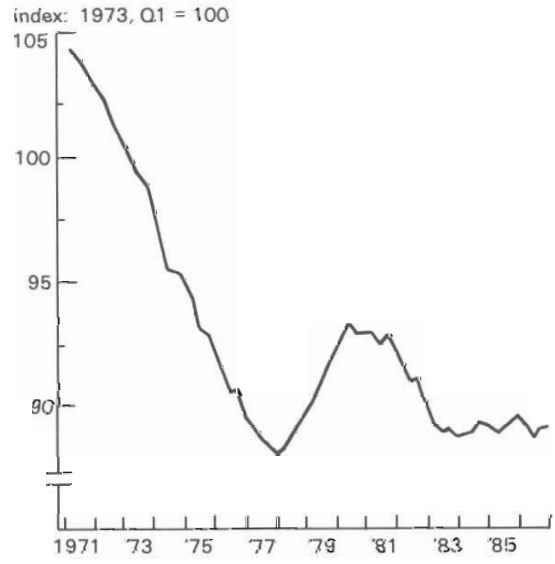
During any given period of time it is only by coincidence that the relative change in inflation for any two countries changes in proportion to the observed change in the nominal exchange rate. Thus, a measure of the "real" economic consequences of a relative change in an exchange rate requires that the nominal exchange rate be adjusted to take into account the divergence in real developments.

Those aggregate exchange rate indexes that have incorporated real adjustments have typically used relative price levels between countries as the adjustment factor. A real adjustment factor based on the relative change in prices has several advantages, not the least of which is the availability of data. In a market economy prices incorporate, albeit indirectly, a broad spectrum of real and nominal economic forces. To the extent that components related to price change (due to advances in productivity, quality change, inflation, and so forth) can be isolated to accurately identify the non-real influences on the economy, a country's price index is a useful tool in the measurement of the progression of relative economic developments between countries.

Consider what relative price adjustments mean in terms of the impact on exchange rates. If U.S. prices are declining relative to prices abroad (exchange rates remaining the same) foreign buyers will be able to buy more U.S. goods for a fixed amount of foreign currency. Furthermore, because U.S. goods are less expensive relative to foreign goods U.S. buyers will tend to substitute U.S. goods for foreign goods. In this sense, the relative decline in U.S. prices is equivalent in its effect to a depreciation of the dollar. The real economic impact during a period when exchange rates are moving depends on more than just the nominal change in exchange rates.

In an environment where the dollar is depreciating relative to other currencies and at the same time U.S. prices are falling relative to prices abroad—a pattern observed during 1971-1977 (see Figure 1)—the nominal depreciation understates the real depreciation. In an exchange rate/inflation relationship that economists think of as more "normal," such as during 1978-1980, the dollar was continuing to

Figure 1
U.S. consumer prices relative to 16 foreign countries[1]



[1] Australia, Belgium-Luxembourg, Canada, France, Hong Kong, Italy, Japan, Netherlands, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom, and West Germany.

depreciate, but U.S. price levels were moving up, relative to price levels abroad. In this case the increase in the U.S. relative price level was sufficient to offset the nominal depreciation in the dollar. Thus, the real value of the dollar was appreciating.[6]

In sum then, a nominal measure of the change in an exchange rate may not provide the whole story, indeed possibly not even an accurate story. Under conditions where there is a divergence in price performance between countries the failure to adjust nominal exchange rates for the divergence leads to a distortion of the aggregate index. Clearly, however, so long as the relative price conditions between economies remain stable, whether the index is nominal or real doesn't make any difference. Under such conditions a nominal index is a satisfactory proxy for a real index.

All price measures are not the same

What is the appropriate price index? In our view the answer depends as much on the question being asked as the specifics of the price index. We contend that questions dealing with the macroeconomic relationships of the exchange rate as they relate to broad scale competitive factors, such as the relative cost of doing business in one economy as compared with another, might appropriately lean toward the use of a general price indicator. A general index, such as a GNP deflator or consumer price index (which we use in the 7-Gr index), that reflects overall price performance can fulfill this requirement.

On the other hand, questions that are strictly concerned with merchandise trade patterns might best be addressed using a price measure that is more closely aligned with internationally traded goods and that does not include a services component, such as the wholesale/producer price measures or export/import prices. (Morgan Guaranty argues for the use of wholesale/producer prices—excluding the volatile foods and fuels categories—as the appropriate deflator.) From a practical point of view, price data are most readily available by country for the consumer price index. Indeed, as the number of countries included in an index increases, one is forced toward the use of the CPI.

Apart from the issue of which price index to use, price adjustments in general have other difficulties. They face problems of comparability of coverage across countries as well as within countries. In addition to such measurement problems, we are faced with bias introduced by price/wage distortions resulting from government action—such as price controls and administered prices. Thus, real adjustments to the aggregate measures of the exchange rate must be interpreted with some caution.

This caveat applies in particular to those countries where the question of data reliability is a major concern and where inflation rates are comparatively high, as in much of Latin America. Measurement error potentially has serious implications under these conditions. A hypothetical measurement error of 10 percent, for example, may be acceptable from an empirical point of view for countries with similar and comparatively low rates of inflation, or where inflation rates hold reasonably stable.

The implications are quite different, however, if the same degree of measurement error is present and one country's prices are increasing at, say, a 5 percent rate while another country's prices are advancing at a 150 percent rate. The magnitude of the error, by itself, for the high inflator could swamp several times over the change in the rate of inflation for the low inflator.

In dealing with this issue economists are faced with an environment in which several important trading partners of the United States fall into this category of high inflation countries—Mexico and Brazil in particular among major U.S. trading partners. Mexico's average annual inflation rate rose 66 percent between 1980 and 1986 and Brazil's average annual inflation rate rose 152 percent during the same period. The comparable figures for the United States and the major trading countries of Western Europe were 5 percent and 6 percent, respectively (see Table 1, column 5).

Thus, the analyst faces a dilemma. Several high inflators are important trading partners of the United States. At the same time, the inclusion of high inflators in an aggregate exchange rate index may present serious analytical problems. In a nominal index one or two high inflators, even those with relatively small amounts of U.S. trade, exert considerable distortion on the movements of the index. Under such conditions a real adjustment is requisite. While the result of the adjustment

justment must be viewed with considerable caution, still, one must expect that the relative-price-adjusted index, though it might be flawed by measurement error, would be superior to the unadjusted nominal index.

The indexes: Are they different with respect to the dollar's value?

The first step in our statistical analysis of the 12 indexes is based on the pair-wise correlation of the indexes—both on levels and on growth rates. Given the construction of the indexes we expected that the indexes would be highly correlated in terms of levels, but that in itself would not be very enlightening. On the other hand, a high degree of correlation between the indexes for both levels and growth rates would constitute a substantially stronger statement as to the similarity between the various indexes.

Of the 12 indexes included in this study, which we refer to generically as "actual" indexes, a first examination shows one index stands out from the others. The Dallas X-131, a nominal index, diverges from the pack early in the series (see Figure 2).

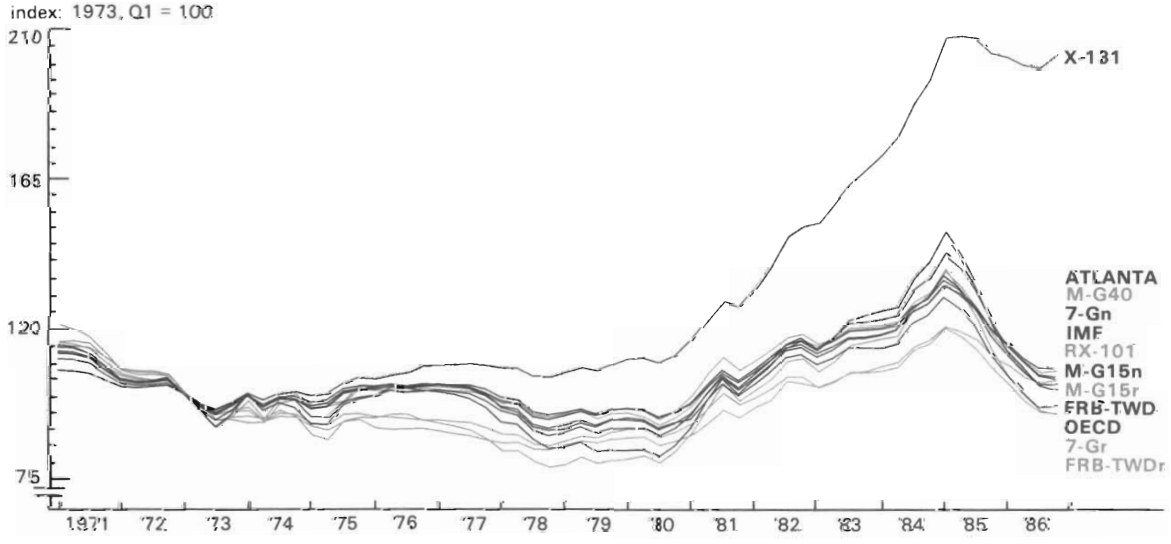
The X-131 bottomed out in 1973, shortly after the dollar floated, in contrast with the other 11 indexes where the dollar trough occurred during the 1978-1980 period. Based on this index, the deterioration in the competitive position i.e., the rise, of the dollar began in the third quarter of 1973, not the late 1970s-early-1980s, and extended to the first quarter of 1985 when the dollar peaked for all 12 of the indexes. Following the 1985 peak the X-131 showed only a slight decline as compared with substantial declines recorded by the other indexes.

The difference in the pattern traced by the X-131 index also shows up in the correlations between the various indexes. The correlations between the X-131 and the other 11 indexes, in both levels and growth rates, are relatively low (see Tables 4 and 5).

This pattern is not unique to the X-131 but rather is common to those indexes that include the currencies of countries with high and divergent rates of inflation, and for which no adjustment is made for relative rates of inflation. Morgan Guaranty Trust reports in its November/December 1986 issue of *World Financial Markets* that its nominal 40-country broad index (not published), which serves as the base for its real 40-country broad index, suffers from the same inflation-induced distortions that we outlined earlier in the sections on nominal/real indexes and price measures.

Indeed, we found the patterns traced by the X-131 and the Morgan Guaranty 40-country nominal (not formally included in

Figure 2
Trade-weighted dollar indexes
(real indexes in color)



this analysis) indexes to be similar, with correlation coefficients for index levels and growth rates at 0.996 and 0.975, respectively. With respect to the number of countries included in a nominal index, Morgan Guaranty notes that "... the currency list could be slashed to the top 20 U.S. trade partners, including LDCs, and still provide much the same reading on the dollar." On this point they conclude: "Once these high-inflation developing-country exchange rates are included in a dollar index, a purely nominal construct loses all utility for gauging U.S. trade competitiveness."[7] We concur. At best, we do not know how to interpret such an index; at worst, it is misleading.

The minimal index: A base for analysis

As noted above, simple correlations between the various indexes indicate a high degree of similarity of the indexes, one with another. From Tables 4 and 5 we see that the coefficients between the levels of the various nominal indexes (excluding X-131) are 0.960 and above. Importantly, in this connection, the correlations in terms of growth rates are also high—0.952 or higher. Even the relationships between the nominal and real indexes tend to be respectable. Interestingly, the correlations between the real indexes are less uniformly high, a fact that seems to be related to the form of the deflators—a point we will discuss in more detail later.

The indexes we are now dealing with range in size, in terms of countries in the base, from 10 to 22 for the nominal indexes and 10 to 101 for the real indexes. It appears that the number of countries might not be a major factor in the performance of the index, in so far as how closely they are related one to another.

This raises an interesting question. How much information, in terms of the correlation between indexes, would we lose by constructing a "minimal" index incorporating, say, only five currencies? Would such an index be able to account for most of the variation observed in the more detailed indexes during the past 15 years?

The selection of five countries is not an arbitrary number for the construction of a minimal index. Indeed, the results of the previous work suggests that the source of the variability in the indexes is localized in a few geographical regions—Europe, the Pacific rim, and Canada. Thus, we contend that a five-country minimal index (which we refer to as the MINn [nominal], the $MINr_c$ [real, consumer price-adjusted] and the $MINr_w$ [real, wholesale price-adjusted—constructed to explore in more detail the Morgan Guaranty real indexes]), actually has reasonably strong theoretical underpinnings.

Eight Western European currencies have been closely tied to each other in the European Monetary System (EMS) for much of the 1971-1986 period. One major currency out of this area could reasonably be expected to represent the general currency movements of the region. Because of the importance of the German mark as an international currency we selected it as the representative currency for continental Europe, with the trade weights applicable to the sum of U.S. bilateral trade with the eight Western European countries included in the 7-G indexes (Belgium-Luxembourg, Germany, France, Italy, the Netherlands, Spain, Sweden, and Switzerland—not all are members of the EMS).

The four remaining currencies included in the minimal index are the U.K. pound (a major international currency and the fifth largest trade partner of the United States), the Canadian dollar (the largest trade partner of the United States), the Japanese yen (a major international currency and the second largest trade partner of the United States), and the Korean won (the seventh largest trade partner of the United States). The won is included to represent the changing composition of U.S. trade with the Pacific rim countries. The trade weight applicable to the won is based on the sum of U.S. bilateral trade with South Korea, Taiwan, Hong Kong, and Singapore. (The five countries that make up the minimal index accounted for 51 percent of the dollar value of U.S. merchandise trade in 1986.)

The mechanics of the nominal minimal index construction are the same as for the Chicago Fed's 7-Gn index. The real consumer price-adjusted index uses the CPI of the United States relative to the CPIs of the five minimal index countries as the deflators. The real wholesale price-adjusted index uses the WPI (excluding food and fuel) of the United States relative to the WPIs (excluding food and fuel) of the five minimal index countries as its deflator.

The six actual nominal indexes were compared with the nominal minimal index. As indicated in Table 6 the actual indexes recorded correlations with the minimal index that were all above 0.977 in levels and 0.958 in growth rates.

Not surprisingly, the five real indexes were not as strongly correlated with the nominal minimal index, having values above 0.917 in levels and 0.881 in growth rates. However, when the minimal index was adjusted for relative price changes, using consumer prices or wholesale prices, the correlations improved. The correlations between the real indexes (three CPI-based and two WPI-based) against the corresponding real minimal indexes (CPI- or WPI-based, respectively) are above 0.969 in levels and 0.937 in growth rates.

Thus, the actual indexes are highly correlated with the similarly based minimal index. Correlation analysis indicates the strength of the linear relationship between the two series. A way of graphically displaying the difference between the minimal and actual series, above and beyond a linear relationship as noted above, is to modify one of the series using a linear transformation. Graphically displaying the minimal series against the transformed series will highlight whether there is any difference beyond this simple linear transformation. We chose to transform the actual trade-weighted dollar series using the slope and in-

Table 4
Correlation coefficients between the indexes—levels

	Nominal indexes							Real indexes				
	FRB-TWD	M-G15n	7-Gn	IMF	ATLANTA	OECD	X-131	FRB-TWDr	M-G15r	7-Gr	M-G40	RX-101
FRB-TWD	–											
M-G15n	0.9953	–										
7-Gn	0.9795	0.9889	–									
IMF	0.9952	0.9975	0.9915	–								
ATLANTA	0.9845	0.9935	0.9965	0.9951	–							
OECD	0.9833	0.9866	0.9602	0.9769	0.9682	–						
X-131	0.7632	0.7796	0.8417	0.8037	0.8918	0.6737	–					
FRB-TWDr	0.9606	0.9520	0.9136	0.9527	0.9637	0.9576	0.6366	–				
M-G15r	0.9701	0.9801	0.9790	0.9792	0.9812	0.9689	0.7562	0.9440	–			
7-Gr	0.9109	0.9087	0.8641	0.9083	0.9607	0.9198	0.5795	0.9851	0.9117	–		
M-G40	0.9707	0.9793	0.9795	0.9814	0.9903	0.9576	0.7962	0.9398	0.9906	0.9112	–	
RX-101	0.9067	0.9016	0.8701	0.9116	0.9460	0.8782	0.7060	0.9567	0.8844	0.9656	0.9129	–

Table 5
Correlation coefficients between the indexes—growth rates

	Nominal indexes							Real indexes				
	FRB-TWD	M-G15n	7-Gn	IMF	ATLANTA	OECD	X-131	FRB-TWDr	M-G15r	7-Gr	M-G40	RX-101
FRB-TWD	–											
M-G15n	0.9732	–										
7-Gn	0.9676	0.9955	–									
IMF	0.9867	0.9902	0.9858	–								
ATLANTA	0.9576	0.9966	0.9943	0.9816	–							
OECD	0.9518	0.9878	0.9861	0.9761	0.9884	–						
X-131	0.8832	0.9074	0.9033	0.9025	0.9126	0.8779	–					
FRB-TWDr	0.9854	0.9651	0.9597	0.9777	0.9509	0.9441	0.8837	–				
M-G15r	0.8876	0.9198	0.9192	0.9101	0.9133	0.9093	0.8358	0.9910	–			
7-Gr	0.9297	0.9696	0.9729	0.9563	0.9725	0.9610	0.9007	0.9580	0.9112	–		
M-G40	0.8507	0.8878	0.8904	0.8745	0.8866	0.8811	0.8448	0.9513	0.9849	0.8829	–	
RX-101	0.8688	0.9084	0.9054	0.8967	0.9072	0.8924	0.9343	0.9060	0.8588	0.9488	0.8633	–

Table 6
Correlation coefficients between the actual indexes and the minimal indexes

	Nominal indexes						Real indexes				
	FRB-TWD	M-G15n	7-Gn	IMF	ATLANTA	OECD	FRB-TWDr	M-G15r	7-Gr	M-G40	RX-101
Levels											
MINn	0.9903	0.9948	0.9857	0.9943	0.9934	0.9771	0.9583	0.9812	0.9215	0.9809	0.9173
$MINr_c$ CPI-adjusted	–	–	–	–	–	–	0.9880	–	0.9943	–	0.9687
$MINr_w$ Wholesale/producer price-adjusted	–	–	–	–	–	–	–	0.9918	–	0.9911	–
Growth rates											
MINn	0.9580	0.9787	0.9834	0.9664	0.9791	0.9675	0.9581	0.9121	0.9701	0.8812	0.9035
$MINr_c$ CPI-adjusted	–	–	–	–	–	–	0.9499	–	0.9875	–	0.9371
$MINr_w$ Wholesale/producer price-adjusted	–	–	–	–	–	–	–	0.9529	–	0.9495	–

tercept coefficients generated by least squares regression analysis.

We used the nominal and real minimal indexes as dependent series and regressed pairwise the respective nominal and real indexes being examined. We then plotted on the same graph the minimal index and the transformed actual series using the regression coefficients to perform the transformation. The results of this exercise are presented in Figures 3 to 7. In each of these graphs the bold line represents one of the minimal indexes. If the hypothesis that there is no substantial difference between the indexes holds, one would expect the indexes to trace similar and tight patterns over time. To the degree the transformed values of the actual indexes differ from the minimal index this suggests that the series are different. In Figure 3 the nominal minimal index, along with the transformed values of the actual indexes, both real and nominal, seem to track one another fairly well. Some of the real indexes tended to be either the furthest above (1971-1973) or below (1973-1974, 1976-1978, 1983-1985) the nominal minimal index.

The distinction between the real and nominal indexes is clearly indicated in Figures 4 and 5. These figures graphically illustrate the close relationship between the nominal minimal index and the transformed values of the actual nominal indexes (Figure 4) and the somewhat different path of the nominal minimal and the real indexes (Figure 5). The lower correlation of the Morgan indexes with the other real indexes is borne out in Figures 5 and 6 as these indexes, somewhat surprisingly, tend to stay with the nominal minimal index during the 1970s (Figure 5) and depart from the real consumer price-adjusted minimal index (Figure 6). Figure 7 plots the relatively close path followed by the consumer price-adjusted real minimal index and the transformed values of the three real indexes that use the CPI as an adjustment factor—FRB-TWDr, 7-Gr, and RX-101. As indicated in Table 6, lines 2 and 5, in general the correlations between these

Figure 3
Nominal minimal index and the linear transformation of the nominal and real indexes

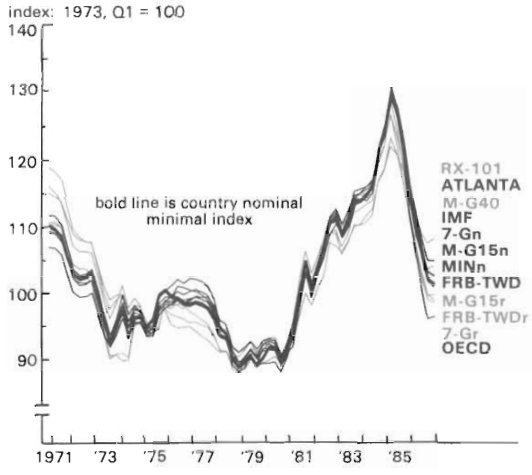


Figure 4
Nominal minimal index and the linear transformation of the nominal indexes

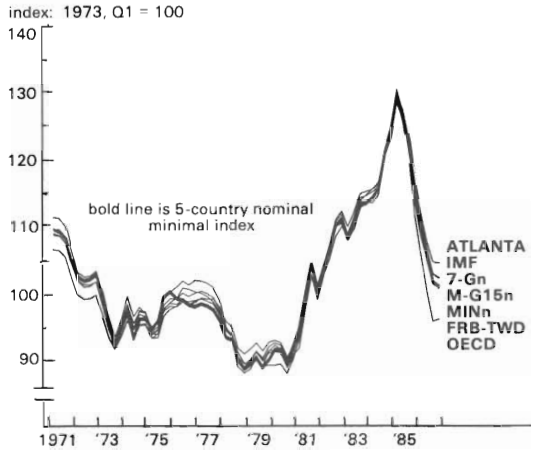


Figure 5
Nominal minimal index and the linear transformation of the real indexes

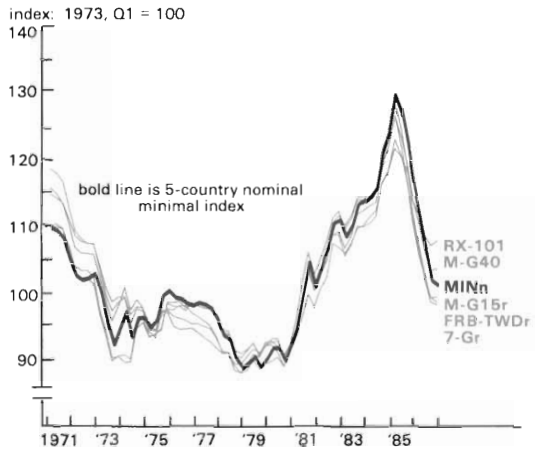


Figure 6
Real minimal index (CPI-adjusted) and the linear transformation of the real indexes

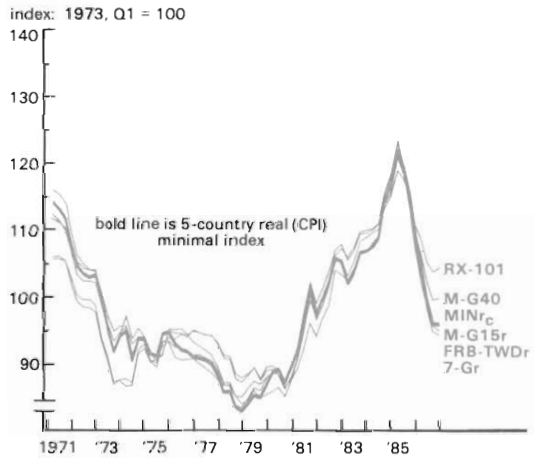
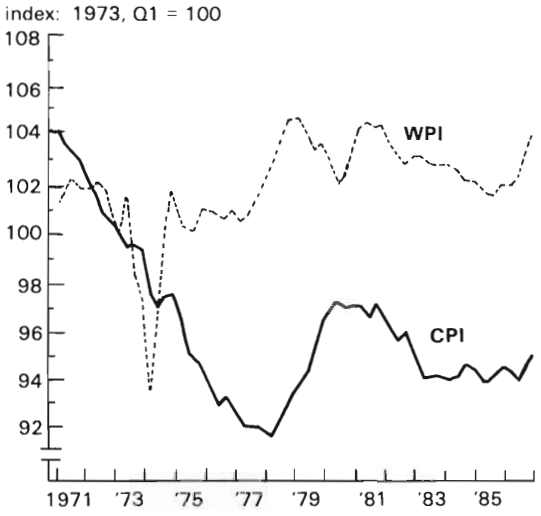


Figure 7
Real minimal index (CPI-adjusted) and the linear transformation of the CPI-adjusted real indexes

three indexes and the minimal index improved in both levels and growth rates when the minimal index was adjusted for consumer price changes. The diverging index during late 1985 and 1986 is the RX-101. In Figure 6 we see both broad indexes, the RX-101 and the M-G40, diverging from the pack during 1986.

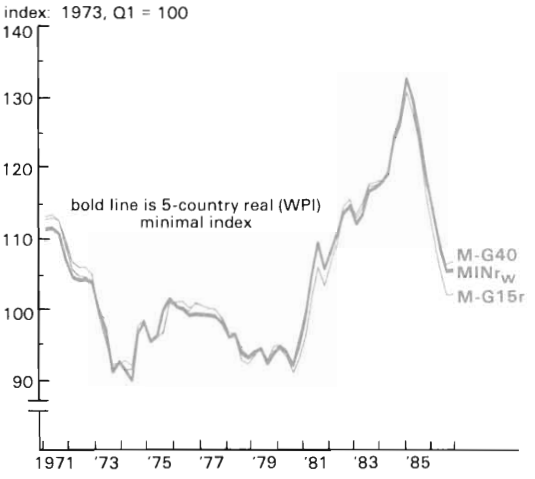
We expected that in large part this difference with respect to the Morgan Guaranty indexes might be due to the use of different deflators in the minimal index. Recall that Morgan uses relative wholesale/producer prices for manufactured goods, excluding food and fuels (for those countries for which those series are available and consumer prices for the others). Cursory examination of the paths traced by relative CPIs and WPIs (see Figure 8) during the 1971-1986 period indicates that some

Figure 8
U.S. consumer and wholesale prices relative to 5 foreign countries[1]



[1]Canada, Japan, South Korea, United Kingdom, and West Germany.

Figure 9
Real minimal index (WPI-adjusted) and the linear transformation of the WPI-adjusted real indexes



distinction should be expected between dollar indexes deflated by the two forms of deflator. During the period 1971-1977 U.S. consumer prices declined relative to those abroad. Relative U.S. prices trended upward in the late 1970s and early 1980s, but from 1983 through 1986 relative CPIs remained stable. Throughout this period, relative wholesale/producer prices appeared to vary around a constant level. Thus, one would expect that a wholesale price-adjusted index would perform similarly to a nominal index, that is, an index that was unadjusted or adjusted using a multiplicative factor of one.

To test this supposition we reformulated the deflator of the real minimal index, replacing relative consumer prices with the relative wholesale prices used by Morgan (see Figure 9). The results of this modification, shown in Table 6 (lines 3 and 6), support our contention. The correlation coefficients between the relative price adjusted minimal indexes and the Morgan real indexes increase. The correlation between the index levels of the MINn and the M-G15r and M-G40 were both 0.981, but increased to 0.992 and 0.991, respectively, when the MINn was adjusted using relative wholesale prices ($MINr_w$). A similar increase was also noted in the correlations between the growth rates of the indexes.

Recovery-ratios

Since the exchange value of the dollar peaked and began to decline in the first quarter of 1985 there has been considerable emphasis in the literature on the magnitude of that decline. The magnitude is typically expressed as a percentage decline in the value of the dollar against a specific currency or the percentage decline of a specific aggregate dollar exchange rate index. Percentage change measures of the dollar's decline from the first quarter of 1985 through the fourth quarter of 1986 result in substantially different answers, depending upon which index is used. These differences have been a major contributing factor in the recent interest in aggregate exchange rate indexes.

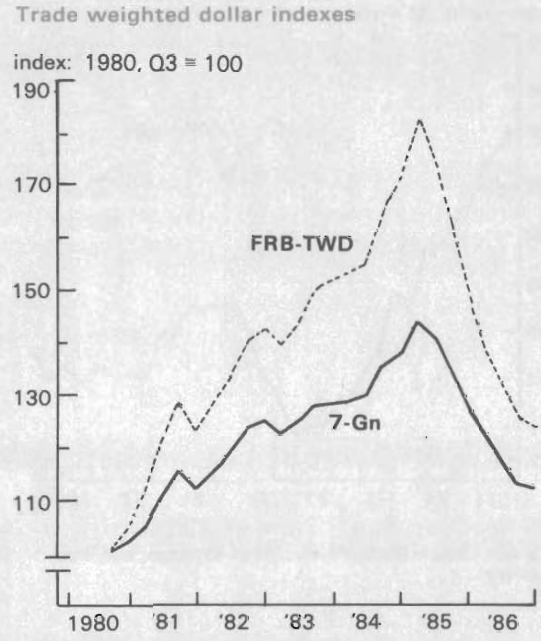
Of the large number of indexes we examined, all but two recorded percentage declines in a broad range of 20 percent to 38 percent (logarithmic basis) during the period 1985-Q1 to 1986-Q4. (Two indexes diverge from the others on the low end, with declines ranging from 2.4 percent to 14.3 percent for the X-131 and RX-101, respectively.)

We contend that any comparison of these aggregate exchange rate indexes that looks only at the measured declines in percentage terms since the first quarter of 1985 offers an inade-

Recovery-ratios

The recovery-ratio for any specific aggregate exchange-rate index is defined as the recorded decline in the index since the peak as a ratio of the previous recorded increase from the trough. The specific recovery-ratio we deal with is the change in an aggregate exchange-rate index during 1985-Q1 to 1986-Q4 as a ratio of the change in the index between 1980-Q3 and 1985-Q1. The difference in construction of the indexes contribute to differences in scale between the indexes. Over time the indexes will also show different degrees of variability. But as our linear transformation analysis indicated, a great deal of the apparent difference between the various indexes is little more than scale difference.

Thus, to note that one index declines, for example, by 38 percent while during the same period another index declines by 24 percent is a noninteresting tidbit of information if we do not know the historical track of the two indexes. During the previous five years had the first index increased 60 percent, or 37 percent, or not at all? By the same token, had the second index also increased 60 percent, or 37 percent, or not at all?



In fact, the indexes in this example, the FRD-TWD and the 7-Gn, respectively, (see figure), increased during the first half of the 1980s by 60 percent and 37 percent, respectively, and their subsequate, if not a distorted, view of recent exchange rate movements. While comparisons of such measures may be "interesting," standing alone they are void of economic content. The magnitude of the decline for any specific index relative to another index, as a statement about international competitive developments, is relevant only in terms of the previous recorded increases for those two indexes. Otherwise, we are faced with a "scale" problem between indexes the importance of which we are unable to gauge.

We are convinced that if the issue is the international competitiveness of a currency, as reflected by an aggregate index, a longer term view is required in order to place the issue in proper perspective. Specifically, we suggest that the 1985-1986 depreciation of the dollar be viewed in relation to the 1980-1985 appreciation—a relationship we have called the "recovery-ratio" (see box).

Of the 15 aggregate dollar indexes (including the three minimal indexes), five nominal indexes and one real index (FRB-TWD, M-G15n, 7-Gn, IMF, MINn, and $MINr_w$) recorded tight recovery-ratios, between 0.67 and 0.72 (see Table 7). Four of the real indexes recorded tight but somewhat higher recovery-ratios. The FRB-TWDr, M-G15r, 7-Gr, and $MINr_c$ were clustered at 0.74 and 0.76. The OECD's nominal index recorded a recovery-ratio of 0.82. This large value for the recovery ratio is probably explained by the OECD's significantly larger weight on the Japanese yen.[8] Two of the remaining four indexes, M-G40 and ATLANTA (real and nominal, respectively), recorded somewhat lower, but

quent declines during the past two years—38 percent and 24 percent, respectively—were such that their recovery-ratios (that is, the declines in the two indexes as ratios of their respective previous increases) are virtually identical—0.70 for the FRB-TWD and 0.69 for the 7-Gn. Clearly this result would not have been expected from comparing only the post-1985-Q1 percentage declines for these two indexes. The table includes the typically reported percentage declines (column 4) as well as the recovery-ratios (column 5) for the twelve indexes plus the minimal indexes constructed for this paper.

Recovery-ratio of the indexes[1]

Index	Index level 1980, Q3	Index high 1985, Q1	Recent index value 1986, Q4	Percentage decline from 1985, Q1 to 1986, Q4[2]	Recovery-ratio
FRB-TWD	81.52	149.33	102.13	−38.0	0.70
M-G15n	89.74	136.42	103.71	−27.4	0.70
7-Gn	93.24	134.97	106.10	−24.1	0.69
IMF	87.72	143.06	105.51	−30.4	0.68
ATLANTA	93.63	133.41	108.59	−20.6	0.62
OECD	90.22	129.92	97.27	−28.9	0.82
X-131	109.83	207.27	202.37	−2.4	0.05
MINn	89.99	129.99	101.40	−24.8	0.71
FRB-TWDr	78.97	137.74	94.40	−37.8	0.74
M-G15r	92.00	136.98	103.21	−28.3	0.75
7-Gr	86.57	120.08	94.60	−23.8	0.76
M-G40	90.34	133.02	107.22	−21.6	0.60
RX-101	84.30	120.60	104.50	−14.3	0.44
$MINr_c$	87.42	122.26	96.36	−23.8	0.74
$MINr_w$	92.01	132.38	105.35	−22.8	0.67

[1] All indexes are normalized to 100.0 as of 1973, Q1.

[2] Logarithmic basis: $100 \cdot \ln \left[\frac{\text{(index value 1986, Q4)}}{\text{(index value 1985, Q1)}} \right]$

not out-of-range, recovery-ratios of 0.60 and 0.62, respectively.

Not surprisingly, the Dallas X-131 index recorded a ratio of only 0.05. The Dallas RX-101 index recorded a substantially higher recovery-ratio than did the nominal, but at 0.42 it remained well below that of the other indexes, indicating that, despite the rather high correlations noted earlier, this index is likely a somewhat different series than the other real indexes.

Conclusion

In the wake of floating exchange rates, a broad spectrum of exchange rate relationships has unfolded. During the past 15 years the exchange value of the dollar has varied dramatically and in contrary fashion against some currencies and has varied hardly at all against others. Numerous diverse attempts have been made by researchers intent on exploring what has "truly" happened to the international value of the dollar. If that measure can be accurately formulated then possibly we can more firmly grasp an understanding of the competitive impact on the U.S. economy of changes in the exchange value of the dollar. In this paper our exploration has been more modest. We examined 12 published indexes of the dollar's international value, asking a simple question. Are these indexes different?

The formulations of the indexes are indeed different. The number of countries included in the indexes and the schemes for determining how much importance should be placed on each currency vary widely. Five in-

Table 7
Recovery-ratio of the indexes

Index	Recovery-ratio
FRB-TWD	0.70
M-G15n	0.70
7-Gn	0.69
IMF	0.68
ATLANTA	0.62
OECD	0.82
X-131	0.05
MINn	0.71
FRB-TWDr	0.74
M-G15r	0.75
7-Gr	0.76
M-G40	0.60
RX-101	0.44
$MINr_c$	0.74
$MINr_w$	0.67

dexes take into account relative rates of inflation. Seven do not.

But, do the indexes differ in their behavior? Not much. Indexes that include countries with large rates of inflation and where adequate adjustment for that inflation is not incorporated are indeed different from the pack. In our view that difference is based on flawed conceptual construction. Those broad indexes that do attempt to account for the inflation issue by incorporating a relative price adjustment track considerably closer to the pack, but we remain concerned about the measurement bias in the relative price statistics, particularly for the high-inflation countries and those where prices are administered. Apart from that difficulty the indexes are remarkably similar. The indexes are highly correlated in terms of levels and growth rates. Furthermore, in most cases their recovery-ratios during the 1980-1986 period are similar.

One further distinction needs to be drawn—that is, with respect to deflators used to adjust the nominal indexes. Our analysis suggests that serious consideration be given to the rationale for the selection of the deflator series, as some difference appears between the CPI and WPI (excluding food and fuel) series—total WPI (not reported in detail in this analysis) provides yet another pattern. As we noted earlier, we think that the appropriate deflator is dependent on the question of interest; we do not believe that there is a "right" adjustment index for all purposes.

In summary, with modest exception, the more recently constructed indexes of the dollar's international value differ little from those constructed a decade ago. We suggest that if additional profitable research is to be done in this area it will likely be necessary to look at aggregate exchange-rate measures defined by trade sector (or industry grouping) by country.[9] In any case, the new aggregate exchange-rate indexes do not appear to provide measures of the international value of the dollar that shed much additional light on questions pertaining to *past* developments in the U.S. trade account.

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[1] In fact, the basis for an aggregate dollar-value index existed prior to the dollar's devaluation in 1971. The International Monetary Fund created a unique form of international reserve asset called Special Drawing Rights (SDRs), the first allocation of which was made in 1970. The SDR was initially valued in terms of gold. In July 1974 the IMF abandoned gold as the basis for valuation and adopted a weighted average of the currencies of 16 countries (including the United States) to define the SDR. In 1981 the number of country/currencies used to define the SDR was reduced to five (the French franc, German mark, Japanese yen, U.K. pound, and U.S. dollar). A problem with using the SDR as an aggregate index, apart from the shift in country composition, is that the U.S. dollar weighs heavily in the SDR's composition.

[2] A point that should be obvious but one that has been too often forgotten or ignored: Until the depreciation in the exchange value of the dollar translates into increases in import prices, and consequently a depressant on the demand (as determined by the elasticity of demand in the relevant markets) for imports there is no reason to expect the decline in the exchange value of the dollar by itself to result in slower (or a reversal in) import growth. This translation—from a change in exchange rates, to a price change for goods, to a change in demand for goods—occurs with a substantial lag. The length of the lag is determined in large part by the conditions specified in previous contracts (the currency of the contract and the duration of the order) and the degree to which foreign producers and exporters and domestic importers and retailers are willing to cut profit margins in order to maintain market share, or the degree to which domestic producers choose to match the price increases of competing imports. A parallel argument can be drawn with respect to the foreign currency cost of

U.S. goods and services and the eventual impact on U.S. exports.

[3] An analytically more pleasing weighting scheme would weight bilateral exports and bilateral imports, by country, separately. This distinction might be of special interest where there is a large discrepancy between exports and imports.

[4] Work by Morgan Guaranty published in *World Financial Markets*, August 1983 outlines this methodology which accounts for third-country effects. They noted at that time that while they believed the procedure to be "conceptually preferable" to a straight bilateral weighting scheme they chose not to make that modification on their long-standing 15 country index. It is, however, incorporated in their 40-country index.

[5] Another index issue that we do not address in this article concerns the mathematical construction of the index—specifically the use of arithmetic or geometric averages. Most of the major indexes (all of those included in this analysis) use a geometric average. A primary exception to this approach among the published indexes is a broad-based index, which uses arithmetic averaging, reported in the *Treasury Bulletin* by the U.S. Department of the Treasury. For more detailed discussions of the geometric/arithmetic averaging issue see: the *Federal Reserve Bulletin*, August 1978, p. 700 and Michael T. Belongia, *Review* of the Federal Reserve Bank of St. Louis, January 1986, p.9.

[6] See Hervey and Strauss, *Economic Perspectives*, March/April 1987, pp. 29-31.

[7] See *World Financial Markets*, Morgan Guaranty Trust Company of New York, October/November 1986, pp. 14-19. These distortions, no doubt, were critical to Morgan Guaranty's decision not to publish their broad-based nominal index. In addition, both recovery-ratios (0.21 for the M-G40 nominal and 0.05 for X-131) are far smaller than for the other indexes and the minimal-index comparisons. Not surprisingly, we conclude that these two indexes are different from the minimal index.

[8] The larger weight on the yen became especially apparent during the post-1985-Q1 period when the U.S. dollar was depreciating rapidly against the yen. During the first half of the 1980s the dollar's appreciation against the yen was modest, by comparison with European currencies, thus the OECD index did not diverge appreciably from the other indexes during that period.

[9] Cox at the Dallas Fed and Rosensweig at the Atlanta Fed have looked at aggregate dollar indexes based on geographic classification (e.g., Western Europe, Pacific rim). Such categorization of the indexes may have significance for analysis of regional trade. Indexes based on specific trade sector/country trading partners would carry this approach a potentially informative one step further.

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