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INTERNATIONAL SOURCES OF DOMESTIC INFLATION

by

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There is considerable controversy regarding the sources of the rapid rise in prices that has occurred recently in the United States. Some attribute the current inflation to inappropriate monetary or fiscal policies; that is, the inflation is seen as mainly the consequence of an excessively rapid expansion in the money supply and a large deficit in the federal budget. Another factor cited is the large increase in wages and other costs since the ending of controls. Finally, others point to the influence of extraordinary developments outside the domestic economy, such as the quadrupling in the price of petroleum charged by oil-exporting countries, the depreciation of the dollar, the sale of large amounts of wheat to the Soviet Union and others, and the world-wide expansion in economic activity leading to sharply rising prices for internationally-traded commodities.

In this paper we focus upon the last factor: namely, the extent to which influences of primarily external origin have affected domestic inflation, centering on the degree to which, over the past 2-3 years, both increases in the prices of U.S. imports and exports of goods, as well as changes in the trade balance itself, have contributed to the overall rate of inflation in this country. We look at two aspects of internationally-generated inflation: (1) the effect of the weighted average depreciation

*Staff, Board of Governors of the Federal Reserve System. The views expressed in this paper are our own and do not necessarily reflect those of the Federal Reserve Board or its staff. The helpful comments on an earlier draft of this paper by other members of the Board's staff are gratefully acknowledged. Peter Clark is the principal author of the paper. Richard Berner and Barbara Lowrey performed the input-output calculations. Richard Berner wrote Technical Appendix 1 and Jared Enzler and Richard Berner wrote Technical Appendix 2. This paper was prepared at the request of the Joint Economic Committee of the U.S. Congress.

of the dollar that took place between 1971 and 1973, and (2) the effect of other factors, mainly the rapid increase in world-wide demand for primary agricultural commodities and industrial raw materials.[1] Our quantitative estimates of the additional inflation arising in the United States as a result of these two international developments are, first, that the exchange rate adjustments that began in 1971 did indeed have a discernible impact on the domestic price level, but that the depreciation of the dollar accounts for a relatively small proportion of the total inflation we have experienced over the past three years. We find, secondly, that the abnormally-large increases in U.S. import and export prices not related to the depreciation had a significantly greater impact on domestic inflation than depreciation of the dollar alone. These differing impacts reflect mainly the fact that the dollar's decline in foreign exchange markets was much less important than other factors in raising U.S. import and export prices between 1971 and the first half of 1974.

The distinction we made above between internal and external sources of inflation is by no means clear cut. Developments within the United States clearly have influenced both the course of the dollar's exchange rate vis-à-vis other currencies, as well as movements in the prices of the commodities that the U.S. imports and exports. Relatively-high inflation in the United States during the 1960's was no doubt one of the

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[1] We include under the heading of "other causes" the rise in the price of petroleum engineered by the OPEC countries. The domestic inflationary consequences of this aspect of imported inflation have been examined much more extensively in another paper written at the Board. See James L. Pierce and Jared J. Enzler, "The Effects of External Inflationary Shocks," Brookings Papers on Economic Activity, 1974, Vol. 1.

causes of the depreciation of the dollar between 1971 and 1974. Also, greater demand for foodstuffs within the United States contributed to the recent unusually large increases in the prices of internationally-traded agricultural commodities. Therefore the prices of these commodities are by no means completely exogenous to the United States.

It is difficult to separate the influence of the United States world prices, and the influence of world prices on prices in this country. Because we lack the requisite tools, we have not attempted to estimate the repercussion on world inflation of the price behavior generated within the United States; as a consequence, we have by necessity been forced in our analysis to treat the increases in U.S. import and export prices between 1971 and 1974--caused both by the depreciation of the dollar and by other factors--as though they arose completely independently of developments within the United States. Since we know that this assumption is not entirely valid, our results tend to overestimate the true influence of the international sources of domestic inflation considered in this paper. Nevertheless, we feel that our results are useful because they do provide what is probably an upper limit of the contribution of foreign developments to domestic price increases.[2]

We first briefly describe recent developments in the U.S. weighted average exchange rate and in import and export prices. We then discuss

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[2]Our results are based on the assumption that the growth in monetary aggregates between 1971 and mid-1974 was unaffected by internationally-generated inflation. If in fact the growth in monetary aggregates was higher as a result of this source of inflation, then it is possible that our results could underestimate the impact of foreign developments on domestic inflation.

the channels through which a depreciation of the dollar in particular, and a rise in import and export prices in general, affect the aggregate domestic price level. Our empirical results, which were obtained with a variety of techniques, are described in the final section. A more technical description of the calculations is given in the appendices.

I. Magnitude and Timing of Exchange Rate and Import and Export Price Movements

It is now nearly three years since the first U.S. devaluation was formalized in the Smithsonian Agreement that was signed in December 1971. The actual depreciation of the dollar in fact began somewhat earlier when both the German mark and the Dutch guilder were allowed to float and the Swiss franc was revalued in May of 1971. Further depreciation took place in August, when in response to Nixon's New Economic Policy, the pound, the yen, the lira, the Belgian franc and the Swiss franc were allowed to find their own level in the foreign exchange market. An additional decline in the international value of the dollar took place in 1972 when several currencies moved to the ceiling 2-1/4 percent above the Smithsonian central rates. The second devaluation took place in the first two quarters of 1973, with the decline in the dollar's value equalling that which took place in 1971-1972. Between mid-1973 and January, 1974, however, the dollar appreciated markedly, but then depreciated until May of this year. Since then the dollar has appreciated in most foreign exchange markets. These fluctuations in the international value of the dollar, as measured by a weighted average of

the dollar price of sixty-seven currencies (which is referred to as the effective exchange rate of the dollar), are shown in Figure 1 and in Table 1.[3]

Also shown in Figure 1 and Table 1 are the movements in aggregate U.S. import and export prices (unit values). Since these prices rose considerably more than the dollar depreciated, other factors, such as the commodity boom and the inordinate rise in the price of petroleum, must account for most of the movement in the prices of U.S. imports and exports over and above the inflation rate in the United States. Furthermore, there are good reasons (explained below) for believing that the depreciation did not cause an equivalent rise in import and export prices; in other words, the percentage increase in import and export prices is less than the percentage depreciation of the dollar. Hence it is unlikely that recent changes in the effective exchange rate of the dollar are a major cause of domestic inflation, represented by the Consumer Price Index in Figure 1.

Factors other than the depreciation provided tremendous boosts to the prices of the goods traded by the United States. Between the first quarter of 1971 and the second quarter of 1974, aggregate import prices rose four times, and aggregate export prices rose two times faster than domestic prices. Beginning in the fourth quarter of 1973, a sizeable fraction of the increase in import prices has been due to the decision by the OPEC countries to raise the price of their petroleum exports.

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[3]This measure of the average dollar cost of foreign currencies has been constructed by Louis Moczar, formerly of the Department of Commerce and presently at the Federal Reserve Board. Figure 1 shows the average dollar price of foreign currencies; thus, an upward movement in this series corresponds to a downward movement or depreciation of the dollar.

Figure 1

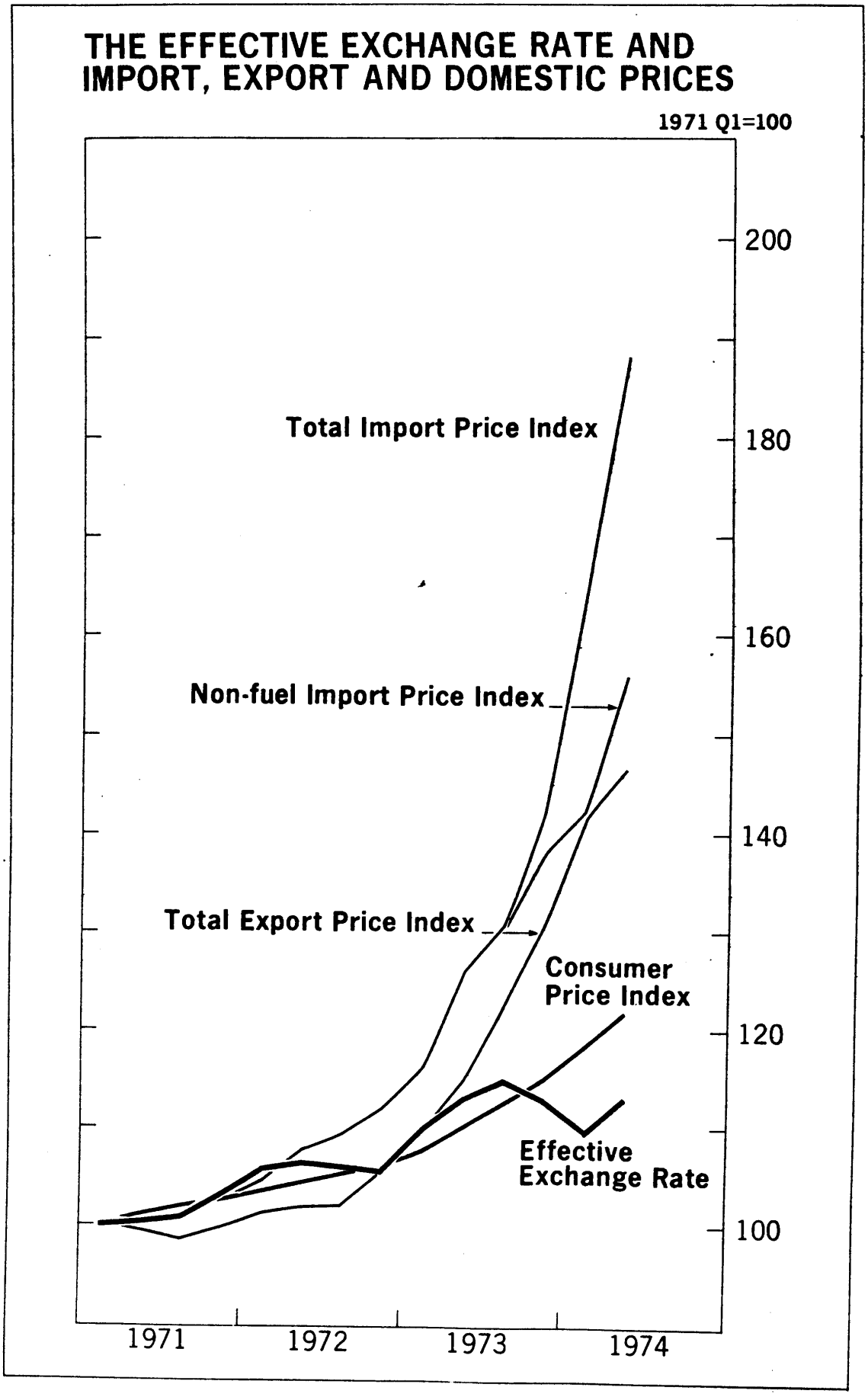
THE EFFECTIVE EXCHANGE RATE AND IMPORT, EXPORT AND DOMESTIC PRICES
1971 Q1=100
200
180
160
140
120
100
Total Import Price Index
Non-fuel Import Price Index
Total Export Price Index
Consumer Price Index
Effective Exchange Rate
1971
1972
1973
1974

Table 1

The Effective U.S. Exchange Rate and Import, Export and Domestic Prices (1971.1=100)

	Effective Exchange Rate (U.S. $ price of foreign currencies)	Total Import Price Index	Non-fuel Import Price Index	Aggregate Export Price Index	Consumer Price Index
1971.2	100.2	100.3	100.2	99.6	101.1
1971.3	100.8	101.1	100.9	98.6	102.0
1971.4	103.1	102.6	102.6	99.8	102.6
1972.1	105.8	104.5	104.5	101.2	103.5
1972.2	106.4	107.8	108.1	101.9	104.3
1972.3	106.1	109.3	109.7	102.1	105.3
1972.4	105.5	111.9	112.3	105.4	106.1
1973.1	109.8	116.1	116.3	109.5	107.7
1973.2	112.8	125.9	126.5	114.6	110.0
1973.3	114.8	130.7	130.4	122.4	112.5
1973.4	112.8	142.1	138.5	130.9	115.1
1974.1	109.7	165.4	142.2	141.6	118.3
1974.2	113.1	188.3	156.0	146.7	121.8

But if we subtract imports of fuels and lubricants from total imports, we still find a very considerable rise in the average price of non-oil imports, as shown in Figure 1 and Table 1. Thus internationally-generated inflation, as seen in the behavior of U.S. import and export prices, cannot be attributed solely to the increased cost of petroleum, but reflects also the inflated cost of other industrial raw materials and foodstuffs.[4]

The exact source of inflation in internationally-traded goods prices is not, however, our particular concern in this paper. Rather, the rapid rise in import and export prices unrelated to the depreciation of the dollar is assumed to be given, and attention is focused on the effects of this rise on the general U.S. price level.

II. Tracing Through the Effects of Dollar Depreciation and Extraordinary Price Increases on the Domestic Price Level

A depreciation of the dollar affects the domestic rate of inflation by raising import prices in dollar terms and lowering export prices in terms of foreign currencies, thereby reducing imports and raising exports and shifting demand toward domestic goods. The stimulus to demand in the export and other sectors arising from a depreciation will raise real income and employment, at least in the short run, whereas exogenous

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[4]Over the period covered by Figure 1 and Table 1, the unit value index for U.S. imports of industrial materials and supplies less fuels and lubricants rose by 78.7%. Over the same period the unit value index for foods, feeds and beverages rose by 57.3%. The prices of manufactured goods rose at a much slower rate, however. For example, the unit value index for capital goods (less autos) increased by 32.2%, and the index for autos, engines and parts rose by 35.5% during this period. A similar picture emerges if one looks at the price behavior of U.S. exports.

increases in export and import prices may in fact have the opposite effect and reduce aggregate demand expressed in real terms.

To elucidate this and other differences we first describe how a depreciation affects the economy, and then compare this behavior with the response of the economy to increases in import and export prices that have been caused primarily by developments in the rest of the world.

A depreciation involves an increase in the dollar price of foreign currencies. This makes foreign goods and services more expensive in dollar terms, since if prices in foreign currencies remain the same, one must pay out more dollars to obtain the same quantity of imports. Since the United States has a large share in world trade, there will, however, be some reduction in the foreign currency prices of U.S. imports, and consequently U.S. dollar prices of imported goods will not rise by the same percentage as the depreciation. In other words, if the U.S. dollar is devalued by, say, ten percent, then there will be a reduction in U.S. demand for foreign products, some fall in the foreign currency prices of these products, and therefore the prices of imports measured in U.S. dollars will increase by less than ten percent.

The rise in the dollar cost of imports directly affects the general price level by an amount that depends on the weight given to imports in various price indices. The devaluation-induced effect on domestic prices includes increases in the dollar prices of both imported finished goods, which enter mainly the Consumer Price Index (CPI), and imported intermediate inputs, which would show up first in the Wholesale Price

Index (WPI).[5] The additional cost of imported inputs will then raise the prices of domestically-produced finished goods, thereby providing further impetus to the CPI.

A devaluation also has a direct price effect on the export side. American goods become less expensive to foreign purchasers, and as a result there is a shift in demand away from goods produced in other countries and toward U.S. output. This shift in demand will tend to raise the dollar prices of those goods exported by the United States, the extent of the rise depending on the elasticity of supply of U.S. output. In general, a devaluation will cause a less-than-proportionate rise in the dollar prices of exportable commodities. As in the case of imports, the additional foreign demand induced by the dollar depreciation will result in higher dollar prices of both final and intermediate-input exportable goods. The impact of higher prices on aggregate U.S. price indices depends on the weight that exportable commodities have in these price indices.

So far we have considered the effect of a depreciation of the dollar on goods that are actually traded internationally. There is in addition a significant indirect effect on the domestic price level which occurs because domestic demand shifts away from higher-priced imports

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[5] As of December 1972, imported commodities comprised 3.1 percent of the items included in the CPI and 1.5 percent of the items covered in the WPI. It should be noted that since imports are subtracted from total expenditures to obtain Gross National Product (GNP), the price index or deflator for GNP does not include any direct effect of import prices when properly weighted to exclude the effects of imported intermediate inputs. The GNP deflator will rise in response to higher import prices only as a result of the shift in domestic and foreign demand towards domestically-produced goods, thereby causing the value of U.S. output to increase.

and toward domestically-produced goods and services. The greater is the substitutability of domestic goods for imports, the larger is this shift in demand.[6] The size of the impact of this re-direction in expenditures on domestic prices depends on supply as well as demand conditions. The induced rise in the prices of domestic substitutes depends on the extent to which domestic output of substitutes can be changed and the speed with which available capacity can be utilized or increased. For example, if labor markets are tight and capacity utilization is high, the upward pressure on prices of domestic substitutes for goods produced abroad will be greater than if the depreciation comes at a time of general slack in the economy.

A similar mechanism operates when the dollar prices of the types of goods exported by the United States increase. As these goods become more expensive in the United States, domestic consumers and producers will shift some of their expenditures to other domestically-produced goods. For example, a devaluation-induced increase in the price of wheat makes bread more expensive, and this will provide an inducement to consumers to purchase larger amounts of other forms of carbohydrates.

The shifts in demand toward domestic output described above on the part of both foreigners and domestic residents will generally be associated with an improvement in the current account of the balance of payments that is included in Gross National Product as "net exports of goods and services." The devaluation-induced improvement in the current

[6] Cross-price elasticities of demand, which depend on substitutability, determine the extent of the demand shift.

account is equivalent (in real terms) to the initial increase in total demand for U.S. output that is reflected in the shifts in expenditures described above. The higher income resulting from the improved current account may generate further expenditures on domestic output. Thus it is possible for the total increase in demand caused by an exchange rate depreciation to be some multiple of the balance-of-payments effect.

The extent to which total (i.e., domestic and foreign) expenditures rise as a result of a depreciation, and therefore the magnitude of the response in domestic prices, is quite sensitive to the macroeconomic policies that are pursued while the exchange rate effects are working themselves out. On the one hand, in the case of a devaluation--where the support level for a country's currency in foreign exchange markets is changed by a discrete amount--there may be an automatic increase in the money supply, depending on the effects of changes in the balance of payments and reserve holdings on the domestic monetary base. In this case the induced increase in the domestic money supply results from the intervention by the central bank in the foreign exchange market. As the U.S. dollar is a major reserve currency, this consideration is less important for the United States than for other countries. On the other hand, when the exchange rate simply depreciates in the foreign exchange market with no intervention by the central bank, there will be no induced increase in the domestic money supply.

Nevertheless, even though a central bank may control the domestic money supply--either by adopting a floating exchange rate or by offsetting the domestic monetary consequences of discrete exchange-rate

adjustments--a depreciation in a country's currency, whether it be discrete or gradual, may induce a change in macroeconomic policies because of the repercussion the depreciation can have on domestic output, employment, prices and interest rates. For example, if monetary-fiscal policies remain unchanged following a depreciation of the dollar (i.e., tax rates, government expenditures and monetary aggregates are not altered in response to the depreciation), the additional foreign and domestic demand for U.S. output would tend to increase interest rates because of the rise in real income and prices. The rise in interest rates would, however, tend to limit the increase in domestic expenditures and thereby attenuate the effect on the general price level. In an extreme case interest rates could rise to such an extent that spending by domestic residents would decline by the full amount of the improvement in the current account, so that there would be no increase in income and little or no domestic price effect. If, on the other hand, policy makers responded by moderating the upward movement in interest rates caused by the depreciation in order to avoid unduly hurting certain sectors, e.g., the housing industry, that are quite sensitive to shifts in monetary policy, the induced effect on aggregate demand would be considerably larger and therefore the inflationary impact would also be stronger than if the growth of monetary aggregates were set independently of interest rates.

The response in macroeconomic policies is especially important when an economy is close to, or at, full employment. In this case it will be difficult, especially in the short run, to expand real output

at existing commodity and factor prices in order to satisfy the additional demand for exports and import substitutes. One way macroeconomic policies can assist in achieving an improvement in the current account following a depreciation under conditions of full employment is by curtailing domestic demand, making more domestic output available for exports and simultaneously reducing the demand for imports. Such policies would attenuate the inflationary impact that is inevitable if the increase in aggregate demand resulting from the depreciation is greater than the feasible increase in total domestic supply. In the absence of such policies, prices will rise until the excess aggregate demand is choked off. Therefore monetary and fiscal policies that put a brake on domestic expenditures both improve the current account and reduce the inflationary consequences of a currency depreciation, and for the same reason: they reduce aggregate excess demand.

Such policies, however, are not necessarily costless. In general, cuts in expenditures resulting from these policies will not exactly match, sector by sector, the additional demand generated by the depreciation. Since there are frictions in the movement of labor and capital between the housing sector and the manufacturing sectors producing for the export market, for example, a restrictive monetary policy designed to reduce the inflationary consequences of a depreciation will have undesirable short-run consequences for output and employment in the residential construction industry. These short-run costs must therefore be weighed against the gains from pursuing policies which enhance the likelihood that the depreciation will improve the balance of payments; to avoid these short-run costs a country may in fact pursue an expansionary monetary policy, thereby moderating the rise in interest rates resulting from the depreciation.

A final, and quite important, channel through which a devaluation--as with price increases from other sources--affects the domestic price level is through the wage response. The direct and indirect effects on consumer prices described above lead to an induced increase in wages as workers try to catch up with inflation, which then results in still further increases in consumer prices. Consequently the initial domestic price response is magnified depending on the sensitivity of wages to changes in consumer prices.

In analyzing the inflationary impact of a currency depreciation, it is important to distinguish between the effects of permanent devaluations and the effects of short-run, reversible fluctuations in exchange rates that may occur under a regime of managed floating. A once-and-for-all depreciation, such as the devaluation of the dollar in August 1971, will lead to a lasting increase in the domestic price level. Since a "once-and-for-all impact" on the domestic price level would work itself out only over time, however, the rate of change of the price level would be affected during the period of adjustment. Nonetheless, while a permanent depreciation results in a permanent increase in the price level, it leads to only a temporary, although perhaps quite prolonged, increase in the rate of inflation.

Exchange-rate changes that are reversed in the short run have different effects than do permanent changes. Episodes such as the depreciation of the dollar between February and July of 1973--which was largely reversed by the end of January 1974--are less likely to lead to a permanent rise in the domestic price level. The spot dollar prices

of internationally-traded homogeneous goods (like wheat) will increase at the time of the exchange rate change, but the dollar prices of these goods can be expected to decline following a subsequent appreciation, or more precisely, because of the subsequent appreciation they will rise more slowly than they otherwise would have. And, as long as a depreciation is short-lived, there are reasons to believe that such increases in spot prices for these commodities probably would not feed through to the prices of manufactured goods. First, raw materials costs are affected only in part by fluctuations in spot commodity prices since procurement contracts are typically written at a fixed price for extended periods of time. Second, prices of final goods change relatively slowly in response to small changes in costs or in demand. For administered prices, there is usually a considerable smoothing of price changes to final purchasers. While the recent inflationary environment has no doubt shortened the lags in price setting behavior, there are reasons to believe that significant lags remain. We believe, therefore, that changes in the effective U.S. exchange rate that are soon reversed are not likely to have a significant impact on the domestic price level.

Up to this point we have been considering the domestic inflationary consequences that result from a depreciation of the dollar. These consequences occur primarily from rising import and export prices. Between 1972 and 1974 U.S. import and export prices also rose on account of other developments in the world economy. The question then arises as to whether the domestic price effects of these developments operate through the same mechanism as those arising from a depreciation.

In general, there need be no fundamental differences. Higher import prices, whether due to a depreciation or other factors, raise domestic costs and shift demand toward domestic output. If higher export prices are caused by an increase in foreign demand for U.S. output, then domestic prices will respond in a manner similar to that induced by a depreciation.

Given the particular nature of the price increases that actually occurred, however, there may well be important differences. First of all, the increase in import prices in 1973-1974 was concentrated in fuels, other industrial materials and supplies, and agricultural commodities, the demand for which is price inelastic. This means that as a result of higher prices, total dollar expenditures on these imports increased. With no change in savings, the higher import prices will cause a decline in expenditures on domestic goods and services relative to what would have occurred in the absence of the extraordinary price rises. In particular, the exogenous increase in the price of imported oil (which caused the price of domestic petroleum products to rise) has been likened to the imposition of a sales tax: since the proceeds of this tax are not immediately spent, either by OPEC countries or American oil companies, there is a net contractionary effect on the economy because of a decline in aggregate demand.[7]

Higher import prices also reduce spending on domestic output for one other reason. The increase in the domestic price level resulting

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[7]For an extensive discussion of the contractionary impact of the oil price rise, see the article by Pierce and Enzler, op. cit.

from higher-priced imports reduces consumers' real income and wealth, which causes them to cut back on their purchases of domestic goods and services.

Furthermore, there may be an additional effect reducing output in the short run arising from an upward shift in the aggregate supply schedule for domestic output. The higher cost of imported intermediate inputs, especially industrial raw materials, will raise the prices of finished domestically-produced goods. If there is some price sensitivity in demand for these goods, there will be a reduction in the quantities purchased. Thus abstracting from other factors, there may be a short-run decline in total output because of the increase in production costs caused by higher import prices.[4] Over a longer period, there would tend to be some reduction in wage rates because of the lower output, and this decline in costs would shift the aggregate supply curve back towards its initial position. In the long run, then, there would probably be little impact on total output as a result of factors affecting domestic costs of production.

On the export side, it was mentioned above that the effects of an exogenous increase in export prices will be the same as those induced by an exchange rate depreciation if in the former case the price rise is caused by additional foreign demand. Under these circumstances the increase in export price is associated with a positive stimulus to U.S. income. However, a price rise can also be caused by a reduction in supply, in which case there would be a decline in exports (expressed in real terms) and therefore a reduction in real output. This appears

to have happened during some quarters with regard to agricultural exports as a result of shortfalls in several crops. Thus during these periods higher agricultural export prices were associated with lower real exports and lower aggregate real domestic income compared with a situation where there were no shortages of agricultural products.

An additional contractionary effect resulting from increased import and export prices may operate through the financial system. In the absence of accommodating action by the monetary authorities, the higher overall domestic price level will reduce real cash balances, which in turn will raise interest rates. The higher interest rates will then lower investment expenditures, including residential construction, thereby reducing aggregate demand over what it otherwise would have been.

Most of these contractionary effects were also induced by the depreciation, but they were much less pronounced than in the case of the commodity price rises, where it appears that these contractionary forces caused a net reduction in aggregate real demand. This reduction in demand for real output offset part of the inflationary impact of the higher import and export prices. In contrast, the depreciation provided a stimulus to total spending in real terms. This stimulus reinforced the inflationary impact of the higher import and export prices brought about by the exchange rate changes.

III. Empirical Evidence

A. Effects of the Depreciation of the Dollar on U.S. Import and Export Prices

We shall begin by describing the inflationary impact of the depreciation of the dollar. In estimating the extent to which import and export prices rose as a result of the exchange rate changes that took

place from 1971 through the first half of 1974, it should be noted that even if traded-goods prices increased by the full extent of the depreciation, most of the recent increases in these prices would still remain unaccounted for. Between the first quarter of 1971 and the second quarter of 1974 the import price (unit value) index rose 88 percent and the export price (unit value) index rose about 47 percent, whereas over the same period the effective depreciation of the dollar amounted to only 13%. Clearly most of the inflation in the prices of internationally-traded goods (expressed in dollars) is due to factors other than recent adjustments in exchange rates.

The assumption that U.S. import and export prices rose by the full amount of the depreciation is, however, untenable. Because the United States has such a large share of world trade--about fourteen percent during this period--the price effects will be split between an increase in dollar prices and a reduction in foreign currency prices (relative to what they otherwise would have been). Therefore, it is necessary to make separate calculations of the extent to which the increase in the average dollar price of foreign currencies was reflected in higher U.S. import and export prices.[8]

For these calculations U.S. imports and exports have been dichotomized on the basis of the degree of competition in the market in which they are bought and sold. On the one hand, some commodities have

[8]The estimates presented below are taken from a separate paper by one of the authors. See Peter Clark, "The Effects of Recent Exchange Rate Changes on the U.S. Trade Balance," to appear in The Effect of Exchange Rate Adjustments, papers presented at a conference held at the U.S. Treasury, April 4-5, 1974, edited by P. Clark, D. Logue and R. Sweeney.

standard characteristics and are traded on organized international commodity markets. Because of arbitrage, the prices of these goods in different countries tend to differ by no more than freight, insurance, interest charges, and such trade barriers as tariffs, quotas, and special marketing arrangements (e.g., the Common Market's variable levies on agricultural imports). Even in the face of these trade barriers, the perfectly competitive model would appear to be a good approximation of the mechanism determining the prices of these goods. Using this model, the impact of the multilateral exchange rate changes during 1971-1974 on the dollar prices of these commodities can be calculated from knowledge of the magnitude of countries' exchange rate changes vis-à-vis the dollar, their share in world trade in these commodities, and on the basis of assumptions regarding supply and demand elasticities.

On the other hand, there are commodities that are not homogeneous, being characterized by substantial product differentiation, such as finished manufactured products. Since these goods are not traded on organized markets, and sellers of these goods have a substantial degree of discretion in setting prices, the assumptions of perfect competition do not hold. It is therefore necessary to use a different method to obtain estimates of the effects of exchange rate changes on the prices of these commodities. This method involves the application of regression analysis to determine whether after allowing for the influence of input costs and other factors, the movement in the dollar's effective exchange rate can explain movements in the prices of these goods.

The competitive model was used to calculate the increase in the dollar prices of three broad categories of U.S. traded goods. These were imports of foods, feeds and beverages, industrial materials and supplies (less fuels and lubricants), and exports of agricultural commodities. According to our calculations, the dollar prices of these commodities rose from seven to ten percent as a direct consequence of the net effective depreciation of the dollar between 1971 and mid-1973, when the depreciation was at a maximum. Since that time there has been a net appreciation of the dollar, so that by now the net increase in the prices of these commodities probably ranges from six to nine percent.

In looking at the price behavior of U.S. exports of finished and semi-finished manufactured goods, we have been unable to detect any significant exchange rate effect. It appears that cost and demand conditions in the U.S. manufacturing sector can explain nearly all of the variation in the prices of U.S. manufactured exports. In other words, it seems that American exporters did not raise the prices they charge to foreigners in any substantial degree as a result of the depreciation of the dollar; rather, they charged the same price as that quoted to domestic customers. We therefore find little or no inflationary impact as a result of the increase in demand for U.S. manufactured exports.

With respect to imports of finished manufactures, however, we do find that the depreciation of the dollar did cause a significant rise in the cost of these commodities. By 1974 the prices of these imports are estimated to have risen between ten and twelve percent as a result of the higher dollar cost of foreign currencies. This estimate is

higher than that obtained for the other categories of imports mentioned above. The main explanation for this difference is that U.S. imports of finished manufactures are supplied by those countries that appreciated the most against the dollar, e.g., Germany and Japan, whereas imports of foods, feeds, and beverages and industrial materials and supplies come from a more diversified group of countries that on average appreciated by a smaller amount vis-à-vis the dollar.

B. Input-Output Results

The increases in import and export prices described above constitute the direct effect of the dollar depreciation on the domestic price level. To take account of the indirect effects arising from (1) higher-priced imported intermediate inputs raising domestic production costs and (2) the increases in prices of domestic substitutes for imports, we used input-output weights to calculate the total, i.e., direct plus indirect, effect of depreciation-induced import price rises on the deflator for personal consumption expenditures (PCON).[9] (A detailed explanation of these calculations is given in Technical Appendix 1.) In making our calculations we assumed that the prices of domestic substitutes for traded goods in seven input-output sectors rose by 100% of the increase in import prices, and by 50% of the rise in import prices

[9]The deflator for personal consumption expenditures, PCON, is a Paasche price index, that, by contrast with the CPI, covers all personal consumption expenditures.

in two other sectors.[10] We found that PCON rose by .79 percent, as shown in the top row of Table 2. If it is assumed that it took until the second quarter of 1974 for the full pass-through of higher import costs to occur, we can compare this figure with the actual increase in PCON over this period, namely 18.6 percent. Thus this calculation indicates that only a small fraction (4.2%) of recent inflation in the United States (as measured by PCON) can be attributed to the depreciation of the dollar.

Input-output analysis was also employed to compute the domestic price effects caused by import price changes arising for reasons other than the depreciation of the dollar. We first made a simple calculation of the impact on domestic prices of increases in "extraordinary" import prices alone. Based on the past relationships between movements in U.S. domestic and import prices, we estimated that approximately three-eighths of the actual rise in import prices was caused by the depreciation and the normal trend in such prices, and that the remaining five-eighths could be considered "extraordinary." Using this measure of extraordinary import price rises, we calculated that the inflationary impact on the

[10]The seven input-output sectors are livestock, other agriculture, forestry and fishing, iron ore, nonferrous ores, lumber and paper. The two other sectors are rubber and iron and steel. It was assumed that domestic prices rose in step with import prices in these seven sectors because imports and domestically-produced goods in the corresponding sector were judged to be nearly perfect substitutes. For the other two sectors, a smaller sympathetic rise in domestic prices appeared appropriate because it was assumed that foreign and domestic output cannot be as easily substituted for each other.

Table 2

Increase in the Personal Consumption Deflator (PCON)
Using Input-Output Analysis

Change in PCON due to:	Percentage Change in PCON	Fraction (in %) of Total Change in PCON over 1971.3 - 1974.2
Depreciation of the dollar with increases in prices of domestic substitutes	.79	$\frac{.79}{18.6} = 4.2$
Extraordinary increase in prices of imports only	1.53	$\frac{1.53}{18.6} = 8.2$
Extraordinary increase in import prices and in prices of domestic substitutes	4.48	$\frac{4.48}{18.6} = 24.1$

deflator for consumption expenditures was 1.53 percent. Again assuming that the prices of final goods and services fully reflected the pass-through of the higher costs of imported inputs by the second quarter of 1974, about 8 percent of the total rise in PCON between mid-1971 and mid-1974 can be attributed to the direct effect of the unusually rapid rise in import prices.

This calculation leaves out, however, the increase in the prices of domestic substitutes for imports. As foreign goods become more expensive in the United States, demand shifts to domestically-produced counterparts, thereby raising their prices. As in the depreciation case, we assumed that in certain sectors domestic prices rose by the full extent of the extraordinary increase in import prices.[11] Our calculations, reported in the third row of Table 2, show that PCON rose by 4.48 percent as a result of the increase in costs associated with the direct and indirect consequences of the abnormally-rapid rise in import prices between 1971 and mid-1974.[12] This is equal to 24.1 percent of the total increase in PCON over this period.

There are two reasons for the difference in results between the second and third rows of Table 2. First, the 4.48 percent figure includes the rise in the average price of domestic oil, and we calculate that this alone raised PCON by 1.1 percent. Second, the direct and

[11] See footnote 10 for a list of these sectors.

[12] In these calculations we assumed that the entire increase in the average price of domestic crude oil in the United States between 1971 and the first part of 1974--an increase from $3.41 to $6.33 per barell--was extraordinary, and therefore the figures in the third row of Table 2 include this source of inflation.

indirect requirements to produce the items in PCON are much larger for domestically-originating output than are the import requirements in comparable sectors. These domestic requirements (excluding oil) add altogether 1.85 percent to the deflator for consumption expenditures. Thus 4.48 is equal to the sum of 1.53 (import requirements), 1.10 (oil requirements) and 1.85 (domestic non-oil input requirements).

It must be stressed that the input-output technique only takes account of cost factors. Because it does not include the change in aggregate demand for U.S. output, the results in Table 2 will tend to underestimate the true effect if there has been an upward shift in total demand. Offsetting this downward bias is a tendency for input-output analysis to overestimate the price increase because of the explicit assumption of fixed input coefficients. Since firms will to some extent substitute lower-priced inputs for those that have risen in cost, and consumers will substitute lower-priced goods for those that have become more expensive, the results in Table 2 will have an upward bias because they do not take account of this substitution. Finally, because we have assumed in the majority of cases (7 out of 10 input-output sectors) that domestic prices rose by the same amount as the extraordinary increase in import prices, we have built an upward bias into our results, since except for homogeneous goods like wheat, soybeans, etc., the sympathetic rise in domestic prices was probably less than 100 percent.

It is also useful to recall here the point made in the introduction. We have assumed the extraordinarily large increases in U.S. import prices (defined as the increase over and above that implied by the

average relationship between import and U.S. domestic prices) was exogenous to the United States. Since in fact part of this "exogenous" increase was due to demand and supply conditions in this country, the figures in the second and third rows of Table 2 tend to overestimate the true impact on U.S. inflation of economic developments in the rest of the world.

C. Results From Simulating the Federal Reserve Board's Econometric Model

As we mentioned above, one of the limitations of the input-output approach is that it cannot take account of aggregate demand effects. Another limitation is that it exoludes the rise in wages induced by the higher prices of imported and domestic consumer goods. Finally, monetary effects cannot be included in input-output calculations.

To take account of these excluded effects we have simulated the Federal Reserve Board's quarterly econometric model. (An extensive discussion of the procedures used in these simulations is given in Technical Appendix 2.) In our first experiment we try to measure the contribution of the depreciation of the dollar to domestic inflation. In simulating the Board's model of the U.S. economy we have programmed a world in which the depreciation of the dollar did not occur. The model will tell us what might have happened to prices, income, interest rates, etc., if the foreign currency value of the dollar had been constant during the last three years. In making this simulation we have assumed that the monetary aggregates grew at their actual rate.

The results of this simulation experiment are shown in Figure 2, where the heavy solid line denotes the actual value of the deflator for

Figure 2

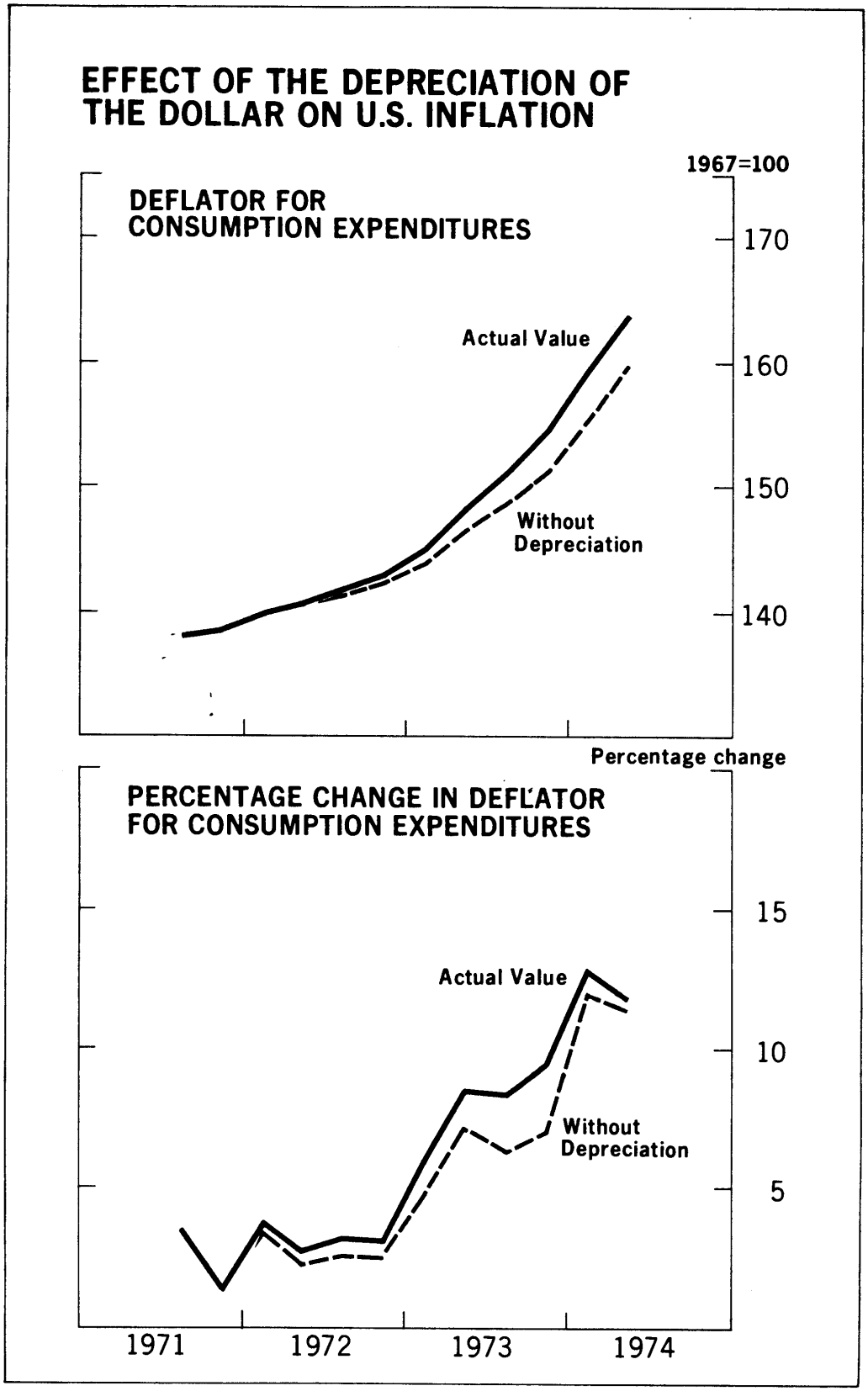
EFFECT OF THE DEPRECIATION OF THE DOLLAR ON U.S. INFLATION
1967=100
DEFLATOR FOR CONSUMPTION EXPENDITURES
Actual Value
Without Depreciation
170
160
150
140
Percentage change
PERCENTAGE CHANGE IN DEFLATOR FOR CONSUMPTION EXPENDITURES
Actual Value
Without Depreciation
15
10
5
1971
1972
1973
1974

Table 3

Effect of the Depreciation of the Dollar on U.S. Inflation: 1971.3-1974.2

	1971.3	1971.4	1972.1	1972.2	1972.3	1972.4	1973.1	1973.2	1973.3	1973.4	1974.1	1974.2
1) PCON (1967=100)	138.1	138.6	139.9	140.8	141.9	143.0	145.1	148.1	151.1	154.6	159.3	163.8
2) PCON without depreciation	138.1	138.6	139.8	140.5	141.4	142.3	144.0	146.5	148.7	151.2	155.5	159.9
3) 1-2	0	0	.1	.3	.5	.7	1.1	1.6	2.4	3.4	3.8	3.9
4) % Change in 1	3.5	1.4	3.8	2.7	3.2	3.1	6.0	8.5	8.4	9.5	12.8	11.8
5) % Change in 2	3.4	1.3	3.4	2.2	2.6	2.5	4.8	7.2	6.3	7.0	12.0	11.4
6) 4-5	.1	.1	.4	.5	.6	.6	1.2	1.3	2.1	2.5	.8	.4

Notes: Percentage changes are annual rates compounded quarterly. The figures for the percentage changes may not correspond to what is implied by the figures for the level of PCON because of rounding.

consumption expenditures (expressed in both level form and as a percentage change) and the dashed line portrays how PCON would have behaved in the absence of the depreciation.[13] The numbers used to construct these lines are given in Table 3. In the upper panel we see that by the second quarter of 1974 the depreciation had raised PCON by 3.9 index number points out of a total increase of 25.7 points during this period. This model simulation result therefore implies that over the entire period the depreciation caused a 2.8 percent (=3.9/138.1) increase in the prices of consumer goods and services, thereby accounting for 15 percent (= 3.9/25.7) of the total inflation in PCON of 18.6 percent.

In the lower panel we can see that the inflationary impact of the depreciation is concentrated in 1973. This reflects the current and lagged effects of the depreciation, which reached a peak in the third quarter of 1973, as well as the fact that price controls were being removed from a large part of the economy in the latter part of the year. Before decontrol began, prices of domestic substitutes for higher-priced imports were not allowed to rise, thus suppressing some important indirect price effects of devaluation.

In the first two quarters of 1974, however, the actual and simulated rates of inflation are much closer than they were in 1973. This

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[13] In the model simulations the definition of the deflator for consumption expenditures differs somewhat from that used in the input-output calculations. In the model PCON is defined as the deflator for purchases of non-durable goods and services plus the services of durable goods. Over the three year period covered in the simulations the difference in definitions does not affect the comparability of the results with the input-output calculations.

is primarily a result of the appreciation of the dollar against many major currencies in late 1973 and early 1974, as shown in Figure 1 and Table 1.

There are three reasons why the result from the simulation experiment exceeds that using the input-output approach. First, increases in export prices have been taken into account in the model simulation. Second, wages have been allowed to respond endogenously to higher consumer prices. Third, the shift in demand from traded to non-traded goods has been explicitly taken into account. Further discussion of the results of this simulation experiment are contained in the last part of Section A in Technical Appendix 2.

In our second experiment with the macroeconomic model we simulated the impact of the extraordinary increases in import and export prices described above. The results are shown by the dashed lines in Figure 3 and are reported in Table 4. According to our calculations, prices of consumer goods and services rose 4.5 percent as a result of abnormally high prices of petroleum, industrial materials and supplies, and agricultural commodities.[14] This accounts for 24 percent of the total rise in PCON between mid-1971 and the second quarter of 1974. Additional details of the results of this simulation can be found in the last part of Section B in Technical Appendix 2.

A comparison of these figures with those reported in Table 2 shows that the macroeconomic model and the input-output approach yield results

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[14] As in the case of the depreciation experiment, monetary aggregates were assumed to grow at their actual, observed rates.

Figure 3

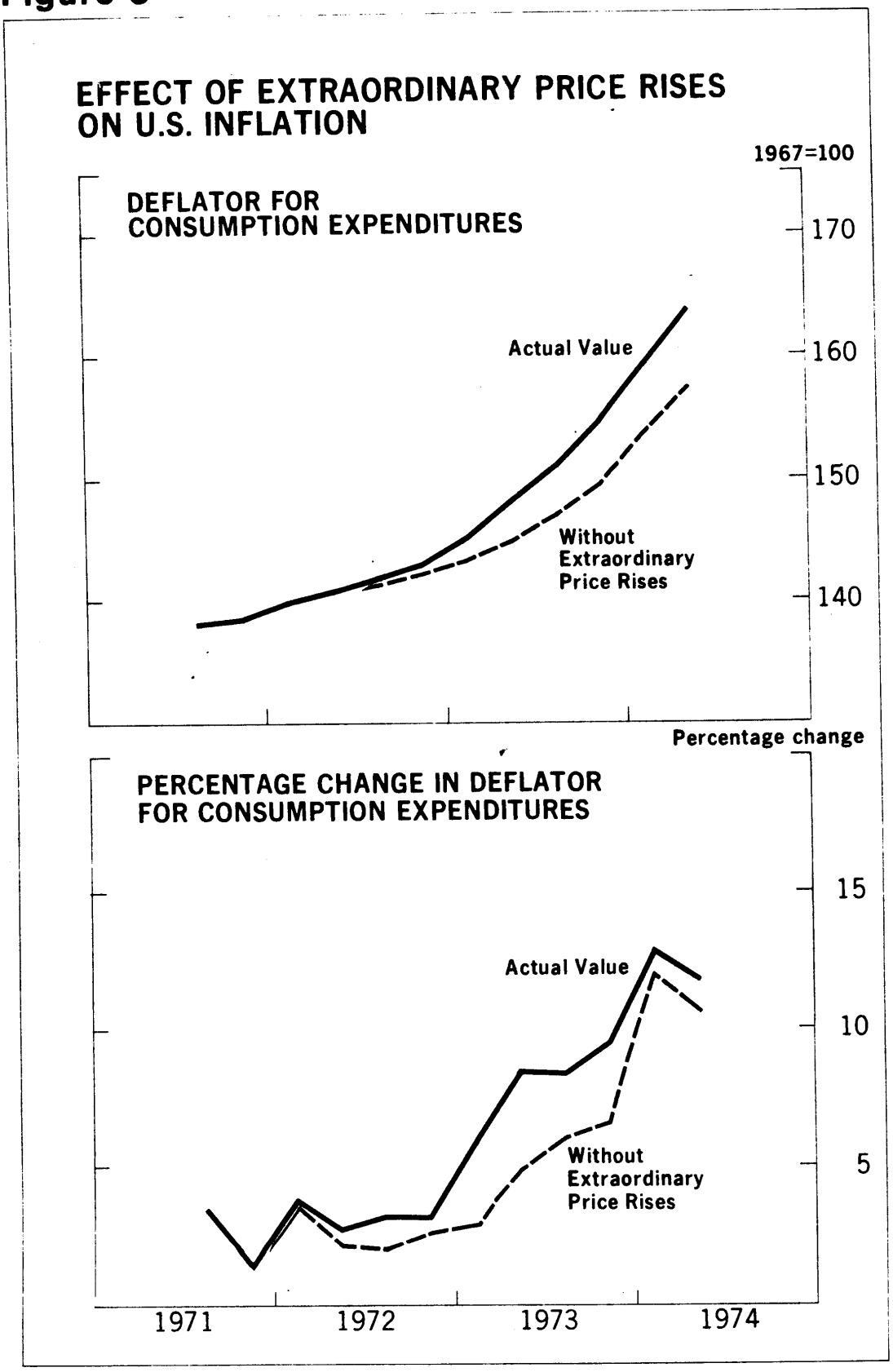
EFFECT OF EXTRAORDINARY PRICE RISES ON U.S. INFLATION
1967=100
DEFLATOR FOR CONSUMPTION EXPENDITURES
170
160
150
140
Actual Value
Without Extraordinary Price Rises
Percentage change
PERCENTAGE CHANGE IN DEFLATOR FOR CONSUMPTION EXPENDITURES
15
10
5
Actual Value
Without Extraordinary Price Rises
1971
1972
1973
1974

Table 4

Effect of Extraordinary International Price Rises on U.S. Inflation: 1971.3-1974.2

	1971.3	1971.4	1972.1	1972.2	1972.3	1973.4	1973.1	1973.2	1973.3	1973.4	1974.1	1974.2
1) PCON (1967=100)	138.1	138.6	139.9	140.8	141.9	143.0	145.1	148.1	151.1	154.6	159.3	163.8
2) PCON without extraordinary price rises	138.1	138.6	139.8	140.6	141.3	142.2	143.2	144.9	147.0	149.4	153.7	157.6
3) 1-2	0	0	.1	.2	.6	.8	1.9	3.2	4.1	5.2	5.6	6.2
4) % Change in 1	3.5	1.4	3.8	2.7	3.2	3.1	6.0	8.5	8.4	9.5	12.8	11.8
5) % Change in 2	3.5	1.2	3.6	2.1	2.0	2.6	2.9	4.9	6.1	6.6	12.0	10.6
6) 4-5	0	.2	.2	.6	1.2	.5	3.1	3.6	2.3	2.9	.8	1.2

Notes: Percentage changes are annual rates compounded quarterly. The figures for the percentage changes may not correspond to what is implied by the figures for the level of PCON because of rounding.

for the inflationary impact of exogenous price rises that are almost identical in size. The main explanation for this close correspondence is that in simulating the model we find that the higher exogenous prices are associated with a reduction in real GNP. This means that there was no inflationary pressure from the side of aggregate demand in the experiment involving the macroeconomic model; and since aggregate demand effects are ruled out in input-output analysis, the results from using the two different methods turned out to be quite comparable.

This same deflationary impact on real income arising from the exogenous price increases is also one of the reasons why there is not a larger difference in the results of the two simulation experiments, the first involving the depreciation and the second focusing on the exogenous price effects. The initial price disturbance in the second experiment is roughly four times larger than that in the first, and yet the impact on PCON is not even doubled--15 percent vs. 24 percent. The reason is that the much larger inflationary shock to the economy in the second experiment is not accompanied by an initial stimulus to aggregate demand, as is the case with the depreciation experiment, because there is no improvement in the trade balance and because the higher price level reduces the real money stock, raises interest rates and thereby chokes off some investment expenditures. When this negative effect from the monetary side is combined with the deflationary impact of higher import

prices, the net overall impact is a reduction in real income.[15] This reduction in aggregate demand thus tends to offset part of the initial inflationary disturbance, so that the ultimate effect on PCON is much less than when income and prices move in the same direction.

Finally, it should be noted that the 15 and 24 percent figures cannot be added to obtain a combined effect for both the depreciation and the exogenous price increases. The reason is that the macroeconomic model is non-linear, which means that doubling the size of the initial disturbance to the model does not necessarily double the impact on the price level.

IV. Summary and Conclusion

In this paper we have examined two disturbances to the American economy that occurred between 1971 and mid-1974. One of these disturbances--the depreciation of the dollar--accounts for a non-negligible fraction of the total rise in the cost of consumer goods and services. Using input-output analysis, we find that this fraction is roughly 4 percent; however, using the Federal Reserve Board's econometric model of the United States to take account of aggregate demand factors, we find that this fraction rises to roughly 15 percent. The other disturbance we investigated--the extraordinarily large increase in import and export prices between 1971 and 1974--had a more pronounced effect on the prices

[15] Recall that we have assumed that monetary and fiscal policies are unaffected by the inflationary disturbance. This is, no doubt, a restrictive assumption in this second experiment because it is quite likely that some offsetting measures would be undertaken in order to moderate the decline in real income which otherwise occurs.

of consumption goods and services: 24 percent, or roughly one-quarter, of the inflation in the consumer sector can be accounted for by extraordinary price disturbances.

From our investigation we can draw two conclusions. First, in measuring the total inflationary consequences of an external shock, whether it be an exchange rate adjustment or in some other form, it is quite important that consideration be given to the sympathetic rise in the prices of domestically-produced goods and services. This is especially important in input-output analysis, where the results are quite sensitive to the assumptions one makes regarding the extent to which U.S. producers raise their prices in response to a rise in the prices of imported goods. Second, the particular nature of the inflationary shock does make a substantial difference in determining the ultimate impact on the domestic price level. In examining the effects of higher import and export prices, one must know something about which prices were affected and the reasons why they have risen in order to take proper account of how they affect the overall domestic price level. And in particular, one must know whether the disturbance caused a positive or negative stimulus to aggregate demand, since the inflationary outcome in the domestic economy depends crucially on whether real income rises or falls as a result of the disturbance.

Finally, we need to emphasize that in this paper we have been talking of international developments as sources of recent U.S. inflation only in a proximate sense. Part of the extraordinary rise in the international prices of agricultural primary products, for example, has been strictly exogenous. Thus the purchase by the Soviet Union of large amounts of U.S. grain, and the disappearance of the achovies in the Pacific, which increased world demand for soybeans, were clearly external factors that raised prices in the United States. However, the rise in the international prices of these commodities was also in part due to supply and demand conditions in the United States. Since we have not accounted for the fact that the extraordinary increases in international commodity prices were to some extent the result of events in this country, we have probably overestimated the domestic inflationary consequences of what we have referred to as "external" price rises.

Similarly, it is quite likely that we have also overestimated the degree to which the depreciation of the dollar was itself a cause of domestic inflation, since relatively high inflation in the United States was one of the causes of the exchange rate changes that took place in the early 1970's. If the dollar had been floating during the 1960's, it would have gradually depreciated in the foreign exchange markets, thereby eliminating the disequilibrium in the U.S. balance of payments that in fact emerged. As it turned out, the depreciation was delayed until 1971. What this delay meant is that for several years prior to 1971 the rate of inflation in the United States was <u>lower</u>

than it would have been had the dollar been floating, the reason being that the United States was buying foreign goods at lower dollar prices than was consistent with balanced external accounts. If we offset the higher prices in the early 1970's with the lower prices of the late 1960's, we would find that the depreciation of the dollar had a much smaller overall domestic inflationary effect than the estimate we have presented here.

TECHNICAL APPENDIX 1

This appendix describes the input-output computations reported in the text. Input-output tables can be manipulated to yield a set of weights that convert import and sympathetic domestic industrial price changes into changes in the price of final demand. The component of final demand for which the price change is considered in the text is personal consumption expenditures.

The well known advantage of input-output is that the direct plus indirect changes in the final price resulting from sector price changes can be computed. For example, if the price of oil rises, not only does the price of gasoline rise, but the increase in the cost of producing all goods that use oil as an input, directly or indirectly, results in an increase in the prices of all (in general) final goods. This arises because oil is used, e.g., to generate electric power, which in turn is used, e.g., to refine aluminum, which in turn is used in making cans, conduits, doorframes, and aluminum foil.

The weights that are calculated for the import-price-increase part of inflation and for the sympathetic domestic price increase part of inflation are contained in two matrices, labelled C and D.

In words, C_{ij}, the i, j^{th} element of the matrix C will give the direct plus indirect requirements of value added from industry i to satisfy a unit of the j^{th} final demand. Similarly, D_{ij} (the i, j^{th} element of the matrix D) will give direct and indirect import requirements to satisfy a unit of final demand j. C and D can also be used as weights to convert changes in prices by industrial sector

to changes in prices of final demand, since the total cost in producing a unit of final demand j is

$$(1) \quad \text{cost } j = \sum_i C_{ij} \, PV_i + \sum_i D_{ij} \, PM_i$$

where PV_i and PM_i are the value added deflator and import price for industry i, respectively.[1]

Denoting percentage change by a Δ, and using the symbol ' to denote vector transpose, we have, in matrix notation,

$$(2) \quad \Delta\text{cost} = \Delta PV' \, C + \Delta PM'D.$$

Equation (2) was used in carrying out the computations reported in the text. To compute the required weight matrices, the 1970 Bureau of Labor Statistics (BLS) 130 sector input-output table was aggregated to the Bureau of Economic Analysis (BEA) 87-industry classification, and the following matrices were computed:

$$(3) \quad C \equiv B^{-1} \, (I - A)^{-1} \, H$$

$$(4) \quad D \equiv M \, (I - A)^{-1} \, H,$$

---

[1] Actually, cost j must be divided by a scale factor equal to $\Sigma_i C_{ij} + \Sigma_i D_{ij}$, the sum of the column sums of each matrix C and D, because C's columns sum to unity, and adding those of D gives a set of weights that add to more than unity.

where

A is the 87x87 coefficient (direct requirements) matrix,

H is the 87x10 final demand matrix normalized so that columns sum to unity,

B is the 87x87 diagonal matrix containing the ratios of gross output to value added on the diagonal,

I is the 87 order indentity matrix,

M is the 87x87 diagonal matrix containing the ratios of imports to gross output on the diagonal,

and -1 denotes inverse.

Table A-1 reports the four marginal price vectors that were used to compute the cost effects of foreign price and exchange rate changes on domestic inflation. Column (1) was derived from detailed import unit value index changes over the period 1971 Q3 through 1974 Q2. These were scaled by a factor of 5/8 to produce the same marginal (i.e., increase above trend, 3/8 of the actual) increase used in the model simulations reported in the text. Column (2) gives the sympahetic domestic price response in those industries that produce output felt to be extremely close substitutes for the import. Column (3)gives the import price change caused (ΔPMD) by the average change in the U.S. exchange rate over the same period, and column (4) gives the sympathetic domestic price increases (ΔPVD) analogous to those of column (2).

Table 1

Marginal Price Vectors for Import Price Increases and Devaluation
(in percent)

BEA Industry No.	Industry	ΔPM (1)	ΔPV (2)	ΔPMD (3)	ΔPVD (4)
1	Livestock & livestock products	24	24	9.84	9.84
2	Other agricultural products	26	26	9.84	9.84
3	Forestry & fishery products	26	13	9.84	9.84
4	Agricultural, forestry & fishery services	26	0	7.38	7.38
5	Iron & ferroalloy ores mining	8	8	7.38	7.38
6	Nonferrous metal ores mining	146	146	7.38	7.38
8	Crude petroleum & natural gas	151	88	7.38	0
9	Stone & clay mining & quarrying	146	0	7.38	0
10	Chemical & fertilizer mineral mining	146	0	7.38	0
14	Food and kindred products	37	0	7.38	0
15	Tobacco manufactures	44	0	7.38	0
16	Broad & narrow fabrics, yarn & thread mills	4	0	7.38	0
17	Miscellaneous textile goods & floor coverings	69	0	7.38	0
18	Apparel	38	0	7.38	0
19	Miscellaneous fabricated textile products	69	0	7.38	0
20	Lumber & wood products, except containers	30	30	7.38	7.38
22	Household furniture	29	0	7.38	0
23	Other furniture & fixtures	29	0	7.38	0
24	Paper & allied products, except containers	58	29	7.38	7.38
25	Paperboard containers & boxes	58	0	7.38	0
27	Chemicals & selected chemical products	33	0	7.38	0
28	Plastics & synthetic materials	33	0	7.38	0
29	Drugs, cleaning & toilet preparations	89	0	7.38	0
30	Paints & allied products	89	0	7.38	0
31	Petroleum refining & related industries	163	0	7.38	0
32	Rubber & miscellaneous plastics products	89	44	7.38	7.38
33	Leather tanning & industrial leather products	-18	0	7.38	0
34	Footwear & other leather products	-18	0	7.38	0

Table 1 (cont.)

BEA Industry No.	Industry	ΔPM (1)	ΔPV (2)	ΔPMD (3)	ΔPVD (4)
35	Glass & glass products	89	0	7.38	0
36	Stone & clay products	89	0	7.38	0
37	Primary iron & steel manufacturing	44	22	7.38	7.38
38	Primary nonferrous metal manufacturing	43	0	7.38	0
39	Metal containers	44	0	7.38	0
40	Heating,plumbing & structural metal products	44	0	7.38	0
41	Stampings,screw machine products & bolts	44	0	7.38	0
42	Other fabricated metal products	44	0	7.38	0
43	Engines & turbines	18	0	7.38	0
44	Farm machinery & equipment	18	0	7.38	0
45	Construction,mining & oil field machinery	18	0	7.38	0
46	Materials handing machinery & equipment	18	0	7.38	0
47	Metalworking machinery & equipment	18	0	7.38	0
48	Special industry machinery & equipment	18	0	7.38	0
49	General industrial machinery & equipment	18	0	7.38	0
50	Machine shop products	18	0	7.38	0
51	Office,computing & accounting machines	18	0	7.38	0
52	Service industry machines	18	0	7.38	0
53	Electric industrial equipment & apparatus	18	0	7.38	0
54	Household appliances	29	0	7.38	0
55	Electric lighting & wiring equipment	86	0	7.38	0
58	Miscellaneous electrical machinery, equipment & supplies	18	0	7.38	0
59	Motor vehicles & equipment	22	0	7.38	0
60	Aircraft & parts	18	0	7.38	0
62	Scientific & controlling instruments	18	0	7.38	0

Table 1 (cont.)

BEA Industry No.	Industry	ΔPM (1)	ΔPV (2)	ΔPMD (3)	ΔPVD (4)
63	Optical,ophthalmic & photographic equipment	29	0	7.38	0
64	Miscellaneous manufacturing	30	0	7.38	0
65	Transportation & warehousing	25	0	7.38	0
68	Electric,gas,water & sanitary services	25	0	7.38	0
70	Finance & insurance	25	0	7.38	0
76	Amusements	25	0	7.38	0
81	Business travel,entertainment & gifts	25	0	7.38	0

Thus, the figures reported in the text in Table 2 are $\Delta PMD'D + \Delta PVD'C$ in the first line, $\Delta PM'D$ in line 2, and $\Delta PM'D + \Delta PV'C$ appears in line 3. Since the weights are additive, the figures in the three lines may be added to obtain the marginal cost impact, assuming full passing-through, of the increase in import prices and the exchange rate changes on the consumer price deflator.

Technical Appendix 2

PART A: ESTIMATING THE EFFECT OF THE DEVALUATION USING THE FEDERAL RESERVE ECONOMETRIC MODEL

This part of the appendix describes the use of the Federal Reserve econometric model in analyzing the effects of the currency depreciation. The effects are measured by comparing two model simulations, one of which assumed a currency depreciation and one of which did not. Actually three simulations of the 1971 III - 1974 II period were done. In the first, each equation of the model was simulated in isolation using actual values of all right-hand side variables. The error for each equation was recorded for each quarter. In the second simulation a simultaneous solution of the equations was generated. The errors from the first simulation were added to the appropriate equations in the appropriate quarters. When simulated in this manner the model will track historical values exactly, apart from minor rounding errors. This second simulation we label the CONTROL simulation. In the third simulation we again solve the system simultaneously and again we add the appropriate error to each equation. This time we also make changes to the exogenous variables and behavioral equations as necessary to represent the direct effects of the phenomenon we are investigating. We call this the ALTERNATE simulation. Since in fact we did have a currency depreciation in the period in question both history and the CONTROL simulation incorporate the effects of the depreciation. The difference between the ALTERNATE and CONTROL simulations we take as our measure of <u>not</u> having a currency depreciation.

The reason for adding the equation errors to both the CONTROL and ALTERNATE simulations is simple. The model is nonlinear and therefore its response to exogenous shocks depends on such things as the level of economic activity. We want to measure the effect of the depreciation at as close to historical levels as possible. Therefore, to assess as accurately as possible the effects of the depreciation, we want to eliminate the tracking errors of the model by adding them to both the CONTROL and ALTERNATE simulations.

The Federal Reserve econometric model is not ideally designed for an analysis of changes in the exchange rate. It contains no international sector other than equations for imports of goods and services. Its treatment of relative prices is extremely awkward in this context. The major direct effects of exchange rate changes must be introduced into the model by assumption. Once that is done however, the model will have something to say about the manner and extent to which these direct effects are transmitted throughout the domestic economy.

Effects of a Devaluation

At this point it may help to list the important effects of a devaluation on the domestic economy. The list is arranged so as to facilitate discussion of the manner in which the assumptions relating to the devaluation were entered into the model.

(1) Import prices are increased. This will occur with a lag. The effect will vary from commodity to commodity and the average effect will probably be considerably less than the total amount of the exchange rate change.

(2) Export prices are increased. The same qualifications as in (1) apply here.

(3) The increased import prices, when passed on, directly increase the average value paid by ultimate purchasers of goods and services

(4) The increased export prices directly increase the average price of goods sold by businesses and farms and at least temporarily increase business profits.

(5) The increased import prices may not be fully passed on to ultimate consumers at first. This works toward a temporary decrease in business profit margins.

(6) The increase in the price of imports allows price increases for import-competing goods. This raises both the average price paid by ultimate domestic purchasers and the the average price received by business for their product.

(7) The increased price of export goods may cause producers of those goods to raise prices on the portion of those commodities sold on domestic markets. Producers of close substitutes for these goods may also find it profitable to raise prices.

(8) The higher import prices as viewed by domestic purchasers lead to a decrease in the real quantity of imports.

(9) Lower export prices, as viewed by foreigners in foreign currency, lead to an increase in the real quantity of exports.

(10) The increased import prices may lead to an increase in the demand for money by increasing the total value of economic transactions. Since the model's money demand function uses nominal GNP

as a proxy for transactions, and since increased import prices do not cause nominal GNP to rise, the model does not capture this effect.

(11) Increased consumer prices reduce the real net worth position of households which has a depressing influence on consumption.

(12) The devaluation redistributes real income from domestic to foreign persons and this works to reduce consumption.

(13) The increased prices will cause participants in the labor market to attempt to get wage increases. The short-run Phillips curve is shifted upward. To the extent that workers succeed in obtaining higher money wages, further upward pressures on prices are created.

(14) Both the direct and induced price increases lead to higher interest rates which eventually work to hold down real output if monetary aggregates are allowed to rise in an accommodating fashion.

(15) The familiar multiplier and acceleration responses to all these effects are set in motion.

Either effects (1) through (10) are not a part of the specification of the model, or (in the case of (8)) the measurement of the effect is not to be trusted. Effects (11) through (15) are captured reasonably well in the model. Therefore, we feel justified in undertaking this simulation exercise.

We will now take these effects one at a time and discuss how we dealt with them in the simulation. Necessary parts of the model's structure will be elucidated as needed.

Direct Effect of Devaluation on the Dollar Price of Internationally-Traded Goods (1 and 2)

The model has nothing to say on this subject. We specified its effects on the National Income Accounts deflators for imports and exports which are taken as exogenous variables by the model. We introduced programming into the model to make the percentage deviation of the import and export deflators from their historical values depend on a distributed lag on the difference of exchange rates from historical values; e.g.,

$$\frac{P'm - Pm}{Pm} = \sum_t \sum_i W_i V_{-t,i} DEV_{-t}$$

where Pm is the historical import price deflator, P'm is the adjusted deflator, DEV_{-t} is the extent of the currency revaluation t periods earlier, W_i is the proportion of a subgroup i of imports, (e.g., agricultural imports). The W_i sum to unity and $V_{-t,i}$ is the reaction of the i^{th} subgroup to a devaluation t periods earlier.

We set the devaluation problem up with 3 categories of both imports and exports. These categories are labelled (with apologies to experts in this field) as agricultural, other primary tradeables, and non-primary tradeables. The proportions used (W_s) were .0449, .2752, and .6288 respectively. (The proportions are a slight modification of estimates supplied by Barbara Lowrey. The V's were taken partially from work by Peter Clark and partly from discussion with a number of people from the International Division.) The assumed V's are listed in Table 1. The values in Table 1 constitute one of the most important sets of assumptions

of the entire exercise.

Table 1

Reaction of Import Transaction Prices to a Unit Devaluation

	Agri-cultural	Other Primary Tradeables	Non-Primary Tradeables
V_0	.2	.150	.06
V_1	.3	.225	.15
V_2	.2	.150	.18
V_3	.1	.075	.12
V_4	.0	.0	.06
V_5	.0	.0	.03
SUM	.8	.600	.60

There are other foreign prices in the model but in one way or another we suppressed the effects of these variables and incorporated them into some kind of judgemental adjustment so they need not concern us here.

Direct Effect of Increased Import prices on Domestic Price Indexes and Deflator

In order to explain this adjustment it will be necessary to describe the wage-price sector in some detail. Following is a schematic representation of the model's wage-price sector.[1]

(1) $PBNF = f(\overline{W},\overline{CU})$

(2) $PC = \overline{UPC} * PBNF * k$

(3) $PI = \overline{UPI} * PBNF * k$

(4) $PF = \overline{UPF} * PBNF$

(5) $PGNP * GNP = \overline{C} * PC + \overline{I} * PI + \overline{X} * \overline{PX} - \overline{M} * \overline{PM}$

(6) $PGNP * GNP = BNF * PBNF + \overline{F} * PF$

[1]The star(*) denotes multiplication.

(7) $GNP = \overline{C} + \overline{I} + \overline{X} - \overline{M}$

(8) $BNF = GNP - \overline{F}$

(9) $\frac{\dot{W}}{W} = f(U^{-1}, \frac{\dot{PC}}{PC})$

Equation (1) is the central price equation which generates the deflator for nonfarm business output (PBNF) as a function of wage rates (W) and capacity utilization, (CU). The solid lines that appear over some variables denote variables exogenous to the wage-price sector. Equation (2) and (3) determine the deflators for consumption (PC) and investment (PI) using their historical ratios (UPC and UPI) to PBNF as exogenous variables. Thus it can be seen this model explains the price level but does not explain relative prices. The remaining variable (k) will be described below. Equation (4) is a similar equation for farm prices (PF). Equation (5) adds up the expenditure side of the simplified NIA accounts to nominal GNP. C, I, X, and M represent consumption, investment, exports, and imports respectively, all measured in 1958 dollars. Equation (6) adds up the current dollar industry side of the accounts to nominal GNP. BNF and F represent nonfarm and farm output in 1958 dollars. Equations (7) and (8) are analogous constant dollar identities. Thus there are 8 equations and only 7 variables to be determined. It is a property of implicit deflators that both (5) and (6) hold in the national income accounts. However, in a model simulation where all the real quantities do not match historical values, equations (5) and (6) will not compute the same nominal GNP. In order to get around this the factor (k) is introduced into the relative price equations which forces the identities to add to the same number. The computation of k is not described here;

suffice it to say it is defined such that the two identitites give the same GNP. We will rely on the factor k to cover all mix problems in the deflator. This is a crude approximation but is probably the best that can be done. Equation (9) is a so-called Phillips curve relating the rate of change of wages to the inverse of the unemployment rate and the rate of change of consumption prices.

Now consider the direct effect of an increase in import prices. Suppose initially that the increase is fully passed through to ultimate consumers. In this case it has no direct effect on PBNF or PGNP since they are value-added deflators. It does increase PC and PI, however.

TABLE 2

Use of Product	Source of Product		
	XBNF	XF	XM
C	A_{11}	A_{12}	A_{13}
I	A_{21}	A_{22}	A_{23}
X	A_{31}	A_{32}	A_{33}

Suppose the coefficients A_{ij} in Table 2 represent a modified input-output table for our simplified economy.[2] Output originates in three sectors: nonfarm business, on farms, or outside the country. It is used in three ways: for consumption, investment, or export. A_{21} is thus the proportion of investment goods purchases the value added of which arises

[2]For a more complete description of the input-output table see Technical Appendix 1.

from the nonfarm business sector. Rows of this matrix must then sum to unity. Now consider how consumption prices are related to import prices.

$$PC * C = A_{11} * C * PBNF + A_{12} * C * PF + A_{13} * C * PM$$

$$PC = A_{11} * PBNF + A_{12} * PF + A_{13} * PM$$

Let PC' and PM' be consumer goods prices and import prices that incorporate the effects of a change in PM.

$$PC' = A_{11} * PBNF + A_{12} * PF + A_{13} * PM + A_{13} * (PM' - PM)$$

Assume

$$PBNF \approx PF \approx PM \approx P.$$

Then

$$PC' = A_{11} P + A_{12} P + A_{13} P + A_{13}\Delta PM$$

$$\frac{PC'}{P} = A_{11} + A_{12} + A_{13} + A_{13} \frac{\Delta PM}{P} = 1 + A_{13} \frac{\Delta PM}{P}$$

or in other words the percentage increase in consumer goods prices approximately equals the percentage of the value of consumption goods in which the value added originated outside the country times the percentage increase in import prices. This approximation breaks down if the A_{ij} do not remain constant, but it is hoped that k will cover this.

A table of the same form as Table 2 has been programmed into the model, breaking both imports and exports into 3 categories as discussed in the earlier section. The A_{ij} were computed insofar as possible from the 1970 Bureau of Labor Statistics modified input-output table.

One disadvantage of using the input-output coefficients is that they do not reflect shifts in demand away from the higher-priced imports. The results produced here may therefore overstate the effect of import prices increases.

The complications introduced in this section are necessary to compute the direct effect of increased import prices on consumption prices so that we can use a correct consumption price variable in the Phillps curve. Aside from this, the distribution of the direct effects of increased import prices on the relative prices of the various categories of final output is not very important to the outcome of the exercise.

Effect on Agricultural and Food Prices

It seems appropriate to discuss domestic agricultural prices at this point. We assumed that domestic agricultural prices rose by the same amount, and at the same time (see Table 2) as those of internationally-traded agricultural products. This causes a further shift upward in the ratio of the price of consumer nondurables to nonfarm business output. This effect was also computed with input-output coefficients. The method is identical to that used for increased import prices.

Direct Effect on Export Prices

The model has nothing to say about the prices of export goods. Assumptions are therefore made exogenously, using Peter Clark's work. Export prices were treated in a manner identical to import prices. The following table is analogous to Table 1 (which shows the treatment for imports).

TABLE 3

Reaction of Export Prices to a One Percent Devaluation

	nonprimary non-ag	primary non-ag	ag
V_0	.080	.2	.2
V_{-1}	.075	.3	.3
V_{-2}	.090	.2	.2
V_{-3}	.060	.1	.1
V_{-4}	.030	0	0
V_{-5}	.015	0	0
ΣV_{-i}	.350	.8	.8

Direct Effect on Export Price

Since exports are outputs of business, if export prices increase the average price received by nonfarm business will rise, and such ratios as PC/PBNF will fall. This effect will partially counteract the effect of the previous section on these ratios. Given the percentage increase in the prices of primary and nonprimary, nonagricultural goods, one can, using input-output coefficients, calculate the effect on nonfarm prices assuming no change in the mix, and the ratios such as UPC can be reduced by that amount. This was done, and the main price equation for PBNF was adjusted upward by that same percentage.

There is a question as to the length of time for which this adjustment is appropriate. It seems unlikely that business profit margins would be permanently increased. In time, resources should flow into export

industries until profit on invested capital is no higher there than elsewhere. We have assumed that this does not happen in the twelve quarters of our simulation.

Lags in the Price Pass-Through

It is possible that import prices increases are not fully passed along to ultimate consumers in the short run. We know very little about this effect. The model's central price equation does in fact have a negative term in the percentage change in the price of foreign and agricultural raw materials with an estimated coefficient. We suppressed this term but added another based on the price of imported primary tradeable goods. We increased the size of the coefficient (from the estimated -.012 in the equation to -.03) partially on the grounds that these prices were broader in scope and covered goods and services where importers were not accustomed to sudden price changes,[1] and partially because the simulation period was one involving price controls where all price increases were subject to bureaucratic delays. Fortunately, sensitivity tests indicated the results are not sensitive to the assumption made here. Different assumptions affect slightly the speed with which the price effects operate but the extent of the effect is unaffected.

Effects on prices of Import and Export Competing Goods

When the price of imported goods rises, domestic producers of substitutes find they can increase prices and still maintain their share

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[1]For example, the dollar cost of French mechanics hired by Pan Am would increase, yet it might take time for Pan Am to pass on this increase in costs.

of the domestic market. To some extent they are bound to do so. Similarly when producers find the dollar price at which exported goods can be sold has increased, there is an incentive to raise domestic prices, particularly if capacity is short. This is potentially a powerful effect. Unfortunately, we have no reliable measure of its size. In addition, the size of the effect would be altered by price controls.

We attempted to come to a judgment about this effect by examining, at a very disaggregated level, the various categories of final purchases in the national income accounts. We guessed the extent of this phenomenon for each category, then weighted together the guesses using 1970 purchases as weights. For some categories we thought this effect would be rather pronounced. Automobiles, for example, might be a case where prices could be increased substantially if the price of imported cars went up. On the other hand there were a great many large categories where the effect must be close to zero (i.e., medical, educational, and housing services). Weighting together our best guess about each category we concluded that the average domestic, nonfarm value-added prices would rise by about 10 percent of the amount that internationally-traded, nonfarm goods and services rose.

This assumption is a crucial one, and a complex one as well. We are working toward an adjustment of our central price equation which has as its dependent variable the value added price deflator for nonfarm business product (PBNF). If the price of raw materials to the nonfarm business sector increases, and these increases are passed through to final

consumers, then PBNF is left unchanged. Suppose now we consider the food purchases category of consumer expenditure. If import prices rise, and if farm prices rise and if these costs are passed through to the consumer, this does not call for adjustment to our equation. If, on the other hand, food processers or merchants can raise their profit margins because of this, then an adjustment would be necessary. (If Armour meat packing can raise prices because the retail price of Polish hams has increased, then adjustment is necessary.) In fact, we thought the scope for this sort of thing in the food industry was minimal. In consumer durables (and for some softgoods such as clothing), on the other hand, we felt this effect was quite large. By contrast, most services we considered to be largely unaffected by import prices.

In the absence of price controls this import competing good effect would probably work fairly quickly. It so happens, however, that the real world devaluation occurred at a time of price controls where controlled sellers were not allowed to increase prices except in cases where they were justified by cost increases. This would seem to rule out any competing goods effect, at least through Phase II. However, the price controls did not cover some small businesses and we do not wish to underestimate the ingenuity of businessmen in justifying price increases where such easy profits are to be made. Accordingly, Table 4 enumerates the adjustment in all simulations where price controls were assumed to be in effect.[3]

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[3]That is, the values in Table 4 were multiplied by the direct change in imported nonfarm goods and services prices, and the products was added to the equation for PBNF. This is, of course, only the direct competitive effect. To the extent that increased prices cause increases in wage rates, further upward price pressures are created.

TABLE 4

Elasticity of Domestic Nonfarm Prices with Respect to the Price of Imported, Nonfarm Goods

	1971		1972				1973				1974	
	3	4	1	2	3	4	1	2	3	4	1	2
adjustment	0	0	.01	.01	.01	.01	.03	.03	.04	.07	.09	.10

Thus we allow minimal adjustment in Phases I and II, about half the adjustment in Phase III and then the full adjustment with decontrol in 1974.

Obviously, there is a great deal of guesswork in this, but it is our best judgement. We conducted sensitivity tests on this assumption: the above effects were halved, and then doubled. The effects for the results are not substantial. If, however, we multiply the effect by 4, or 8, the effects are marked indeed. Arthur Laffer has been writing articles which seem to imply the correct adjustment is closer to 100 percent than 10 percent. While this seems unreasonable to us because of the large percentage of final goods and services which do not appear to have potential internationally traded substitutes, if Laffer is correct our results seriously underestimate the inflationary effects of devaluation.

Imports and Exports

Obviously, one important effect of a devaluation is its effect on the quantity of imports and exports. The model contains an import equation which explains imports goods and services largely as a function of real incomes and relative foreign and domestic prices. Exports

are ordinarily exogenous to the model. We introduced an arbitrary export equation for goods and services together which depended on relative prices and which had price elasticities by quarter of .1, .2, .4, .6, .8 .9. 1.0, 1.0, 1.0, 1.0, 1.0, 1.0. The import equations were altered to have approximately the same price elasticity, though the estimated income elasticity was maintained.

Miscellaneous other Adjustments

Farm proprietor income is a variable exogenous to the model. Obviously, it rises and falls with farm prices. We added an equation for farm profits which altered them by 75 percent of the change in the dollar value of farm production. This is necessary because corporate profits are obtained as a residual by subtracting from national income wages, interest, rent, and farm proprietors' income. Failure to adjust farm profits leads to incorrect corporate profits, dividends, and value of shares.

Consumer net worth (which enters the model in an important way) includes the value of farm land, which is normally exogenous to the model. We entered an equation to "explain" the value of farm land which makes it proportional to farm profits with a 5 year distributed lag.

No adjustment was made for any uncaptured effect on farm investment. The model's investment equation includes farms and one of its arguments is the price of business output (including farms). It was felt that the effect of farm prices on investment through this equation was, if anything, too strong.

Monetary and Fiscal Policy Response

The effect of a currency depreciation depends in a major way, of course, on the response to this event by the monetary and fiscal authorities. The behavior of these authorities is not endogenous to the model. For purpose of this exercise we assumed that in the absence of the depreciation the Federal Reserve would have kept the money stock (M^1) at its historical levels. This is an important assumption. If we had assumed, for example, that the Federal Reserve attempted to keep interest rates, rather than monetary aggregates unchanged, the effects would have been considerably larger. In fact, the monetary authority probably gave some weight to controlling each of these variables. To the extent that interest rates were in fact stabilized, our simulations will understate the total price effect of the depreciation.

It was further assumed that fiscal policy was not changed in response to the devaluation. In practice, this means that constant dollar federal purchases, current dollar federal transfers and all Federal Government tax rates were held unchanged.

Macro Effects of the Exchange Rate Change

Selected results from the simulation described above are reported in Table 5. The results shown there are the difference between the ALTERNATE and CONTROL simulation and therefore purport to be the consequences of not having had the dollar depreciate.

The effect on prices is represented by the first two lines in the table showing the effect on the level and rate of change of the consumption deflator. The effects are rather minor until 1973 when the size of the

depreciation increased markedly. The results suggest the rate of inflation would have averaged about 1.7 percentage points lower during 1973 had it not been for the dollar depreciation. The effect on the rate of inflation falls off rapidly in 1974, partly because the dollar actually appreciated relative to other currencies in that period. Avoiding the depreciation would have reduced the consumption level by 2.5 percent by 1974 II.

The initial reduction in prices arising directly from import prices is augmented by the fact that lower prices cause lower wages which result in lower prices, and so on. In addition, the reduction in domestically supplied aggregate demand from increased imports and reduced exports cause higher unemployment rates which in turn reduces inflation. To get some indication of the extent to which these feedback mechanisms contribute to the reduced inflation, consider the effect on the rate of increase of compensation per man hour. In the ALTERNATE simulation, wage pressures are lower throughout the period, and by 1974 wages are increasing by over 1 percent less at annual rates than in the CONTROL case.

These mechanisms are self limiting. The lower prices and real incomes, combined with an unchanged money stock, cause interest rates to fall. If the simulation had been extended these lower interest rates eventually would have induced enough real output and increased the unemployment rate sufficiently to get the inflation rate back to its CONTROL levels. Hence, as described in the text, a depreciation raises the rate of inflation only temporarily.

Table 5

Effects of not having a Currency Depreciation
(ALTERNATE Solution Minus CONTROL Solution)

	1971		1972				1973				1974	
Consumption deflator (PCON)	III	IV	I	II	III	IV	I	II	III	IV	I	II
(1) (percent difference in levels)[1]	.0	.0	-.1	-.2	-.4	-.5	-.8	-1.1	-1.6	-2.1	-2.4	-2.5
(2) (annual percent rate of increase)	-.1	-.1	-.4	-.5	-.6	-.6	-1.2	-1.3	-2.1	-2.5	-.8	-.4
Compensation per man hour												
(3) (annual percent rate of increase)	.0	.0	-.1	-.1	-.3	-.4	-.5	-.6	-.8	-.9	-1.1	-1.2
Gross National Product												
(4) (billions of dollars)	-.1	0.6	-2.1	-4.4	-7.8	-11.5	-17.1	-22.9	-29.4	-35.8	-38.0	-41.1
Gross National Product												
(5) (billions of 1958 dollars)	.0	-.2	-.8	-1.7	-3.4	-5.1	-6.9	-8.5	-9.3	-8.8	-7.8	-7.9
(6) Unemployment Rate	.0	.0	.0	.1	.1	.2	.3	.4	.4	.4	.4	.4
(7) Treasury Bill Rate	.0	.0	-.1	-.1	-.2	-.3	-.5	-.8	-1.4	-1.4	-1.5	-1.6

[1]This line shows the percent difference between the levels of the consumption deflator in the CONTROL and ALTERNATE simulations.

PART B: The Effect of Increased Farm and Internationally - Traded Goods Prices

In this part simulations done to assess the effects of the dramatic increases in farm and imported goods prices are described. We exclude from the analysis in this part the portion of those increases which were due to the currency depreciation. The methodology is similar to that used earlier in the estimate of the currency depreciation effects. That is, since these farm and import price increases did occur, we will be examining the effects of not having them occur.

Consider once more the simplified wage-price sector described by equation (1) through (9) of Part A. Reduction in import and farm prices would decrease the ratios (UPC, UPI, and UPF) of consumption, investment, and farm prices to the nonfarm business deflator.

Given assumption about PM, PX, and PE, we can again use the input-output coefficients to compute the effects on UPC, UPI, and UPF. As in the currency depreciation case, this lowers domestic prices directly. In addition, wage rates (W) depend on consumption prices (PC). As wages are pushed downward they reduce nonfarm business prices through the central price equation (1). This further reduces consumption and investment prices, setting in motion another round of downward price pressures.

In the case of the currency depreciation this mechanism was reinforced by the fact that the changed prices of internationally traded goods caused a reduction in real exports and an increase in real imports. This reduces domestic production which further depresses prices. In the

present exercise this effect is absent.

The price reductions are self-limiting if we again assume (as we do) that the monetary authorities keep the money stock at historical levels. The lower prices reduce the demand for money and, therefore, interest rates. Real output is increased and the unemployment rate is reduced. This causes upward wage and price pressures that partially offset the original stimulus.

One difficulty with these measurements is that when we are examining the effect of one stimulus to the system, the result will depend on the state of the economic world. For example, in the devaluation case we found that the result depended on whether or not price controls were in effect. If we had been examining price controls the result would have depended on whether or not a devaluation occurred. Due to nonlinearities in the econometric model, the effect of both price controls and devaluation would be different from the sum of each considered separately. The price changes interact with price controls and with devaluation. We examined this case by simulating the results of not having farm and import prices rise more than what could be expected from normal cyclical causes and from devaluation. In other words, we assumed both the price controls and the devaluation occurred. We cannot, therefore, reason that if both the devaluation and the increased farm and import prices had not occurred, the total effect would be the simple sum of the effects given in this note.

Deflator Assumptions

The most important assumption of this exercise are those concerning the path of the import, export, and domestic farm price deflators in the absence of special occurrences. This section describes our calculations of time paths for those variables for use in the ALTERNATE simulations.

Table 1 shows the assumptions for the import price deflator. Column 1 (PEIM) shows the actual deflator. Column 2 (PNBF) shows actual values of the nonfarm business deflator. Column 3 is the ratio of (1) to (2). Column 4 ($PEIM^d$) is the import price deflator resulting from the currency appreciation simulation described in Part A. Column 5 ($PNBF^d$) is the nonfarm business deflator from that simulation. Column 6 is the ratio of $PEIM^d$ to $PNBF^d$. Column 7 is the ratio of 3 to 6. It shows our estimate of the percentage amount by which the ratio of PEIM to PBNF would have been altered by the absence of the currency depreciation.

The historical ratio of PEIM to PNBF appears to vary positively with the business cycle. We examined this ratio over earlier cycles and estimated it typically rose about 5 percent from the bottom of a cycle to the top. Column 8 (cyclical component) is a guess as to how this would have progressed in the absence of special factors. Column 9 (Base) represents our assumption as to the path of the ratio of PEIM to PNBF in the absence of cyclical, currency adjustment and special factors. The first three values are taken from column 6. After that point the ratio in unchanged. Column 10 is calculated as the product of columns 8 and 9 and represents the cyclically adjusted price ratio. Column 11 is column 10 times column 7. It is the ratio expected at the particular stage of the cycle given that a devaluation had occurred. Column 12 is 11 divided

Table 1

Calculation of Alternate Import Deflator

Quarter	1 PEIM	2 PNBF	3 Ratio 1 ÷ 2	4 PEIM[d]	5 PNBF[d]	6 Ratio 4 ÷ 5	7 Exchange rate effect 3 ÷ 6	8 Cyclical component	9 Base	10 Base times cycle 8 * 9	11 Base times cycle times devaluation 10 * 7	12 Special factors 11 ÷ 3
1	125.2	132.5	.9449	125.1	132.5	.9441	1.0008	1.0	.9441	.9441	.9449	1.0
2	126.7	132.6	.9555	126.2	132.6	.9517	1.0040	1.0	.9557	.9517	.9555	1.0
3	128.6	134.2	.9583	126.9	134.2	.9456	1.0134	1.0	.9456	.9456	.9583	1.0
4	133.0	134.6	.9881	129.9	134.5	.9658	1.0231	1.005	.9456	.9503	.9723	1.0162
5	135.5	135.3	1.0015	131.2	135.1	.9711	1.0313	1.010	.9456	.9551	.9850	1.0168
6	137.6	136.3	1.0095	132.7	136.0	.9757	1.0346	1.015	.9456	.9598	.9930	1.0166
7	141.3	137.6	1.0269	135.5	137.0	.9891	1.0382	1.020	.9456	.9645	1.0013	1.0256
8	152.3	139.4	1.0925	144.9	138.5	1.0462	1.0443	1.025	.9456	.9692	1.0140	1.0774
9	158.9	141.4	1.1238	149.0	140.1	1.0635	1.0567	1.030	.9456	.9740	1.0358	1.0850
10	171.1	144.4	1.1849	158.8	142.5	1.1144	1.0633	1.035	.9456	.9787	1.0407	1.1386
11	194.3	149.0	1.3040	180.7	146.5	1.2334	1.0572	1.040	.9456	.9834	1.0396	1.2543
12	215.5	154.1	1.3984	201.4	151.2	1.3320	1.0498	1.045	.9456	.9882	1.0374	1.3480

by 3. It shows the percentage amount we are attributing to the special factors.

Actually, the figures in column 11 are the ones introduced into the model. The import deflator is endogenized by making it equal to PNBF times this proportionality factor.

Table 2 shows the same computation for exports, and Table 3 that for farm prices. The assumptions embedded in these tables are extremely important for the results.

The farm price assumption deserves some special attention. Agricultural prices advanced rapidly in this period. Part of the increase was caused by crop failure abroad but part of it was caused by domestic droughts and floods. We have implicitly incorporated these domestic agricultural problems as part of the special factors.

Relative Prices and the Input-Output Table

For this aspect of the problem the basic methodology of the devaluation case seemed appropriate but the import categories were altered. This time the three import categories used were agriculture, oil and all other.

The input-output table was so modified. It was assumed that 3/4 of all oil eventually was consumed as consumer nondurables and services and that the remaining quarter was spread evenly over other final product categories. Figures from the 1970 input-output table corroborated this assumption.

Unit value indexes for foods, feeds and beverages (FFB), and for fuels and lubricants (F&L) were available. We assumed these categories

Table 2

Calculation of Alternate Export Deflator

Quarter	1 PEEX	2 PNBF	3 Ratio 1 ÷ 2	4 PEEX[d]	5 PNBF[d]	6 Ratio 4 ÷ 5	7 Exchange rate effect 3 ÷ 6	8 Cyclical component	9 Base	10 Base times cycle 8 * 9	11 Base* cycle* exchange rate effect 7 * 10	12 Special factors 3 ÷ 11
1	125.6	132.5	.9479	125.5	132.5	.9472	1.0007	1.0	.9472	.9472	.9479	1.0
2	125.9	132.6	.9495	125.1	132.6	.9434	1.0065	1.0	.9434	.9434	.9495	1.0
3	127.2	134.2	.9478	125.0	134.2	.9314	1.0176	1.0	.9314	.9314	.9478	1.0
3	129.1	134.6	.9591	125.3	135.5	.9247	1.0372	1.0	.9247	.9247	.9591	1.0
4	129.1	134.6	.9591	125.3	135.5	.9247	1.0372	1.0	.9247	.9247	.9591	1.0
5	130.4	135.3	.9638	125.6	135.1	.9297	1.0367	1.0	.9297	.9297	.9638	1.0
6	133.0	136.3	.9758	127.8	136.0	.9397	1.0384	1.0	.9392	.9392	.9753	1.0005
7	137.2	137.6	.9971	130.9	137.0	.9555	1.0435	1.0	.94	.94	.9809	1.0165
8	144.9	139.4	1.0395	136.6	138.5	.9863	1.0539	1.0	.94	.94	.9907	1.0193
9	155.2	141.4	1.0976	144.1	140.1	1.0285	1.0672	1.0	.94	.94	1.0032	1.0941
10	165.0	144.4	1.1427	151.7	142.5	1.0646	1.0734	1.0	.94	.94	1.0090	1.1325
11	179.3	149.0	1.2034	165.7	146.5	1.1311	1.0639	1.0	.94	.94	1.0001	1.2033
12	189.5	154.1	1.2297	175.7	151.2	1.1620	1.0583	1.0	.94	.94	.9948	1.2361

Table 3

Calculation of Alternate Farm Price Deflator

Quarter	1 Actual UPF	2 Exchange rate simulation UPF	3 Exchange rate effect 1 ÷ 2	4 Cyclical component	5 Base	6 Base times cycle 4 * 5	7 Base times cycle times exchange rate effect 6 * 3	8 Estimated special factors
1	.870	.869	1.001	1.0	.869	.869	.870	1.0
2	.934	.927	1.0075	1.0	.927	.927	.934	1.0
3	.936	.917	1.0207	1.0	.917	.917	.936	1.0
4	.964	.931	1.0354	1.0	.931	.931	.964	1.0
5	1.040	.995	1.0452	1.015	.931	.9450	.9877	1.052
6	1.083	1.034	1.0474	1.030	.931	.9589	1.0044	1.078
7	1.240	1.177	1.0535	1.045	.931	.9729	1.02495	1.210
8	1.394	1.301	1.0715	1.060	.931	.9869	1.0574	1.318
9	1.652	1.509	1.0948	1.075	.931	1.0008	1.0957	1.508
10	1.583	1.429	1.1078	1.090	.931	1.0148	1.1242	1.408
11	1.506	1.370	1.0993	1.105	.931	1.0288	1.1309	1.332
12	1.157	1.061	1.0905	1.120	.931	1.0427	1.1371	1.018

would have risen at the same rate as the import deflator would have risen had it not been for the special factors. The astute readers of this will note that we don't know how much the import deflator would have risen until after we run the simulation. The procedure used involved guessing the deflator, running the simulation and simulating using the simulated import deflator. Table 4 shows the simulated deflator and the deflator indexed at 1971 II = 1.0. Table 5 shows (among other things) the calculation of the special factors price increases for fuels and lubricants. Column 3 is the unit value index for fuels and lubricants, which shows the 1971 II value to be 109.9. Column 6 is 109.9 times column 2 of Table 4. This purports to be what the unit value index would have been if F & L increased at the same rate as the deflator. Column 7 is the percentage difference between column 6 and column 3.

Table 4

	(1) Adjusted PEIM	(2) Indexed Adjusted PEIM 1971 II = 1.0
1971 II	123.5	
III	125.2	1.014
IV	126.7	1.026
1972 I	128.6	1.041
II	130.9	1.060
III	133.2	1.078
IV	135.2	1.095
1973 I	137.5	1.113
II	140.7	1.139
III	145.1	1.175
IV	147.5	1.194
1974 I	150.8	1.221
II	154.2	1.249

Table 5

Imported Fuels and Lubricants

	1	2	3	4	5	6	7
	Quarterly value of F&L imports (millions)	Import value index 1967=1.0	Unit Value index 1967=100	Quantity index 1967=1.0 2/3	Estimated[1] 1958 dollar F&L imports	1973 II value of unit value index times indexed PEIM	Percent reduction of column 3 needed to obtain column 6
1971 I	772	1.384	107.2	1.291	2.081		
II	940	1.676	109.9	1.525	2.458		
III	1004	1.790	112.1	1.597	2.574	1.114	.006
IV	1048	1.868	112.7	1.658	2.673	1.128	.001
1972 I	1099	1.959	112.8	1.737	2.800	1.144	.014
II	1188	2.118	114.6	1.848	2.979	1.165	.017
III	1281	2.283	115.5	1.977	3.187	1.185	.026
IV	1316	2.346	117.4	1.998	3.221	1.203	.025
1973 I	1537	2.740	122.0	2.246	3.621	1.223	.002
II	1838	3.276	128.9	2.542	4.098	1.252	-.029
III	2132	3.800	142.4	2.668	4.301	1.291	-.093
IV	2722	4.852	186.9	2.596	4.185	1.312	-.298
1974 I	4769	8.501	397.5	2.139	3.448	1.342	-.662
II	6675	11.898	504.6	2.358	3.801	1.373	-.728

[1]Estimated as total 1967 import in 1958 dollars (38.5 billion) times the current dollar proportion of F & L in total imports for 1967 (4.19 percent) times column 4.

Table 6

Imported Foods, Feeds and Beverages

	1 Quarterly value of FFB imports (millions of dollars)	2 FFB import value index 1967=1.0	3 Unit value index 1967=1.0	4 Quantity index 1967 =1.0 2/3	5 Estimated[1] 1958 dollar FFB imports	6 1973 II value of FFB unit value index times indexed adjusted PEIM	7 % reduction of column 3 needed to obtain column 6
1971 I	1546	1.354	1.173	1.154	3.785		
II	1684	1.475	1.165	1.266	4.152		
III	1878	1.645	1.166	1.411	4.628	1.181	.013
IV	1260	1.103	1.172	.941	3.087	1.195	.020
1972 I	1876	1.643	1.185	1.386	4.546	1.213	.024
II	1705	1.493	1.230	1.211	3.972	1.234	.001
III	1810	1.585	1.272	1.246	4.087	1.252	-.016
IV	1888	1.653	1.315	1.257	4.123	1.276	-.030
1973 I	2133	1.868	1.367	1.367	4.484	1.297	-.051
II	2236	1.958	1.483	1.320	4.330	1.327	-.105
III	2194	1.921	1.580	1.152	3.779	1.369	- 133
IV	2505	2.194	1.701	1.299	4.621	1.391	-.182
1974 I	2850	2.496	1.718	1.413	4.766	1.422	-.172
II	2680	2.346	1.845	1.271	4.169	1.455	-.111

[1]Estimated as total 1967 imports in 1968 dollars (38.5 billion) times the current dollar proportion of FFB in total imports for 1967 (8.52 percent) times column 4.

Table 7

Imported "Other"

	(1) Imports of goods and services (billions of 1958 dollars, annual rate)	(2) "Other" imports (billions of 1958 dollars, annual rate)	(3) Value of mdse. imports (billions of dollars annual rate)	(4) Value of F&L imports (billions of dollars, annual rate)	(5) Value of FFB imports (billions of dollars, annual rate)	(6) Value of "other" import (billions dollars, annual rate) 6=3-4-5	(7) Price of "other" imports 6/2	(8) 1971 II price of "other" imports times indexed PEIM	(9) Percent reduction of 7 needed to get 8
1971 I	50.6	44.8	62.3	3.1	6.1	53.1	1.185		
II	53.9	47.2	66.6	3.8	6.7	56.1	1.189		
III	54.4	47.2	68.1	4.0	7.5	56.6	1.199	1.206	.006
IV	51.6	45.8	65.4	4.2	5.0	56.2	1.227	1.220	-.006
1972 I	59.2	51.9	76.1	4.4	7.5	64.2	1.237	1.208	-.023
II	56.9	49.9	75.7	4.8	6.8	64.1	1.285	1.260	-.018
III	57.6	50.3	78.1	5.1	7.2	65.8	1.308	1.282	-.020
IV	60.9	53.6	82.8	5.3	7.6	70.9	1.323	1.302	-.016
1973 I	63.4	55.3	89.5	6.1	8.5	74.9	1.354	1.323	-.023
II	62.4	54.0	94.9	7.4	8.9	78.6	1.456	1.354	-.070
III	61.1	53.0	96.9	8.5	8.8	79.6	1.502	1.397	-.070
IV	61.0	52.2	104.3	10.9	10.0	83.4	1.598	1.420	-.111
1974 I	61.8	53.6	119.9	19.1	11.4	89.4	1.668	1.452	-.129
II	65.1	57.1	140.0	26.7	10.7	102.6	1.797	1.485	-.174

Table 6 shows the same calculation for foods, feeds, and beverages. The relevant columns again are 3, 6, and 7.

For the "other" category the calculation is more complicated. First we must calculate what the implied price rise was. To do this we must create a series on current dollar "other" divided by constant dollar "other". Column 3 of Table 7 is current dollar total imports. Column 4 and 5 are current dollar imports of fuels and of FFB. Column 6 is current dollar "other" and is calculated by subtracting column 4 and 5 from 3.

Next we must estimate constant dollar other imports. In Table 5, column 1 is the value of F & L imports. Column 2 is the value series indexed at 1967 = 100. Column (3) is the unit value index. Column (4) = (2)/(3) and is a quantity index. In 1967 F & L comprised 4.19 percent of current dollar imports and we assumed it comprised the same proportion of 1958 dollar imports. Obviously this assumption is not strictly correct. Total 1958 dollar imports in 1967 were 38.5 billion. 4.14 percent of 38.5 is 1.612 billion. This quantity multiplied by the quantity index yields column 5 which is an estimate of F & L imports in 1958 dollar.

A similar calculation was made for FFB (see Table 6). Column (1) of Table 7 is total 1958 dollar imports. Column (2) is column (1) less the previously calculated 1958 dollar estimates for F & L and FFB and represents 1958 dollar other. Column (7) is (6)/(2) and is the price of "other". Column (8) is similar to column (6) of Table 4 and (5). Column (9) is the percentage reduction of (7) needed to get (8). The right hand columns of Tables 5, 6, and 7 were the raw material ground through the input-output table as in the exchange rate case.

There are obviously some heroic assumptions in this section, but keep in mind these assumptions are not very important. The price changes have been kept insofar as possible consistent with the assumed deflators. If we err in the mix of price changes we only upset slightly relative prices and the strength of the feedback through the wage equation.

Export Prices

It was also necessary to calculate price changes for export goods. For exported FFB we used exactly the same methodology as for imported FFB. This is done in Table 8. Nonagricultural products were aggregated into one "other" category and a price index similar to imports "other" was calculated. It did not seem to behave very differently from the assumed export deflator, however, so the price change for the series was set to zero. In other words, we assumed the price of "other" exports apparently rose about the rate we would have expected for that phase of the cycle in the presence of a devaluation.

The calculation in this section has only a very minor effect on the results. As a sensitivity test we assumed a special other price effect of 25 percent, which altered the rate of inflation was altered by about 1 percent.

Imports and Exports

For agricultural imports and exports we assumed a total price elasticity of .75 and the elasticity reached 10% of that value in the initial quarter, then 20%, 40%, 60%, 80%, 90%, and 100% in succeeding quarters. The fuel price elasticity was assumed to be .3 and phased in on the same

Table 8

Exported Foods, Feeds, and Beverages

		(1) Adjusted export deflator	(2) Indexed adjusted export deflator	(3) Unit value index, exported FFB	(4) 2 * 3	(5) 4/3
	I					
	II	125.4	1.000	108.2		
1971	III	125.2	.998	108.5	108.0	.995
	IV	126.7	1.010	105.4	109.3	1.035
	I	128.6	1.026	106.9	111.0	1.038
	II	130.4	1.040	109.3	112.5	1.029
1972	III	133.2	1.062	111.2	114.9	1.030
	IV	135.2	1.078	119.7	116.6	.974
	I	137.5	1.047	129.1	118.7	.853
	II	140.7	1.122	155.8	121.4	.764
1973	III	145.1	1.157	192.1	125.2	.652
	IV	147.5	1.176	209.7	127.2	.607
	I	150.8	-.203	233.3	130.2	.558
1974	II	154.2	1.230	231.9	133.1	.574

schedule. We did not try to take account of the non price effects of the oil embargo which, of course, temporarily pushed the U.S. off its demand schedule. The "other" import price elasticity (remember it includes services) was assumed to be 1.0. The export "other" elasticity is irrelevant since we assumed no price change.

Import and Export Competing Goods

This subject is, if possible, more complicated than it was in the devaluation case. There, when all import prices went up more or less together, the choice of which import price to base their adjustment on was not particularly important. Now it is. In general, it is finished goods which are relevant. The unit value series on capital goods except autos proxies for the price of imported finished goods. Table 9 shows the calculation. Column (1) is the indexed import deflator, column (3) is the unit value index re-indexed on 1971 II and column (4) the percentage difference. As in the devaluation case it was assumed that in the absence of price controls a 10 percent increase in the price of foreign finished goods would lead to a 1 percent increase in the average price of domestic nonfarm goods, given wage costs. This was phased in the same manner as the devaluation case to reflect the impact of price controls.

Oil is a special case. Here we know how much domestic oil prices were allowed to rise. The increased price of domestic oil was sufficient to raise the nonfarm deflator by about 1 percent. However, not all of this increased oil has been passed along to final consumers even yet (e.g., apartment rents, often controlled by leases, have not yet been fully increased along energy costs). We assumed about 3/4 of the increased oil cost were passed on by the second quarter of 1974.

Table 9

Import Competing Goods Adjustment

	(1) Indexed adjusted import deflator	(2) Unit value index 1967=100 imported finished goods except autos	(3) Unit value index re-indexed in 1971 II = 100	(4) Percentage reductions in column 3 needed to obtain column 1
1971 2	1.0	105.6	1.000	
3	1.014	107.0	1.013	.001
4	1.026	102.1	.967	.061
1	1.041	104.7	1.006	.035
2	1.060	107.3	1.016	.043
3	1.078	116.0	1.098	-.018
4	1.095	118.0	1.117	-.020
1	1.113	126.6	1.199	-.072
2	1.134	137.5	1.302	-.125
3	1.175	133.0	1.259	-.067
4	1.194	142.1	1.346	-.113
1	1.221	138.0	1.307	-.066
2	1.249	148.1	1.402	-.101

The Macro Effects of Lower Import Prices

Table 10 shows the difference between the CONTROL simulation and the ALTERNATE simulation incorporating lower farm and import prices. The consumption deflator is used to demonstrate the price effects. By the end of the simulation period, the difference in the price level resulting from no extraordinary import price increases is about four and one half percent. Most of the reduction occurs in 1973 largely because farm price actually fell in early 1974. In 1972 the inflation rate averages 3 and one third percent below the control simulation. Since the assumed effect of the special factors on import prices is about 4 times the effect of devaluation on import prices, we might have expected the effect to be about 4 times what they were in that exercise. In fact, the effects seem to be about double what they were in the exchange rate simulation. The main reason for this is that in the present case the price effect on real net exports is not large. Thus, the unemployment rate does not rise but actually falls. This in turn is because the lower prices lead to lower interest rates which increase output.

This is the same self limiting mechanism discussed in the currency depreciation case which, in the absence of further farm and import price reductions, would return the inflation rate to its CONTROL levels.

Table 10

Effect of not having Extraordinary Farm and Import Price Increases
(ALTERNATE Solution Minus CONTROL Solution)

	III	IV	I	II	III	IV	I	II	III	IV	I	II
Consumption deflator (PCON)												
(1) (percent difference in levels)[1]	.0	.0	-.1	-.1	-.4	-.6	-1.3	-2.2	-2.7	-3.4	-3.5	-3.8
(2) (annual percent rate of increase)	.0	-.2	-.2	-.6	-1.2	-.5	-3.1	-3.6	-2.3	-2.9	-.8	-1.2
Compensation per man hour												
(3) (annual percent rate of increase)	0	0	0	0	-.1	-.2	-.0	-.3	-.5	-.6	-1.1	-.9
Gross National Product												
(4) (billions of dollars)	0	.1	.3	1.1	-.6	- .5	-3.8	-6.2	-8.9	-10.1	-5.8	-2.7
Gross National Product												
(5) (billions of 1958 dollars)	.0	.0	.3	.8	1.7	2.6	4.8	7.8	10.9	14.5	15.8	16.3
(6) Unemployment Rate	.0	.0	.0	.0	.0	.1	-.3	-.4	-.6	-.8	-.9	-1.0
(7) Treasury Bill Rate	.0	.0	.0	.0	.0	-.1	-.5	-.6	-1.1	-1.0	-.8	-.7

[1]This line shows the percent difference between the levels of the consumption deflator in the CONTROL and ALTERNATE simulations.