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Introduction and Summary

The sensitivity of the U.S. economy to international influences has increased significantly over the past two decades, with a rapid expansion of U.S. trade taking place in an environment of divergent growth and inflation rates across countries and increasingly sharp fluctuations in exchange rates. These developments have elicited a growing demand for accurate forecasting and policy analysis in the international sector of the economy. However, the development and improvement of analytical techniques has not kept pace with that demand.

In particular, the technology underlying one set of fundamental analytical tools -- trade elasticities -- is little changed from that which was soundly criticized by Orcutt (13) in 1950. Income and price elasticity estimates are still derived for the most part in single demand equations that include real income and relative prices as the determinants of trade volumes. Attempts to estimate elasticities with simultaneous equation techniques have met with only marginal success because of difficulties involved in specifying separate supply relationships. Efforts to incorporate additional supply variables in the demand equations have been more fruitful-- Gregory (5) formalized and successfully implemented the use of nonprice rationing variables to capture the impact on U.S. imports of cyclical swings in supply conditions that were not adequately represented in relative price movements.

Nevertheless, even with this innovation aggregate U.S. trade demand equations continue to exhibit two disturbing characteristics. The first is temporal instability. Several studies have established the existence of significant shifts in the U.S. import demand function during the past two decades. Wilson (15) and Hooper (6), found statistically significant upward shifts and Joy and Stolen (10) a downward shift in the estimated income elasticity of import demand during the early-1960's, based on a somewhat arbitrary splitting of estimation sample periods.^{1/} Stern et al. (14), using more sophisticated search techniques over the period from the mid-1950's to the mid-1970's, concluded that the U.S. import function showed a significant shift around 1970 (although the direction of shift for individual coefficients was not indicated), while the export function showed no significant shift. No attempt has been made yet to correct for the specification error implied by these shifts.

The second disturbing characteristic is the apparent persistence of Houthakker and Magee's (8) empirical result that the income elasticity of demand for U.S. imports is substantially greater than that of demand for U.S. exports. Since the mid-1950's the volume of U.S. imports has grown twice as fast as U.S. real GNP, after correcting for the influence of relative price changes. The volume of exports has grown only 1-1/4 times as fast as real GNP in U.S. major trading partners. Despite these elasticity differences, U.S. exports and imports grew at roughly the same rate (until recently), reflecting the fact that U.S. income growth during the 1960's and early 1970's was substantially below the average of other major industrial countries. During the past two years, however, U.S. growth has been above the average of other major industrial countries, and the

U.S. trade deficit has widened to an unprecedented level.^{2/} If the recent pattern of U.S. GNP growth relative to foreign growth continues, ceteris paribus, the Houthakker-Magee result implies a continuing rapid deterioration of the U.S. trade position.

This paper postulates that both the Houthakker-Magee result and the observed instability of the import equation can be attributed, at least in part, to specification error in the standard functional form of that equation. In the first section of the paper, the time pattern and direction of shifts in standard export and import demand functions over the past twenty years are identified. This analysis focuses on nonagricultural exports and nonoil imports; the excluded categories are briefly considered separately for completeness. The results reveal significant upward shifts in estimates of both income and price elasticities of U.S. nonoil imports during the early 1960's, followed by significant downward shifts in those estimates during the early 1970's. The export demand function is found to be relatively stable over time, confirming the results of previous analyses.

The second part of the paper tests the hypothesis that observed shifts in the nonoil import function were associated with changes in foreign supply conditions. The timing and direction of observed shifts in the import function coincide with a rapid expansion of imports of new products (automobiles, consumer durables, etc.) from Japan and Europe that previously had not been produced for export by those countries. Such a fundamental shift in foreign supply conditions

would not have been reflected adequately in relative price or cyclical variables, though it may well have been spuriously correlated with the strong upward trend in U.S. GNP during the shift period. Several variables designed to capture these supply effects are tested in the import equation. They are found to explain part of the shifts in the income and price elasticities. In doing so, they also reduce both the magnitude of the estimated income elasticity and the significance of the Houthakker-Magee result. They also help to stabilize the import function.

I. Testing for Structural Shifts

A. Statistical Tests

The standard statistical test for structural shift is the familiar F-test developed by Chow (4). The usefulness of this test is limited inasmuch as the shift period must be specified a priori. Stern et. al. (14) tested for structural change in U.S. trade equations with an alternative series of statistical procedures developed by Brown et al. (3) and implemented by Kahn (11) which are designed to determine directly from the data whether or not structural change has taken place and, if so, when. The adoption of these techniques was a useful innovation, and the results appeared to indicate a structural shift in the import equation around 1970. However, the results of the three alternative tests were not altogether consistent, and they did not reveal the direction of shift either in the entire equation or in individual coefficients.

A different procedure is adopted in this paper in an effort first to identify the timing and direction of shifts in income and price elasticities. Once the shift periods have been identified, they are tested for statistical significance using Chow's F test. The search procedure is straightforward. Export and import volume equations are specified first. These equations are then estimated over successive (overlapping) 6-year (24-quarter) sub-sample periods spanning the entire 21-year sample period from 1957 to 1977. The results yield a listing of successive (partially independent) elasticity estimates that have been allowed to change gradually over time as changes in the underlying structure have taken place.

B. Equation Specifications

Two alternative equation specifications are employed. The first is the same basic functional form employed by Houthakker and Magee.^{3/} Trade volume is expressed as a function of real income and a distributed lag of relative prices.^{4/} A dummy variable is added to the equation to explain unusual variance due to dock strikes. The equations are estimated in logarithmic form in order to obtain constant elasticity estimates:

$$(1a) \quad \ln \frac{XNA}{PXNA} = a_0 + a_1 \ln Y_f + a_2 \ln \left(\frac{PXNA \cdot ER}{Pf} \right) + a_3 \ln DSX + e_a$$

$$(1b) \quad \ln \frac{MNO}{PMNO} = b_0 + b_1 \ln Y + b_2 \ln \left(\frac{TR \cdot PMNO}{P} \right) + b_3 \ln DSM + e_b$$

where,

XNA = Nonagricultural export value
PXNA = Nonagricultural export unit value

- Yf = Weighted average of real GNP in six major foreign industrial countries. ^{5/}
 ER = Weighted average value of the dollar in terms of six major currencies.
 Pf = Weighted average wholesale price index (for all commodities) in six major countries.
 DSX = Dock strike dummy specific to nonagricultural exports (from Isard (9)).
 MNO = Nonoil import value.
 PMNO = Nonoil import unit value.
 Y = U.S. real GNP.
 TR = Index of U.S. tariff rates (reflecting Kennedy - Round reductions).
 P = U.S. GNP deflator.
 DSM = Dock strike dummy specific to nonoil imports.

The second equation specification includes cyclical (nonprice rationing) variables, and in the case of imports, an inventory change variable. Cyclical variables are assumed to behave the same as price variables: as demand pressure and capacity utilization fluctuate during cyclical swings, supply is rationed (at least in the short run) by changes in order-delivery lags, customer credit terms and other contract "extras."^{6/} Inventory change is included to account for the impact of changes in the domestic stock of imported goods on the flow of those goods.^{7/} Much of the sharp fluctuation in U.S. imports in 1973-75, for example has been attributed to domestic inventory behavior.^{8/} These equations are written:

$$(2a) \quad \ln \frac{XNA}{PXNA} = a_0 + a_1 \ln Yf + a_2 \ln \frac{PXNA \cdot ER}{Pf} + a_3 \ln CYCf + a_4 \ln CYC + a_5 \ln DSX + e_a$$

$$(2b) \quad \ln \frac{MNO}{PMNO} = b_0 + b_1 \ln Y + b_2 \ln \frac{TR \cdot PMNO}{P} + b_3 \ln CYC + b_4 \ln CYCf + b_5 \ln CINV + b_6 \ln DSM$$

where,

CYC = The ratio of actual U.S. industrial production to trend industrial production.

CYCf = Weighted average ratio of actual to trend industrial production for six major countries.

CINV = Change in U.S. constant dollar nonfarm business inventories.

C. Results -- Nonagricultural Exports and Nonoil Imports

These equations were estimated using quarterly data over sixteen successive (overlapping) six-year sub-sample periods spanning 1957-77. The income and price elasticity estimates and their t-ratios are listed in Tables 1 and 2 for nonagricultural exports and nonoil imports, respectively.

The results for the basic nonagricultural export equation (on the left hand side of Table 1) show relatively stable income and price elasticity estimates for that equation over the past 20 years. The income elasticity generally fluctuated between 1.15 and 1.35 and the price elasticity between -0.6 and -0.9. In only three subperiods between 1969 and 1976 did the estimates deviate substantially from these ranges. During the first two of those subperiods (beginning in 1969), the income elasticity fell well below its range, while the price elasticity rose substantially above its range. These movements were reversed in the next subperiod (1971-1976), with a substantial increase in the income elasticity matched by an equally great decline in the price elasticity.

The offsetting movements in the income and price elasticities are symptomatic more of collinearity between the income and relative price variables during those periods than of structural shift in the export equation.^{9/} Indeed, Chow's F-test run on the sample period split alternatively at the end of 1969, 1970 and 1971 failed to reveal any statistically significant shift in the equation.

The addition of U.S. and foreign cyclical variables to the equation did not significantly affect the results. In most cases

coefficients on the cyclical variables were statistically insignificant. In some cases income elasticities declined while price elasticities increased (in absolute magnitude), but there was no evidence of significant shift in the equation. The income and price elasticity estimates for the entire sample period (1958-77) were about the same in both equations (just under 1.25 and -0.75, respectively).

The results for the nonoil import equation (Table 2) show considerably less stability than those for exports. In the basic equation (excluding cyclical variables), the estimated income elasticity shifted up from less than 1.5 in the late 1950's and early 1960's to more than 2.0 during the middle and late 1960's. In the early 1970's it abruptly shifted down again, from a level of about 2.8 to a level below 1.8. There is little evidence that these shifts were the result of collinearity with the relative price term. In fact, the price elasticity estimates generally did not shift in an offsetting direction (as was the case in the export equation), but in the same direction as the income elasticity, with both increasing in absolute value during the 1960's. The upward shift in the price elasticity reinforced the positive effect of the shift in the income elasticity because the ratio of U.S. nonoil import prices to the U.S. GNP deflator was steadily declining during the mid-late 1960's.

The addition of cyclical variables to the equation tended to reduce both the income and price elasticity estimates during the cyclical periods of the late 1950's - early 1960's, and the 1970's (as shown on the right hand side of Table 2). During the period of strong trend growth from the early 1960's to the early 1970's, there

was minimal variance in the cyclical variables though they tended to raise the income and price elasticities. Estimates obtained for the entire sample period showed little difference between the two equations, with the income elasticity averaging about 2.05 and the price elasticity about -1.10.

Based on the above results the sample period was spilt at the end of 1963 and again at the end of 1970. The elasticity estimates obtained for the resulting three independent subperiods are shown in the bottom half of the table. F-tests run on the equation results for the first two subperiods indicated a statistically significant shift at a 95 per cent confidence level, and for the second two subperiods a statistically significant shift at a 90 per cent confidence level. These results are consistent with the earlier work of Joy and Stolen (10), Wilson (15) and Hooper (6) who found shifts in the import function during the early-mid 1960's, and Stern et. al. (14) who found a shift around 1970.

D. Total Exports and Imports

The above tests were also run for total U.S. exports and imports using the same functional forms. The results for total exports were fairly similar to those for nonagricultural exports, with no evidence of significant shifts. However, the estimated income elasticity for the whole sample period was lower (0.8 to 0.9), while the price elasticity was higher (-1.1 to -1.2). Agricultural exports

(in volume terms) have expanded less rapidly than nonagricultural exports, on average, over the past twenty years. But in recent years they have fluctuated more widely, reflecting the impact of shifts in world supply conditions. An abnormal rise (and subsequent decline) in agricultural exports in 1973, for example, reflected temporary widespread crop failures in major foreign producing regions (notably the Soviet Union). It would have been misleading to attribute such shifts to a change in income and price-related consumption patterns.

The total import equation behaved much the same as the non-oil import equation during the 1950's and 1960's, showing a significant shift during the early 1960's. However, there was no evidence of a significant shift around 1970, and if anything, the income elasticity estimate appeared to be greater in the 1970's than in the 1960's. The income elasticity estimates obtained for total imports over the 1957-1977 sample period were above those for nonoil imports (2.30 - 2.50 compared with 2.03 - 2.10). This result reflects in large part the acceleration of oil imports during the 1970's, which offset much of the decline in nonoil import growth during that period. The expansion of oil imports (in volume terms) jumped from an average annual rate of about 6 per cent during the 1960's to nearly 16 per cent during the 1970's. In contrast, growth of non-oil import volume dropped from about 9 per cent per year during the

earlier period to 5 per cent per year. Between 1967 and 1977, the ratio of oil imports to nonoil imports (in constant dollars) rose from .08 to .17 at 1967 prices, or from .21 to .42 at 1977 prices.

It would be misleading to conclude from the aggregate import equation results that the relationships of individual commodities to domestic income and relative prices had shifted in offsetting directions, leaving the aggregate relationship unchanged. As with agricultural exports the shift in oil imports during the 1970's reflected changes in supply conditions rather than demand conditions. Domestic oil consumption has continued to grow at about the same rate as real GNP throughout the 1960's and 1970's, but domestic oil production shifted from an average annual increase of just over 3-1/2 per cent during the 1960's, to an average annual decline of more than 1-1/2 per cent during the 1970's.^{10/} It should be noted that even if domestic production were constant over time, the observed elasticity of oil imports with respect to domestic GNP would still be unstable. Constant domestic production implies an ever-increasing share of imports in domestic consumption as consumption grows over time. As that share increases, the percentage change in imports required to meet a given change in consumption -- the observed consumption (income) elasticity -- will decline.

To summarize, movements in U.S. oil imports and agricultural exports reflect changes in supply conditions at home and abroad (respectively) as much as they do changes in demand conditions. For

this reason they should be treated separately in an excess demand or excess supply framework.^{11/} If instead oil imports and agricultural exports are included in single aggregate import and export demand equations, they will yield biased and unstable estimates of the true demand elasticities. The degree of bias will vary with the extent to which supply shifts are correlated with income and relative prices. While such correlation could facilitate forecasting, its usefulness may be limited in view of the historical instability of supply conditions.

Finally, even if both supply and demand conditions for these categories were stable, observed income elasticities could still shift over time as the shares of imports (exports) in domestic (foreign) consumption changed.

II. Stabilizing the Nonoil Import Equation

The degree of instability in the nonoil import equation is a strong indication of specification error. One or more factors (in addition to income, relative prices and nonprice rationing) that influenced imports during the sample period were not adequately represented in the equation. The instability may have been related in part to changes in domestic supply conditions -- particularly for nonoil raw materials -- much as changes in domestic oil production has influenced oil imports. However, the particular time pattern of shifts in the elasticity estimates, along with the

movements in various components of nonoil imports over the past two decades, suggests that much of the observed shift was associated with secular changes in foreign supply conditions that would not have been reflected in relative price changes.

From 1963 to 1971 the volume of U.S. nonoil imports grew at an average annual rate of about 9 per cent, twice the 4-1/2 per cent rate recorded during both 1956-63 and 1971-77. Nearly two-thirds of the very rapid growth during 1963-71 was accounted for by iron and steel products and finished durable goods (including capital goods, automobiles and other consumer durables)^{11a/}. The share of these goods in nonoil imports rose from 20 per cent in 1963 to 47 per cent in 1971. After 1971 the growth of these imports (in volume terms) slowed considerably, and their share of total nonoil imports dropped slightly (to 46 per cent in 1977).

During the rapid growth period from 1963 to 1971 nearly two-thirds of the increase in imports of steel and finished durable goods came from Western Europe and Japan, while a little less than one-third came from Canada and the rest of the world accounted for about 5 per cent. Most of Canada's share of the growth reflected the expansion of automotive trade following the signing of the Canadian - U.S. Automotive Agreement in 1965 and the increase in Canadian automotive production capacity during the latter 1960's. Imports of autos from Canada rose from less than \$50 million in 1963 to more than \$4.5

billion in 1971. Imports of autos from Western Europe and Japan rose almost as dramatically (without the help of an accommodating trade agreement), as did imports of consumer durables, capital goods and steel products.

The substantial shift in the pattern of U.S. imports towards sophisticated durable goods reflected more than just the effects of changes in U.S. income and (observed) relative-prices. It also reflected a fundamental change in foreign supply conditions -- the expansion of foreign production capacity into new product areas and the penetration of new markets (with investment in sales and service overhead and advertising) in the United States.^{12/} Increased efficiency in production undoubtedly helped foreign producers to penetrate the U.S. market. These developments would not have been adequately reflected in changes in observed relative price series since many of the imports were new products that previously had not been included (or had had a much lower weight) in the relevant price indexes. Instead, to the extent that they were correlated with the strong trend increase in income during the mid-late 1960's, they had the effect of increasing the estimated income elasticity (both in the mid-late-1960's and for the whole sample period) to implausibly high levels.^{13/}

In an effort to correct for this specification error two different variables designed to capture the shift in foreign supply conditions were tested in the import volume equations. These included a time trend and a distributed lag on foreign real domestic investment in plant and equipment (as a proxy for changes in foreign output capacity). Equations including these variables were estimated over the entire sample period and over the 1964-70 sub-period. In the former case the supply shift variables were held constant before 1964 and after 1970.^{14/} These estimation results are listed in Table 3; columns 1-3 list the basic equations with and without the supply shift variables and columns 4-6 list comparable equations including cyclical (nonprice rationing) variables.

The addition of the supply shift variables effectively reduced the estimated income elasticities for both sets of equations. In the equations including nonprice rationing variables, the income elasticity was reduced from 2.1 to between 1.3 and 1.7. The income elasticity reduction was somewhat less in the equations excluding cyclical variables. The time trend variable had a greater effect on the income elasticity estimate than the foreign domestic investment variable, and in the equation including cyclical variables it had the a priori undesirable effect of diminishing the relative price coefficient. The results for the equations estimated over

1964-70 were similar to those reported in Table 3, though the reduction in income and price elasticities were more extreme.

In addition to reducing the elasticity estimates, the two supply shift variables also increased the overall stability of the equation. Chow tests were run on the equations including those variables, splitting the sample period at the end of 1963 and again at the end of 1970. In both cases the significance of the structural shift in the early 1960's was reduced from 95 per cent to 90 per cent, and that of the shift in the early 1970's was reduced from 90 per cent to less than 80 per cent. These results suggest that some but not all of the structural change in those equations could be explained by the particular supply shift variables that were chosen.

III. Conclusions

This analysis has provided some useful insight into the recent historical behavior of standard aggregate trade equations and elasticity estimates. Based on this insight, several conclusions can be drawn with respect to: (1) the stability of the equations and the elasticity estimates, (2) the current magnitude of the elasticities, and (3) implications for the Houthakker-Magee result.

1. Stability

The conventional demand equation for U.S. nonagricultural exports has been relatively stable over the past twenty years. That for U.S. nonoil imports, however, has shown considerable instability. Both the income and price elasticities of import demand shifted up

significantly in the early 1960's and back down again (though not by as much) in the early 1970's. These shifts reflected a rapid acceleration of durable goods imports during the 1960's, which can be attributed at least in part to fundamental shifts in foreign supply conditions that would not have been fully captured in a standard demand equation. By adding variables representing these foreign supply shifts, the shifts in the income elasticity estimates and the instability of the overall equation can be reduced significantly, though not eliminated. This technique was less successful in stabilizing the import price elasticity.

2. Current Levels of Elasticities

The income elasticity of nonoil import demand, (based on an equation including cyclical variables) has averaged about 1.6 (in recent sub-sample period estimation) for the 1970's. This average is significantly below the point estimate of 2.1 obtained for the whole sample period (1957-77), but it is well within the range of estimates obtained when foreign supply shift variables were added to the equation. The 1.6 estimate is above the average estimate of about 1.2 obtained for the late 1950's and early 1960's subperiod. This apparent increase in the income elasticity between the two subperiods is consistent with the impact of the foreign supply shift on the commodity composition of U.S. imports. The supply shift during the 1960's helped to raise the share of finished durable

goods (plus steel manufactures) from one-fifth to nearly one-half of U.S. nonoil imports. Since finished durables are generally more income elastic than most other goods, a net increase in the total nonoil income elasticity from the 1950's to the 1970's could be expected.

Movements in the price elasticity for imports have been even more volatile than those in the income elasticity. Based on recent sub-period estimates and supply-shift-adjusted estimates for the whole sample period, the point elasticity would appear to be somewhere in the neighborhood of -0.5 currently. However, there is a wide band of uncertainty surrounding this estimate. Depending upon the particular supply shift variable included and whether or not cyclical factors are taken into account, the estimated price elasticity varies between -1.2 and -0.1, and going back historically the range has been even greater. Both the cyclical variables and the supply shift variables may be capturing price effects, thereby causing a downward bias in the estimated price elasticity.^{15/}

The income and price elasticity estimates for Nonagricultural exports have been more stable, averaging about 1.25 and -0.75, respectively.

3. Implications for Houthakker-Magee Result

Houthakker and Magee (H-M) obtained income elasticity estimates of 1.0 and 1.7 for total U.S. exports and imports, respectively, estimated over the period 1951-66. Using similar equations for nonagricultural

exports and nonoil imports over the period 1957-77, estimates of 1.2 and 2.0 were obtained in this study, suggesting that the H-M result may have strengthened over time.^{16/} However, when the effects of shifts in foreign supply conditions and short term cyclical fluctuations were taken into account, the import elasticity dropped by enough (to about 1.6) to suggest that the H-M result may in fact have weakened over time.

Footnotes

*/ I would like to thank my colleagues, especially Edwin M. Truman, Michael P. Dooley, Samuel Pizer and Walther Lederer for their helpful comments and suggestions, and Chiriyon Dominick for her considerable assistance with the computational work that went into this paper. My thanks also extend to Henry C. Wallich for originally suggesting this topic. The views expressed herein are my own and do not necessarily represent the views of the Board of Governors of the Federal Reserve System or anyone else on its staff.

1/ Joy and Stolen's result can be attributed to collinearity between the income term and a time trend that they included in the import equation. (See Hooper (7).)

2/ During the six-month period ending in March 1978, the trade deficit rose to \$43 billion at an annual rate, or to about 2.2 per cent of current nominal GNP -- by both measures, substantially greater than at any other time in the past two decades.

3/ The functional form used here differs from that employed by Houthakker Magee (H-M) in several respects. In the export equation the H-M used foreign export prices instead of foreign domestic wholesale prices as the denominator of the relative price term. Also, H-M used annual data instead of quarterly data, total imports and exports, no lags, and a broader sample of countries.

4/ The lag on relative prices in the import equation is five quarters, and that in the export equation seven quarters. The Almon technique was used to estimate the lags (using a second-degree polynomial with a zero end-constraint.) Lag lengths ranging from 0 to 12 quarters were tested (for the entire sample period); those chosen yielded the best equation fits.

5/ The six countries with their respective weights (based on bilateral trade shares) in parentheses include: Canada (41%), Japan (26%), Germany (13%), U.K. (10%), France (5%) and Italy (5%).

6/ See Gregory (5) for a more detailed discussion of nonprice rationing and its impact on trade flows. Most studies (including Gregory's) have considered only the impact of nonprice rationing in the importing country. The specifications used in this study extend this concept to include the impact of nonprice rationing in the exporting country as well.

Footnotes

7/ Changes in total nonfarm business inventories are used as a proxy for inventories of imported goods (for which data are not available). The inventory variable is excluded from the export equation because of insufficient historical data.

8/ U.S. Department of Commerce, Survey of Current Business (December 1975) p. 14, Board of Governors of The Federal Reserve System, Federal Reserve Bulletin (April, 1976) p. 286.

9/ The coefficient of simple correlation between foreign real GNP and the specific 8-quarter distributed lag on relative prices over the period 1968-1975 was -0.76. This reflects the fact that the price of U.S. nonagricultural exports relative to foreign wholesale prices in dollars declined from 1969 to 1973 when foreign real GNP was rising, and rose from 1974 to 1975 when foreign real GNP was falling. Since the impact of relative price movement on exports was directly correlated with the impact of income changes during this period, a decline in income responsiveness could accompany an increase in price responsiveness without a shift in export growth.

10/ In the late 1950's U.S. oil production averaged just under 8.0 million barrels per day. Production rose fairly steadily until it reached a peak of 11.7 mbd in 1970, it then declined to 10.4 mbd in 1977 and has risen slightly in early 1978 with the coming-on-stream of Alaskan oil.

11/ Income and price elasticities of import demand are not well defined for goods that are not differentiated across countries. See Leamer and Stern (14), pp. 11-12, for a discussion of this problem.

11a/ Iron and steel products accounted for about 10 per cent and finished durable goods for about 55 per cent of the growth in nonoil imports from 1963 to 1971.

12/ Artus and Turner (2) have documented the rapid growth of capital stock in manufacturing in Japan and Europe during the 1960's, which has slowed substantially during the 1970's.

13/ An income elasticity of 2.0 - 2.1 is implausible as a long run proposition, as it implies an ever-increasing share of imports in domestic absorption and (in conjunction with a much lower export elasticity) a continually deteriorating trade balance.

Footnotes

14/ This particular treatment of the supply shift variable was suggested both by the pattern of elasticity estimates illustrated in Table 2, and by the pattern of foreign capital stock growth reported by Artus and Turner (2). Additional knowledge concerning further supply shifts would enhance the forecasting usefulness of this specification. While it is evident that the expansion of output capacity has slowed in major industrial countries, such supply shifts could still be taking place in newly industrializing countries such as Korea, Taiwan, Singapore, Brazil and Mexico.

15/ Several other factors may have contributed to the relatively low estimated price elasticity: (1) in the presence of upward-sloping foreign supply curves, the elasticity estimate is a combination of a negative price elasticity of demand and a positive price elasticity of supply (See Orcutt (13)), (2) the GNP deflator (in the denominator of the relative price term) includes expenditure categories with relatively low price elasticities (health care, rent, etc.) and, (3) nonoil imports include various raw and semi-manufactured materials whose prices have been much more volatile than those of manufactured goods.

16/ The addition of agricultural exports would have reduced the total export elasticity, while the addition of oil imports would have increased the import elasticity, thereby strengthening further the H-M result. A recent study by Akhtar (1), using the H-M estimation framework found the income elasticity of total U.S. imports estimated over the period 1952-76 to be 2.2. Oil imports and agricultural exports have been excluded from the present analysis because of inherent instability of income elasticities for those categories caused by shifting supply conditions in the importing country.

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*/ A listing of statistical sources and data may be obtained from the author upon request.

Table 1

Income and Price Elasticity Estimates for U.S. Nonagricultural Exports Over Alternative Sample Periods, 1958-1977 (Quarterly Data)

| Estimation Sample Period | Basic Equation (Excluding Cyclical Variables) | | Equation Including Cyclical Variables | |
|--------------------------|---|----------------------------|---------------------------------------|----------------------------|
| | Income Elasticity (t-ratio) | Price Elasticity (t-ratio) | Income Elasticity (t-ratio) | Price Elasticity (t-ratio) |
| 1958-63 | 1.32 (5.05) | -1.74 (-1.22) | 1.14 (3.45) | -1.41 (-0.97) |
| 1959-64 | 1.19 (7.39) | -0.77 (-5.40) | 1.03 (5.69) | -0.92 (-5.68) |
| 1960-65 | 1.03 (12.95) | -0.92 (-12.77) | 0.75 (5.67) | -1.17 (-9.64) |
| 1961-66 | 1.16 (21.88) | -0.80 (-16.40) | 0.85 (3.38) | -1.08 (-4.68) |
| 1962-67 | 1.15 (18.55) | -0.81 (-14.03) | 1.05 (7.39) | -0.90 (-6.79) |
| 1963-68 | 1.20 (15.66) | -0.75 (-10.38) | 1.14 (8.75) | -0.82 (-6.80) |
| 1964-69 | 1.28 (24.74) | -0.69 (-13.76) | 1.18 (9.25) | -0.77 (-6.63) |
| 1965-70 | 1.38 (37.32) | -0.59 (-15.90) | 1.21 (19.40) | -0.74 (-12.38) |
| 1966-71 | 1.35 (27.80) | -0.61 (-12.65) | 1.07 (10.03) | -0.88 (-8.44) |
| 1967-72 | 1.36 (20.01) | -0.60 (-8.85) | 1.10 (5.36) | -0.85 (-4.14) |
| 1968-73 | 1.05 (5.36) | -0.92 (-4.64) | 0.77 (3.45) | -1.17 (-5.22) |
| 1969-74 | 0.61 (2.12) | -1.36 (-4.62) | 0.47 (0.80) | -1.51 (-2.50) |
| 1970-75 | 0.84 (2.50) | -1.14 (-3.30) | 1.05 (2.39) | -0.92 (-2.03) |
| 1971-76 | 1.42 (6.96) | -0.54 (-2.53) | 1.39 (4.86) | -0.57 (-1.94) |
| 1972-77 | 1.24 (7.52) | -0.72 (-4.19) | 1.22 (4.04) | -0.75 (-2.41) |
| 1958-77 | 1.22 (60.62) | -0.74 (-37.56) | 1.23 (60.91) | -0.74 (-37.62) |

Table 2

Income and Price Elasticity Estimates for U.S. Nonoil Imports Over Alternative
Sample Periods, 1957-1977 (Quarterly Data)

| Estimation Sample Period | Basic Equation (Excluding Cyclical Variables) | | | Equation Including Cyclical Variables | | |
|--------------------------------|---|----------------------------------|-----------|---------------------------------------|----------------------------------|-----------|
| | Income Elasticity (t-ratio) | Price Elasticity (t-ratio) | (t-ratio) | Income Elasticity (t-ratio) | Price Elasticity (t-ratio) | (t-ratio) |
| 1957-62 | 1.44 (5.90) | -0.27 (-0.82) | | 1.20 (4.47) | -0.03 (-0.08) | |
| 1958-63 | 1.32 (5.34) | -0.10 (-0.32) | | 1.10 (4.96) | 0.16 (0.55) | |
| 1959-64 | 2.27 (3.91) | -1.41 (-1.77) | | 1.17 (7.28) | 0.09 (0.42) | |
| 1960-65 | 1.87 (12.60) | -0.85 (-4.25) | | 1.23 (38.02) | 0.00 (0.12) | |
| 1961-66 | 2.05 (20.29) | -1.10 (-7.97) | | 1.05 (12.26) | 0.26 (2.27) | |
| 1962-67 | 2.07 (21.73) | -1.13 (-8.64) | | 1.72 (20.56) | -0.66 (-5.74) | |
| 1963-68 | 2.24 (20.69) | -1.36 (-9.11) | | 2.29 (7.33) | -1.45 (-3.35) | |
| 1964-69 | 2.29 (29.91) | -1.43 (-13.46) | | 1.84 (7.19) | -0.83 (-2.38) | |
| 1965-70 | 2.32 (23.14) | -1.46 (-10.39) | | 2.34 (10.06) | -1.49 (-4.64) | |
| 1966-71 | 2.50 (11.05) | -1.72 (-5.38) | | 2.59 (9.49) | -1.83 (-4.83) | |
| 1967-72 | 2.76 (12.38) | -2.09 (-6.59) | | 2.76 (17.45) | -2.08 (-9.34) | |
| 1968-73 | 1.37 (4.44) | -0.09 (-0.20) | | 2.19 (16.74) | -1.27 (-6.81) | |
| 1969-74 | 1.14 (6.37) | 0.26 (1.09) | | 1.76 (14.63) | -0.66 (-3.88) | |
| 1970-75 | 1.71 (15.38) | -0.59 (-3.76) | | 1.64 (6.49) | -0.49 (-1.39) | |
| 1971-76 | 1.71 (13.67) | -0.58 (-3.31) | | 1.63 (7.37) | -0.48 (-1.52) | |
| 1972-77 | 1.79 (8.91) | -0.69 (-2.48) | | 1.60 (9.48) | -0.44 (-1.83) | |
| 1957-63 | 1.28 (6.17) | -0.05 (-0.20) | | 1.15 (5.51) | 0.09 (0.34) | |
| 1964-70 | 2.36 (26.17) | -1.52 (-12.07) | | 2.49 (13.94) | -1.71 (-6.97) | |
| 1971-77 | 1.73 (10.49) | -0.60 (-2.62) | | 1.64 (9.03) | -0.50 (-6.94) | |
| 1957-77 | 2.03 (10.65) | -1.04 (-3.90) | | 2.10 (10.07) | -1.15 (-3.97) | |

Table 3

U.S. Nonoil Import Volume Equation Estimates, 1957-1977 (Quarterly)

| Equation No: Variable: | Coefficient Estimates (and t-ratios) | | | | | |
|--------------------------------|--------------------------------------|------------------|------------------|------------------|----------------|-----------------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Income | 2.03 (10.65) | 1.72 (9.58) | 1.89 (8.01) | 2.10 (10.07) | 1.27 (7.65) | 1.70 (5.53) |
| Relative Price | -1.04 (-3.90) | -0.69 (-3.07) | -1.06 (-4.18) | -1.15 (-3.97) | -.14 (-.66) | -.92 (3.19) |
| U.S. Cyclical Variable | | | | .20 (.76) | .01 (.03) | -.08 (-.29) |
| Foreign Cyclical Variable | | | | -.50 (-1.43) | -.19 (-.70) | -.51 (-1.54) |
| U.S. Inventory Change | | | | .01 (2.76) | .01 (3.60) | .01 (2.99) |
| Time Trend | | .01 (2.59) | | | .01 (5.38) | |
| Foreign Domestic Investment | | | .24 (1.00) | | | .37 (1.66) |
| R ² (corrected) | .9928 | .9930 | .9928 | .9935 | .9941 | .9937 |
| SER | .0387 | .0382 | .0387 | .0366 | .0349 | .0363 |
| DW | 1.82 | 1.75 | 1.77 | 1.87 | 1.78 | 1.86 |
| Rho | .95 (25.86) | .87 (16.07) | .93 (22.91) | .91 (19.93) | .71 (9.11) | .89 (17.49) |

* / Held constant before 1964 and after 1970.