USING DISAGGREGATED DATA TO DISSECT THE U.S. TRADE DEFICIT

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I. Introduction

For the past decade there has been a continuing concern over the ongoing massive U.S. trade deficit, as well as related questions regarding America's ability to "compete" internationally and the consequent impact on American jobs and wages. Economists and politicians alike have debated the origination, magnitude and proper resolution of this problem. Indeed this was a frequently argued topic in the 1992 Presidential election. More recently these issues have been raised as part of the controversy over the North American Free Trade Agreement. Economists, in particular, have contributed to the debate by attempting to identify and quantify the factors which first caused the U.S. trade deficit to increase sharply and then allowed it to persist throughout the 1980s (see Table A.)

Prior to the 1980s, the Keynesian macro trade models underlying these U.S. trade analyses (which are primarily based on consumer demand theory) relied almost entirely on the influence of price and demand effects to explain trade flows, and they generally performed fairly well (i.e. the volume of a country's imports was related to two factors: the overall level of demand for goods in the economy, and the relative price of imports compared to the price of similar domestic goods). Using these models as a guide, the growth of the trade deficit in the early 1980s was assumed to be related to the sharp appreciation of the dollar during this period, which made imported goods comparatively cheaper than equivalent domestic goods and U.S. exports more expensive than foreign goods. The corollary to this assumption was that if the dollar were to depreciate, the trade deficit would come down with it since the price of imports should climb. Unfortunately, while the dollar fell dramatically from 1985 through 1987, the trade deficit actually grew worse. Furthermore as Hickok and Hung (1992) point out, although in 1989 the level of relative prices and relative demand between the U.S. and the world were at roughly the

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same level as had prevailed in 1979, the U.S. still had a substantial trade deficit.[1] Indeed in 1992 the trade deficit, which had declined somewhat by 1991, actually increased to 95.8 billion dollars.

The continued sluggish response of U.S. trade flows to the sharp decline in the dollar has led to growing dissatisfaction with the performance of standard macro trade models and their associated quantitative analyses. Furthermore this has led to dissatisfaction with managing exchange rates as an appropriate--or sufficient--Government response. Attention has thus turned to more satisfactory explanations and more effective remedies for the causes and persistence of the trade deficit. For politicians and business leaders this shift has manifested itself in calls for new and different policy approaches such as protectionism, federal support for individual industries in an attempt to make them more competitive, and massive Government-sponsored worker retraining programs.[2] For economists this search comes at a time when there has been a melding of new theories in industrial organization (such as increasing returns to scale or using differentiated products models) with a perceived need to update international trade theory and make it more micro-based.[3]

Concurrent with the growing importance of trade issues has been the establishment of the International Price Program by the Bureau of Labor Statistics. The Program was developed primarily to measure price trends of U.S. exports and imports. These detailed data permit a richer statistical analysis of the major factors underlying U.S. trade. In contrast, most of the previous quantitative analyses of trade have been undertaken at a relatively aggregated level. Usually the import data would be divided between oil and non-oil categories, while exports would be split between agricultural and non-agricultural.[4]

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[1] This rise was partially attributable to the well-known J-curve effect whereby, on a nominal basis, when a currency is devalued, a trade balance will get worse before it gets better. This happens because the volume of imports will decline more slowly than their corresponding prices will rise. Thus the total *value* of imports will rise, at least temporarily. The analysis in this paper is based on inflation-adjusted, or quantity, trade flows. As Table A indicates, the trade deficit was considerably worse on a nominal basis than on a 'real' basis .

[2] In March 1992 the bipartisan Competitiveness Policy Council presented to Congress a report which called for the United States to establish a serious competitiveness strategy through both sector-specific and generic policies. In an interview with the Washington Post published March 5, 1992, C. Fred Bergsten, the Council chair admitted that his earlier belief in the overriding role of exchange rates was misguided. "I've changed my thinking for two reasons," he said. "First, it is clear that macroeconomic policy alone didn't work. Second, I would now say that structural and other micro issues are more important than I thought." Professor Robert Reich, who has since been named Secretary of Labor in the Clinton Administration, is paraphrased in the Post article as seeing the report as a concession from mainstream economists that solving the competitiveness problem is not just a matter of macroeconomic policy.

[3] See, for example, Krugman (1990) and Helpman (1981). This interest was sparked in part by the tremendous growth in *intra*-industry trade after World War II. Traditional trade theory holds that most trade would be *inter*-industry.

[4] See Helkie and Hooper (1988), Krugman and Baldwin (1987), Hickok and Hung (1992) , Blecker (1992), Cline (1990) and Lawrence (1990).

By making use of these new data, this study examines U.S. trade at a considerably more disaggregated level of product groupings than previously possible. This is especially true in the construction of detailed estimates of U.S. price and income elasticities as well as exchange rate pass-through values for individual commodity groupings.[5] This more micro approach to trade analysis is consistent with some of the paradigms in the new trade theories which emphasize the need to look at industry sectors individually.[6] The results of this study provide new answers to such questions as:

A. What role did the fluctuations in the dollar play in the trade deficit?
    1. How much of the change in the exchange rate was "passed through" into higher import or export prices?
    2. How sensitive were trade flows to changes in relative import or export prices? (usually referred to as its price elasticity)

B. How sensitive were trade flows to changes in total demand for goods? (usually referred to as its income or activity elasticity)

C. Does an analysis of disaggregated trade data reveal significant trends indicating underlying trade flows not related to the price or activity variables?

D. How much did each of these factors contribute to the trade deficit?

E. How do these results compare with the conclusions of earlier (primarily aggregated) analyses.

While the study was essentially limited to trade in manufactured goods only, recent trends confirm the growing dominance of this sector of U.S. merchandise trade[7] (see

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[5] A price elasticity indicates how sensitive trade flows are to relative price changes. An income (or activity) elasticity indicates how sensitive trade flows are to changes in demand for either total goods (usually GNP) or demand for the commodity grouping. Pass-through values indicate how much of a change in an exchange rate is "passed through" into higher (or lower) prices in terms of the buyer's currency.

[6] Some recent studies have attempted to analyze disagregated data in order to assess microeconomic factors, e.g. Hooper and Mann (1989), Hickok (1991) and Lenz (1992). While the need for disaggregated analysis has been frequently reiterated-- see Orcutt (1950), Magee (1975) and Goldstein and Khan (1985)--it has been on occasion called into question. While admitting that in theory disaggregated data should produce more accurate results, Grunfeld and Griliches (1960) and Aigner and Goldfeld (1974) argue that detailed data is frequently subject to larger measurement errors than aggregate data. They also raise the possibility that models of detailed data are more likely to be misspecified.

[7] A point also emphasized in Hickok (1991). While the service component of trade is also growing (and BLS is expanding its coverage of price indexes in this sector), the data appear to be too sporadic to attempt to incorporate it into this analysis.

Table B). In addition, since much of the interest in trade is in monetary policy (e.g. exchange rate targeting), as well as trade problems between developed nations, which trade primarily in manufactured goods, concentrating on manufactured goods would seem appropriate. Finally, note that this analysis, like most others, focuses on changes in trade *volumes*, not trade *values*. As the difference between current dollar and constant dollar estimates of the trade deficit in Table A implies, much of its persistence can also be attributed to higher import prices.

II. AVAILABILITY OF NEW DATA

In the early 1970s BLS, which already had responsibility for the consumer and producer price indexes, began publishing indexes measuring price trends of U.S. imports and exports. These indexes were developed in order to supplant the notoriously defective unit-value indexes published by the Bureau of the Census.[8] In the early 1980s BLS completed its initial phase of sampling, releasing the first all-import price index in the fourth quarter of 1982 and the first all-export price index the following year. By the end of the decade, after BLS switched from quarterly publication to monthly, the Bureau of the Census discontinued publication of the unit-value series. The BLS data are currently produced using three classification structures: SITC (Standard International Trade Classification), End Use, and HS (Harmonized System).[9] Until recently BLS also constructed indexes by SIC (Standard Industrial Classification), which were discontinued due to budget constraints.[10] An earlier study conducted by the author, Alterman (1991b), was based on the series by SITC. However, in order to incorporate detailed U.S. domestic data into this analysis, this study was based on data published by the SIC system. It should also be kept in mind that the duration of this analysis had to be limited since comprehensive BLS data have only been available for about 15 years.

The second crucial BLS series used in this analysis is the trade-weighted exchange rate indexes. This series used bilateral U.S. trade weights to construct a separate exchange rate for each detailed level of import and export price indexes. For example, the weights used in the construction of an exchange rate index for the imported automobile index would be dominated by the Yen, Canadian dollar and Deutschemark, the currencies of our three major suppliers of automobiles.[11] These series were used to calculate industry-level pass-

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[8] See Alterman (1991a) for a discussion of the limitations of unit value indexes.

[9] In general, BLS attempts to publish an index for any category with roughly one billion dollars or more of trade in 1990. BLS was originally iven the task of producing these data because of its experience in producing the consumer and producer price indexes.

[10] The Bureau hopes to resurrect these series sometime in the near future.

[11] For further details on these series, see Alterman et al (1987).

through values, as well as estimates of the average foreign currency price indexes of U.S. exports and imports.[12]

III. ESTIMATES OF EXCHANGE RATE MOVEMENTS

The first question which must be addressed is calculating exactly how much the dollar exchange rate fluctuated during the 1980s and whether or not this varied by product area. Recently there have been a number of new and different estimates of an average U.S. exchange rate. These exchange rate indexes vary by type of weight (e.g. global vs. bilateral trade), the number of countries (from 10 to 131), and whether they have been adjusted for inflation (nominal vs. real). Several articles--see Pauls (1987) or Batten and Belongia (1987) for example--have reviewed these various aggregate exchange rates. Pauls found that depending on which exchange rate was used, the dollar appreciated anywhere from 3 to 40 percent between 1980 and 1985. Generally these indexes indicate that the more the index is weighted toward industrial trading partners, the more pronounced the volatility of the dollar was during the 1980s.

Unfortunately, there has been comparatively little empirical analysis of exchange rate variations by product category.[13] In Alterman (1991a, 1991b) the author relied upon the BLS experimental inflation-adjusted exchange rate index which used 84 countries and bilateral weights. Those studies found significant variations in the trade-weighted exchange rate by product area in the 1980s.

The analysis in this new study was based on the BLS *nominal* exchange rate indexes, which only used exchange rate data for the 40 countries whose rates of inflation were similar to U.S. rates during the 1980s. The detailed tables (see Appendix Table B-1 for imports and Table B-2 for exports) include changes in the average dollar exchange rate for two periods. The first, from 1980 to 1985, covers the period of strong dollar appreciation, while the second, from 1985 to 1988, represents the succeeding sharp depreciation. Clearly there were substantial differences by SIC category. For example, the trade-weighted import dollar declined over 50 percent between 1985 and 1988 in SIC 386 (photographic supplies) but only 16 percent in SIC 23 (apparel), which is imported primarily from developing countries. Graph 1 illustrates this variation by comparing the Federal Reserve Board exchange rate index with the exchange rate indexes for the two industry-based series.[14] Note the relatively small appreciation of the dollar in the photographic supplies exchange rate index during the early 1980s, as well as the comparatively small depreciation of the dollar in the apparel exchange rate index during

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[12] Unfortunately, here too, budget constraints have forced the temporary suspension of the calculation and publication of these series.

[13] Feinberg (1991) constructs trade-weighted exchange rate indexes for 80 4-digit SIC categories in his analysis of the impact of exchange rate fluctuations on *domestic* price levels.

[14] The FRB dollar exchange rate index includes data for 10 industrial countries only and is weighted by each country's total value of trade.

the late 1980s. These variations provide the first evidence of the need for a disaggregated analysis, as the standard view of first the sharp appreciation and then subsequent sharp depreciation of the dollar in the 1980s cannot be applied equally to all sectors of U.S. trade.

IV. PASS THROUGH ESTIMATES

A. Previous Estimates of Pass-Through Values

The next question to be addressed is how much, if any, of the exchange rate fluctuations were "passed through" into the final selling price of internationally traded goods. Presumably if the exchange rate variation has no impact on the final selling price, then the demand for the imported good will be unchanged.[15] The pass-through question has very strong policy implications for the period under question since September 1985 at the meeting of the Group of Five Finance Ministers in New York, there began a concerted world-wide effort to force the dollar to depreciate.[16] Most analyses assumed that the fall in the dollar exchange rate would in the long run be passed through almost completely into higher import prices (and lower export prices), shrinking the trade deficit. Several studies however, such as Hooper and Mann (1989) and Baldwin (1988) concluded that the change in the exchange rate had less of an impact on U.S. import prices than had been expected based on past experience. Estimates of the import pass-through parameter vary from 50 to 100 percent (see Table C.)

Several explanations have been offered for the smaller than expected import pass-through rate. One, suggested by Parsley (1991), is that there has been an aggregation bias in the construction of an aggregate pass-through value, and that properly constructed, the estimate would be larger. The most frequent hypothesis, Baldwin (1988), attributes the mystery to the hysteresis effect, that the pass-through relationship changed permanently as a result of the sharp appreciation earlier in the decade. Melick (1990), however, after performing a battery of stability tests, disputes this notion, arguing that these aggregate models are subject to misspecification.

Although there have been numerous studies of aggregate pass-through rates--for a summary see Goldstein and Khan (1985)-- comparatively little empirical work has been

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[15] Of course it could also have an impact on the supply side, especially for multinational firms. See, for example, Rangan and Lawrence (1993).

[16] Other explanations for the exchange rate depreciation have also been suggested (e.g. differences in real interest rates, the "safe haven hypothesis," etc.).

done using disaggregated data.[17] The author's 1991 papers may have been the most comprehensive. In those papers, pass-through rates were constructed at the 2-digit SITC level for both exports and imports.[18] Pass-through rates for finished goods varied from 100 percent down to 25 percent according to the 1991 study. Like other recent studies, it indicated a higher pass-through value for manufactured U.S. exports than manufactured imports, evidence of an apparent tendency for foreign companies to be more willing to engage in "pricing to market."[19] The earlier study also found a fairly high correlation of price trends for similar categories of export and import *unmanufactored* goods, evidence supporting the existence of a "world price" for basic commodities. In contrast, there was comparatively little correlation of price trends for similar categories of import and export *manufactured* goods.

B. New Pass-Through Estimates

The first empirical component of this disaggregated study was designed to produce new estimates of the relationship between prices and exchange rates, the so-called "pass-through" rates or elasticities. The analysis follows on Mann (1986), Dornbusch (1987) and Hooper and Mann (1989), which provide some elaboration on pass-through theory and, more importantly, why it may vary by industry. The basic imperfect substitutes model for import pass-through rates is:

(1) $\Delta PM_i = f(\Delta ER_i, C_i)$

where

PM_i = Import price index of SIC sector i,

ER_i = Trade-weighted exchange rate for SIC sector i,

C_i = Monotonic trend for changes in price of SIC sector i.

The export model is constructed in a similar manner, with the export price in foreign currency terms the dependent variable, and the reciprocal of the exchange rate the dependent variable.[20]

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[17] Some examples of disaggregated pass-through rates include Mann (1986), Ohno (1989), Parsley (1991), Knetter (1989) and Hooper and Mann (1989). Parsley calculates pass-through values for five product groups also finding no significant indication of instability or hysteresis.

[18] SITC is the Standard International Trade Classification of the UN. In theory it is the classification structure most likely to be used in international comparisons. However, since no domestic data is produced using this structure, its utility is somewhat limited.

[19] Marston (1989), for example, discusses how Japanese manufacturers vary prices depending on the market targeted. See also Knetter (1989).

[20] The export price index in foreign currency terms is calculated by multiplying the export price index in dollar terms by the trade-weighted average exchange rate index. In a perfect substitutes model, which assumes the seller has no market power, the exchange rate would not be a factor in the selling price. The import price would be subject to the law of one price and would therefore be the same as the world price

Clearly this study used a relatively simple form of the model, regressing the percent change in the current quarter's import price against the percent change in the current quarter's exchange rate as well as a 5 quarter lag of changes in the exchange rate. More complicated models add other factors such as foreign costs, domestic prices, and the degree of competition in an industry. Ceglowski (1991) and others have used models where import prices and domestic prices are derived simultaneously. A constant term was used to pick up some of these factors which unfortunately do not have sufficient data for a comprehensive disaggregated analysis, but which eventually would be crucial to any exhaustive industry-level analysis of trade. The obvious drawback of a constant term is the assumption that the impact of these other factors would be the same from one period to the next, regardless of variations over time in these factors.

The actual equation for estimating the pass-through rate for U.S. import prices used the following formula:

$$\Delta \ln PM_{t,i} = \alpha_i + \sum_{j=0}^{5} \beta_{j,i} \, \Delta \ln ER_{t-j,i} + u_{t,i} \qquad (2)$$

where PM is the import price index in U.S. dollars in quarter t, ER is the trade-weighted average exchange rate in quarter t (and 5 lag periods) for group i. The sum of the 6 estimated β coefficients is equal to the pass-through rate. α represents a constant linear trend for SIC sector i, and u is a random error term which is uncorrelated across product groups.[21] Because of concerns about serial correlation in the error terms, these equations were run as first order differences of the logs, that is the percent change in the price index was regressed against the percent change in the exchange rate index. This is a standard adjustment when auto correlation is present.[22] No distribution has been imposed upon the lag coefficients.[23] The export equations were constructed in a similar manner.

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after exchange rate adjustment. For example, at any given time there is one price in the world for gold. Consequently someone exporting gold (and who presumably was not large enough to impact the market for either its supply or demand), would have to match that price, regardless of what happened to the exchange rate. The pass-through value would be 0.0 percent since exchange rate fluctuations would not impact the final selling price. This type of pattern is consistent with the findings referred to in Alterman (1991b). Ideally one could round out a comprehensive trade analysis by using a perfect substitutes model for the non manufacturing component of U.S. trade.

There is some evidence that even in manufactured goods a perfect substitutes model may be of use. For example, Althukola (1991) argues that for Korean exporters, exchange rate fluctuations do not appear to be a critical factor in the selling price of their manufactured goods. In general, models with perfect substitution appear more useful for analyzing small countries and those relying primarily on exports of raw materials.

[21] See Appendix A, Data Sources, for a fuller discussion regarding the construction of the individual data series.

[22] See Maddala (1988), p. 188. Most of the comparable studies are actually done using log *levels*.

[23] One should also keep in mind that these are border prices exclusive of duty, either at home or abroad, and that 30 to 40 percent of U.S. trade is, in fact, intracompany trade.

Calculations were run for both imports and exports for 54 manufacturing industries. In 1991 these industries accounted for 92 percent of imports and 87 percent of exports. Estimate 1 in Table D was constructed by weighting together the detailed estimates of pass-through rates using 1986 trade values and adjusting for "distribution elasticity."[24] Estimate 2 relies on the more common method for calculating aggregate pass-through rates, and therefore represents a single equation using only the total series for all manufacturing.[25]

The results indicate an overall pass-through rate of 50.6 percent for imports and 86.3 percent for exports. Interestingly the import pass-through value was nearly identical whether it was constructed from the total manufacturing series or compiled by aggregating together the 54 individual series used in the analysis. However at the disaggregated level, some individual rates were as low as near zero, while in a few cases the rate was over 100 percent. (See Appendix Tables B-1 and B-2 for the individual calculations.) This variation lends further credence to models which emphasize an industrial organization approach to pass-through values. Although the overall import pass-through estimate is lower than some of the earlier estimates, it is consistent with the perception that exchange rate fluctuations may not have had as significant an impact on U.S. import prices as had been originally expected. Export pass-through values, which also showed some variation, were higher on average than the import rates, consistent--more or less--with earlier studies. This argues that the exchange rate fluctuations of the 1980s would have had a greater impact on export prices and trade flows than on import prices and trade flows.[26] It is also consistent with BLS data which indicate that almost all U.S. exports and most U.S. imports are invoiced in U.S. dollars.[27]

V. PRICE AND INCOME ELASTICITIES

A. Previous Estimates of Price and Income Elasticities

The next step was to measure the sensitivity of trade flows to changes in relative prices and changes in demand. In part because of the wealth of data in international trade, there

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[24] Barker (1970) shows that, when aggregating elasticities in log linear form, an allowance must be made for the "distribution elasticity" of price changes. A series component which tends to show greater volatility than the series average should be given a relatively more important weight in the index. For example, if high-elasticity components tend to have relatively larger price changes than low-elasticity components, the aggregate level change will tend to be greater.

[25] These tables also include regressions for five non-manufacturing industries, (SIC codes 017, 10, 12, 13 and 14).

[26] An additional topic for research would include a stability analysis to determine if the pass-through rate varies depending on whether the home currency is appreciating or depreciating and, in particular, whether there was a shift or break in rates in the mid-1980s.

[27] See Alterman (1991a) for a breakdown of invoicing currencies by country and by product area.

have been numerous studies of price and income elasticities in world trade. Given the need to monitor imports (primarily for duty assessment) and to a lesser degree exports, trade data in particular, but also price data--though usually in the form of unit value indexes--have been available for many years. The adaptation of Keynesian empirical analysis to open economy modeling also hastened these studies.

Controversy over the results of trade analyses are not new. Indeed much of the early literature on price elasticities focused on the policy issue of whether or not a currency devaluation is effective in helping improve a country's trade balance.[28] A number of the empirical studies between World War I and World War II reported price elasticities which seemed unusually low--so low that the crucial Marshall-Lerner Condition, necessary for a currency devaluation to improve a country's trade balance would not be satisfied.[29] If this condition were not satisfied, then it called into question the feasibility of using a currency devaluation to adjust a country's balance of trade position.

Some of the more recent estimates of price and income elasticities do cover at least part of the period in the 1980s when the U.S. trade deficit soared (see Table E). Price elasticities varied from -0.45 to -1.4 in the most recent studies and even wider in some earlier estimates (see Goldstein and Khan, (1985) p. 1082).[30] While these results do infer that a currency devaluation can help a country's trade balance, the figures are sufficiently varied enough to leave open the question of exactly how much the devaluation will help.

Part of the interest in estimates of income elasticities is related to the thesis that if a country's import income elasticity is higher than its export value, that country's economy would be constrained to grow more slowly than the rest of the world.[31] Otherwise the country would be continuously running a trade deficit as the volume of its imports would grow more rapidly than the volume of exports. This concern is based on the reasonable assumption that a country cannot run a large trade deficit indefinitely.

Recent estimates of income elasticities have tended to be fairly large, averaging 2 or higher.[32] Many of the post World War II but pre-1980 estimates reported in Goldstein and Khan (1985, p. 1082) however, tended to be less than 2.[33] More importantly, the evidence

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28 See for example Orcutt (1950).

29 Given certain assumptions, this condition posits that, in response to a currency depreciation, if the sum of the import and export price elasticities are greater than one, the trade balance will improve.

30 A price elasticity of -0.6 means that for every 1 percent increase in import prices *relative* to domestic prices, the volume of imports will decline 0.6 percent.

31 See, for example, Lawrence (1990), whose analysis attributed most of the deficit to differing income elasticities.

32 An income elasticity of 2 means that for every 1 percent increase in income, there is a 2 percent increase in spending on imports.

33 Bear in mind that earlier studies usually relied on annual data, while in most cases the more recent data was constructed from quarterly series.

has been mixed on whether the income elasticity for imports is appreciably higher than the comparable export value.[34] Most, but not all, import elasticity estimates have been higher.

These studies have calculated elasticities only at very high levels of aggregation. The relatively few studies that have attempted to estimate elasticities by commodity grouping, e.g. Deyak et al (1989), tended to report higher elasticities for both the activity and relative price variables for manufactured goods.[35] Given the general shift in trade towards manufactured goods, this could possibly explain the higher income elasticities recorded in the more recent studies.

B. New Estimates of Price and Income Elasticities

In modeling sector-specific trade flows, it may be appropriate to view them as part of a two-stage budgeting process. In the first stage, total expenditures, or in this case the total demand for manufactured goods, is allocated by "consumers" among different product categories. In the second stage, this product demand is next allocated between imports and comparable domestically produced goods. Trade models of this nature assume demand for goods is separable among broad categories of goods, but not for individual products within the goods category (i.e. between export and domestic production).[36] Following along the

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34 Blecker's study also included a trend variable. For imports he estimated a quarterly trend of 0.8 percent, equivalent to 3.2 percent on an annual basis (significant at the 10 percent level), while for exports he estimated a quarterly trend of -0.3 percent (not significant, even at the 15 percent level). Note that when a trend variable is included, the importance of equality of income elasticities becomes less crucial.

35 Other examples of detailed analyses include Kreinin (1967; 1973), Houthakker and Magee (1969), Price and Thornblade (1972), Stone (1979), Shiells et al (1985), Reinert and Shiells (1991) and Reinert and Holst (1991).

36 First developed by Armington (1969), these models have also been used by Shiells et al (1985), Reinert and Holst (1990) and Reinert and Shiells (1991). In theory, detailed product groups in this analysis should consist of relatively homogeneous goods. Unfortunately because even 3-digit SIC groupings can be fairly broad, the model is necessarily inexact since the appropriate level of data are not available. In addition, it would be better to do a *demand* analysis--such as this one-- using a classification system built on a detailed *end use* structure. Again however, there is a lack of comparable data.

Some of the more advanced models in trade solve for all product groupings simultaneously and include a production function. Here too, the model in this study was relatively stripped-down. Most likely the former would not add significantly to the model, and as mentioned earlier, it would not appear that sufficient data are available for the latter. Although there has been some literature generated on possible supply side effect, like most studies (see Goldstein and Khan (1985), p. 1048, Deyak at al (1989), Rousslang and Parker (1984) and Haynes and Stone (1983), these are assumed to be not large enough to impact this analysis, even at the detailed level. Upward sloping supply curves are generally thought to be more of a problem in raw material and other areas subject to a perfect substitution model. The author has given less attention to these areas in this study. As mentioned earlier, Alterman (1991a) ran a correlation test on prices of imports and exports in the same category. The results indicated a much higher correlation of prices in categories of goods for raw materials and intermediate products than for manufactured goods.

lines of Krugman and Baldwin (1987), the model attempt to capture the impact of any structural changes by use of a time trend. As with the pass-through estimates, the obvious drawback of a constant term is the assumption that the impact of these other factors would be the same from one period to the next, regardless of variations over time in these factors. Here too, a lack of detailed disaggregated data precludes a more sophisticated analysis. Meanwhile, traditional fiscal and monetary effects are captured by the income and price elasticity variables.

The basic model for estimating import price and income elasticities will be:

(3) $\Delta M_i = f(\Delta D_i, \Delta PM_i, \Delta PD_i, C_i)$

where

M_i = U.S. imports of goods in SIC sector i,
D_i = U.S. demand for goods in SIC sector i (domestic production in sector i minus exports of goods in sector i plus imports of goods in sector i),
PM_i = Import price index for SIC sector i,
PD_i = Domestic price index for SIC sector i,
C_i = Monotonic trend for changes in imports of goods in SIC sector i.

The corresponding export model is more limited due to lack of data. Thus the study used an average of 10 countries GNP for the demand variables, and the foreign PPI was limited to an averaging of data from just 4 countries.

(4) $\Delta X_i = f(\Delta DF_{10}, \Delta PX_i, \Delta PF_4, C_i)$

where

X_i = U.S. exports of goods in SIC sector i,
DF_{10} = 10 country Foreign GNP,
PX_i = Export price index for SIC sector i,
PF_4 = 4 country Foreign Producer price index,
C_i = Monotonic trend for changes in exports of goods in SIC sector i.

1. Import Elasticities

The specification of the model for estimating import price and income elasticities in log-linear differences is as follows:

$$(5) \quad \Delta \ln M_{t,i} = \alpha_i + \sum_{j=0}^{1} \beta_{j,i} \Delta \ln D_{t-j,i} + \sum_{k=0}^{8} \gamma_{k,i} \Delta \ln \left(\frac{PM}{PD}\right)_{t-k,i} + u_{t,i}$$

where M is the value of real imports in period t for SIC sector i, D is the domestic demand in period t (and 1 lag period) for SIC sector i, PM is the import price index in period t (and 8 lag periods) for SIC sector i, PD is the U.S. producer price index in period t (and 8 lag periods) for SIC sector i. The sum of the 9 estimated γ coefficients is equal to the relative price elasticity, while the sum of the 2 estimated β coefficients is equal to the activity elasticity. α represents a constant linear trend for group i, and u is a random error term which is uncorrelated across product groups.[37] As in the pass-through equations, these estimates were calculated using first differences of logs, which is a common response when autocorrelation is considerable. Even so, the Durbin-Watson statistics, which are a measure of the correlation among the residuals, is still troubling. No structure has been imposed upon the lag coefficients. However, the author's earlier studies calculated parallel results using both a polynomial distributed lag form and a set of equations without a structure. The elasticities and other terms were similar, regardless of methodology. Like most studies, this analysis collapsed the import and export prices into one relative price variable by deflating the import price indexes by the comparable U.S. PPI data, and by using an aggregate average of foreign PPIs for the export data.[38]

This study included two complete sets of 54 import regression equations; one run incorporated a constant term while the other--in order to facilitate comparisons with most of the earlier studies--did not (see Table F for a summary). Next the 54 disaggregated elasticities were weighted together to produce estimates of total import price and income elasticities. Estimate 1 averages the results of the 54 individual regressions using 1986 import trade weights. Again, as in the estimates of pass-through values, these weights were adjusted for "dispersion" differences. Calculating the regressions without an intercept (see Estimate 2) had a significant impact on the disaggregated estimates, reducing the absolute price elasticity while increasing the activity elasticity. For purposes of comparison with the studies in Table E, four additional equations--relying on aggregate data only--were calculated. Estimate 3 (with constant trend) and Estimate 4 (without a constant) used total U.S. domestic purchases for the activity variable, making it--in theory--generally consistent with the methodology underpinning the studies reported in Table E. In Estimate 5, (with trend) and Estimate 6 without trend) the activity variable has been limited to total U.S. consumption of manufactured goods only. (The complete set of

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[37] See Appendix A, Data Sources, for a fuller discussion regarding the construction of the individual data series.

[38] One possible problem with the relative price variable could be the difficulty of properly accounting for new products in trade. If the price of an item declines because it has been shifted from domestic production to overseas production, it would not be properly reflected in this analysis.

disaggregated regressions used in the construction of Estimate 1 is found in Appendix Table B-3.)

Among the 54 detailed regressions which used a constant term, there were two incorrect (negative) activity elasticities, both in food categories, and eight incorrect (positive) price elasticities, none of which were significant at even the 15 percent level. With the exception of the price elasticity for SIC 29--petroleum products--the incorrect price elasticities were all under 0.5. Forty-six groups had positive trends and seven had negative trends.

Several numbers stand out in these tables. First, the activity elasticity for imports using disaggregated data in estimating 1 and 2 seem remarkably low compared with the earlier estimates presented in Table E. These figures indicate that for a given individual product area, a given change in U.S. demand will lead to a similar change in demand for U.S. imports. Part of the explanation for this relatively small estimate can be found in the disaggregated regression for SIC 3711, motor vehicles. This category represents approximately one-sixth of U.S. imports. Its individual income elasticity was 0.386. Two factors appear to go into this low figure. First, the quarterly trend for imported motor vehicles is +0.010. This means that quarter after quarter, automobile imports went up by 1.0 percent during the period in question, regardless of changes in U.S. auto demand. The second, and perhaps more interesting factor, is the role of industry transplants (primarily Japanese assembly plants in America). In 1985 transplants fulfilled 4.3 percent of U.S. demand. In 1990 transplants satisfied 21.7 percent of U.S. demand. If transplants were added to imports the elasticity figure for automobiles would rise considerably. This anomaly for the motor vehicle sector should not be considered too surprising since it is an industry subject to a heavily managed trade regime with voluntary export restraints.

The second number in Estimate 1 which necessitates comment is the +0.011 constant trend value. This says that during the 1980s, the volume of U.S. imports would go up 1.1 percent every quarter, in addition to whatever change in trade flows might be induced by changes in relative prices or changes in the total level of domestic spending in the U.S. Most of the earlier aggregate estimates either found no evidence, or didn't look for, any trend component to imports. One of the few that did was Blecker (1992) who in one of his estimates using log differences reported a constant value of +0.008.[39]

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[39] This study also looked at the complete set of equations using the average exchange rates instead of the relative prices. This would presumably attempt to capture some of the impact of the changes in the exchange rate which may not show up directly in the relative prices, but which might, for example, affect the supply side. In these estimates the elasticity of import volume with respect to the exchange rate was -0.494, considerably less in magnitude than the comparable price elasticity. The trend was again 0.011. Finally, the indexes were calculated using log levels, the form used in the majority of earlier studies. While the magnitude of the elasticities tend to be larger when log levels are employed (-0.951 for prices and 1.175 for activities), here too, the use of disaggregated series indicates strong evidence of a trend (0.009).

The estimate of the elasticity of import trade flows with respect to relative prices (-0.767) appears slightly lower than the average of most recent estimates. Interestingly enough, however, when the regressions were rerun using data only up through 1989 (the approximate end period for the more recent estimates), the magnitude for the relative price elasticity increased to 1.090, a figure very much in line with the other studies.

The calculation of detailed regressions also supplied confirmation of the need for disaggregated analysis of the data. Two separate F-tests were run in order to determine the likelihood that price and income elasticities as well as the constant term were the same across industries. One test analyzed the eight 3-digit SICs in SIC 35 (non-electrical machinery); the other analyzed the eight 3-digit SICs in SIC 36 (electrical machinery).[40] The test for SIC 35 produced an F value of 2.578, significant at the 0.03 percent level. The figures for SIC 36 were F value = 2.295, significant at the 0.15 percent level. These results support the idea that trade flows are more properly analyzed at a detailed level.

2. Export Elasticities

The specification of the model for estimating export price and income elasticities in log-linear differences is as follows:

$$(6) \quad \Delta \ln X_{t,i} = \alpha_i + \sum_{j=0}^{1} \beta_{j,i} \Delta \ln DF_{10_{t-j}} + \sum_{k=0}^{8} \gamma_{k,i} \Delta \ln \left(\frac{PX_i}{PF_4}\right)_{t-k} + u_{t,i}$$

where X is the log value of real exports in period t for SIC sector i, DF_{10} is a trade-weighted average of foreign GNP in period t (and 1 lag period) for 10 countries, PX is the export price index in foreign currency terms in period t (and 8 lag periods) for SIC sector i, PF_4 is an average of 4 foreign producer price indexes in period t (and 8 lag periods) and is not sector specific. The sum of the 9 estimated γ coefficients is equal to the relative price elasticity, while the sum of the 2 estimated β coefficients is equal to the activity elasticity. α represents a constant linear trend for group i, and u is a random error term which is uncorrelated across product groups.

As mentioned earlier, due to a lack of foreign data, it is not possible to run the equivalent price and income disaggregated elasticity analysis for U.S. exports. Two crucial pieces of data are missing. First, there are no compatible detailed estimates of producer prices among all of the major trading partners of the United States. Second, there is a lack of comparable consumption (or production) data available from these

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[40] In 1992 these 2 components accounted for approximately 30 percent of U.S. manufacturing imports.

countries. As a result, in order to produce relative export prices, it was necessary to deflate each of the detailed U.S. export price indexes by the same aggregate estimate of a trade-weighted foreign producer price index. Similarly, for the foreign activity variable, the analysis relied on a trade-weighted estimate of total foreign GNP. The disaggregated data was, however, aggregated up using sector-specific trade weights see Appendix A for details). Nevertheless, the analysis of 54 export groups did uncover some interesting figures (see Table G. The disaggregated estimates of the price elasticity of exports are very similar to the disaggregated import estimates and appear to be lower than for several earlier studies reported in Table E. In contrast to the import analysis (but consistent with Blecker's study which also sought evidence of a trend), the constant value appears to be insignificant. Given the lack of disaggregated consumption data for exports, it should not be surprising that the income elasticity coefficient is similar to the values estimated in the recent studies reported in Table E. The complete set of regressions for models with intercepts is found in Appendix Table B.[41]

VI. CONTRIBUTION TO U.S. TRADE DEFICIT

Several of the recent studies carried their analyses to the next logical step and estimated the actual (constant) dollar contributions of the different factors to the trade deficit in the mid-1980s (see Table H). Helkie and Hooper (1988) and Lawrence (1990) found that the price (or exchange rate) variable was the leading cause of the large trade deficit, while Krugman and Baldwin (1987) indicated this factor was somewhat less significant.

In order to be able to produce comparable results, this analysis next takes the twelve variables (9 price, 2 activity and one constant) and calculates the cumulative contribution of each to the change in trade volumes from 1982:1 through 1991:4.[42] This computation, summarized in Table I, also attempted to determine how much of the change in the volume of imports was simply due to the change in the overall U.S. demand for the good. From a statistical standpoint, the large bump in the "Other" values during the mid-1980s appears related to the problem with the Durbin-Watson statistics mentioned earlier.[43] Further analysis will be necessary to assess what economic factors contributed to this bump.[44]

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[41] For comparison purposes, both with the export series and the earlier studies, contributions to import trade flows using *total* U.S. domestic purchases as the activity variable for all disaggregated groups were calculated. Unsurprisingly (presumably because the methods were more nearly similar), the results were more consistent with the role of trends indicated by the aggregate Estimates 3, 4, 5, and 6 in Table F and inferred by the studies in Table E. In addition, the estimates reduced the impact of falling import prices on the rise in import trade in the mid-1980s, but increased the perceived impact of rising import prices on the relative decline in import trade in the late 1980s.

[42] The estimates could not begin until 1982 because of the need to include 8 lagged relative price variables.

[43] The "Other" category is derived by subtracting the amount of imports attributable to the four delineated factors from the actual flow of imports. Recalculating these equations while adjusting for autocorrelation in the error terms did not appreciably change the results.

[44] A similar large residual also showed up when the calculations were redone using exchange rates instead of relative prices.

Of special note is the relatively minor role played by variations in relative prices. This is also consistent with the argument that the trade deficit does not appear tractable to managed exchange rates. In contrast, Helkie and Hooper (1988) attributed half of the change in import trade volume to changes due to relative prices.[45] Equally interesting, much of the increase in imports, which--when calculated at the aggregate level--appears to reflect the sensitivity of imports to total demand; however, when constructed at the detailed level, the increase simply mirrors the overall rise in demand for goods in a specific sector. This analysis is consistent with the elasticity estimates in Table F and is further evidence that much of the jump in import trade is indeed due to an ongoing upward trend in imports, unrelated to the traditional macro price and income elasticity explanations.

Despite the aforementioned data limitations inherent in modeling the export side of the trade balance, the results of this analysis were used to estimate the relative contribution of the different factors in explaining recent U.S. export trade flows (summarized in Table J). Interestingly enough, despite the higher pass-through rates for exports, the cumulative effect of the higher export prices (in foreign currency terms) from the early 1980s was still negative as late as 1991. Other studies, in contrast, had indicated that by 1990 the cumulative effect would be near zero.[46] In addition, there appears to be little evidence of an underlying trend in exports, nor any problems with the residual.

The results of these calculations are summarized and compared to the studies in Table H. The new estimates are somewhat consistent with the other studies regarding the role of differences between the U.S. and the foreign rates of growth on the U.S. trade deficit. Here too, the data indicates the earlier studies may have overemphasized the importance of the role of relative prices (and therefore the exchange rate) in producing the large trade deficit between 1980 and 1985. The new analysis assigns a significantly greater contribution to other, presumably structural, sources of the trade deficit.[47]

Finally, the results were further compared with the other published studies (see Table K), which have attempted to quantify that part of the 1989 trade deficit which might be attributable to structural shifts in factors affecting U.S. trade. As mentioned earlier, 1989 is significant because by then the macroeconomic factors impacting trade, exchange rates and growth rates, had reverted to the levels prevailing prior to the large U.S. trade deficit.

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[45] Part of this difference can be explained by differences in the data used to represent domestic price levels. Helkie and Hooper use the implicit price deflator which registered nearly twice the price increase than the PPI series labeled "Total manufactures," which was used for the aggregate manufactured goods series here.

[46] See, for example, Lawrence (p. 370), who calculates the change in exports from 1980 to 1990 attributable to changes in relative prices as a negative 2.0 percent.

[47] Note however that if the "Other" category in Table I is added to the relative price component, the proportion of the 1986 trade deficit attributed to relative prices reaches 61 percent, which is very similar to the other studies. This might be an appropriate assumption if the impact of relative prices on trade flows has a greater lag effect than the two years used in this, and most other, studies.

It was further assumed that any lag effects would have also played out by then. And yet, in current dollars the 1989 trade deficit was 113.5 billion dollars (54.3 billion in constant 1982 dollar terms). The new estimate in this report of the amount of the trade deficit which could be attributed to structural factors was somewhat higher than the earlier estimates. Again this is consistent with the comparatively smaller role assigned to the relative price and income elasticity factors.

VI. CONCLUSIONS

Using only recently available disaggregated data, this study attempted to provide answers to several questions regarding the sources of the U.S. trade deficit in the 1980s. First, how much of the changes in the dollar were passed through into higher export or import prices during the decade? The evidence indicates that for imports approximately 51 percent of the dollar's change was passed through into the import price, while for exports the comparable figure was 86 percent. These figures are fairly consistent with some, but by no means all, of the earlier studies. The second question asked how sensitive trade flows are to price elasticities. This study indicates exports and imports are relatively inelastic, that is a percent change in the price of exports (imports) leads to a less than 1 percent change in the volume of exports (imports). This result is also consistent with some, but not all, of the earlier studies. Third was the question of how sensitive trade flows are to total changes in overall demand (income or activity elasticity). The disaggregated data indicate that the activity elasticity for imports was less than one, considerably less than earlier studies. The export activity elasticity, which due to data limitations was not strictly comparable, was much higher than the comparable import value and more consistent with earlier studies. Finally, the study answered the question of whether some of the trade deficit spurt in the mid-1980s might be related to other, less traditional factors. The study indicates that a significant portion, up to 52 percent, may have had other sources. This figure was more than double found in any of the earlier studies. It was also consistent with the evidence indicating that these structural factors continued to play a role in the persistence of the deficit through the 1980s and into the 1990s.

These new estimates call into question the concerns about constraints on U.S. economic growth due to differences in import and export activity elasticities. However, essentially it appears to shift the concern about the trade deficit away from differences in elasticities, and towards the underlying upward trends (primarily in imports), uncorrelated with growth rates. Possible explanations for the apparent structural increase in the U.S. trade deficit include the growing stock of overseas capital investment, the debt crisis in developing countries, changes in trade barriers, lower foreign wages, the low U.S. savings rate, the previously mentioned "hysteresis" effect, or possible shifts in consumer preferences.[48] The answer may be found in a combination of these and other factors.[49]

Clearly this topic requires additional research. Unfortunately a relative dearth of detailed and consistent sector-specific international information (such as price and consumption data) precludes a more systemic analysis of this trend. Indeed as trade shifts away from merchandise and more towards intangibles such as overseas investments, travel, financial services, etc., data on trade flows may become even more problematic.

[48] Lower foreign wages would normally manifest itself in lower import prices. However, if products were shifted from domestic production to foreign production this would not show up in an import price index.

[49] Feenstra and Shiells (1994) argue that the problem is attributable to an upward bias in the BLS import price indexes due to the inability to properly reflect price decreases associated with the introduction of new foreign sources of products.

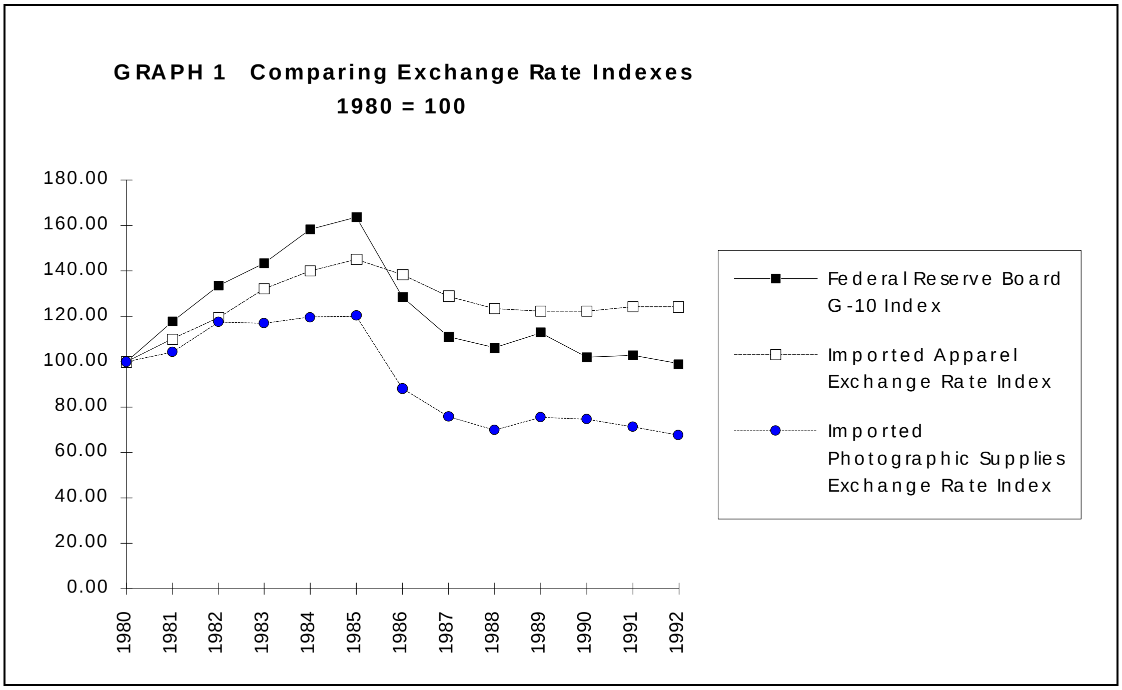

Table A--Trends in U.S. Trade

	1980	1985	1987	1989	1991	1992
Trade balance for all merchandise (current dollars, in billions)	-22.6	-120.9	-157.1	-113.5	-74.3	-95.8
Trade balance for all merchandise (constant 1987 dollars, in billions)	+12.6	-141.7	-157.1	-106.6	-67.2	-89.2
Exchange rate index (3/73=100)	87.4	143.0	96.9	98.6	89.8	86.6

Sources: Bureau of Economic Analysis,
Federal Reserve Board

Table B--Percent of Manufactured Goods in U.S. Merchandise Trade

	1966	1980	1991
Exports	66.7	81.7	91.7
Imports	58.4	65.0	87.5

Note: Based on data from U.S. Bureau of the Census, in current dollars. In this table and elsewhere in the paper manufactured goods are those products which have been classified into SIC commodity division 2 (nondurables) or 3 (durables).

Table C--Estimates of U.S. Import and Export
Pass-Through Rates, in percent

	Imports	Exports
Moffett (1989)	50	100
Helkie and Hooper (1988)	91	n.a.
Krugman and Baldwin (1987)	107	n.a.
Hooper and Mann (1989)	50-60	n.a.
Lawrence (1990)	71	76

Table D--New Estimates of Pass-Through Values
(for Manufactured Goods)

	Imports	Exports
1. Disaggregated (weighted average of 54 series)	50.6	86.3
2. Aggregate (all manufacturing)	50.3	82.1

Table E--Estimates of Price and Income Elasticities for U.S. Trade

Study	Sample Period	Price Elasticity Import	Price Elasticity Export	Income Elasticity Import	Income Elasticity Export
Houthakker and Magee	1951-1966 (annual)	-1.03	-1.51	1.68	0.99
Moffett		-0.64	-0.84	2.46	1.14
Krugman and Baldwin	1977:2-1986:4 (quar.)	-0.86	-1.40	2.87	2.42
Helkie and Hooper	1969:1-1984:4 (quar.)	-1.15	-0.83	2.11	2.19
Cline	1973:1-1987:4 (quar.)	-1.36	n.a.	2.44	1.70
Blecker (in log dif.)	1975:1-1989:4 (quar.)	-0.72	-0.69	1.74	2.05
Hickok and Hung	1967:1-1988:4 (quar.)	-1.28	-0.45	2.15	1.90
Lawrence	1976:1-1990:1 (quar.)	-1.03	-1.05	2.47	1.60

Note: Results from these studies may differ in part because of different time periods as well as different data sources. These studies, as well as the others mentioned in the paper, usually calculated more than one estimate. In some cases the figures reported herein represent averages of several estimates.

Table F--New Estimates of Import Price and Income Elasticities

	Price Elasticity	Income Elasticity	Quarterly Trend
1. Disaggregated	-0.767	0.838	0.011
2. Disaggregated, No Trend	-0.600	0.914	
3. Aggregate (activity = total U.S. domestic purchases)	-0.838	2.962	-0.002
4. Aggregate, No Trend (Activity = total U.S. domestic purchases)	-0.855	2.818	
5. Aggregate (Activity = U.S. consumption of Manufactured goods only)	-1.074	1.613	0.004
6. Aggregate, No Trend (Activity = U.S. consumption of Manufactured goods only)	-1.047	1.745	

Table G--New Estimates of Export Price and Income Elasticities

	Price Elasticity	Income Elasticity	Quarterly Trend
1. Disaggregated	-0.772	1.840	0.001
2. Disaggregated No Trend	-0.774	2.113	
3. Aggregate (Activity variable=GNP)	-1.068	2.092	-0.003

Table H--Sources of the Real Trade Deficit
(percent contribution of factors)
(excludes agricultural exports and oil imports)

Study	Due to different U.S.-- foreign rates of growth	Due to change in relative prices	Other
Helkie and Hooper (1980-1986)	11 %	73 %	16 %
Krugman and Baldwin (1980-1986)	35%	46 %	19 %
Lawrence (1980-1985) author's estimates	32 %	66 %	2 %
This report (1982-1986)	8 %	40 %	52 %

Note: Some differences between studies may be due to differences in period under review as well as definitional differences. Lawrence (1990) for example, is based on *level* of trade deficit in 1985 as well as trade in *services*.

Table I--Contribution to Change in Import Trade Volumes
from First Quarter 1982, Selected Years
(1986 constant dollars, in bil.)

Year	Total Change	Due to Demand for Good	Due to Relative Demand for Imports	Due to Relative Price Effects	Due to Trend	Other
1985	107.0	55.7	-11.3	13.9	26.4	22.3
1986	125.0	61.3	-9.4	11.1	38.2	23.8
1987	124.5	65.2	-9.8	-0.7	50.8	19.0
1989	147.7	78.8	-5.7	-19.0	78.7	14.9
1991	148.1	59.6	-3.9	-23.2	109.5	6.1

Note: The relative demand for imports is calculated as the change in demand for imported goods minus the change in total U.S. demand for that class of good. For example, if U.S. demand for import cars goes up 10 percent while total U.S. demand for all cars went up 12 percent, the relative demand for imported cars would actually be minus 2 percent.

Table J--Contribution to Change in Export Trade Volumes
from First Quarter 1982, Selected Years
(1986 constant dollars, in bil.)

Year	Total Change	Due to Demand Effects	Due to Relative Price Effects	Due to Trend	Other
1985	-8.6	30.7	-35.6	-1.0	-2.7
1986	-4.9	41.2	-41.2	-0.9	-4.0
1987	1.5	44.5	-39.9	0.0	-3.1
1989	64.8	89.5	-22.2	1.0	-3.5
1991	110.1	114.4	-15.6	4.4	6.9

Table K--Estimates of Structural Contributions to Real Trade Deficit
(excludes agricultural exports and oil imports)
(in bil. 1982 constant dollars)

Study	Period covered	Amount of 1989 trade deficit attributable to structural shifts
Blecker	1980-1989	86.0
Hickok and Hung	1979-1989	67.0
Alterman	1982-1989	95.7

Note: The analysis in this report was constructed using 1986 constant dollars. Since import and export prices both edged down approximately 4 percent between 1982 and 1986, then if this study had actually been done using 1982 constant dollars, the change in the trade deficit attributable to structural shifts would have been approximately $100 billion. In 1987 constant dollars (the base used by the U.S. Dept. of Commerce), the inflation-adjusted 1989 trade deficit was $106.6 bil.

APPENDIX A Data Sources

The analysis was conducted using the 1972 Standard Industrial Classification (SIC). A total of 59 detailed groups were analyzed: two 4-digit groups (motor vehicles and parts for motor vehicles), forty-seven 3-digit groups and ten 2-digit groups. Five of the groups represent non-manufacturing categories and are shown for informational purposes only. Not all groups had sufficient data for each of the analyses. The levels were chosen in part due to the paucity of usable data at the 4 digit SIC level. Other studies have also been done at this level.[50] In general the 3 digit level was used unless the dollar value was too small (below $1 bil. in either imports or exports).

As mentioned in the text, the import and export price indexes as well as exchange rate and foreign currency price indexes came from the Bureau of Labor Statistics. Although BLS began publishing a limited number of monthly indexes in 1989, the data in this study represents the third month of each quarter. The first-quarter 1980 start date was chosen because earlier BLS price data were not comprehensive enough to allow detailed analysis for more than just a handful of series. In some cases the BLS data, especially from the early part of the 1980s, is not published. However, the information in this report is consistent with the Bureau's rules regarding confidentiality.

The data on total U.S. domestic purchases (GDP minus exports plus imports), were from the Bureau of Economic Analysis and were constructed using 1987 as the base. Data on domestic production were obtained primarily from the Industrial Production Indexes produced by the Federal Reserve Board. For ten series data were not available from the FRB. In three of those instances (SICs 364, 382, 384), the author used data from the Monthly Industry Series published by the Bureau of the Census. In the remaining 7 cases (SICs 326, 349, 361, 362, 387, 391 and 394), only yearly data from the Census Annual Survey of Manufactures and other sources was available. The figures were then converted into a quarterly series by using a cubic spline approximation technique.[51]

I used data from ten countries in constructing a time series estimate for foreign GNP. The data were averaged together using a country's relative share of U.S. exports in 1986. The percentages for the three European countries were adjusted upward to account for all of Europe. The percentages for the two Latin American countries were adjusted upward to account for all of Latin America. The percentages for the three Asian countries were adjusted upward to account for all of Asia. All percentages were then adjusted to sum to 100 percent. The series were combined using the following proportions:

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[50] This includes Shiells et al (1985).

[51] For more information see SAS/ETS User's Guide (1988), Chapter 11 "The EXPAND Procedure."

Canada	22.1
Japan	21.9
Germany	10.9
United Kingdom	11.7
France	7.4
Korea	5.1
Taiwan	4.5
Australia	2.7
Mexico	10.4
Brazil	3.3

Figures on foreign GNP were accessed from the International Financial Statistics database maintained by the International Monetary Fund. In general, the series represented constant dollar GNP figures. However, the industrial production index was used for Mexico. Data for Taiwan were from official Taiwan publications and were converted from an annual to a quarterly basis. Data for Brazil also needed to be converted from an annual to a quarterly basis. In both instances the cubic spline approximation technique was again employed.

Domestic price series (used for converting import prices into *relative* import prices and for deflating Census value of shipments data) were from the BLS Producer Price Index database. Since many of the PPI series were not published by SIC code until the mid-1980s, earlier WPI series were spliced together to produce a complete historical series. In some instances these linkages were previously developed in an internal BLS study. In many cases the matches were developed by the author, and in all cases PPI data from the third month of each quarter was used to be consistent with import and export price data.

To construct an average foreign producer price index, used to construct a series of *relative* U.S. export prices, applying the same trade weights for constructing a foreign GNP series, the wholesale price indexes of Canada, Japan, Germany and the United Kingdom from the IFS database were aggregated.

Values for nominal U.S. exports and imports were accessed from the COMPRO database maintained by the Office of the U.S. Trade Representative. In an earlier study, these data were highly volatile, even on a quarterly basis, but specialists in the Dept. of Commerce verified that much of this raggedness was due to collection problems and not to true economic fluctuations. As a result, in this study as in the previous one, the data was seasonally adjusted with the X11 procedure.[52] The final data set consisted only of the "trend" component of the old data. Although

[52] For more information see SAS/ETS User's Guide (1988), Chapter 20 "The X11 Procedure."

this no doubt raises certain statistical issues, it does not appear all that different from the type of adjustments made to the aggregated series normally used in this type of analysis.[53]

Estimates for prices and "real" shipments of computers have been a constant problem in analyzing the U.S. economy.[54] BLS export and import price indexes have demonstrated relatively little price change in this category during the 1980s. The Bureau's new producer price index for computers has only been published for several years. In contrast, for a number of years the Bureau of Economic Analysis has been producing their own estimates of price trends for domestic, exported and imported automated data processing equipment--estimates which have shown substantial price declines. (It is not clear what price indexes were used to construct the FRB production series for this category.) In any event, in order to ensure consistency between the ADP equipment categories for domestic production, imports and exports, current dollar estimates of both domestic production and exports were deflated by the BLS export price index and the current dollar estimates of imports were deflated by the BLS import price index. The values for domestic consumption, production, exports and imports were converted to constant dollars using 1986 as the base.

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[53] The problem with the Durbin-Watson statistic noted earlier may be related to this smoothing process. This may have imposed more structure on the dependent variable, and consequently the residuals, than was called for. It is unclear if this significantly biased the elasticity or intercept estimates.

[54] The problem focuses on determining the quality difference between a new computer and an old computer. See Young (1989), Denison (1989) and Triplett (1986).

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