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A New Effective Exchange Rate Index for the Dollar and Its Implications for U.S. Merchandise Trade

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Introduction

One of the most critical problems facing our economy today is the unprecedented size of the foreign-trade deficit. The rapid growth of imports relative to exports since 1980 has been blamed for curtailing the rate of economic expansion in recent years, and is symptomatic of the deteriorating position of some U.S. industries in world markets. Recognition that the trade deficit must be reduced has led to calls for protectionist legislation, as well as to official efforts aimed at encouraging more stimulative economic policies among our trading partners. For the most part, though, hopes for improving the trade imbalance have rested with the depreciation of the dollar in foreign-exchange markets over the past two years.

Since early 1985, the dollar has depreciated sharply against the individual currencies of a number of our major trading partners, with the Japanese yen and the currencies of Europe being the most notable examples. By and large, most conventional measures, or indexes, of the dollar's ***average*** foreign-exchange value are built around this group of currencies. Hence, the unprecedented cumulative depreciation of the dollar relative to these particular currencies formed the basis for widespread predictions that the U.S. balance of trade would improve dramatically in 1986 and 1987.

Unfortunately, a significant improvement in the U.S. balance of trade has yet to materialize. This failure has prompted analysts and policymakers alike to reexamine their interpretations of how far the dollar's average value against a broad group of foreign currencies has fallen during the past two years. The result has been the emergence of a variety of new measures of the dollar's average value in foreign-exchange markets.

For the most part, the newer indexes have two common characteristics. First, they include a broader group of foreign currencies than the more conventional measures, which, for the most part, are built on the currencies of Japan, Europe, and Canada. Second, as a result of the additional currencies they include, the newer measures show much less depreciation in the dollar since early 1985 than the conventional measures depict. The implicit conclusion from these newer indexes, then, is that the U.S. trade balance is not likely to improve as much as might have been expected.

While the efforts at constructing new, broader indexes of the dollar have shed much light on how the dollar's foreign-exchange value has been changing, a number of important questions remain unanswered. The first set of questions involves the specifics of how an index measuring the dollar's average foreign-exchange value should be constructed. The second set has to do with evaluating the usefulness of the indexes for explaining and predicting trade flows. The purpose of this article is to address both sets of questions.

Our analysis is presented as follows. In part I, a new trade-weighted effective exchange-rate index is constructed in both nominal and real terms. The index differs from the traditional indexes by including currencies of more of the United States' principal trading partners (including

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several that recently have become more important U.S. trade partners), and by updating the weights. Any index must be judged by how well it serves the purpose for which it was constructed. We built our index to help explain and predict prices and volumes of U.S. imports and exports. We have found that our index is as good as, and probably better than, the other indexes we tested for these purposes for the time periods that we examined.

Part II develops a model of US. merchandise trade that is designed to capture the effects of changes in the value of the dollar on U.S. export and import prices and quantities. We use this model to compare the usefulness of our exchange-rate index to others in predicting trade prices and quantities, and to show that the magnitude of predicted changes in trade flows is significantly affected by how the dollar index is constructed.

I. Trade-Weighted Effective Exchange Rate Indexes for the Dollar

The Dollar and U.S. Trade: An Overview

One of the more important determinants of U.S. trade flows is the foreign-exchange value of the dollar. An increase in the dollar's nominal foreign-exchange value raises the foreign currency price of U.S. goods sold abroad, and lowers the dollar price of foreign goods sold in the United States. Over time, then, an appreciation of the dollar would be expected to worsen the U.S. balance of trade by lowering foreign demand for U.S. exports and by raising the U.S. demand for foreign goods. A depreciation of the dollar works in the opposite direction, and would be expected to improve the U.S. balance of trade.

A key issue in assessing the impact of changes in the dollar's foreign-exchange value on U.S. trade flows is determining which measures of the dollar and trade to employ. The United States trades many different types of goods and services with a large number of countries, and the dollar's foreign-exchange value can be expressed in terms of any number of more than 150 foreign currencies. While there are many possible versions of the definition of trade flows and the dollar, it is clear that the specific measure of the dollar's foreign-currency price that is selected ought to be motivated by the nature and breadth of trade flows being investigated. For example, in explaining the effects of a change in the dollar's foreign-.exchange value on the flow of certain manufactured goods between the United States and Japan, the most appropriate measure of the dollar may simply be its price relative to the Japanese yen. However, when the scope of analysis is broadened to include additional countries, or a greater variety of goods, a more encompassing measure of the dollar is needed.

Most broad-based inquiries into the relationship between the dollar and trade are built around U.S. exports and imports of merchandise to and from the rest of the world, and a trade-weighted effective-exchange-rate index.' Trade in services is excluded primarily for two reasons. First, the U.S. trade deficit is the result of an overwhelming imbalance in the merchandise component. In 1986, for instance, the total real-trade deficit was about $148 billion.* Of that total, the balance for trade in services was a surplus of nearly $33 billion, while the balance for trade in merchandise was a deficit of just over $181 billion. Consequently, the balance of trade in services has not been high on the agenda of policy concerns. Second, trade in services does not tend to be as responsive to the same set of determinants as trade in merchandise is, particularly when it comes to the exchange rate.[3]

Typically, the exchange-rate index used to explain trends in merchandise trade is, or resembles, one of the well-established indexes, such as the Federal Reserve Board's (FRB), the Morgan Guaranty Trust Company's (MG), or the International Monetary Fund's (IMF).[4] These aggregative measures of the dollar were developed largely in response to the deterioration in the early 1970s of the fixed exchange-rate regime, which was finally abandoned altogether in March 1973. As the dollar's value began to change by varying degrees and in different directions against individual foreign currencies, the need arose for a summary measure, or index, of the dollar's average foreign-currency price.

For the most part, the conventional indexes were built around a group of currencies that were freely convertible, used frequently in international transactions and investments, and from countries that were important trading partners of the United States. These considerations narrowed the group to the currencies primarily of Japan, Canada, and countries in Europe.

1 Examples of this type of study include Rude (1986), Feldman (1984), and Hooper (1976).

2 The figures for the real trade deficit and its components are on a national income and product account basis, in 1982 dollars.

3 For evidence, see Proctor (1982).

4 The Federal Reserve Board index is published in the *Federal Reserve Bulletin.* The Morgan Guaranty index is published in *World Financial Markets.* The International Monetary Fund index is published in *International Financial Statistics.* For a more detailed description of the composition of these particular indexes, see Belongia (1986).

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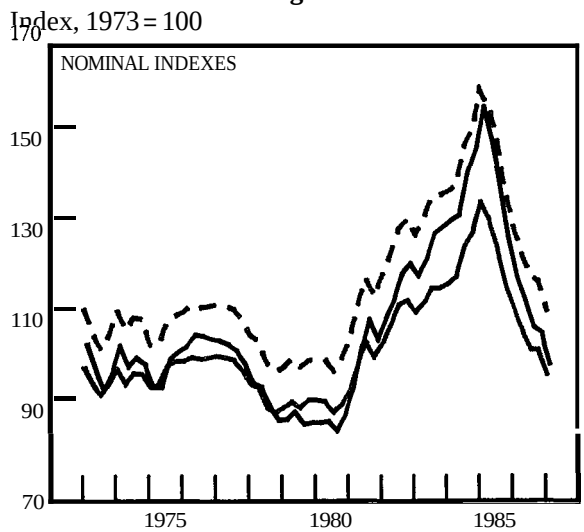
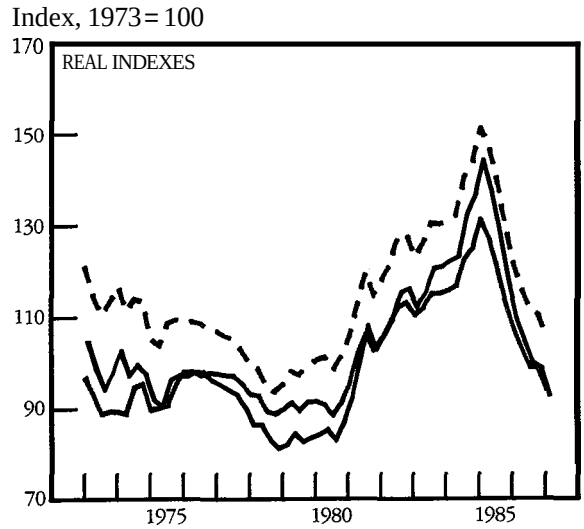
Nominal and Real Trade-Weighted Dollar Indexes





—— FRB Index
Morgan Index
– – – IMF Index

NOTE: Real FRB and IMF indexes are FRBC estimates.
SOURCES: Board of Governors of the Federal Reserve System; *International Financial Statistics*, International Monetary Fund; *World Financial Markets*, Morgan Guaranty Trust Company.

FIGURE 1

While the FRB, MG, and IMF indexes differ somewhat in the details of their construction, each has come to represent the standard profile of the dollar's foreign-exchange value (figure 1).

The heightened concern over the relationship between the dollar and merchandise trade stems from the dramatic changes each has gone through during the past six or seven years. As measured by the indexes in figure 1, the dollar has gone through two sharply distinct phases since 1980. The first phase was a period of unprecedented cumulative appreciation from mid-1980 to early 1985. The second phase, which began immediately thereafter, has been marked by a fairly continuous and rapid rate of depreciation. Although the rates of change measured by each index differ somewhat, the proportion of depreciation from 1985:Q1 to 1986:Q4 to appreciation from 1980:Q3 to 1985:Q1 indicated by each is virtually the same. In nominal terms, the ratio is about 70 percent, while in real terms, it is nearly 75 percent.[5] Put differently, according to conventional measures, the bulk of the dollar's appreciation from mid-1980 to early 1985 has been offset by its depreciation since then.

The merchandise trade balance has also changed significantly since 1980. Unfortunately, the change has been a fairly steady and substantial deterioration in both current and constant dollars, even when imports of petroleum and petroleum products are excluded (figure 2). When petroleum imports are included, the deterioration since mid-1980 is even more pronounced.

In nominal terms, the merchandise trade balance excluding petroleum imports, as illustrated in figure 2, fell from a surplus of $61 billion in 1980:Q3 to a deficit of $122 billion in 1986:Q4. In real terms, the decline was from a surplus of $75 billion to a deficit of $102 billion, equivalent to 3 percent of real gross national product (GNP). Perhaps more importantly, though, during the period corresponding to the dollar's depreciation from 1985:Q1 to 1986:Q4, the trade balance deteriorated almost $67 billion in nominal terms, and nearly $34 billion in real terms. To be sure, the slight uptick towards improvement in 1986:Q4 and 1987:Q1 is encouraging. Whether it is the beginning of a small, short-lived improvement, or of a more sizeable, long-term improvement in the real merchandise trade balance, though, is far from clear. This question represents one of the key issues confronting the U.S. economy.

The failure of the trade balance to improve significantly up to now in response to two years of sharp dollar depreciation has been a source of disappointment and concern to policymakers and economists. Just as the dollar's appreciation was a major factor behind the decline of U.S. net exports from 1980:Q3 through 1985:Q1, the dollar's depreciation since then was expected to bring about noticeable gains in the trade balance.[6] Moreover, the anticipated increase

5 For each index, the ratio of depreciation to appreciation was calculated as the first difference in the index level from 1985:Q1 to 1986:Q4 divided by the first difference in the index level from 1980:Q3 to 1985:Q1. Calculating the ratio in this manner avoids the distortion of comparing a rate of appreciation measured off a low index value to a rate of depreciation measured off a much higher index value.

6 For a discussion and empirical assessment of the effects that dollar appreciation had on the merchandise balance of trade, see Feldman (1984).

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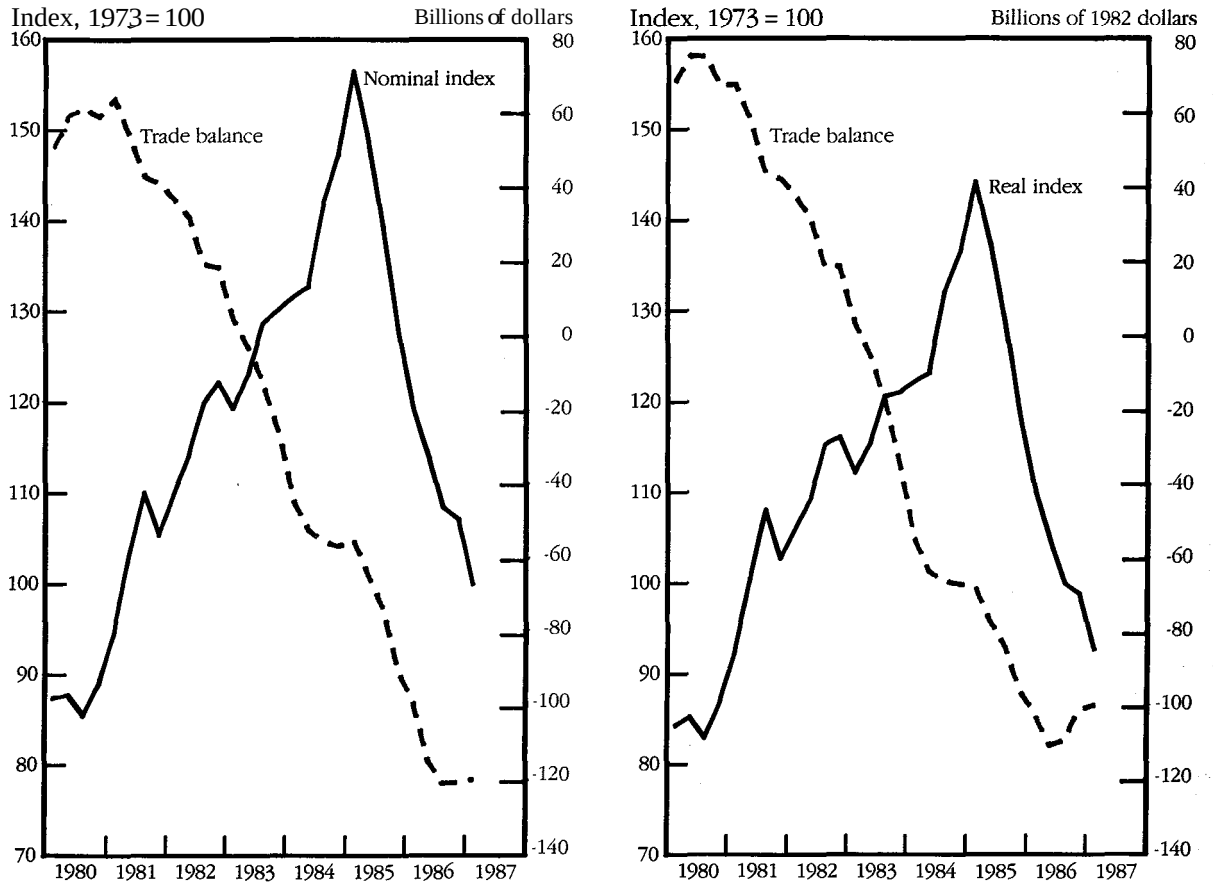
Federal Reserve Board Index and the Merchandise Trade Balance Excluding Petroleum



NOTE: Real FRB index is FRBC estimate.
SOURCES: Board of Governors of the Federal Reserve System; U.S. Department of Commerce; Bureau of Economic Analysis, NIPA.

FIGURE 2

in net exports has been counted on heavily to compensate for a likely negative fiscal stimulus resulting from the Gramm-Rudman-Hollings initiative to reduce the federal budget deficit. In fact, many private forecasts for the U.S. economy for 1986 and 1987 predicted that roughly half of the increase in real GNP (Q4/Q4) would come from an increase in real net exports.[7]

A number of explanations have been offered as to why the trade deficit has yet to improve significantly. First, the response of exports and imports to a decline in the dollar involves time lags that are said to be longer than previously estimated. Second, other determinants of trade, such as slow income growth abroad relative to growth in the United States, have worked to worsen the balance of trade and have outweighed the positive effects of dollar depreciation. Third, foreign exporters have maintained the competitiveness of their goods in U.S. markets by cutting their profit margins to offset the price effects of the dollar's decline.[8] Finally, the rate at which the dollar has depreciated since early 1985 has been significantly overstated by conventional exchange-rate indexes.

While each of these explanations has some degree of merit, the latter one, regarding how far the dollar has depreciated, has received the greatest attention. For the most part, it has come in the form of challenges to the standard profile of how the dollar's average foreign-exchange value is measured. The main criticism levied against the conventional measures is that they exclude the currencies of a number of countries—principally the newly industrialized countries (NIC s) of Asia—whose share of trade with the U.S. over the past decade has been increasing. By excluding these currencies, the conventional indexes continue to calculate the dollar's average foreign-currency price primarily in terms of the currencies of Japan,

7 For example, see DRI (December 1985) and DRI (December 1986).

8 For further discussion of ways that foreign exporters have reduced or delayed the impact of dollar depreciation on import prices, see Anderson and Carlson (1987).

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Countries in the FRBC Trade-Weighted **Dollar** Index

Country	Percent of U.S. World Trade[1] In 1974	In 1984
Japan*	13.7%	17.2%
Canada*	15.8	14.9
W. Germany*	7.0	5.6
United Kingdom*	5.3	4.7
Mexico	5.1	4.6
Taiwan	2.2	4.2
Republic of Korea	1.9	3.3
France*	3.2	3.0
Hong Kong	1.6	2.4
Italy*	2.9	2.4
Netherlands*	3.1	2.2
Brazil	3.0	2.2
Belgium/Luxembourg*	2.4	1.7
Singapore	0.9	1.6
Australia	2.0	1.5
Saudi Arabia	0.5	1.2
Switzerland*	1.2	1.2
China, People's Republic	0.6	1.1
Sweden*	1.1	1.0
South Africa	1.1	1.0
Total	74.6%	77.0%

* Included as one of the 10 countries in the Federal Reserve Board's trade-weighted dollar index. Overall, these 10 countries accounted for 55.7 percent of total U.S. world trade in 1974 and 53.9 percent in 1984.
1. Merchandise exports, plus nonpetroleum merchandise imports, minus auto trade with Canada.
Source: Federal Reserve Bank of Cleveland.

TABLE 1

Canada, and Europe, a group whose aggregate share of U.S. trade has been declining over the past 10 to 15 years and that accounts for little more than half of U.S. trade (table 1).

Of course, if the dollar had been changing by about the same degree relative to the excluded currencies as it has been relative to the included currencies, then the exclusions would be unimportant, at least so far as the standard profile of dollar depreciation and its potential effects on the merchandise trade balance are concerned. However, since 1985:Q1, the dollar has fallen by very little, if at all, against the excluded currencies, while it has fallen sharply relative to almost all of the included ones. For example, between 1985:Q1 and 1986:Q4, on an inflation-adjusted basis, the dollar depreciated by 37 percent, 36 percent, 35 percent, and 24 percent against the currencies of Japan, Germany, France, and Britain, respectively, but fell only 4 percent against the currency of Taiwan and actually rose 4 percent, 2 percent, and 3 percent against the currencies of Korea, Hong Kong, and Singapore, respectively (figure 3).

The outcome of the challenge to the standard profile of how the dollar's foreign-exchange value is calculated has been the emergence of a host of new exchange-rate indexes. The common elements among them are expanding the set of currencies to include those of the United States' emerging trading partners, and updating the weights by which each currency's relative importance in the index is determined.

According to these newer indexes, the dollar has depreciated considerably less over the past two years than the conventional indexes show. This result carries with it two particularly important policy implications. One is that the improvement to the trade balance over the near term is likely to be considerably less than is expected by those analysts who are relying on the conventional indexes. The other implication is that much of the upward price pressures associated with dollar depreciation still lie ahead because less of the dollar depreciation that is needed to redress the trade balance has been achieved than many analysts realize.

To address the criticisms of the conventional dollar indexes and the shortcomings of some more recent indexes, we have constructed a new exchange-rate index for the dollar. Our purpose was to create an index that would be more useful than the others for the purpose of explaining and forecasting price and volume changes of U.S. imports and exports. The construction of our index is explained in the following section.

The Federal Reserve Bank of Cleveland (FRBC) Exchange-Rate Index[9]

An exchange-rate index provides a summary value of the dollar's price relative to other foreign currencies. There are four general features that distinguish one exchange-rate index from another. First is the set of currencies it includes. Second is how, and over what time period, the weight, or relative importance, assigned to each currency is calculated. The third feature involves the technique employed to derive the weighted average of the dollar's foreign-exchange value. The final feature is the price used to deflate each of the individual currencies if the index is expressed in real as well as in nominal terms.[10]

9 For convenience of exposition, the dollar index constructed in this paper is hereafter referred to as the Federal Reserve Bank of Cleveland (FRBC) index. This designation does not imply endorsement by the Federal Reserve Bank of Cleveland or by the Board of Governors of the Federal Reserve System.

10 For a more complete discussion of the issues involved in the construction of an effective exchange-rate index, see Rhomberg (1976).

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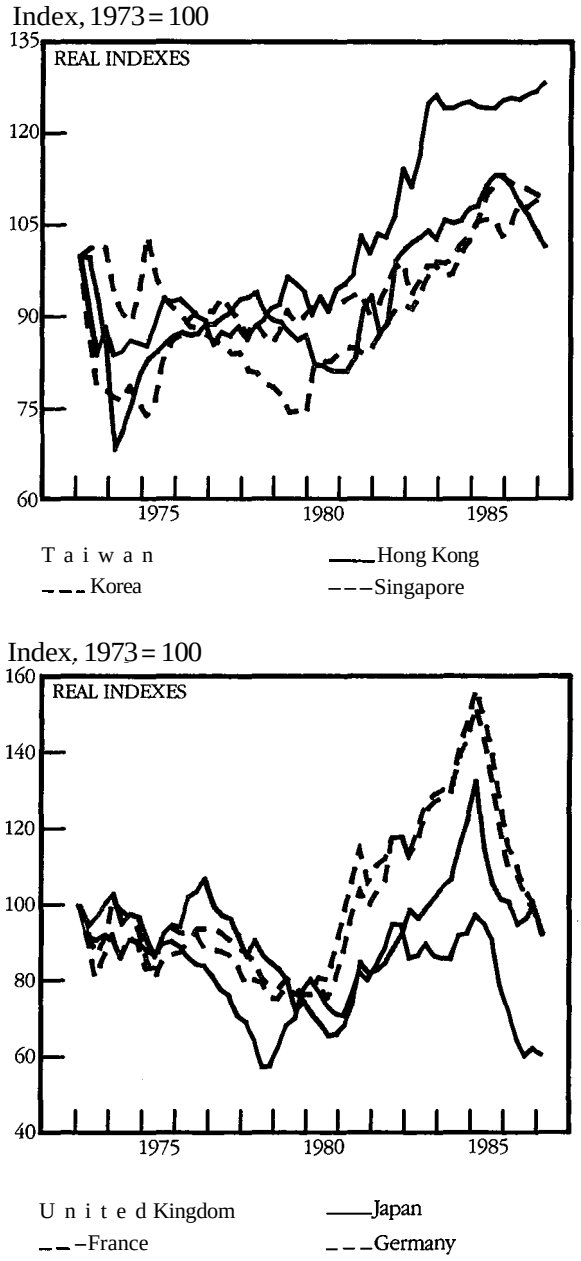
Changes in the Dollar Against Selected Currencies
Foreign Currency Units Per Dollar



NOTE: Real indexes are deflated using CPI values.
SOURCES: *International Financial Statistics*, International Monetary Fund; Board of Governors of the Federal Reserve System.

FIGURE 3

The most important feature of any exchange-rate index may well be the currencies it includes. As indicated earlier, most conventional indexes are built around currencies from Europe, Canada, and Japan. The FRB measure of the dollar incorporates the currencies of eight European countries, plus Canada and Japan. The MG index uses the same 10 currencies as the FRB index, and adds four more European currencies, as well as Australia's. Finally, the IMF's index includes the same 15 currencies as the MG index and adds two more European currencies.

In contrast to the well-established indexes, the new FRBC index takes the FRB index as a point of departure and adds the currencies of Australia and the next nine most-important trading partners of the United States.[11] Included in this group of nine are a number of NICs such as Taiwan, the Republic of Korea, Mexico, and Brazil. The 20 countries included in the FRBC index are listed in table 1.

Several points regarding selection of these countries relative to the currencies included in the Federal Reserve Board index are worth raising. First, together they account for a far-greater share of U.S. merchandise trade—77 percent vs. 54 percent. Second, they reflect the general shift in U.S. trade since 1974 away fi-om Europe and towards Asia (countries other than Japan). While Taiwan, Korea, Hong Kong, Singapore, and the People's Republic of China accounted for about 7.2 percent of total U.S. merchandise trade in 1974, their share had grown to 12.6 percent by 1984. Third, Mexico and Brazil, who together make up nearly 7 percent of U.S. merchandise trade, are also included. While these two countries are usually excluded fi-om conventional nominal-exchange-rate indexes because of their high rates of inflation, their inclusion may nevertheless paint a more revealing picture of the dollar in real terms.

A second important aspect of an effective exchange-rate index is the manner in which each currency's relative significance, or weight, is determined. The standards by which significance is measured can vary, but significance typically is based on shares of trade. In general, there are three types of trade-related weights.

The first type, bilateral weights, emphasizes trade between two countries. A country's weight is equal to its total trade with the United States (exports, plus imports) expressed as a share of total U.S. trade with all countries included in the index. The second type, multilateral weights, is typically calculated on the basis of each country's share of the total world trade of the countries included in the index. Finally, there are trade weights that could be derived from a general equilibrium model of world trade. In theory, these weights are preferred since they can account for unique trade structures, price elasticities, feedback effects, and competition in third

11 From here on, the Federal Reserve Board's effective exchange-rate index is used to represent the broader group of well-established.or conventional, indexes of the dollar's foreign-currency price.

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markets. In practice, though, general equilibrium model weights are extremely complicated to formulate and implement.[12]

The debate over whether bilateral or multilateral weights are preferable is ongoing. The argument most often raised in favor of multilateral weights is that they capture 'third market' or 'third country' effects, whereas bilateral weights do not. For example, a country that may not be an important direct trading partner with the United States can still affect U.S. trade to a significant degree via its trade with other countries or in other markets in which the United States competes. Such a country's currency might be given a small weight or even be excluded from a bilateral index, but it is given greater recognition in a multilateral index.

But while a multilateral index captures third-country effects, it may do so at the expense of introducing some important biases. First, multilateral weights can overstate the third-market effect by assigning large weights to countries that conduct a great deal of trade with each other, but not with the United States. Moreover, such trade relationships can have more to do with political factors than with economic factors. Second, multilateral weights tend to understate the importance of currencies of countries that are important trading partners with the United States, but that have a small share of world trade. Both of these features of multilateral weights can result in misestimating the exchange rate's impact on U.S. trade or inflation, especially in the short run.

In this study, we have used bilateral weights. In this regard, construction of the FRBC dollar index is similar to that of the Morgan **Guaranty** index, but not to the Federal Reserve Board index, which uses multilateral weights.

The years from which the weights are calculated should accurately reflect the composition of U.S. trade, while avoiding years in which exogenous factors played a dominant role in shaping the patterns of trade.[13] The weights in the FRBC index were calculated as an average of bilateral trade shares in 1983 and 1984. These years were chosen because they were not recession years and because they were the most recent years for which complete trade data were available.

Of course, in calculating trade weights, the issue of what types of trade the index should reflect must be addressed. Since our study is concerned primarily with assessing exchange-rate impacts on-merchandise trade, the trade in services that a foreign country has with the United States is excluded from the calculation. In addition, since a portion of U.S. trade with Canada involves intra-automobile-industry transactions that seem to depend primarily on factors other than the value of the U.S. dollar relative to the Canadian dollar—such as the production and sales of domestic autos in the United States—Canada's relative weight is reduced by excluding its automotive imports from and exports to the United States (see Rude [1986]). Finally, U.S. imports of petroleum and petroleum products were excluded from each foreign country's share of trade with the United States because these goods are priced in dollars and are generally regarded to be unresponsive to changes in dollar exchange rates.

Because an index is an average of several components, some method must be used to calculate that average. Both geometric averaging and arithmetic averaging methods have been used to construct dollar indexes. The geometric method is used for our index because it avoids some bias that can result from the arithmetic method.[14]

We have constructed nominal and real or price-adjusted indexes. For the latter, we have used the consumer price index in each country as a proxy for inflation.

The weights assigned to each currency in the FRBC index are presented in the last column of table 2. These weights differ from the trade shares presented in table 1 partly because they are an average for 1983 and 1984 instead of just 1984, but mostly because the shares have been scaled up so they will total 100 percent. Given our purposes for constructing an effective exchange-rate index, and the weighting scheme we have chosen, the Federal Reserve Board's measure appears to understate the importance of the yen and Canadian dollar and to overstate the importance of the mark. Moreover, the currencies of the 10 additional countries included in the FRBC index have, in effect, a weight of zero in the Federal Reserve Board index, even though those countries account for about 23 percent of U.S. merchandise trade.

The differences in weights for currencies between the two indexes have an important bearing on how each index measures changes

12 The IMF multilateral exchange-rate model (MERM) attempts to measure trade weights in a more general equilibrium world-trade model.

13 There is no generally accepted method for choosing a base year. As Belongia (1986) points out, it ought to be one in which absolute purchasing power parity holds, and countries included in the exchange-rate index consume identical commodity bundles. Unfortunately, this standard has little practical application. because the latter condition never exists.

14 For a discussion of the advantages that the geometric averaging technique has over the alternative arithmetic method, see Deephouse (1985) or the *Federal Reserve Bulletin* (August 1978) p 700

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Foreign Currency Weights in Alternative Trade-Weighted Effective Exchange-Rate Indexes (in percent)

Country	Model-Based Weights	Multilateral Weights			Bilateral Weights
	IMF Index[1]	FRB Index[2]	FRB, Updated[3]	FRB, Updated and Expanded[4]	FRBC Index[5]
Japan	21.3%	13.6%	17.4%	13.4%	21.9%
Canada	20.3	9.1	9.6	7.4	19.1
W. Germany	13.0	20.8	19.4	15.0	7.1
United Kingdom	5.1	11.9	11.7	9.0	6.2
France	10.1	13.1	12.1	9.3	3.9
Italy	7.5	8.3	9.3	7.2	3.2
Belgium/Luxembourg	2.4	6.4	6.4	5.0	2.3
Netherlands	3.2	8.3	7.6	5.9	3.1
Sweden	2.7	4.2	3.3	2.5	1.3
Switzerland	1.7	3.6	3.3	2.5	1.7
Taiwan				2.3	5.5
Republic of Korea				2.6	4.3
Hong Kong				2.4	3.1
China, People's Republic				2.2	1.5
Singapore				2.4	2.1
Mexico				1.6	5.8
Brazil				1.9	2.6
Saudi Arabia				3.8	2.0
South Africa				1.6	1.3
Australia	4.9			2.1	2.0
All Other Europe	7.9				
	100%	100%	100%	100%	100%

1. The currency weights are from the exchange-rate index in the International Monetary Fund's Multilateral Exchange-Rate Model. They are calculated from 1977 data.
2. The currency weights are from the Federal Reserve Board exchange-rate index. They are calculated as average weights from 1972 to 1976.
3. This set of currency weights is derived in exactly the same manner as those in the Federal Reserve Board's published index, except that they are calculated by the authors as averages from trade flows in 1983 and 1984.
4. The currency weights in this index are derived in exactly the same manner as those in the Federal Reserve Board's published index, except that they are calculated by the authors as averages from trade flows in 1983 and 1984 across an expanded set of countries.
5. The currency weights in the Federal Reserve Bank of Cleveland exchange-rate index are derived from each country's average bilateral trade shares with the U.S. in 1983 and 1984, excluding Canada's auto trade with the U.S. and each country's petroleum exports to the U.S.
Sources: Federal Reserve Bank of Cleveland; Federal Reserve Board, ***Federal Reserve Bulletin;*** International Monetary Fund, ***International Financial Statistics, Supplement on Exchange Rates.***

TABLE 2

in the value of the dollar. To a certain extent, overstating the influence of the German mark, while understating the influence of the Japanese yen, constitutes offsetting errors since both currencies have appreciated by approximately the same percentage since February 1985. But the Canadian dollar has remained virtually constant vis-a-vis the U.S. dollar since then. Furthermore, the currencies of Hong Kong, Singapore, and Korea have depreciated slightly against the dollar in real terms since February 1985, while the currency of Taiwan has appreciated only slightly (figure 3).

Table 2 also shows the weights for two additional indexes that are intermediate between the Federal Reserve Board index and the FRBC index. One, which we call the FRB Updated index, in the third column, has the same 10 countries as the Federal Reserve Board index with weights calculated by the Board's method, but for trade flows in 1983 and 1984. The other, which we call the FRB Updated and Expanded index, expands the Federal Reserve Board index list of 10 countries to the FRBC index list of 20 countries, with weights calculated by the Board's method, but for trade flows in 1983 and 1984.

The consequences of how the FRBC index was constructed, for interpreting the dollar's value against other currencies, are striking. Compared with the Federal Reserve Board's index, for example, the FRBC index captured the general nominal appreciation of the dollar during the first half of the 1980s, but suggests that the

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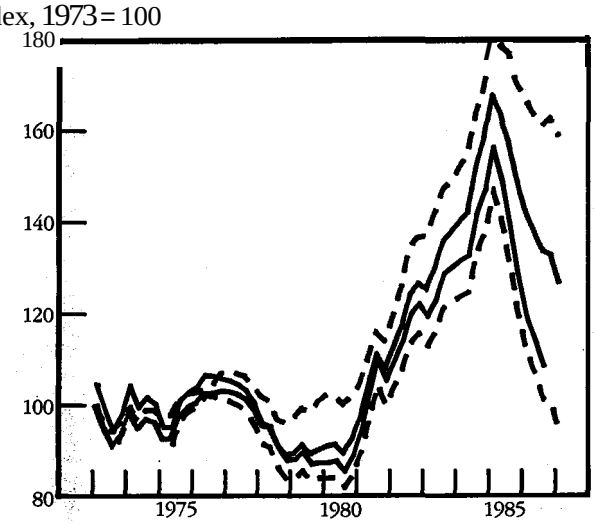
depreciation since then has been much less (figure 4). Between 1980:Q3 and 1985:Q1, the Federal Reserve Board measure of the dollar appreciated more than 83 percent. At the same time, the FRBC measure rose by over 78 percent. However, from 1985:Q1 to 1986:Q3, while the Federal Reserve Board index depreciated by about 30 percent, the FRBC index indicates that the dollar depreciated by only 9 percent, and that depreciation offset considerably less of the dollar's previous appreciation.

Nominal Trade-Weighted Dollar Indexes
Index, 1973 = 100



Board, 10 currencies, multilateral weights
Board updated, 10 currencies, multilateral weights
Board updated and expanded, 20 currencies, multilateral weights
FRBC, 20 currencies, bilateral weights

SOURCES: Board of Governors of the Federal Reserve System; Federal Reserve Bank of Cleveland.

FIGURE 4

A better way to compare the movements in the indexes is to compare the proportion of the appreciation from 1980:Q3 to 1985:Q1 that was offset by the depreciation from 1985:Q1 to 1986:Q3. The Federal Reserve Board index indicates a 68 percent offset, but the FRBC index indicates that only 22 percent was offset.

There are also sharp differences when both indexes are measured in real terms (figure 5). From 1980:Q3 to 1985:Q1, the Federal Reserve Board's measure of the dollar, adjusted for inflation, rose by almost 74 percent while the FRBC index appreciated by 43 percent. Since then, however, the Federal Reserve Board's measure shows depreciation of more than 27 percent in real terms, while the FRBC real measure of the dollar fell by less than 13 percent. In terms of proportions, the Federal Reserve Board index indicates that 72 percent of the appreciation was offset while the FRBC index indicates that only 56 percent was offset. Regarding the two intermediate indexes, the FRB Updated index behaved much like the Federal Reserve Board index, while the FRB Updated and Expanded index behaved much like the FRBC index.

Comparison of the indexes in table 2 shows that the path of a dollar index can be strongly affected by the choice of currencies and weights, and by adjusting for inflation. However, the differences in path are not a criterion by which one index can be regarded as superior to another. There is no single "correct" index. An index should be constructed with its purpose in mind, and should be evaluated by how well it serves that purpose. We make such evaluations in part II.

II. The Model for Merchandise Trade

Our purpose for constructing a dollar index is to develop a tool that is helpful for explaining and predicting the effects of exchange-rate changes on U.S. merchandise trade. In this part, we use the FRBC index in developing a model of U.S. merchandise trade. The model employed in this study is a standard partial-equilibrium, four-equation representation of prices and quantities for U.S. merchandise exports and imports.[15] The model is designed to be a tool for short-run analysis and forecasting. With the model, the degree to which dollar appreciation or depreciation brings about changes in import and export prices, and the subsequent effect this has on the levels of real merchandise trade, can be estimated directly. Furthermore, the impact that economic growth in the United States relative to its major trading partners has on the balance of merchandise trade can also be evaluated.

The model works in two stages. In stage one, prices for exports and imports are derived from exogenous factors, including the exchange rate. In stage two, these predicted prices of exports and imports along with other exogenous determinants of demand generate the quantities of exports and imports. There is no feedback from stage two to stage one.[16]

15 With a few exceptions, the approach taken to modeling merchandise trade in this study is quite similar to that taken in Feldman (1984), and to the aggregate version of the model in Rude (1986). While it is also generally similar to Hooper (1976), it is less ambitious in its specification. For additional approaches, see Deppler and Ripley (1978), Spitaller (1980), and Artus and McGuirk (1981).

16 Of course, an exchange rate is not completely exogenous and trade volumes probably affect prices, but a general equilibrium model is beyond the scope of this project.

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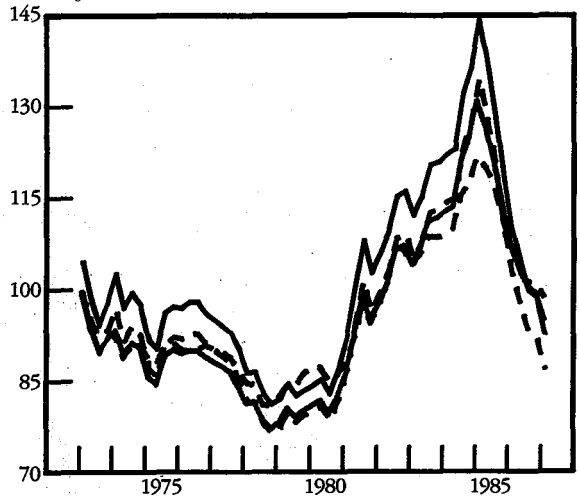
The principal assumption underlying the model is that merchandise trade takes place in world markets that are characterized by imperfect competition. The products exported by any one country are differentiated from other foreign and domestic goods by differences in quality, contracts and agreements regarding delivery and servicing, and other factors that attract a buyer to a seller.[17] Producers are concerned about maintaining or increasing profit margins, or market shares, or both. Consumers strive to maximize utility subject to their income and to the relative prices of foreign and domestic goods.

Real Trade-Weighted Dollar Indexes

Index, **1973** = 100



Board, 10 currencies, multilateral weights
Board updated, 10 currencies, multilateral weights
Board updated and expanded, 20 currencies, multilateral weights
FRBC, 20 currencies, bilateral weights

SOURCE: Federal Reserve Bank of Cleveland.

FIGURE 5

This type of market environment has important implications for how exchange rates and economic growth affect the balance of trade. To begin, prices are not determined solely by world supply and demand conditions. Rather, since exporters in each country are imperfect competitors, they are able to exercise a certain amount of control in setting their prices. Given their concern for profit margins, one determinant of the price they establish is unit cost of production. Because they are also concerned with their market share, and face at least some degree of competition from foreign producers, they take the prices of competing foreign goods into consideration as well. Hence, pricing behavior is consistent with a conventional markup model where markets are oligopolistic.

Price ***Equations.*** Within this particular framework, U.S. merchandise export prices can be generalized as a function of the prices of competing foreign goods, the exchange rate, and production costs:

1) $PX = f(PF, ER, UC),$

where PX is an index measure of prices for merchandise exports, *PF* is a price index of foreign goods that compete with U.S. exports expressed in units of foreign currencies, *ER* is a trade-weighted effective-exchange-rate index expressed as dollars per unit of foreign currency, and *UC* is an index measure of unit costs of production.[18] The price of exports is expected to be positively related to the dollar price of competing foreign goods and to unit costs.

The approach for U.S. merchandise import prices is much the same:

2) $PM = f(P, ER, UCF),$

where PM is an index measure of prices for U.S. merchandise imports, P is an index measure of prices for U.S. goods that compete with foreign imports, and UCF is a measure of foreign unit costs of production. The price of imports is expected to be a positive function of the price of competing U.S. goods, the exchange rate, and foreign unit costs.[19]

The model provides a direct channel, then, by which changes in the exchange rate can affect the prices of U.S. exports and imports. The transmission of this impact is referred to as the "pass-through" effect. Pass-through is usually defined in terms of the price effect measured in terms of the importing country's home currency. In principle, the degree of pass-through depends

17 For instance, even if it were the same price or slightly more expensive than the other three, a consumer might still have strong reasons, stemming from tastes, product availability, and perceived quality differences, for buying a station wagon produced in Japan over a very similar one produced in Sweden, Germany, or the United States.

18 The exchange-rate index expressed as dollars per unit of foreign currency is simply the inverse of the exchange-rate index developed in part I of this study.

19 Previous studies have also included a measure of domestic and foreign demand pressures in their interpretations of how export and import prices are set. Typically, demand pressures are proxied by domestic and foreign capacity utilization rates. However, the results obtained in other empirical analyses from incorporating these additional determinants of pricing behavior have been mixed. Because of data limitations across the expanded set of countries used in our study, we omitted measures of demand pressure from the price equations altogether.

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The Merchandise Trade Model[1]

1) Implicit Price Deflator for *Merchandise Exports*

$$PX_t = -0.91 + 0.36\,(ERX \cdot FPX) + 0.51\,DP_t + 0.63\,e_{t-1}$$
$$(-2.11)\quad(4.80)\qquad(7.98)\qquad(5.42)$$

R^2 (adjusted) = .9987 DW = 1.3
(t-statistics in parentheses) F-statistic = 8402.7
Sample period: 1975:Q1 - 1986:Q1

The coefficient for the exchange-rate term is a long-run elasticity and is the sum of the following contemporaneous and lagged coefficients:

t	t-1	t-2	t-3	t-4
0.06	0.09	0.10	0.08	0.03
(0.91)	(3.00)	(2.13)	(2.28)	(0.45)

Definitions:

PX = Implicit price deflator for U.S. merchandise exports.

ERX = Federal Reserve Bank of Cleveland merchandise export-weighted foreign-exchange-rate index. In estimating the model, the index is inverted so that it measures dollars per unit of foreign currency.

FPX = Merchandise export-weighted average foreign wholesale price index. The countries and weights are the same as in *ERX*.

DP = U.S. wholesale price index.

e = Identically and independently distributed random variable with mean of zero.

[1] Each equation was estimated on quarterly data using a maximum likelihood estimator with a correction for first-order autocorrelation. Lags were constrained to be second-order polynomials. All variables are in natural logs.

2) Implicit Price Deflator for *Nonpetroleum* Merchandise *Imports*

$$PM_t = -1.80 + 0.49\,ERM + 0.59\,DP_t + 0.33\,FPM_t + 0.75\,e_{t-1}$$
$$(-3.27)\quad(4.43)\qquad(3.01)\qquad(1.83)\qquad(7.74)$$

R^2 (adjusted) = .9986 DW = 1.3
(t-statistics in parentheses) F-statistic = 8103.6
Sample period: 1975:Q1-1986:Q1

The coefficient for the exchange-rate term is a long-run elasticity and is the sum of the following contemporaneous and lagged coefficients:

t	*t*-1	*t*-2
0.32	0.16	0.01
(5.13)	(4.43)	(0.17)

Definitions:

PM = Implicit price deflator for U.S. nonpetroleum merchandise imports.

ERM = Federal Reserve Bank of Cleveland nonpetroleum merchandise import-weighted foreign-exchange-rate index. In estimating the model, the index is inverted so that it measures dollars per unit of foreign currency.

DP = U.S. wholesale price index.

FPM = Nonpetroleum merchandise import-weighted average foreign wholesale price index. The countries and weights are the same as in ERM.

e = Identically and independently distributed random variable with mean of zero.

Source Federal Reserve Bank of Cleveland

BOX 1

on a variety of factors, including importantly U.S. and foreign exporters' trade-offs between desired profit margins and market shares.[20]

For example, consider the simplified scenario in which the dollar has depreciated against foreign currencies. For U.S. exporters, this means the dollar price of their goods has become less expensive relative to competing foreign goods, since one unit of foreign currency can now be exchanged for more dollars. At that point, U.S. firms can respond to the depreciation by adjusting the dollar price of their exports in one of three ways. If their sole objective is a higher profit margin, without regard to a greater market share, they could raise the dollar price of their goods by an amount sufficient to restore the pre-depreciation relative price of their product vis-a-vis competing foreign goods. Under these circumstances, no portion of the dollar's depreciation would be passed through into the foreign-currency prices of U.S. exports. At the other extreme, if their only objective is a greater market share without regard to raising profit margins, they would not raise the dollar prices of their

[20] In the longer term, pass-through also depends on the effect that depreciation has on the cost of labor and other inputs, especially imported inputs. This is likely lo be more important in nations where the ratro of trade volume to real GNP is high.

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3) Real *Merchandise Exports*

$$QX_t = -5.40 - 1.18\, PX/(ERX \cdot FPX) + 1.00\, FGNPX_t + 0.73\, e_{t-1}$$
(-3.56) (-4.43) (8.72) (7.07)

R^2 (adjusted) = .9913 DW = 1.7
(t-statistics in parentheses) *F*-statistic = 1259.9
Sample period: 1975:Q1-1986:Q1

The coefficient for the relative price term is a long-run elasticity and is the sum of the following contemporaneous and lagged coefficients:

t	*t*-1	*t*-2	*t*-3	t-4	*t*-5	t-6
-0.02	-0.13	-0.20	-0.24	-0.24	-0.21	-0.14
(-0.12)	(-1.82)	(-2.47)	(-2.57)	(-3.12)	(-2.85)	(-0.88)

Definitions:

QX = U.S. merchandise exports, excluding automobile exports to Canada, on a balance-of-payments basis in 1982 dollars.
PX = Implicit price deflator for U.S. merchandise exports.
ERX = Federal Reserve Bank of Cleveland merchandise export-weighted foreign-exchange-rate index. In estimating the model, the index is inverted so that it measures dollars per unit of foreign currency.
FPX = Merchandise export-weighted average foreign wholesale price index. The countries and weights are the same as in ERX.
FGNPX = Merchandise export-weighted foreign real gross national product. The variable FGNPX is the average of its contemporaneous and one-quarter-lagged values, where each period is assigned a weight of 0.5 in calculating the average. The countries and weights are the same as in ERX.
e = Identically and independently distributed random variable with mean of zero.

4) Real Nonpetroleum Merchandise *Imports*

$$QM_t = -6.58 - 1.74\,(PM/DP) + 2.43\, GNP_t + 0.71\, e_{t-1}$$
(-6.31) (-5.77) (11.21) (6.77)

R^2 (adjusted) = .9851 DW = 2.1
(t-statistics in parentheses) *F*-statistic = 729.71
Sample period: 1975:Q1 - 1986:Q1.

The coefficient for the relative price term is a long-run elasticity and is the sum of the following contemporaneous and lagged coefficients:

t	*t*-1	*t*-2	*t*-3	*t*-4	*t*-5	*t*-6
-0.33	-0.35	-0.35	-0.31	-0.24	-0.14	-0.01
(-1.52)	(-3.49)	(-3.36)	(-2.58)	(-2.40)	(-1.56)	(-0.56)

Definitions:

QM = U.S. nonpetroleum merchandise imports, excluding automobile imports to Canada, on a balance-of-paymentsbasis in 1982 dollars.
PM = Implicit price deflator for U.S. nonpetroleum merchandise imports.
DP = U.S. wholesale price index.
GNP = U.S. real gross national product. The variable GNP is the average of its contemporaneous and one-quarter-lagged values, where each period is assigned a weight of 0.5 in calculating the average.
e = Identically and independently distributed random variable with mean of zero.

products at all, and the foreign-currency prices of their products would fall by the full amount of the depreciation. In this case, there would be complete pass-through. Finally, if U.S. exporters were interested in raising both their profit margins and their market shares, they would raise their dollar prices by less than the amount of the depreciation. Thus, the foreign-currency price of U.S. exports would still fall in response to the partial pass-through, but by an amount proportionately less than the depreciation. Changes in the exchange rate are passed through into U.S. import prices by foreign exporters in the same fashion and according to a similar set of considerations.

There are, of course, limits to the latitude with which U.S. and foreign exporters are willing and able to adjust their prices in response to changes in the exchange rate. Restated, there are constraints on the pass-through strategies that firms pursue vis-a-vis their profit-margin and market-share objectives. Some arise out of general macroeconomic uncertainties, having to do with the outlook for the economy or with monetary and fiscal policies.[21] Some constraints are contractual.

21 For a discussion of how these types of uncertainties might enter into firms' pricing decisions, see Mann (1986) pp. 368-369.

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For example, if the dollar depreciates and U.S. exporters' prices were fixed in dollars by a contract, the degree of pass-through would by necessity be 100 percent. In contrast, if their prices were contractually fixed in units of a foreign currency, the degree of pass-through would be zero. Most studies of this topic, though, focus on constraints that are microeconomic in nature—market conditions having to do with the demand for and supply of a firm's product across international markets.

In practice, the degree of flexibility that U.S. firms have to raise the dollar price of their exports is generally greater the less price-elastic foreign demand for their good is and the less price-elastic supplies from other foreign or domestic competitors are. For the most part, foreign demand will be less elastic the more differentiated or specialized the exported good is, and the greater the world market share the U.S. exporter commands. The elasticity of supply for an exported good varies inversely with the level of capacity utilization in domestic and foreign industries producing the product, varies directly with the rate at which capacity for the production of the good can be increased at home and abroad, and varies directly with the supplies of the good held in inventories. Conversely, the more price-elastic demand for and total supplies of the exported good are, the greater will be the incentive for U.S. exporters to leave their dollar prices unchanged, thereby passing a higher portion of the depreciation through into lower foreign-currency prices. The degree of pass-through from foreign exporters into U.S. import prices is constrained by a similar set of factors.[22]

Volume ***Equations.*** The equations for quantities of merchandise exports and imports are demand functions expressed in terms of real income and relative prices. For merchandise exports, the general form is:

3) $QX = f[YF, PX/(PF \cdot ER)],$

where QX is the quantity of U.S. merchandise exports, YF is an index of foreign real income, and the ratio $PX/(PF \cdot ER)$ measures the price of U.S. exports relative to the price of competing foreign goods. Exports are expected to respond positively to changes in foreign real income and negatively to changes in relative prices.

Similarly, for imports:

4) $QM = f(Y, PM/P),$

where QM is the quantity of U.S. merchandise imports, Y is U.S. real income, and the ratio PM/P is the price of U.S. imports relative to competing domestic goods. Here again, quantities are expected to be positive functions of real income and negative functions of relative prices.[23]

The specification of the price and quantity equations has important implications for how changes in the nominal versus the real exchange rate affect merchandise trade. To be specific, since some portion of a change in the nominal exchange rate is passed through into export and import prices, it is also passed through into the relative price term in each quantity equation. There, it is deflated by a broader price index. Consequently, even though the exchange rate explicitly enters into the model in nominal terms, there is a real exchange-rate effect that implicitly enters into the equations for quantities.

Estimating the Model

In order to estimate the equations for merchandise export and import prices and quantities, a number of adjustments were made to the stylized version of the model. They were necessitated by the types of merchandise that the United States exports and imports, by data limitations, and by lags in some relationships.

One of the more important issues in modeling merchandise trade is deciding on which particular goods to include in the analysis. In this regard, it is worth recalling from our previous discussion that two basic premises embodied in the model are that traded goods are differentiated across sources of supply and that, by and large, exporters set prices according to a standard markup formula. While most manufactured goods may fit into this framework of analysis, certain basic commodities might not. Petroleum, for instance, is a fairly homogenous good regardless of who is exporting it. Moreover, since the early 1970s, the prices and quantities of petroleum and petroleum products worldwide have been influenced heavily by OPEC pricing strategies and output quotas. Finally, since petroleum is priced in dollars on world markets, its price is not directly sensitive to changes in the dollar exchange rate. For these reasons, petroleum and petroleum products are excluded from U.S. import prices and quantities in this study, as they are in most other empirical studies of merchandise trade.

22 See Spitaller (1980) and Feldman (Summer 1982) for a more complete discussion of microeconomic factors affecting the degree of pass-through.

23 Other studies have included additional determinants of demand in their specification of the quantity equations. These additional factors include proxies for demand pressures, dummy variables for dock strikes, and oil prices. Because the results obtained from incorporating these additional factors were mixed in other studies and because of data limitations across the expanded set of countries used in our study, we have excluded them.

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Similar arguments can also be raised against including agricultural products: they are not easily differentiated across exporting nations; foreign suppliers frequently receive government subsidies to export their commodities; and, taking wheat as an example, agricultural products are often part of special purchasing deals between governments. Be that as it may, though, casual observation of developments in farm sectors in the United States and abroad indicate the occurrence of several important shifts in the 1970s and early 1980s. One is that the United States has become one of the world's high-price producers of many types of agricultural commodities. In addition, foreign production of agricultural goods has increased steadily. As a result, the United States now acts as the residual supplier to the rest of the world for a number of commodities. Moreover, U.S. imports of agricultural commodities have been on the rise since the early 1970's. All in all, these developments suggest that the U.S. balance of agricultural trade could well be sensitive to exchange-rate-induced changes in the relative prices of agricultural commodities in the United States and abroad, as well as to domestic and foreign income growth.

In this vein, Schuh (1984) has argued that changes in the value of the dollar were an important determinant of the U.S. agricultural trade balance in recent years. Furthermore, empirical work by Batten and Belongia (1984) has demonstrated that exports of U.S. agricultural goods are indeed driven by the same set of factors used to predict other types of merchandise exports—real income, relative prices, and the exchange rate. On balance, the reasons for including agricultural prices and quantities in the model seem to outweigh the reasons for excluding them, so they were incorporated into the analysis here.[24]

Finally, U.S. automobile trade with Canada is excluded from the merchandise export and import quantity equations. The reason is that these trade flows are largely the result of U.S. automakers' "exporting" parts to their Canadian factories for assembly, and then having the final products "imported" back. In this case, the volume of trade is more a function of the level of U.S. auto production than it is of the exchange rate, of relative prices, or of income levels in the United States and Canada.[25]

Aside from petroleum imports and automobile trade with Canada, though, the model is aggregative across merchandise export and import prices and quantities.[26] It is also aggregative across the same set of foreign trading partners used in constructing the effective trade-weighted dollar index in part I. As a result, the model cannot be used to address many of the interesting microeconomic issues associated either with U.S. trade relations with a particular country or with the consequences that exchange rates have for a particular industry. Nevertheless, by aggregating across countries and products, the model can be used to explore the causes of the overall trade deficit, as well as to evaluate some of the policy options for reducing the imbalance.

The model is structured so that export and import prices and quantities respond to their determinant factors both contemporaneously and with a lag. Previous empirical studies bear out this specification. In the price equations, U.S. and foreign exporters are assumed to react immediately to changes in their costs of production, but with a lag to changes in the exchange rate. One reason for the lagged response is that the dollar price of some exported goods may be fixed temporarily by individual contracts. Another reason is that exporters in the United States and abroad are less apt to risk a loss in their profit margins or market shares to changes in the exchange rate that they view as short-lived rather than permanent.

In the quantity equations, demand responds to the level of income in the current and previous period, but with a longer lag to changes in relative prices. Here again, U.S. and foreign importers are assumed to be more responsive to changes in the exchange rate that they perceive as permanent rather than temporary because of the transition costs associated with switching their sources of supply. Furthermore, there are likely to be lags between the time a product is ordered, because of a change in the exchange rate, and when it is delivered. Finally, U.S. and foreign consumers may simply be locked into a particular exporter for a certain period of time by a contract.

The lagged response of quantities to changes in relative prices can, in principle, give rise to what is commonly referred to as the "J-curve" effect. For example, following a depreciation in the value of the dollar, the path followed by the U.S. balance of trade over time could be one of an initial deterioration followed

24 The model in this study was estimated both with and without U.S. agricultural export prices and quantities. The equations fit the data about as well in each case, and the coefficient estimates were fairly similar.

25 See Rude (1986) for a discussion of the determinants of U.S.-Canadian auto trade. Although Mexico also borders the United States, U.S.-Mexican auto trade was not eliminated because it is relatively small and because we have no evidence that it is insensitive to exchange rates.

26 See Rude (1986) for an example of some of the insights to be gained from disaggregating a merchandise trade model by type of product. This extension, however, is beyond the scope of our study.

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by an improvement—a path in the shape of a J. The initial deterioration could occur if the increase in U.S. import dollar prices caused a decline in import volume that initially was proportionally smaller than the price increase. Thus, imports in nominal terms would actually rise until quantities adjusted sufficiently to the change in prices. If this rise in the dollar value of imports were larger than the rise in the dollar value of nominal exports, the trade balance would deteriorate. When quantities adjusted more fully to the price changes, we would get the improvement in the trade balance one would ordinarily expect following a depreciation. The J-curve, of course, is relevant to the nominal merchandise trade balance, while this study focuses primarily on the real merchandise trade balance.

Turning to issues regarding data, the two endogenous price variables are represented by the implicit dollar price deflators for U.S. merchandise exports and nonpetroleum imports. Merchandise exports and nonpetroleum imports, each on a balance-of-payments basis excluding automotive trade with Canada, and measured in 1982 dollars, are the two dependent quantity variables. Several proxy variables were used for exogenous variables because of data limitations. The proxies selected are the same as, or similar to, those employed in other empirical studies of merchandise trade. In the export price equation, the U.S. wholesale price index is used to measure U.S. exporters' unit costs, and foreign wholesale price indexes are used to represent the prices of foreign goods competing with U.S. exports. The wholesale price indexes were used as proxies in the equation for import prices in an analogous manner. In the quantity equations, wholesale prices are intended to reflect the prices of goods competing with U.S. exports in foreign markets and with foreign imports in U.S. markets. Finally, U.S. and foreign real GNP served as proxies for real income.

It is worth noting that the foreign price, unit cost, and income exogenous variables, in addition to the exchange rate, are weighted-average indexes. All are constructed across the same set of countries as the exchange-rate index and use bilateral trade weights. For purposes of estimating the model, though, the weights in each index—including the exchange rate—are calculated according to a country's share of either the U.S. merchandise export or import measures employed here, as opposed to shares of total trade, depending on the equation in which they appear.

The model was estimated in log-linear form on quarterly data using a maximum likelihood estimator with a correction for first-order autocorrelation. Since it is specified in log-linear form, the estimated coefficients are elasticities. The sample period spans from 1975:Q1 through 1986:Q1 and, including the lags, does not go back further than 1973:Q2, when a fixed exchange-rate regime prevailed. By extending the sample period beyond the first quarter of 1985, the model is estimated over the latest period of dollar depreciation—a period that previous studies were unable to cover—as well as the preceding episode of appreciation. All lags are first-order or second-order polynomials with their far end unconstrained. Lag lengths were determined through specification search. The coefficient estimates each have the expected sign and, with the exception of several individual lagged coefficients, are statistically significant.[27] The regression results are reported in the box on page 12.

Discussion of Empirical Estimates

There are several important aspects of the empirical results. Starting with the price equations, the magnitudes of the long-run elasticities for the exchange-rate terms indicate that only a portion of changes in the exchange rate are ultimately passed through into export and import prices. For example, in response to a 10 percent depreciation in the dollar, U.S. firms could be expected to raise the dollar price of their exports cumulatively by 3.6 percent by the fourth quarter following the depreciation. That is equivalent to the foreign-currency price of U.S. exports falling by 6.4 percent (3.6 percent minus 10.0 percent). Similarly, foreign suppliers would be expected to raise the dollar price of U.S. imports by just under 5 percent. However, in this case, nearly all of the pass-through into import prices occurs during the current and first lagged periods, suggesting that the direct domestic price impulses from dollar depreciation end quite soon after the period of depreciation is over.

Compared to what studies elsewhere in the literature have found, the estimate of the coefficient for total exchange-rate pass-through into the foreign-currency price of U.S. exports, -0.64, is, on average, about 25 percent

27 With the exception of several individual lagged coefficients and the coefficient for foreign wholesale prices in equation 2, which is significant at the 95 percent level, all coefficients are significant at the 99 percent level.

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larger in absolute value terms.[28] In contrast, the pass-through coefficient in the import price equation of 0.49 is about 25 percent lower, on average, than what has been estimated in the past.

One interpretation of the differences in the pass-through estimates rests with how U.S. and foreign suppliers may be adjusting their prices to the latest period of dollar depreciation. For U.S. suppliers, the argument would be that they have, to a greater extent than previously, foregone increases in their profit margins in order to increase their market shares abroad. In other words, the degree of pass-through into the foreign-currency prices of their exports is greater since the beginning of 1985 than it has been in the recent past.

Similarly, the reasoning in the case of foreign suppliers would be that in order to minimize their losses of market shares in the United States, they have been absorbing a higher-than-usual proportion of the dollar's depreciation—their home currency's appreciation—by reducing their profit margins. Of course, the relative degrees by which U.S. and foreign exporters are limiting their profit margins have important consequences for the extent to which the dollar's depreciation is likely to bring about an improvement in the real balance of merchandise trade over the near term.

Anecdotal evidence supports the profit-margin-cutting explanation. Between 1985:Q1 and 1986:Q2, for instance, the FRBC trade-weighted measure of the dollar fell by about 8.5 percent in nominal terms. At the same time, the implicit deflator for U.S. merchandise exports fell by more than 5 percent—implying that the foreign-currency prices of those goods fell even further—while the implicit deflator for nonpetroleum merchandise imports rose by only about 3.5 percent.

At a more analytic level, the empirical results in Mann (1986) indicate that foreign exporters to the United States are indeed cutting profit margins in the wake of the dollar's depreciation, and that U.S. exporters, while not necessarily cutting theirs, do not seem to be raising them either. Additional evidence comes from a simple re-estimation of the two price equations over a sample period ending in the first quarter of 1985—the apex of the dollar's appreciation. The coefficient of the exchange rate in the import price equation was higher by nearly 30 percent than in the longer sample period, thus eliminating the discrepancy with previous estimates, and supporting the view that foreign exporters are currently absorbing a larger-than-usual portion of the dollar's depreciation. In contrast, the coefficient of the exchange rate in the export price equation showed little change from the one estimated over the longer sample period, thus failing to help explain why our exchange-rate coefficient is smaller than that found in other studies.

The regression results also indicate that domestic cost pressures in the United States, and in foreign countries, play a role in influencing export and import prices. Firms in the United States apparently forward about half of the rate of change in U.S. wholesale prices into export prices. Foreign suppliers, though, transmit only about a third of the increases in their costs to U.S. import prices. Both coefficients—especially the elasticity of import prices to foreign costs—are of a lesser magnitude than what some previous studies have found.[29]

Here again, the differences in estimates may well be due to how U.S. and foreign suppliers have been responding to the dollar's depreciation since February 1985. The comparatively lower elasticity on production costs in both equations could indicate an increased desire on the part of both U.S. and foreign exporters to hold prices down in the face of rising costs, so as to expand market shares in the one case, and to maintain them in the other. Estimating the price equations over the shorter sample period supported this explanation. The coefficients on the domestic cost pressure terms in the export and import equations each rose to about 0.7.

The estimation results from the quantity equations bring to light several interesting conclusions. One is that the income elasticity of demand in the U.S. for imports (2.4) is considerably larger than it is in foreign countries for U.S. exports (1.0). All else constant, then, foreign real economic growth has to be substantially greater than the rate of real economic growth in the United States if the U.S. merchandise trade balance is to improve. Put differently, if real economic growth across our principal trading partners is

28 The magnitude of this coefficient does not seem to be due to the fact that our model is estimated across data from the 20 countries included in our trade-weighted exchange-rate index. When the export price equation was estimated for the 10 countries in the Federal Reserve Board's exchange rate index, using the weights from that index, the coefficient of exchange rate pass-through into the foreign-currency price of exports was found to be -0.75, which is even larger (absolutely) than ours.

29 In the export price equation (#1), we find the coefficient on the producer price index, which is used as a proxy for domestic unit cost of production, to be 0.51. If the proxy is a good one. and firms do not reduce profit margins to protect market share, the coefficient might be expected to be unity, which is what Stem, et al. (1979) found. While our result may raise some concerns, it is consistent with the findings of some other studies. See Feldman (1984) and Warner and Kreinin (1980).

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Table 5 Effects of Dollar Depreciation from 1985:Q1 to 1986:Q4, as Measured by the FRBC Exchange Rate Index, on U.S. Real Merchandise Trade[1]

Change in[2]	Cumulative Percent Change From 1985:Q1 Through: 1986:Q4	1987:Q4	Change in[2]	Cumulative Change in Billions of 1982 Dollars From 1985:Q1 Through: 1986:Q4	1987:Q4
Real Exports	4.6%	6.8%	Real Exports	$10.4	$15.4
Real Imports	-7.3%	-10.2%	Real Imports	-$20.5	-$28.7
Addendum: Import Deflator	6.0%	6.0%	Real Balance of Trade	$30.9	$44.1

1. The effects of the dollar's depreciation were estimated as follows. First, the merchandise trade model was simulated from 1985:Q1 through 1987:Q4, holding all exogenous variables constant at their 1985:Q1 levels. Then the model was simulated through 1987:Q4, allowing the exchange rate index to follow its historical path from 1985:Q1 to 1986:Q4, remaining constant thereafter, while holding all other exogenous variables constant at their 1985:Q1 levels. The difference between the two sets of simulated paths for the endogenous variables is the estimated effect of the dollar's historical depreciation on export and import price and quantity variables from 1985:Q1 through 1987:Q4.
2. Real exports are U.S. merchandise exports on a balance-of-payments basis, excluding automobile exports to Canada, in 1982 dollars. Real imports are U.S. nonpetroleum merchandise imports on a balance-of-payments basis, excluding automobile imports from Canada, in 1982 dollars. The import deflator is the implicit-price deflator for U.S. nonpetroleum merchandise imports.
Source: Federal Reserve Bank of Cleveland.

Table 6 Effects of Dollar Depreciation from 1985:Q1 to 1986:Q4, as Measured by the Federal Reserve Board Exchange Rate Index, on U.S. Real Merchandise Trade[1]

Change in[2]	Cumulative Percent Change From 1985:Q1 Through: 1986:Q4	1987:Q4	Change in[2]	Cumulative Change in Billions of 1982 Dollars From 1985:Q1 Through: 1986:Q4	1987:Q4
Real Exports	12.4%	29.1%	Real Exports	$28.3	$65.8
Real Imports	-14.8%	-19.8%	Real Imports	-$41.7	-$55.7
Addendum: Import Deflator	12.3%	12.5%	Real Balance of Trade	$70.0	$121.5

1. The effects of dollar depreciation as measured by the Federal Reserve Board index were estimated as follows. First, the merchandise trade model in the box was reestimated using the countries, currencies, and weights that correspond to the Federal Reserve Board index. Then this new model was simulated from 1985:Q1 through 1987:Q4 holding all exogenous variables constant at their 1985:Q1 levels. Then the model was simulated through 1987:Q4 allowing the Federal Reserve Board exchange rate index to follow its historical path from 1985:Q1 to 1986:Q4, remaining constant thereafter, while holding all other exogenous variables constant at their 1985:Q1 levels. The difference between the two sets of simulated paths for the endogenous variables is the estimated effect of the dollar's historical depreciation, as measured by the Federal Reserve Board index, on export and import price and quantity variables from 1985:Q1 through 1987:Q4.
2. Real exports are U.S. merchandise exports on a balance-of-payments basis, excluding automobile exports to Canada, in 1982 dollars. Real imports are U.S. nonpetroleum merchandise imports on a balance-of-payments basis, excluding automobile imports from Canada, in 1982 dollars. The import deflator is the implicit-price deflator for U.S. nonpetroleum merchandise imports.
Source: Federal Reserve Bank of Cleveland.

TABLES 5 & 6

partial-equilibrium model, fails to capture feedback and other effects, some of which might be quite important. However, construction of a general equilibrium model is beyond the scope of this study, which has as its main purpose to determine if an index of the dollar that is broader than the conventional indexes is more useful for predicting trade prices and volume.

The simulation with our model indicates that dollar depreciation from 1985:Q1 through 1986:Q4 should, all other trade influences unchanged, yield a $44 billion improvement in the real-merchandise trade balance by the end of 1987. Of this, $31 billion should have occurred by the end of 1986, leaving only a $13 billion improvement to be expected in 1987 (table 5). Of course, all other influences on trade were not unchanged and there was not, nor should we have expected, a net improvement of $31 billion prior to the end of 1986. For example, lagged effects of previous dollar appreciation, income growth, and endogenous price changes also were affecting the trade balance.

To determine how much of this simulation result was caused by use of our broader, newer index, we performed the same test using the same model and a narrower, older, established index. We re-estimated the model using the 10 countries, currencies, and weights that correspond to the Federal Reserve Board index. Then we performed the same simulation, which indicated that dollar depreciation through the end of 1986 should, ceteris paribus, yield a $122 billion improvement in real-merchandise trade by the end of 1987, with $52 billion of it to occur in 1987 (table 6). Thus, the difference in indexes causes a fourfold difference in the predicted impact in 1987. This difference can be attributed to the differences in weights and countries employed in the two indexes and to the differences in coefficients estimated in the models.

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III. Conclusions

Our research suggests four conclusions about exchange-rate indexes for the dollar. First, several nations whose currencies are excluded from the traditional exchange-rate indexes for the dollar have been increasing in importance as U.S. trade partners. Second, the FRBC index, which includes the currencies of some of these other nations and has more up-to-date weights, indicates that a much smaller proportion of the dollar's 1980:Q3-1985:Q1 appreciation had been reversed by 1986:Q4 than is indicated by a traditional index. Third, out-of-sample tests suggest that the trade model estimated in this paper using the FRBC index is probably better than the same model estimated using a traditional index. Thus, the FRBC index developed in this paper appears to be a useful tool for helping to explain and predict U.S. trade flows. Finally, the method of index construction has a significant impact on estimates of the effect of dollar depreciation on the balance of trade.

Appendix
The FRBC Merchandise Trade Model Re-estimated Using the Federal Reserve Board's Trade-Weighted Effective Exchange-Rate Index

1) *Implicit Price Deflator for Merchandise Exports*

$$PX_t = \underset{(-1.18)}{-0.35} + \underset{(5.28)}{0.25}\,(ERX \cdot FPX) + \underset{(15.69)}{0.61}\,DP_t + \underset{(4.77)}{0.58}\,e_{t-1}$$

R^2 (adjusted) = .9986 DW = 1.3
(t-statistics in parentheses) F-statistic = 7609.9
Sample period: 1975:Q1 - 1986:Q1

The coefficient for the exchange-rate term is a long-run elasticity and is the sum of the following contemporaneous and lagged coefficients:

t	t-1	t-2	t-3	t-4	t-5
0.01	0.03	0.05	0.05	0.05	0.04
(0.38)	(2.35)	(1.91)	(2.25)	(3.43)	(1.02)

2) *Implicit Price Deflator for Nonpetroleum Merchandise Imports*

$$PM_t = \underset{(-1.28)}{-0.66} + \underset{(4.01)}{0.31}\,ERM + \underset{(3.45)}{0.75}\,DP_t + \underset{(0.47)}{0.11}\,FPM_t + \underset{(8.91)}{0.80}\,e_{t-1}$$

R^2 (adjusted) = .9986 DW = 1.1
(t-statistics in parentheses) F-statistic = 7582.0
Sample period: 1975:Q1 - 1986:Q1.

The coefficient for the exchange-rate term is a long-run elasticity and is the sum of the following contemporaneous and lagged coefficients:

t	t-1	t-2
0.20	0.11	0.01
(5.05)	(4.01)	(0.07)

3) *Real Merchandise Exports*

$$QT_t = \underset{(-8.32)}{-7.98} - \underset{(-7.61)}{00.9}\,PX/(ERX \cdot FPX) + \underset{(14.24)}{1.94}\,FGNPX_t + \underset{(3.85)}{0.52}\,e_{t-1}$$

R^2 (adjusted) = .9920 DW = 1.7
(t-statistics in parentheses) F-statistic = 1243.7
Sample period: 1976:Q1 - 1986:Q1

The coefficient for the relative price term is a long-run elasticity and is the sum of the following contemporaneous and lagged coefficients:

t	t-1	t-2	t-3
0.01	-0.05	-0.10	-0.13
(0.37)	(-1.78)	(-3.70)	(-3.57)

t-4	t-5	t-6	t-7	t-8
-0.15	-0.14	-0.12	-0.09	-0.03
(-3.79)	(-4.70)	(-6.09)	(-2.24)	(-0.42)

4) *Real Nonpetroleum Merchandise Imports*

$$QM_t = \underset{(-6.31)}{-6.58} - \underset{(-5.77)}{1.74}\,(PM/DP) + \underset{(11.21)}{2.43}\,GNP_t + \underset{(6.77)}{0.71}\,e_{t-1}$$

R^2 (adjusted) = .9851 DW = 2.1
(t-statistics in parentheses) F-statistic = 729.71
Sample period: 1976:Q1 - 1986:Q1.

The coefficient for the relative price term is a long-run elasticity and is the sum of the following contemporaneous and lagged coefficients:

t	t-1	t-2	t-3	t-4	t-5	t-6
-0.33	-0.35	-0.35	-0.31	-0.24	-0.14	-0.01
(-1.52)	(-3.49)	(-3.36)	(-2.58)	(-2.40)	(-1.56)	(-0.56)

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Appendix (continued)

The merchandise-trade model developed in part II is estimated here using the Federal Reserve Board trade-weighted effective exchange-rate index. In this case, all exogenous variables in the model were reconstructed on the basis of the actual multilateral weights and the 10 countries used in the Federal Reserve Board's index (see table 2). The definitions of all variables are the same as those listed in the box. Lag lengths were determined by specification search and, hence, were allowed to differ from the FRBC version of the model. Three out of the four equations were estimated over a sample period from 1975:Q1 to 1986:Q1, the same as for the FRBC model. In the other equation, because the lags were longer, the sample period began in 1976:Q1 in order to exclude observations from the period during which exchange rates were fixed. The estimation technique was the same as for the FRBC version, and all variables are in natural logs.

By and large, the estimation results indicate that the version of the model estimated using the Federal Reserve Board dollar index fits the data well. The coefficients are each of the expected sign and, with the exception of the elasticity of import prices with respect to foreign wholesale prices and a few individual lagged coefficients, each is statistically significant.

In the equation for real nonpetroleum merchandise imports, since the exchange-rate term and measures of foreign prices and income do not explicitly appear as determinant factors, the coefficient estimates above are identical to those estimated in the FRBC version of the model.

REFERENCES

Anderson, Gerald H. and John B. Carlson. "Does Dollar Depreciation Matter: The Case of Auto Imports from Japan," Federal Reserve Bank of Cleveland, *Economic Commentary,* May 1, 1987.

Artus, Jacques R. and Anne Kenny McGuirk. "A Revised Version of the Multilateral Exchange Rate Model," *International Monetary Fund Staff Papers,* vol. 28, no. 2 (June 1981), pp. 275-309.

Batten, Dallas S. and Michael T. Belongia. "The Recent Decline in Agricultural Exports: Is the Exchange Rate the Culprit?,"Federal Reserve Bank of St. Louis, *Review,* vol. 66, no. 8 (October 1984), pp. 5-14.

Belongia, Michael T. "Estimating Exchange Rate Effects on Exports: A Cautionary Note," Federal Reserve Bank of St. Louis, *Review,* vol. 68, no. 1 (January 1986), pp. 5-16.

Branson, William H. "Causes of Appreciation and Volatility of the Dollar," in "The U.S. Dollar—Recent Developments, Outlook and Policy Options," Federal Reserve Bank of Kansas City: 1985), pp. 33-52.

Data Resources Inc., *Review of the US. Economy,* (December 1985).

Data Resources Inc., *Review of the US. Economy,* (December 1986).

Deephouse, David L. "Using a Trade-Weighted Currency Index," Federal Reserve Bank of Atlanta, *Economic Review,* vol. 70, no. 6, (June/July 1985), pp. 36-41.

Deppler, Michael C. and Duncan M. Ripley. "The World Trade Model: Merchandise Trade," *International Monetary Fund Staff Papers,* vol. 25, no. 1, (March 1978), pp. 147-206.

Federal Reserve Board of Governors. "Index of Weighted-Average Exchange Value of the U.S. Dollar: Revision," *Federal Reserve Bulletin,* no. 8, vol. 64, (August 1978), p. 700.

Federal Reserve Board of Governors. *Federal Reserve Bulletin,* (various monthly issues from 1973 to date).

Feldman, Robert A. "The Impact of the Recent Strength of the Dollar on the U.S. Merchandise Trade Balance: Some 'First-Round' Effects and Feedbacks from Exchange Rate Induced Changes in U.S.-Relative Inflation," *Journal of Policy Modeling* (vol. 6, no. 1, 1984), pp. 29-44.

Feldman, Robert A. "The Trade Balance Effects of the Dollar's Recent Strength," Federal Reserve Bank of New York, *Research Paper* No. 8206, January 1982.

Feldman, Robert A. "Dollar Appreciation, Foreign Trade, and the U.S. Economy," Federal Reserve Bank of New York, *Quarterly Review,* vol. 7, no. 2, (Summer 1982), pp. 1-9.

http://clevelandfed.org/research/review/
Best available copy

Frenkel, Jacob A "Commentary on 'Causes of Appreciation and Volatility of the Dollar,'" in *The US. Dollar—Recent Developments, Outlook and Policy Options,* (Federal Reserve Bank of Kansas City: 1985), pp. 53-63.

Hooper, Peter. "Forecasting U.S. Export and Import Prices and Volumes in a Changing World Economy," Board of Governors of the Federal Reserve System, *International Finance Discussion Papers,* no. 99, December 1976.

Hooper, Peter and John Morton. "Summary Measures of the Dollar's Foreign Exchange Value," *Federal Reserve Bulletin,* vol. 64, no. 10, (October 1978), pp. 783-789.

International Monetary Fund. *International Financial Statistics,* (various monthly issues from 1973 to date).

Mann, Catherine L. "Prices, Profit Margins, and Exchange Rates," *Federal Reserve Bulletin,* vol. 72, no. 6 (June 1986), pp. 366-379.

Meese, Richard and Kenneth Rogoff. "Was it Real? The Exchange Rate-Interest Differential, 1973-1984," Board of Governors of the Federal Reserve System, *International Finance Discussion Papers,* No. 268, August 1985.

Meyer, Stephen A "Trade Deficits and the Dollar: A Macroeconomic Perspective," Federal Reserve Bank of Philadelphia, *Business Review* (September/October 1986), pp. 15-25.

Morgan Guaranty Trust Company. *World Financial Markets* (various monthly issues, 1973 to date).

Proctor, Allen J. "A Forecasting Model of the Services Account of the U.S. Balance of Payments: Preliminary Results," Federal Reserve Bank of New York, *Research Paper* No. 8237, December 1982.

Rhomberg, Rudolf F. "Indices of Effective Exchange Rates," *International Monetary Fund Staff Papers,* vol. 23, no. 1 (March 1976), pp. 88-112.

Rude, Chris. "The Role of the Dollar and the Changing Composition of Real U.S. Merchandise Trade: 1980 to 1984," unpublished Federal Reserve Bank of New York *Working Paper,* March 1986.

Schuh, G. Edward. "Future Directions for Food and Agricultural Trade Policy," *American Journal of Agricultural Economics,* vol. 66, no. 2 (May 1984), pp. 242-247.

Solomon, Robert. "Effects of the Strong Dollar," in *"The US. Dollar—Recent Developments, Outlook and Policy Options"* (Federal Reserve Bank of Kansas City: 1985) pp. 65-88.

Spitaller, Erich. "Short-Run Effects of Exchange Rate Changes on Terms of Trade and Trade Balance," *International Monetary Fund Staff Papers,* vol. 27, no. 2 (June 1980), pp. 320-348.

Stern, Robert M., Christopher F. Baum and Mark N. Greene. "Evidence on Structural Change in the Demand for Aggregate U.S. Imports and Exports," *Journal of Political Economy,* vol. 87, no. 1, (February 1979), pp. 179-192.

Warner, Dennis and Mordechai E. Kreinin. "Determinants of International Trade Flows," Institute for International Economic Studies, University of Stockholm, Seminar Paper No. 161 (1980).