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The Recent Behavior of U.S. Trade Prices

Prepared by Daniel Citrin*

Authorized for distribution by
Yusuke Horiguchi

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Abstract

There is a widespread view that the adjustment of U.S. trade prices--and hence merchandise trade flows--in the face of the substantial dollar depreciation since early 1985 has been slower than might have been expected. This paper examines the recent behavior of U.S. trade prices, and concludes that the modest movements are largely attributable to a decline in computer prices, swings in commodity prices, and the growing importance of computers in U.S. trade. Empirical results suggest that once the influence of computer and commodity prices are taken into account, the recent behavior of U.S. trade prices is not out of line with historical experience.

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Summary

In spite of the substantial decline in the real effective value of the dollar since March 1985, the U.S. merchandise trade deficit continued to widen in nominal terms until late 1987. While the deficit has narrowed more recently, a widespread view remains that the adjustment to exchange rate changes has been slower than might have been expected. In this connection, attention has been drawn to the behavior of U.S. import and export prices, which have risen by less than might have been expected given the decline in the value of the dollar.

This paper examines the recent behavior of these prices on the basis of different indicators and concludes that the modest movement in the national accounts deflators for nonagricultural exports and non-oil imports is largely attributable to swings in commodity prices and to a decline in the price of computers, which now figure more prominantly in U.S. trade. To take account of the influences of these factors, the paper constructs fixed weighted price indices for manufactured exports and imports, excluding computers.

The paper then outlines a theoretical model of trade price determination and presents an empirical analysis of the movements in the fixed weighted price indices based on the model. Estimation results over the sample period 1974-84 suggest that changes in exchange rates and production costs are fully passed through to changes in U.S. export and import prices in the long run. With regard to import prices, the results suggest that foreign exporters initially absorb roughly one fifth of a loss in competitiveness by lowering profit margins. This behavior, combined with a lag with which changes in foreign export prices are reflected in changes in U.S. import prices, implies significantly less than full pass-through over a period of several quarters.

Results obtained by predicting the movements in trade prices during 1985-87 on the basis of the estimated equations suggest that, when allowance is made for the special factors referred to above, the recent behavior of U.S. trade prices is not out of line with historical experience.

I. Introduction

In spite of the substantial decline in the real effective value of the dollar since March 1985, the U.S. merchandise trade deficit continued to widen in nominal terms until late 1987. While there has been some improvement more recently, a widespread view remains that the adjustment to exchange rate changes has been slower than might have been expected on the basis of historical experience, and in this connection attention has been drawn to the behavior of U.S. import and export prices.

Over the period 1985-87, these prices rose by less than would have been expected given the decline in the value of the dollar. 1/ This behavior has been in part attributed to movements in the prices of commodities and business machines (office equipment and computers) and foreign production costs. 2/ In addition, however, it has been suggested that U.S. exporters may have chosen not to increase profit margins in the face of the dollar's decline in order to regain market shares lost during the dollar's rise. At the same time, foreign exporters are viewed as having curtailed their profit margins by more than would be suggested by historical experience so as to maintain market shares.

This paper examines the recent behavior of U.S. export and import prices and evaluates the roles played by the various factors noted above. Section 2 reviews recent developments with regard to U.S. trade prices. Section 3 outlines a theoretical model of trade price determination, and Section 4 presents an empirical analysis of the movements in export and import prices based on the model. The empirical results suggest that when special factors such as changes in the price of commodities and business machines are taken into account, the recent behavior of U.S. trade prices is not out of line with historical experience.

II. Recent Developments in Trade Prices

1. Export prices

After declining at an annual rate of about 1 1/2 percent from mid-1982 to the first quarter of 1985, the price of nonagricultural exports as measured by the implicit deflator in the national income accounts,

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1/ For example, nonagricultural export prices and non-oil import prices are substantially overpredicted since 1985 in William Helkie and Peter Hooper, "An Empirical Analysis of the U.S. External Deficit, 1980-86," in Ralph Bryant, et al, eds., External Deficits and the Dollar: The Pit and the Pendulum, the Brookings Institution, 1988, and in Hooper and Catherine Mann, "The U.S. External Deficit: Its Causes and Persistence," October 1987.

2/ For a study of import price behavior, see also Steven Dunaway and Lloyd Kenward, "U.S. Import Prices and Dollar Depreciation" (unpublished, IMF, 1987).

continued to fall at a rate of 1 percent a year through the first quarter of 1988. The decline in the earlier period occurred in the face of the rapid appreciation of the dollar, which would have been expected to result in some squeeze in profit margins of U.S. exporters. The continued fall in export prices, however, was a generally unexpected development because a depreciation would be expected to provide exporters room not only to pass on cost increases but also to expand profit margins. 1/ Standard equations based on production costs and competitors' prices adjusted for exchange rate changes have tended to overpredict the level of the implicit deflator for U.S. nonagricultural exports by an increasing amount over the period 1985-87.

Major factors behind the unexpected behavior of the implicit deflator for nonagricultural exports are the movements of export prices of business machines and commodities and the growing importance of business machines in U.S. exports. Export prices of business machines dropped at an average annual rate of 12 percent from the first quarter of 1985 to the first quarter of 1988; prices of commodities also declined sharply until the end of 1986 before recovering in 1987. At the same time, the share of business machines in nonagricultural exports rose from 14 percent in the first quarter of 1985 to 21 percent in the first quarter of 1988. 2/

To take account of the influences of these factors on the implicit deflator, a fixed-weighted price index of U.S. manufactured exports excluding business machines was constructed. 3/ From the first quarter of 1985 to the first quarter of 1988, this index rose at an average annual rate of 2 1/4 percent (compared with the 1 percent a year fall for the implicit deflator noted above) while unit labor costs in the manufacturing sector declined at a 1 percent annual rate and producer prices of intermediate inputs remained flat (Chart 1).

2. Import prices

After declining by 2 percent a year from mid-1981 to early 1985, the price of non-oil imports, as measured by the national income accounts implicit deflator, began to pick up in late 1985. The subsequent rise, however, has been relatively modest given the size of the depreciation of the dollar. From the first quarter of 1985 to the first

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1/ It may be noted in this connection that unit labor costs in the nonfarm business sector have risen at a modest pace since early 1985.

2/ Implicit deflators are current-weighted indices and therefore their movements reflect the effects of both shifts in commodity composition and genuine price changes. The large increase in the weight of business machines has magnified the impact of the drop in their prices on the implicit deflator for nonagricultural exports.

3/ The index is based on 1982 weights and includes autos, capital goods, and consumer goods. Since this is an index for manufactured exports, commodities are excluded.

CHART 1

UNITED STATES

EXPORT PRICES

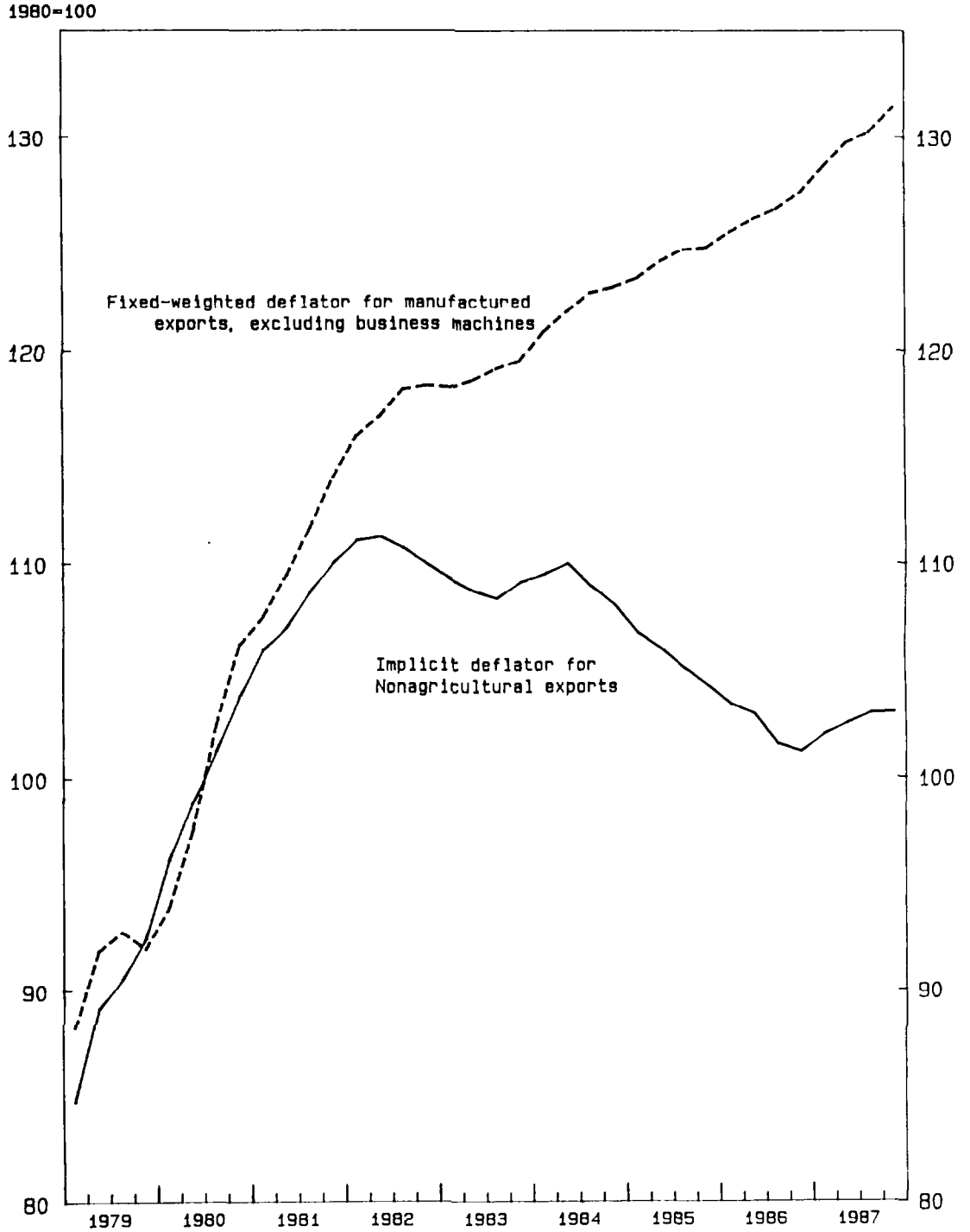
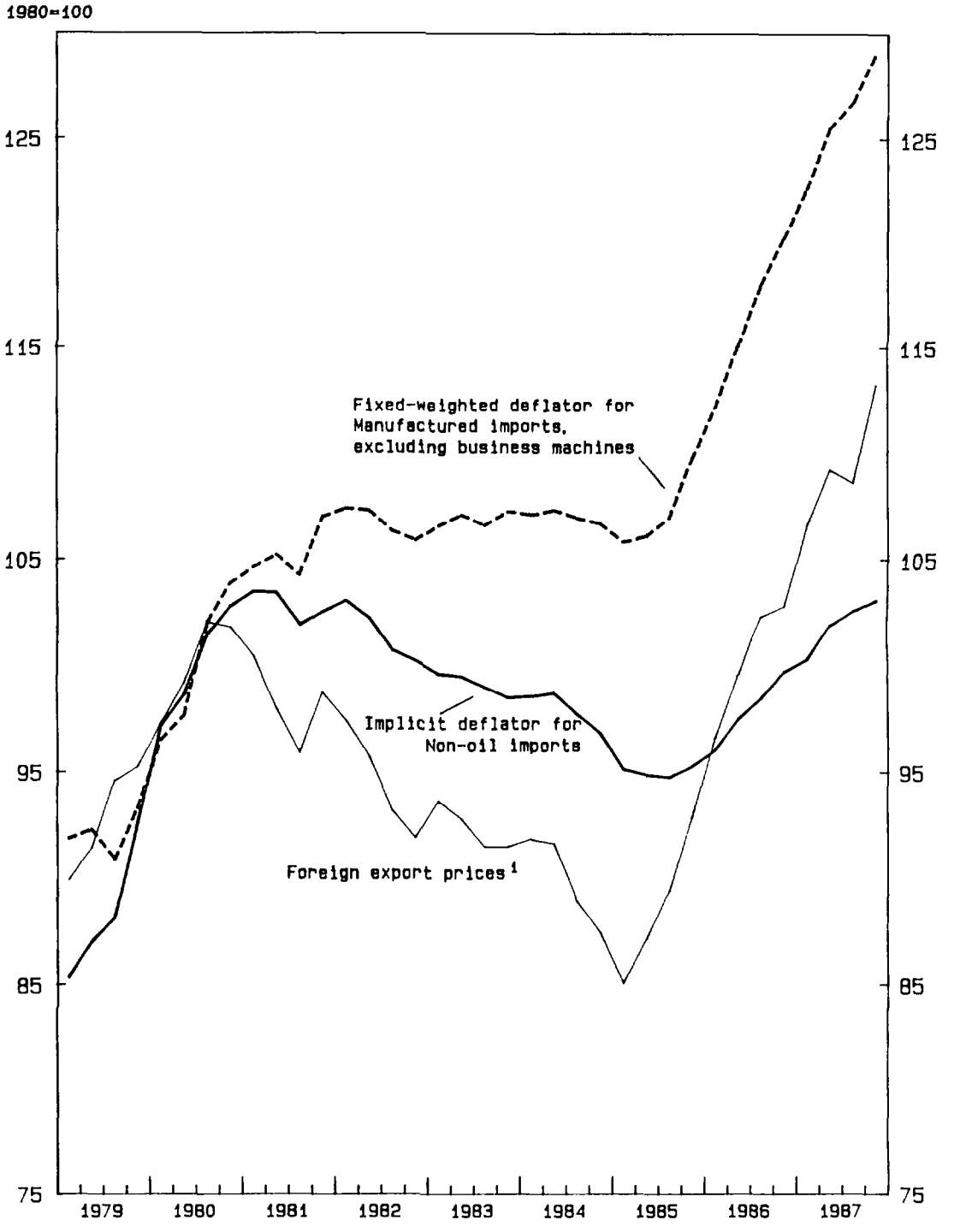


CHART 2

UNITED STATES

IMPORT PRICES



[1]Weighted by shares in U.S. imports of manufactured goods in 1980.

quarter of 1988, the price of non-oil imports increased at an annual rate of only 3 percent, while the nominal effective value of the dollar (MERM weights) declined at an annual rate of about 15 percent. Indeed, standard equations for the implicit deflator for non-oil imports which had performed quite well historically overpredicted the actual rise in import prices over the period 1985-87 by a substantial margin.

The unexpectedly modest rise in the implicit deflator for non-oil imports also may be explained in part by the movements of the prices of business machines and commodities and the rising weight of business machines in total non-oil imports. Import prices of commodities have exhibited wide swings over the past few years, and their level in the first quarter of 1988 was only modestly above that prevailing in the first quarter of 1985. As regards business machines, the deflator for imports used in the official statistics is the same as that for exports, which as noted above has declined substantially in recent years. 1/ Moreover, the impact of this decline on the implicit (current-weighted) import deflators is again magnified by the pronounced rise in the share of business machines in total non-oil imports (from 3 percent in 1982 to almost 8 percent in the first quarter of 1985 and to 15 percent in the first quarter of 1988). To adjust for the influence of these factors, a fixed-weighted deflator for manufactured imports excluding business machines was developed. 2/ This index shows an annual rate of increase of 7 1/2 percent since early 1985, after having remained roughly constant in the first half of the 1980s (see Chart 2).

Even with these adjustments, import prices still appear to have risen less than might have been expected given the size of the dollar's depreciation. The remaining discrepancy largely can be explained by the following two factors.

First, the dollar's depreciation against the currencies of some countries that are important suppliers to the United States has been much less than that against the major industrial countries. An average exchange rate index of 11 principal exporters to the United States that incorporates these currencies shows an annual rate of decline in the

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1/ In both cases, the price of domestically produced business machines is used. In addition to influencing the aggregate indices, this use of domestically produced business machines has two shortcomings. First, the mix of domestic machines differs from that of imports. Second, the steep decline in the dollar since early 1985 probably implies that the price of imported machines is rising relative to those produced domestically.

2/ As in the case of the alternative export price index, this index includes autos, capital goods, and consumer goods, and excludes commodities.

value of the dollar since early 1985 of 10 percent, as compared with the 15 percent rate of decline in the MERM index. 1/

Second, foreign export prices have been held down to some extent by the decline in energy prices, the effects of currency appreciation on prices of imported raw materials and intermediate inputs, and also by modest increases in unit labor costs. A weighted average of manufactured export prices of the major U.S. suppliers included in the alternative exchange rate index remained roughly constant in foreign currency terms during the period 1985-87, owing largely to a 1/2 percent annual average drop in input prices. Over this period, foreign export prices and production costs in manufacturing thus moved broadly in tandem, suggesting that foreign exporters have not reduced their profit margins substantially in response to the appreciation of their currencies. 2/

As a final point in this section, it may be noted that since early 1985 the price of total exports of manufactured goods of partner countries (including certain major developing countries) expressed in U.S. dollar terms has moved broadly in line with the U.S. import price of manufactured goods excluding business machines. This is in contrast to the first half of the 1980s, when foreign export prices in dollar terms fell significantly relative to U.S. import prices. While this could suggest that profit margins on exports to the United States were built up relative to other export markets during those years, there has been no apparent further change in relative profit margins across markets since early 1985. 3/

III. The Trade Price Model

This section presents a simple model that may be used to analyze the movements of U.S. trade prices. A behavioral equation is developed for both U.S. export prices (in U.S. dollars) and foreign export prices (in foreign currency). U.S. import prices are then specified as a function of foreign export prices expressed in U.S. dollar terms.

The pricing of exports is analyzed assuming a producer that discriminates between its export and its domestic markets. The analysis proceeds in the following two steps. An optimal export price for the

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1/ The alternative index covers seven major industrial countries, Hong Kong, Korea, Mexico, and Taiwan Province of China, and is weighted by their shares in U.S. imports of manufactured goods in 1980.

2/ Foreign production costs are calculated as the weighted average of raw materials prices and unit labor costs in manufacturing, using input-output weights for each country.

3/ The difference between movements in U.S. import prices and foreign exports prices in U.S. dollars also may reflect differences in commodity composition and the influence of import restrictions such as the voluntary export restraints on Japanese automobiles.

producer can be specified as one that maximizes profits subject to a short-run production function. The path of actual export prices can then be derived by incorporating certain additional considerations that might cause export prices to deviate from their strict profit-maximizing level.

Assuming a short-run Cobb-Douglas production function with constant returns to scale with respect to variable inputs of labor and intermediate inputs, with producers facing a downward sloping demand curve with constant price elasticity, 1/ the profit-maximizing export price (Px^*) may be written (with lower-case letters denoting logarithms) as:

$$px^* = a_0 + a_1 \, ulc + a_2 \, pi \qquad (1)$$

where ULC is the cost of labor per unit of output, and Pi is the price of intermediate inputs (and raw materials).

The actual path of export prices may deviate from their profit-maximizing level because prices may be sticky due to information costs or uncertainty about the demand response to price changes. In addition, exporters may desire to keep their prices in line with those of their competitors, at least in the short run, in order to protect market shares. The actual export price is assumed to be set so as to achieve the best possible compromise between the objective of maximizing profits and these additional considerations. Since all three objectives would not be attainable at the same time, the actual export price (px) at time t can be determined by minimizing the total cost from not meeting all targets simultaneously. The total cost may be specified according to the following quadratic loss function: 2/

$$L = \ell_1 \, (px - px^*)^2 + \ell_2 \, (px - px_{-1})^2 \qquad (2)$$

$$+ \ell_3 \, (px - pc)^2 + \ell_4 \, ((px - px_{-1}) - (pc - pc_{-1}))^2$$

1/ Constant returns to scale and constant demand elasticity are commonly used assumptions and allow technical progress (or productivity gains) to be subsumed in the unit labor cost variable and the export price to be independent of the level of total output.

2/ For similar formulations of trade price behavior see Jacques Artus, "The Behavior of Export Prices for Manufactures," The Effects of Exchange Rate Adjustments, P. Clark, et al, Ed., Department of the Treasury, 1974; Isher Ahluwalia and Ernesto Hernández-Catá, "An Econometric Model of U.S. Merchandise Imports Under Fixed and Fluctuating Exchange Rates, 1959-73, "IMF Staff Papers," November 1975.

L is the total loss subjectively perceived by suppliers. The coefficient ℓ_1 is the loss associated with deviating from the short-run optimum. The coefficient ℓ_2 is the loss associated with not maintaining stable prices. The loss related to deviations from the foreign competing price in domestic currency terms (pc) is split into two elements. The coefficient ℓ_3 represents the cost of not staying in line with competing prices in the long run, and is a function of the relative price level. The coefficient ℓ_4 represents the loss associated with short-run deviations from foreign prices, and is a function of the relative price change.

Minimizing the loss function (2) with respect to px yields:

$$px = m_1\, px^* + m_2\, px_{-1} + m_3\, pc + m_4\, (pc - pc_{-1} + px_{-1}) \tag{3}$$

where $m_1 = \ell_1/S$, $m_2 = \ell_2/S$, $m_3 = \ell_3/S$, $m_4 = \ell_4/S$,

and $S = \ell_1 + \ell_2 + \ell_3 + \ell_4$.

The equation determining the actual export price may now be obtained by substituting from equation (1) for the optimal short-run price:

$$px = b_0 + b_1\, ulc + b_2\, pi + b_3\, px_{-1} + b_4 pc + b_5\, (pc - pc_{-1} + px_{-1}) \tag{4}$$

The import price faced by a country can be expressed as a simple function of the foreign export price converted into domestic currency ($px^{\$}$), with lagged terms to account for delays between order and delivery:

$$pm = \sum_{0}^{w} c_i \cdot px^{\$}_{-i} \tag{5}$$

IV. Empirical Tests 1/

Equation (4) was used to estimate equations for the fixed-weighted price index for U.S. exports of manufactured goods excluding business machines and the weighted average of foreign export prices discussed above. Equation (5) was used to estimate the relationship between foreign export prices and the fixed-weighted price index for U.S. imports of manufactured goods excluding business machines. The equations were estimated using quarterly data over the sample period 1974:I to 1984:IV. These equations then were predicted over the period 1985:I to 1987:IV in order to test whether the behavior of trade prices has changed significantly during the recent period of a sharp decline in the value of the dollar.

1. Estimation results

The fixed-weighted price index for U.S. exports of manufactured goods excluding business machines (px^{us}) was estimated as a function of unit labor costs and intermediate import prices in the U.S. manufacturing sector, and a weighted average of export prices of competing foreign suppliers in major U.S. export markets expressed in U.S. dollars, (pcx). Because of strong multicollinearity between unit labor costs and intermediate input prices, they were combined into a single variable cost term (vc) using weights obtained from the 1977 U.S. input-output table. The regression results on the equation corrected for serial correlation are presented below (with t-statistics in parentheses): 2/

$$px^{us} = \underset{(1.18)}{0.092} + \underset{(2.73)}{0.246}\ vc + \underset{(0.05)}{0.002}\ pcx + \underset{(1.27)}{0.070}\ (pcx - pcx_{-1} + px^{us}_{-1}) + \underset{(7.67)}{0.667}\ px^{us}_{-1}$$

$$\bar{R}^2 = 0.993 \quad SEE = 0.011 \quad \hat{\rho} = \underset{(3.18)}{0.458}$$

1/ The necessary data was obtained from numerous national sources. Details are available upon request.

2/ Since the equation includes a lagged endogenous variable and initial regressions indicated serially correlated errors, an instrumental variable approach was used in order to obtain a consistent estimate of the degree of first-order serial correlation (ρ). Tests of the residuals of the equation corrected for serial correlation did not indicate any remaining serial correlation. The equation for foreign export prices was estimated in a similar fashion.

The estimation results suggest that over the period 1974-1984, the price of U.S. exports was determined by domestic costs in both the short and the long run. The coefficient on the level of the foreign competing price (pcx) was not significant and almost equal to zero, implying full pass-through in the long run of changes in domestic costs and no long-run impact of changes in exchange rates on U.S. export prices. 1/ The coefficient on the term representing the influence of relative price changes ($pcx - pcx_{-1} + px_{-1}^{us}$) was positive but small and not very significant, suggesting a limited short-run response of U.S. export prices to changes in foreign competing prices in U.S. dollars. The following tabulation illustrates this result.

Cumulative Effects of a 1 Percent Rise in Foreign Prices

(In percent)

Quarterly period	U.S. export price
0	0.042
1	0.033
2	0.027
3	0.022
4	0.019
8	0.011
12	0.009
∞	0.007

Foreign export prices (pxf) in foreign currency terms were estimated as a function of foreign unit labor costs and intermediate input prices in the manufacturing sector, 2/ and competing U.S. producer prices of manufacturing goods expressed in foreign currency (pc). As in the case of the U.S. export price equation, a foreign variable cost term (vcf) was constructed according to appropriate input-output weights to handle multicollinearity between foreign unit labor costs and intermediate input prices. The regression results are presented below:

1/ Pass-through is defined here to measure the extent to which changes in exchange rates, foreign prices or domestic costs would be reflected in export prices. It does not include the indirect effect of exchange rate changes on prices through their impact on domestic costs, which is a separate issue.

2/ In the absence of appropriate data on wholesale prices of intermediate goods, the overall wholesale price index was used for Mexico and Taiwan Province of China, the industrial producer price index for Canada, and the consumer price index for Hong Kong.

$$pxf = \underset{(3.09)}{0.631} + \underset{(6.05)}{0.423}\ vcf - \underset{(0.01)}{0.001}\ pc$$

$$+ \underset{(4.64)}{0.221}\ (pc - pc_{-1} + pxf_{-1}) + \underset{(2.67)}{0.221}\ pxf_{-1}$$

$$\bar{R}^2 = 0.951 \qquad SEE = 0.007 \qquad \hat{\rho} = \underset{(9.28)}{0.843}$$

The estimation results suggest that costs of production are the major long-run determinant of foreign export prices. The coefficient on the competing U.S. producer price term (pc) is not significantly different from zero, suggesting that foreign export prices do not respond to movements in competing prices or the exchange rate in the long-run. The positive and significant coefficient on the term representing the effect of relative price changes ($pc - pc_{-1} + pxf_{-1}$) suggests, however, that in the short run the pricing behavior of foreign exporters can be influenced substantially by movements in exchange rates or by the pricing behavior of U.S. producers. The estimated elasticity of foreign export prices with respect to competing U.S. prices in foreign currency terms is shown in the tabulation below. The results suggest that on average foreign exporters initially absorb roughly one-fifth of a loss in competitiveness by lowering profit margins. Prices adjust quickly thereafter toward their long-run level; after two or three quarters almost all of the initial impact of a change in exchange rates or U.S. prices on foreign export prices (expressed in foreign currency) would be reversed.

Cumulative Effects of a 1 Percent Fall in Competing Prices

(In percent)

Quarterly period	Foreign Export Price	U.S. Import Price
0	-0.219	0.220
1	-0.096	0.557
2	-0.042	0.878
3	-0.018	0.947
4	-0.007	0.977
8	0.001	1.000
∞	0.001	1.001

Finally, the fixed-weighted price index for U.S. imports of manufactured goods excluding business machines was estimated as a distributed lag of current and previous foreign export prices expressed in U.S. dollars ($pxf^{\$}$). Regression results, with the equation corrected for

serial correlation by the standard Cochrane-Orcutt procedure are presented below. 1/

$$pm = \underset{(2.28)}{0.324}\ pxf^{\$} + \underset{(2.24)}{0.380}\ pxf^{\$}_{-1} + \underset{(2.32)}{0.329}\ pxf^{\$}_{-2}$$

$$\bar{R}^2 = 0.992 \quad SEE = 0.018 \quad \hat{\rho} = \underset{(19.07)}{0.963} \quad D.W. = 1.27$$

The results suggest that changes in foreign export prices are fully translated into changes in U.S. import prices after three quarters; the sum of the lag coefficients on foreign export prices is equal to 1.03 and is not significantly different from 1. 2/ Thus, as the last column of the previous tabulation illustrates, changes in exchange rates are fully passed through to U.S. import prices in the long run. In the short run, however, the impact of changes in competitiveness on the pricing behavior of foreign exporters, combined with the lag with which changes in foreign export prices in local currency terms get reflected into changes in U.S. import prices, implies significantly less than full pass-through over a period of several quarters.

2. Predictive performance

In order to examine the extent to which the recent behavior of U.S. trade prices may have deviated from what would have been expected on the basis of historical experience, the estimated equations presented above were forecast over the period from the first quarter of 1985 to the fourth quarter of 1987. 3/ The in-sample (1974:I - 1984:IV) and post-sample performance of the estimated equations are shown in Charts 3 and 4.

Chart 3 indicates that the estimated equation tends to underpredict the behavior of U.S. export prices by an increasing margin. About one half of the forecast errors are due to the fact that the predictions do not adjust for serially correlated errors; remaining errors are within two standard deviations of the mean U.S. export price over the forecast period. These results suggest that once adjustments are made for prices

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1/ The lag coefficients were estimated using an Almon lag distribution of degree 2 with no end-point constraint.

2/ It should be noted, however, that the strong presence of serial correlation suggests that the equation is probably affected by errors of measurement such as differences in commodity composition or changes in pricing to the U.S. market relative to the rest of the world.

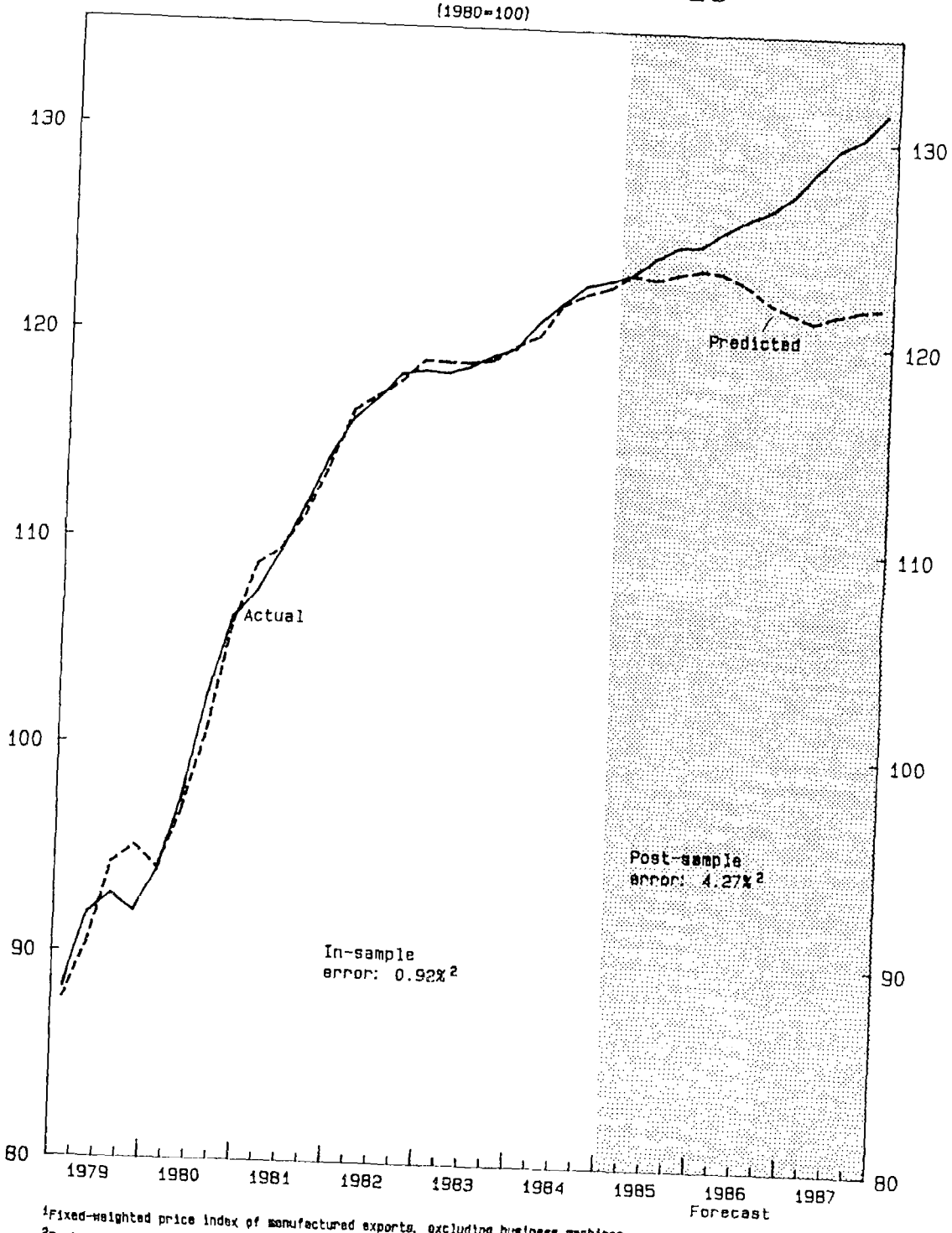
3/ The post-sample predictions did not incorporate the effect of serially correlated errors.

CHART 3

UNITED STATES

ACTUAL AND PREDICTED PRICES OF EXPORTS OF MANUFACTURES[1]

(1980=100)



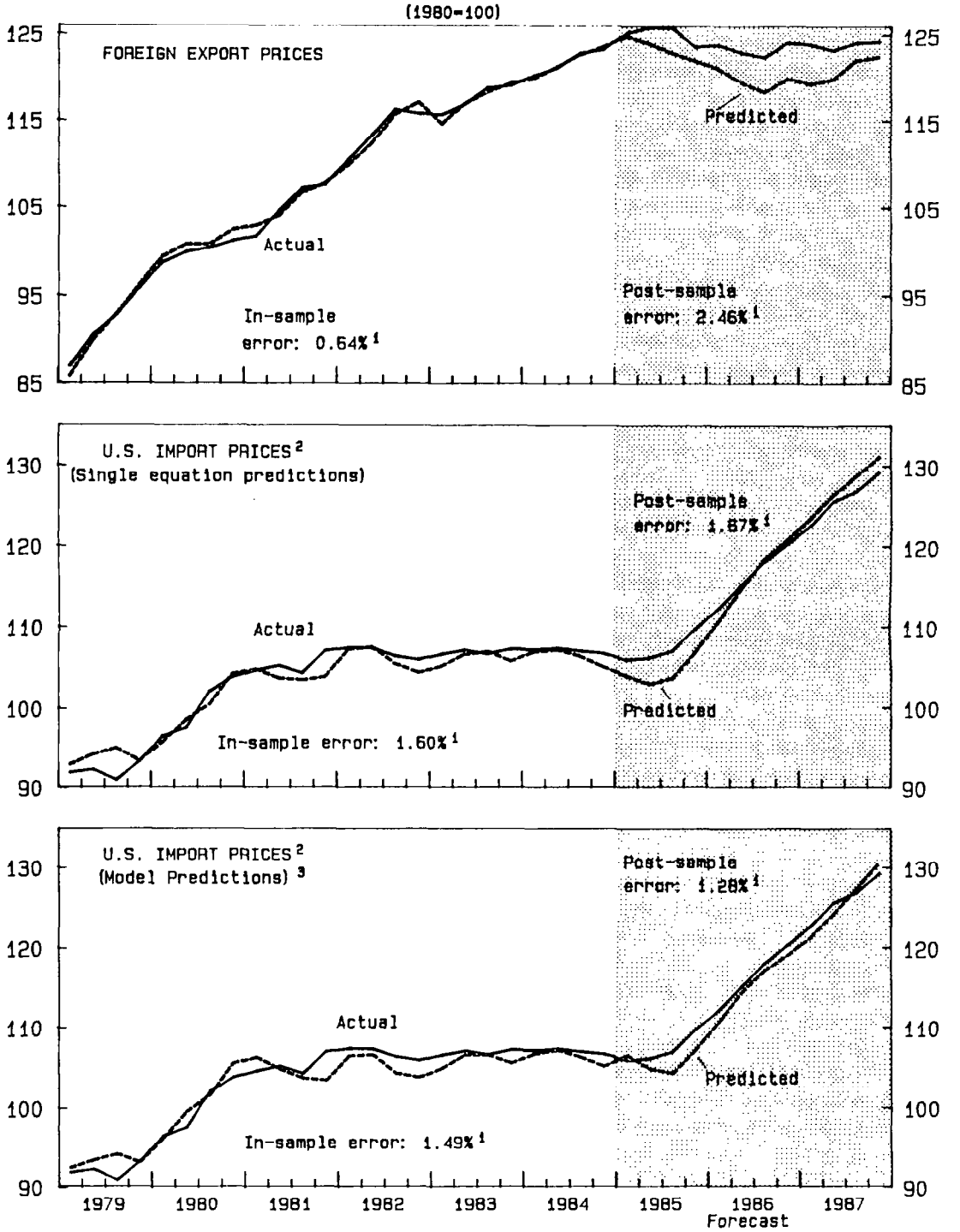
[1]Fixed-weighted price index of manufactured exports, excluding business machines.

[2]Root-mean-squared prediction error in percent of sample mean of actual value.

CHART 4

UNITED STATES
ACTUAL AND PREDICTED PRICES OF FOREIGN EXPORTS AND U.S. IMPORTS OF MANUFACTURES

(1980=100)



[1]Root-mean-squared prediction error in percent of sample mean of actual value.

[2]Fixed-weighted price index of manufactured imports, excluding business machines.

[3]Based on predicted values of foreign export prices.

of commodities and business machines and changes in commodity composition, movements in U.S. export prices since early 1985 have been in line with historical experience. If there had been a significant change in the pricing behavior of U.S. exporters and, as a result, the response of U.S. export prices to the depreciation of the dollar had been restrained in the face of the depreciation of the dollar, the equation would have been expected to overpredict U.S. export prices in the post-sample period.

The top panel of Chart 4 shows the predictive performance of the foreign export price equation. This equation underpredicted foreign export prices in foreign currency terms during the period 1985-87, with the extent of underprediction increasing through the first quarter of 1987 before declining over the rest of the forecast period. Thus, the results suggest that foreign exporters have not significantly changed their pricing behavior by absorbing a greater than normal proportion of the depreciation of the dollar.

The middle panel of Chart 4 shows the single-equation predictive performance of the U.S. import price equation. The bottom panel of the chart shows a forecast for U.S. import prices using predicted values of foreign export prices expressed in U.S. dollars. In both cases, the equation tends to underpredict in the early part of the forecast period, followed by small overpredictions that are not statistically significant toward the end of the forecast period. Thus, the results do not indicate that since early 1985, foreign exporters increasingly cut profit margins on their exports to the United States relative to other destinations in order to maintain their shares of the U.S. market.