

# Dollar Depreciation and Inflation

*By George A. Kahn*

Recent declines in the foreign exchange value of the dollar have created fears of renewed inflation. One reason for concern is the possibility that the falling dollar may indicate an underlying macroeconomic policy that is inflationary. For example, the falling dollar could signal an overly stimulative monetary policy that would result in higher future inflation. Another reason for concern is that the fall in the dollar might in itself put upward pressure on prices. In this case, a falling dollar would tend to raise prices, regardless of the stance of macroeconomic policy.

Apart from its role as an indicator of macroeconomic policy, what does the falling dollar itself imply about inflation? A lower dollar has direct and indirect effects on inflation. As a lower dollar forces up the price of imports, it directly raises the prices American consumers pay. As domestic producers raise their prices in line with the price

of competing imports and imported inputs, a lower dollar indirectly raises the price of domestically produced goods. Thus, the concern that a lower dollar will result in higher overall prices is not misplaced. It is practically a foregone conclusion. The relevant issue, therefore, is not whether a lower dollar will increase inflation, but whether the increase will be small or large, temporary or permanent.

Disregarding the dollar's potential role as a signal of macroeconomic policy, this article examines the causal relationship between the foreign exchange value of the dollar and the U.S. rate of inflation. It argues that changes in the value of the dollar have a relatively minor effect on domestic inflation and that this effect is temporary. The first section reviews the recent behavior of inflation and the U.S. dollar. The second section describes how the foreign exchange value of the dollar influences the inflation rate. And the third section presents evidence on the inflationary consequences of a decline in the value of the U.S. dollar. It shows that the 40 percent decline in the dollar since 1985 will eventually raise the level

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of consumer prices by about 14 percent. But because the rise will occur over a period of five or more years, inflation will increase by only a small amount.

### **The dollar and inflation: recent experience**

The value of the U.S. dollar has fluctuated widely since the advent of floating exchange rates in 1973. Along with these fluctuations in the dollar, U.S. inflation has been volatile. Between 1970 and 1980, the dollar was generally depreciating while inflation was generally rising. Between 1980 and 1985, the dollar was generally appreciating while the rate of inflation was falling. And since 1986, the dollar has again generally fallen, while inflation has increased. Putting these observations together, it is tempting to conclude that changes in the value of the dollar cause changes in inflation—or that changes in inflation cause changes in the dollar. However, this conclusion is unjustified because other factors have influenced both inflation and the dollar during this period.

In the 1970s, for example, the two main episodes of rising inflation also coincided with two sharp increases in oil prices engineered by the Organization of Petroleum Exporting Countries (OPEC). The first oil price shock saw the price of oil more than triple after the outbreak of the Arab-Israeli war in October 1973. The rate of inflation as measured by the consumer price index (CPI) rose from 3.3 percent in 1972 to 11.0 percent in 1974. The second oil price rise came in 1979. That time, the price of Saudi Arabian crude oil more than doubled, and inflation rose from 7.7 percent in 1978 to 13.5 percent in 1980.<sup>1</sup>

<sup>1</sup> The implicit GNP price deflator, a broader price index for nonimported goods and services, shows much smaller increases in inflation over this period.

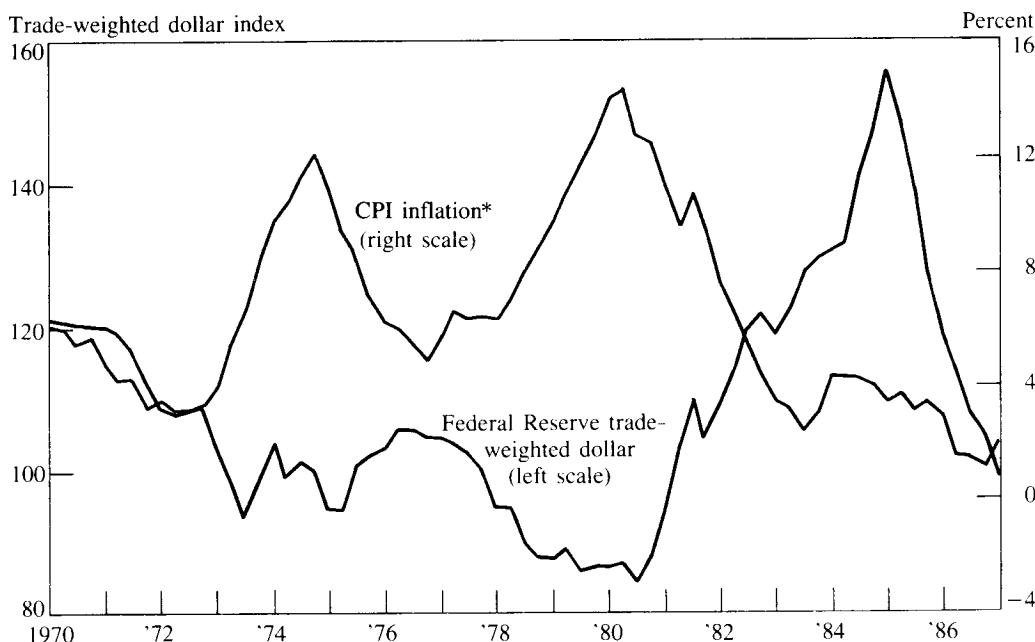
Meanwhile, the value of the dollar fell, especially after 1978, as U.S. inflation rose relative to inflation in other major countries.

In the 1980s, macroeconomic policy has influenced inflation, not only through changes in the value of the dollar but also through other channels. From 1980 to 1983, for example, inflation in the United States fell 10.3 percentage points. This decline in inflation coincided not only with a rise in the value of the dollar but also with the Federal Reserve's adoption of a strong anti-inflationary monetary policy. Associated with this policy, however, was a large increase in unemployment. Economic slack, an appreciating dollar, and tight monetary policy, all combined to contribute to declining inflation. More recently, falling unemployment, rising interest rates, and rising energy prices have combined, along with a depreciating dollar, to raise concern over the prospect for higher inflation.

Despite the variety of potential influences on inflation besides the value of the dollar, an inverse relationship between inflation and movements in the dollar is apparent. Chart 1 shows this relationship. In the chart, the left-hand scale measures the value of the dollar as determined by the Federal Reserve's trade-weighted dollar index, while the right-hand scale measures the rate of inflation as determined by the CPI. Although there are other measures of the dollar and inflation, these two indexes provide a typical picture of the dollar-inflation relationship.<sup>2</sup>

<sup>2</sup> The Federal Reserve's trade-weighted index gives the value of the dollar against a weighted average of ten leading currencies, with multilateral trade weights based on the relative importance of these currencies in total world trade. Because this index gives great weight to western European currencies and less weight to the currencies of Canada and the newly industrializing countries, it may provide a somewhat biased view of dollar fluctuations. However, other indexes constructed to correct this potential bias do not exhibit fundamentally different behavior. For a description and comparison of alternative exchange rate indexes, see Jack L. Harvey and William A. Strauss, "The New Dollar Indexes

**CHART 1**  
**Inflation and value of the dollar**



\*Four-quarter rates of change.

Chart 1 shows that periods of dollar depreciation are associated with periods of increasing inflation and that periods of dollar appreciation are associated with periods of declining inflation. The depreciation of the dollar from 1971 to 1973 was followed by rising inflation from 1972 to

1975. Similarly, the depreciation of the dollar from 1977 to 1980 was followed by rising inflation from 1978 to 1980. In contrast, periods of dollar appreciation are associated with moderating inflation. The best example of the association of falling inflation and a rising dollar occurs between 1980 and 1984, when the dollar rose 58 percent and inflation fell 66 percent.

Are No Different from the Old Ones," *Economic Perspectives*, Federal Reserve Bank of Chicago, July/August 1987, pp. 3-22.

Just as there are many dollar indexes, so are there many inflation indexes. Chart 1 depicts consumer price inflation because it is the most familiar inflation index and the general index most likely to reflect changes in the value of the dollar. The effect of the dollar on the CPI will be felt directly through the price of imported consumer goods and indirectly through the prices of domestic consumer goods that are sensitive to the value of the dollar. The other well-known price index—the implicit GNP deflator—is likely to be less sensitive to changes in the value of the dollar because it measures only the prices of U.S.-produced goods and services. Only through indirect avenues do changes in the dollar affect the GNP deflator.

Although Chart 1 provides compelling evidence of a strong association between the dollar and inflation, anecdotal evidence suggests other factors may be at work moving both variables. Economic theory provides a framework for analyzing the causal relationship between the dollar and inflation and for addressing the following questions. When do changes in the dollar lead to changes in inflation? Under what circumstances is the apparent inverse relationship between the dollar and inflation merely the result of the

influence of other factors? Do changes in the value of the dollar lead to permanent or temporary changes in inflation? The next section provides a theoretical framework for analyzing these issues.

### The relationship between the dollar and inflation

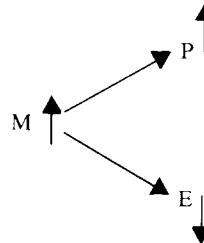
While this article focuses on the effects of changes in the value of the dollar on inflation, it is impossible to examine these effects in isolation from other economic relationships. Many factors influence both the value of the dollar and inflation. To the extent that these other factors cause the dollar and inflation to move in opposite directions, the apparent relationship between the dollar and inflation may be spurious. For example, the effect of the dollar on inflation may be much less important than the independent effect of other factors on each variable. This section first identifies factors that affect both the exchange value of the dollar and inflation. It then provides a framework for analyzing the effect of a change in the dollar on inflation, holding these other factors constant. The purpose, of course, is to identify the independent effect of exchange rate movements on inflation.

#### Factors that influence both inflation and the dollar

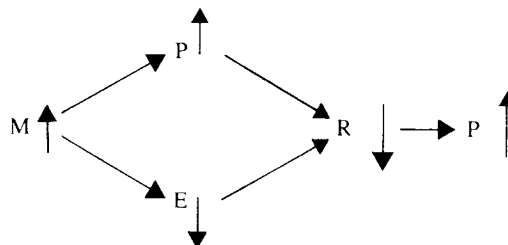
Exchange rate movements reflect, as well as affect, economic conditions. Care must be taken, therefore, in attributing economic developments to exchange rates without first examining the causes of exchange rate fluctuations. A variety of factors, including monetary and fiscal policy, affect the price level and the value of the dollar. To the extent that these factors move the dollar and prices in opposite directions, the independent effect of the dollar on prices will be obscured and difficult to detect. If, for example, these other factors cause the dollar to fall and prices to rise by the same

**FIGURE 1**  
**Effect of a third variable on the dollar and prices**

A. Increase in P equals the decrease in E



B. Initial increase in P is less than the decrease in E



amount, there will be no tendency for prices to rise further and no independent effect of the dollar on prices. This is because *real exchange rates*—market exchange rates adjusted for differences in domestic versus foreign price levels—have not changed. Only to the extent that other factors affect real exchange rates will there be an independent effect of exchange rate movements on prices.

Figure 1 shows how the observed relationship between exchange rates and the price level may result, at least partially, from the influence of a third variable. As shown in the top panel of Figure 1, an increase in a third variable, such as the money supply,  $M$ , may cause prices,  $P$ , to rise. At the same time, the increase in  $M$  may also cause the exchange value of the dollar,  $E$ , to fall. If the fall in the exchange rate just offsets the rise in the domestic price level, there is no further tendency for prices to rise. Prices and the exchange rate are causally unrelated, even though they

moved in opposite directions. But, as shown in the lower panel of Figure 1, if the exchange rate falls by more than prices rise, the real exchange rate,  $R$ , falls, and prices tend to rise further. In this case, the exchange rate exerts an influence on prices, independent of the effect of the third variable. In other words, the decline in the real exchange rate independently causes an increase in prices.<sup>3</sup>

Two examples of “third variables” that affect the dollar and inflation are money growth and changes in the federal budget deficit.<sup>4</sup> An increase in U.S. money supply growth, such as that of the late 1970s, lowers U.S. interest rates relative to foreign interest rates. As a result, foreign assets become relatively more attractive to investors than dollar-denominated assets. As the worldwide demand for dollar assets falls, an excess supply of U.S. dollars is created, and the value of the dollar depreciates in world currency markets. At the same time, faster money growth stimulates aggregate demand in the United States—because lower interest rates stimulate interest-sensitive spending—and upward pressure is exerted on U.S. prices. Thus, an expansionary monetary policy, such as that in the United States in the late 1970s, leads to declines in the dollar and higher inflation. Although a falling dollar may signal expansionary monetary policy and, therefore, the possibility of higher inflation, the falling dollar does not necessarily cause inflation.

<sup>3</sup> For example, if a 10 percent increase in  $M$  causes a 10 percent increase in  $P$  and a 10 percent decrease in  $E$  (and foreign prices are held constant), real exchange rates will not change, and there will be no independent effect of exchange rates on prices. If, on the other hand, a 10 percent increase in  $M$  causes a 5 percent increase in  $P$  and a 10 percent decrease in  $E$  (and foreign prices are held constant), real exchange rates will decline by 5 percent and exert independent upward pressure on prices.

<sup>4</sup> For a detailed analysis of the effects of fiscal and monetary policy in an open economy, see George A. Kahn, “International Policy Coordination in an Interdependent World,” *Economic Review*, Federal Reserve Bank of Kansas City, March 1987, pp. 14-32.

Not all third variables that affect both the value of the dollar and the inflation rate cause the dollar and inflation to move in opposite directions. For this reason, the historical inverse relationship between the dollar and inflation may not always hold. An example of a third factor that moves the dollar and inflation in the same direction is a fiscal expansion. When the budget deficit increases, domestic interest rates rise relative to foreign interest rates. As dollar assets become relatively more attractive to investors than foreign assets, the demand for U.S. dollars rises, causing the dollar to appreciate. At the same time, however, the increase in the budget deficit stimulates aggregate demand in the United States, exerting upward pressure on U.S. prices. Thus, an expansionary fiscal policy leads to increases in both the dollar and inflation.

To the extent that monetary and fiscal policies cause real exchange rates to change, there will be a tendency for prices to respond differently than they otherwise would. With both monetary and fiscal expansion, prices tend to rise. Even though changes in the value of the dollar are not the primary cause of the increase in prices, the dollar may have an independent effect on the price level. Because prices may not fully and immediately respond to policy changes, the real exchange rate may change. Changes in the value of the real exchange rate may lead, in turn, to independent, though perhaps small, changes in the overall price level. In the case of monetary expansion, the real exchange rate may fall, reinforcing the tendency for prices to rise. In the case of fiscal expansion, the real exchange rate may rise and partially offset the tendency for prices to increase. In any event, changes in the exchange rate have an independent effect on the price level only to the extent that they reflect real, as opposed to purely nominal, exchange rate movements.

Aside from macroeconomic policy changes, what causes the real exchange rate to fluctuate? Changes in the real exchange rate, other than those

resulting from monetary and fiscal policy, are caused by movements in relative prices or, more fundamentally, by changes in tastes and technology.<sup>5</sup> For example, changes in the domestic costs of production relative to foreign costs of production lead to changes in the real exchange rate. Likewise, changes in consumers' tastes for domestic products relative to foreign products lead to changes in the real exchange rate. Such fundamental changes affect the price of domestic goods relative to the price of foreign goods. Real exchange rate shocks thus cause real adjustments to take place and cause the level of prices to change. The next section describes how changes in the real exchange rate lead to changes in the aggregate price level.

### *Effects of the dollar on inflation*

Changes in the real exchange value of the dollar affect prices both directly and indirectly. By altering the prices American consumers pay for imported goods and services, a change in the real exchange value of the dollar has a direct effect on the U.S. price level. A decline in the value of the dollar, for example, causes the price of imports to rise, directly increasing the overall level of prices paid for goods and services.<sup>6</sup> A change in the real value of the dollar also has indirect effects on prices. As the dollar falls and import prices rise, domestic producers of import-competing goods can raise prices to increase profit margins. Alternatively, if domestic producers

require foreign inputs to production, costs may rise. Thus, domestic prices also may rise in response to a decline in the dollar and an associated increase in the cost of production. The exact nature of these aggregate price increases are best understood in the context of an economic model.

*Analytical framework.* An aggregate supply and demand model can be used to determine the effects of a change in the exchange rate on the aggregate price level, inflation, and output. In such a model, the economy is divided into a demand side and a supply side. The demand side represents spending on U.S.-produced goods and services by consumers, firms, and the government. The supply side represents the production of goods and services by firms using labor and other inputs. Changes in the real foreign exchange value of the dollar affect both demand and supply. How they affect demand and supply determines the response of the overall price level and output to fluctuations in the value of the dollar.<sup>7</sup>

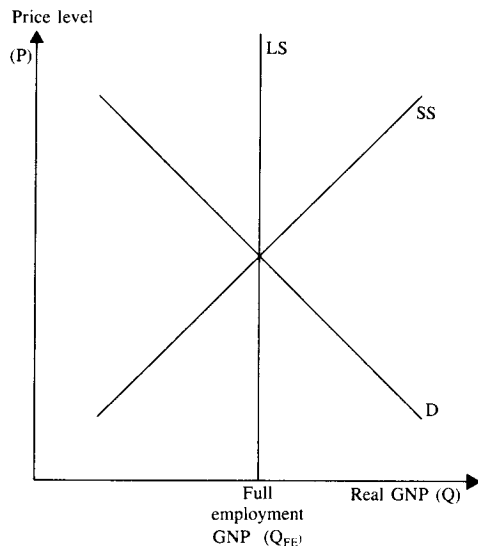
Figure 2 shows a typical demand and supply diagram. The price level is on the vertical axis, and real GNP is on the horizontal axis. The demand curve, D, summarizes the demand side of the economy. It slopes downward because a higher price level, other things equal, requires a higher interest rate to keep the demand for money in line with the given supply of money. The higher interest rate, in turn, causes interest-sensitive spending and real output to decline. Furthermore, higher interest rates cause the dollar

<sup>5</sup> An example of a relative price change is an increase in oil prices. An oil price increase might cause the real exchange rate of an oil-importing country to depreciate and ultimately cause its price level to rise.

<sup>6</sup> A decline in the dollar also causes the price of exports to fall. This fall leads to an increase in the demand for U.S.-produced goods and services and, possibly, to an increase in the aggregate price level.

<sup>7</sup> The framework used here is standard. It assumes that, in the short run, prices adjust gradually to changes in nominal aggregate demand. As a result, nominal shocks to demand temporarily affect aggregate output and employment. Other assumptions about price behavior may, however, lead to different conclusions. For a discussion of alternative models of aggregate supply and the determination of the economy's price level, see George A. Kahn, "Theories of Price Determination," *Economic Review*, Federal Reserve Bank of Kansas City, April 1984, pp. 16-27.

**FIGURE 2**  
**Aggregate supply and demand**



to appreciate. The resulting decline in net exports reinforces the tendency for output to fall. Thus, higher prices are associated with lower output.

The short-run aggregate supply curve, *SS*, summarizes the supply side of the economy. Along the short-run supply curve, nominal wages are held fixed. The short-run supply curve slopes upward because a higher price level, other things equal, lowers real wages. Lower real wages, in turn, induce firms to employ more labor and increase output. However, higher prices can generate greater output only in the short run. This is because workers eventually demand higher nominal wages to bring real wages back into line with desired levels. Thus, in the long run, aggregate supply is independent of the price level. The long-run aggregate supply curve, *LS*, is a vertical line drawn at the level of output associated with full employment.

*Dollar depreciation and demand-induced inflation.* Changes in the real value of the dollar affect the demand for U.S.-produced goods and serv-

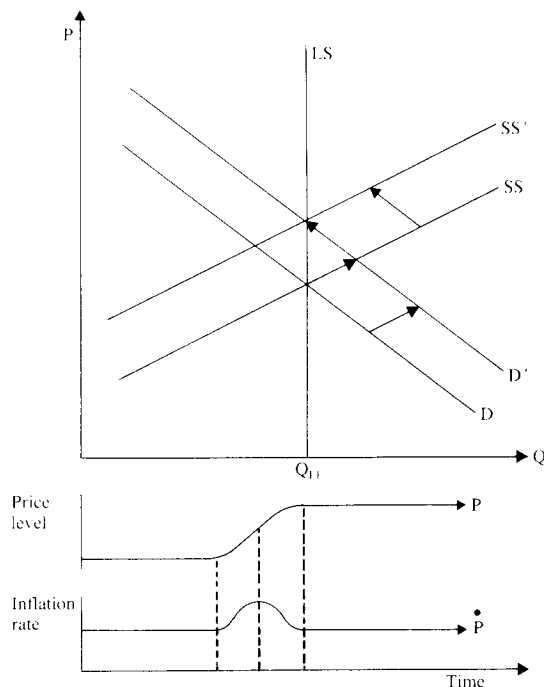
ices.<sup>8</sup> Suppose, for example, that the dollar depreciates. A depreciation in the value of the dollar causes the price of imports to rise and the price of exports to fall. As foreign and domestic consumers substitute less expensive U.S. goods for now more expensive foreign goods, aggregate demand for U.S.-produced goods and services increases. As shown in Figure 3, the aggregate demand curve shifts to the right from *D* to *D'*. Because nominal wages are fixed in the short run, real output and the aggregate price level both rise. Producers are willing to supply more output because real wages and, therefore, real labor costs have fallen.

But this is not the end of the story. Workers with fixed nominal wages are dissatisfied with the lower real wage that results when prices rise. As workers negotiate higher nominal wages to offset the higher price level, the cost of producing any particular level of output rises, and the short-run aggregate supply curve shifts upward. As a result, output falls. Eventually, the short-run aggregate supply curve shifts from *SS* to *SS'*. Real wages are bid back up to their initial level, and output falls back to its initial level. Thus, increases in aggregate demand generated by a dollar depreciation lead to a permanent increase in the price level but only a temporary increase in real output.<sup>9</sup> Similarly, an appreciation of the dollar causes a decline in aggregate demand, a permanent decline in the price level, and a temporary decline in real output.

<sup>8</sup> For the remainder of the article, all changes in the value of the dollar are assumed to be real. This assumption is fairly innocuous, in practice, since most exchange rate fluctuations have a large real component in the short run. That exchange rates are flexible (determined in spot markets) while national price levels are sticky (determined in "customer" markets) makes this result inevitable.

<sup>9</sup> A dollar depreciation would lead to a sustained period of higher inflation only if the Federal Reserve tried to maintain the higher level of output by increasing money growth.

**FIGURE 3**  
**Dollar depreciation**  
**and demand-induced inflation**



From the demand side, the inflationary consequences of a change in the value of the dollar are temporary. While the economy experiences a permanently higher price level after a depreciation of the dollar, inflation is only temporarily higher. Once the price level reaches its new equilibrium, the rate of inflation falls back to its previous level. The lower panel of Figure 3 shows these implied time paths for the level of prices,  $P$ , and the rate of inflation,  $\dot{P}$ .

*Dollar depreciation and supply-induced inflation.* Changes in the real value of the dollar also directly affect aggregate supply. Suppose again that the dollar depreciates and, therefore, import prices rise. Producers using imported inputs find that their costs have risen. To produce the same out-

put as before, they must now charge a higher price to recover costs. In addition, producers manufacturing products that compete with foreign goods face less severe price competition. At every level of output, they may now be free to increase profit margins by raising product prices. For both reasons, suppliers produce less output at any given price level. As shown in Figure 4, the short-run aggregate supply curve shifts upward from  $SS$  to  $SS'$ . In contrast, an appreciation of the dollar lowers profit margins and the costs of imported inputs, thus causing producers to raise their output at any given price.

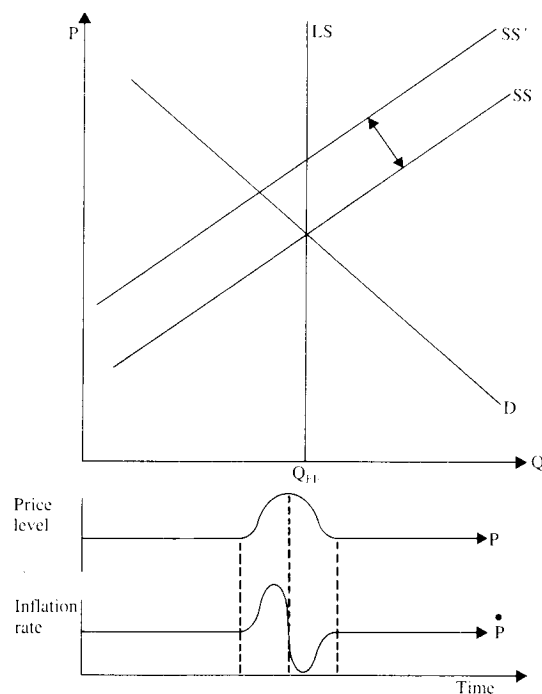
Given aggregate demand conditions, a decrease in aggregate supply caused by a lower dollar causes the price level to rise and output to fall. The higher price level implies that workers receive a lower real wage. But workers restrain their demands for higher nominal wages because output has fallen and unemployment has risen. Otherwise, unemployment would be exacerbated. In fact, for the economy to return to its initial level of employment, workers must lower their nominal wage demands and accept a permanent reduction in real wages.<sup>10</sup> As they do so, nominal wages fall enough to offset the increase in import prices so that production costs return to their original level. And as nominal wages fall, the short-run aggregate supply curve shifts back downward from  $SS'$  to  $SS$ . As a result, the long-run effect of a dollar depreciation is a temporary increase in the price level and a temporary decrease in real output.<sup>11</sup>

<sup>10</sup> For workers to maintain real wages in the face of higher prices, they must bid up the nominal wage. Such behavior, especially if ratified by more rapid money growth, could lead to a period of stagflation—rising unemployment along with rising inflation.

<sup>11</sup> If the decline in the dollar permanently reduces production possibilities, long-run aggregate supply will fall. A decline in the dollar will then lead to a permanent increase in the price level and a permanent reduction in real output. In this article, however, it is assumed that dollar fluctuations do not affect long-run production possibilities.



**FIGURE 4**  
**Dollar depreciation**  
**and supply-induced inflation**



Real wages, however, are permanently lower. Workers must accept a permanent decline in living standards.

As in the demand-side case, the inflation consequences of a dollar depreciation are temporary. However, the supply-side time paths of the price level and inflation are somewhat different. The price level rises temporarily, then falls back to its previous level. Inflation first rises, then falls below its initial rate, and finally returns to its initial rate. The lower panel of Figure 4 shows these time paths for the price level and the rate of inflation.

*Net effect of dollar depreciation on inflation.* A change in the foreign exchange value of the dollar can affect both demand and supply. The

net effect of a change in the value of the dollar, therefore, is the combination of its effects on demand and supply. Because both the demand and supply effects of a dollar depreciation raise the price level, the net effect of a decline in the dollar is clearly higher prices. As long as demand increases as a result of the dollar depreciation, the higher prices will be permanent. But any increase in inflation is temporary.

Short-run output effects are ambiguous. A decline in the value of the dollar temporarily increases output on the demand side and temporarily decreases output on the supply side. Thus, the net effect of a decline in the dollar on output cannot be determined purely by theory. Similarly, an appreciation of the dollar unambiguously lowers prices but has a theoretically ambiguous short-run effect on output.<sup>12</sup>

These results are subject to an important caveat. In assessing the effect of the dollar on inflation, the supply and demand analysis holds all other factors constant. In particular, a variety of other factors, including monetary and fiscal policy, affect aggregate supply and demand and, as previously shown, influence inflation and the value of the dollar. To unscramble the effect of the value of

<sup>12</sup> Attaining a new equilibrium, however, takes time. Price rises take time because domestic producers may have long-term contracts with foreign suppliers that fix input prices for the duration of the contract. And to gain market share, some domestic producers may only slowly raise prices in response to higher input and competing goods prices. Likewise, foreign producers may absorb losses for awhile in an attempt to preserve market share. While economic theory implies that a higher price level is the result of a lower dollar, it does not show how long it takes to fully adjust.

Similarly, adjustment in the labor market takes time. This is because workers are reluctant to accept lower wages. Economic slack in the form of unemployment may only gradually persuade workers to moderate wage demands. Furthermore, some workers may have long-term wage contracts that limit any short-run adjustment of wages. Ultimately, however, if the dollar has an adverse effect on aggregate supply, real wages must fall and standards of living must decline.

the dollar on inflation from the effect of other variables, it is necessary to hold other influences constant. To measure the effect of the dollar on inflation in isolation from other influences, it is necessary to estimate a model of inflation that explicitly controls for a variety of factors. The next section presents estimates from such a model.

### **Empirical evidence on the dollar-inflation relationship**

Economic theory provides a qualitative characterization of the dollar-inflation relationship. According to theory, a fall in the dollar temporarily raises inflation and permanently raises the average level of prices. Determining the size and timing of the effect, however, requires a statistical analysis. This section presents results from forecasts of an empirical model of the economy estimated with quarterly data from 1960:Q1 to 1987:Q1.<sup>13</sup> First, the model is briefly described. Then, conditional forecasts are presented and compared with results from other studies.

#### *Empirical framework*

To hold other factors constant, the estimated model must explain not only inflation but also other relevant variables. While it is impossible to control for all other factors, the model attempts to control for the most important. These factors include unemployment, real GNP growth, money growth, changes in energy prices, and changes in the value of the dollar. Each variable is explained by its own history and by historical values of all the other variables.<sup>14</sup> Each included

variable is designed to control for major factors, besides the value of the dollar, that affect aggregate supply or aggregate demand. For example, changes in money growth influence aggregate demand while changes in energy prices influence aggregate supply (in much the same way as changes in the value of the dollar). The other variables—unemployment and GNP growth—control for other cyclical factors.

The model is estimated using quarterly growth rates of the CPI to measure inflation. The Federal Reserve's trade-weighted dollar is used as the exchange rate. All variables are measured as deviations from their historic trends. When the past influence of relative energy prices, money growth, unemployment, real GNP growth, and inflation are held constant, changes in the value of the dollar have statistically significant effects on inflation.<sup>15</sup>

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on all other variables. Money growth is the quarterly rate of change of M1, and energy prices are the fixed-weight personal consumption expenditure index for energy relative to the index for all personal consumption expenditures. All variables are first regressed on a constant, a dummy variable set equal to one for the post-1972:Q4 period and zero otherwise, three quarterly seasonal dummies, and a time trend. Residuals from these regressions are used as the variables in the VAR. The model can be interpreted as a reduced-form version of the structural aggregate supply and demand model of the previous section.

To conserve degrees of freedom, only a relatively small number of variables is included. One potentially important omitted variable is fiscal policy. By including cyclical indicators such as real GNP growth, money growth, and unemployment, it is hoped that the influence of fiscal policy and other demand-shift variables is held constant. Because results from the empirical model are broadly consistent with results from a variety of other studies with a variety of specifications, it is doubtful that small changes of specification would dramatically change the results.

The lag length of four was chosen initially on the basis of a test suggested by Christopher Sims in "Macroeconomics and Reality," *Econometrica*, January 1980, pp. 1-48. Further experimentation quickly revealed, however, that four lags were inadequate to capture the inflation-exchange rate relationship. Thus, in the inflation equation, the lag length on exchange rate changes was increased to ten.

<sup>15</sup> When changes in the implicit GNP deflator are used to measure inflation, however, no statistically significant relationship can be found between inflation and the dollar, other things equal.

<sup>13</sup> The sample period includes data from the pre-1973 fixed exchange rate era to help determine relationships among the non-exchange rate variables included in the model.

<sup>14</sup> The exact form of the model is a six-variable vector autoregression (VAR) with ten lags on the value of the dollar and four lags

A decline in the value of the dollar, other things equal, has historically caused a small and temporary, but statistically significant, increase in CPI inflation.

### *Empirical relationship between inflation and the dollar*

To give an indication of the empirical relationship between inflation and the value of the dollar, the estimated model is used to forecast each variable under a set of constraints. Specifically, all variables are assumed to grow at their trend rate until, in the initial forecast period, the exchange value of the dollar is assumed to fall 10 percent. All other variables, particularly the inflation rate, are unchanged in the initial forecast period, and for that reason, the entire 10 percent drop in the exchange value of the dollar is assumed to be real. The cause of the decline in the dollar is not specified and could be attributed to any factor that affects the real value of the dollar. The model then traces out the independent effect of the dollar on inflation. Once the initial drop in the real exchange rate has occurred, all other variables in the model are allowed to react according to historical relationships. For example, unemployment is allowed to react to the change in the dollar so that the long-run adjustments described in the theoretical model can occur. Furthermore, money growth is not held fixed, but allowed to react to a lower dollar as it has in the past.<sup>16</sup>

<sup>16</sup> Monetary policy is held fixed over the forecast horizon in the sense that money growth reacts to changes in the value of the dollar only as it has in the past. To the extent that the dollar has not been a target of monetary policy and that monetary policy has reacted passively to temporary, dollar-induced increases in inflation, the endogeneity of money in the presence of a change in the value of the dollar seems justified. During periods of money demand shocks, constant money growth would not be consistent with an unchanged monetary policy.

Two experiments are conducted. The first experiment assumes that after its initial decline, the value of the dollar remains permanently fixed at its new lower level. In this experiment, the dollar is treated as an exogenous variable that is unaffected over the forecast horizon by other variables in the model. While this assumption is somewhat unrealistic, it allows an examination of the effects of a once-and-for-all drop in the value of the dollar, ignoring feedback to the dollar from other variables. The assumed time path of the dollar might result if foreign central banks intervened in foreign exchange markets to lower the real value of the dollar in the initial period, then acted to maintain the lower nominal level of the dollar indefinitely into the future.

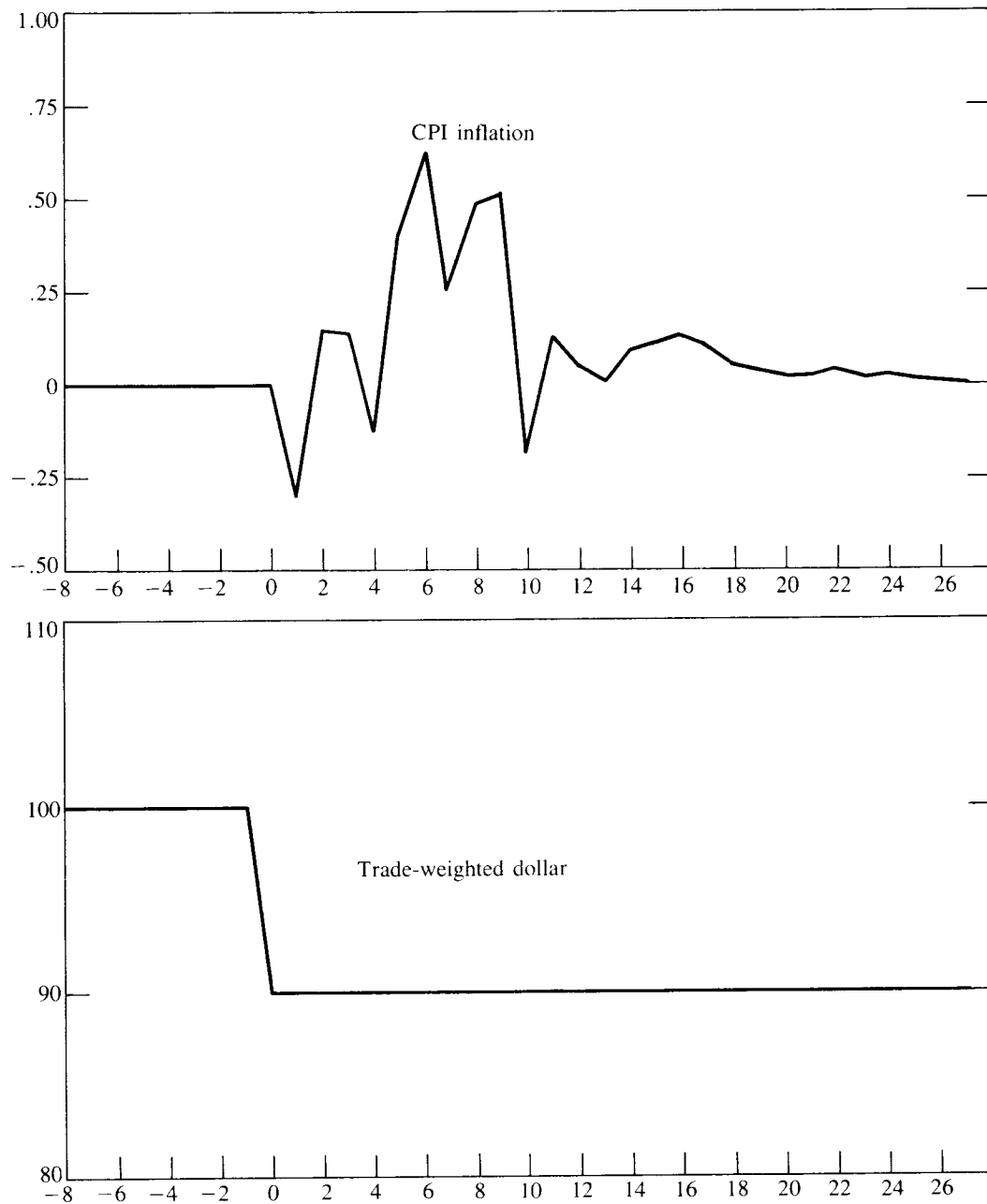
The second experiment allows the dollar to react, after its initial decline, to movements in other variables in the model. This experiment, therefore, allows feedback from inflation and other variables to the value of the dollar. Induced changes in the value of the dollar are then allowed to influence inflation and other variables. This assumed time path for the dollar might result if foreign central banks intervened in foreign exchange markets to lower the real value of the dollar in the initial period, then withdrew from the market and allowed the dollar to take its own course.<sup>17</sup>

*Effects of a once-and-for-all decline in the dollar.* Chart 2 indicates that a once-and-for-all 10 percent decline in the dollar has historically led to an increase in inflation concentrated in the fifth to ninth quarters after the decline. The value of the dollar and inflation are measured as deviations from historic trends. Inflation peaks in the sixth quarter at 0.64 percentage points above

<sup>17</sup> The forecasts are dynamic. In the first experiment, all right-hand side variables except the dollar are forecast. Over the forecast horizon, the dollar is made exogenous. In the second experiment, all variables are forecast, including the dollar.

**CHART 2**

**Effect on inflation of a permanent drop in the dollar—without feedback**



trend.<sup>18</sup> Inflation then begins to fall, returning to its trend rate of growth in about 14 quarters. Thus, the pattern of inflation depicted by the conditional forecast is consistent with theory. Inflation first rises, then falls back to its initial level. The size of the effect on inflation, however, is relatively small.

The effect of a decline in the dollar on the price level is given in Chart 3.<sup>19</sup> Here again, the forecast is consistent with theory. After an initial delay of about four quarters, the price level rises to a peak of about 103. Thus, the effect of a decline in the dollar on the price level is permanent, even though the effect on inflation is temporary. Because the price level is permanently higher, theory indicates that the decline in the dollar increased aggregate demand.<sup>20</sup>

*Effects of a decline in the dollar with feedback to the dollar.* When the dollar is treated as an endogenous variable—a variable that reacts to movements in other variables—the effect of a decline in the value of the dollar on inflation is more pronounced. Chart 4 shows that a 10 percent decline in the value of the dollar causes CPI inflation to increase to a peak of 0.84 percentage points above trend in the ninth quarter after the drop in the dollar. After about five years, however, inflation returns to its historic trend. The increase in inflation, which exceeds the increase from the previous experiment, is accompanied by an induced decline in the dollar of roughly 10 per-

cent.<sup>21</sup> This further decline in the dollar is temporary, lasting roughly 22 quarters. It is caused by feedback from the higher rate of inflation to the dollar, as well as by inertia in the behavior of the exchange rate itself. The further decline in the dollar exacerbates the increase in inflation.

The effect of a drop in the dollar on the price level, when the dollar is treated as an endogenous variable, is shown in Chart 5. After an initial delay of about four quarters, the price level rises from its initial level of 100 to a peak of almost 105. While the effect on inflation is temporary, the effect on the price level is permanent. Even though the price level falls off a bit from its peak, to about 104, prices remain permanently higher as a result of a fall in the dollar. Thus, each forecast, regardless of whether the dollar is assumed exogenous or endogenous, confirms theory. A decline in the value of the dollar leads to a permanently higher price level and a temporarily higher inflation rate. A 10 percent decline in the dollar leads to a 3 percent increase in the price level in the first experiment and a 4 percent increase in the price level in the second experiment. These results, as previously noted, assume that the Federal Reserve reacts to the falling dollar and its effects on inflation and output only as it has, on average, in the past.

Given the estimated effects of a hypothetical 10 percent decline in the dollar, the permanent effect on the price level of the recent dollar decline can be roughly predicted. Since early 1985, the Federal Reserve's trade-weighted dollar has fallen approximately 40 percent in real terms. The effect of this decline on prices can be predicted by multiplying the estimated effect of a 10 percent

<sup>18</sup> The initial decline in the inflation rate below trend should not be taken too seriously. It might simply be a statistical aberration.

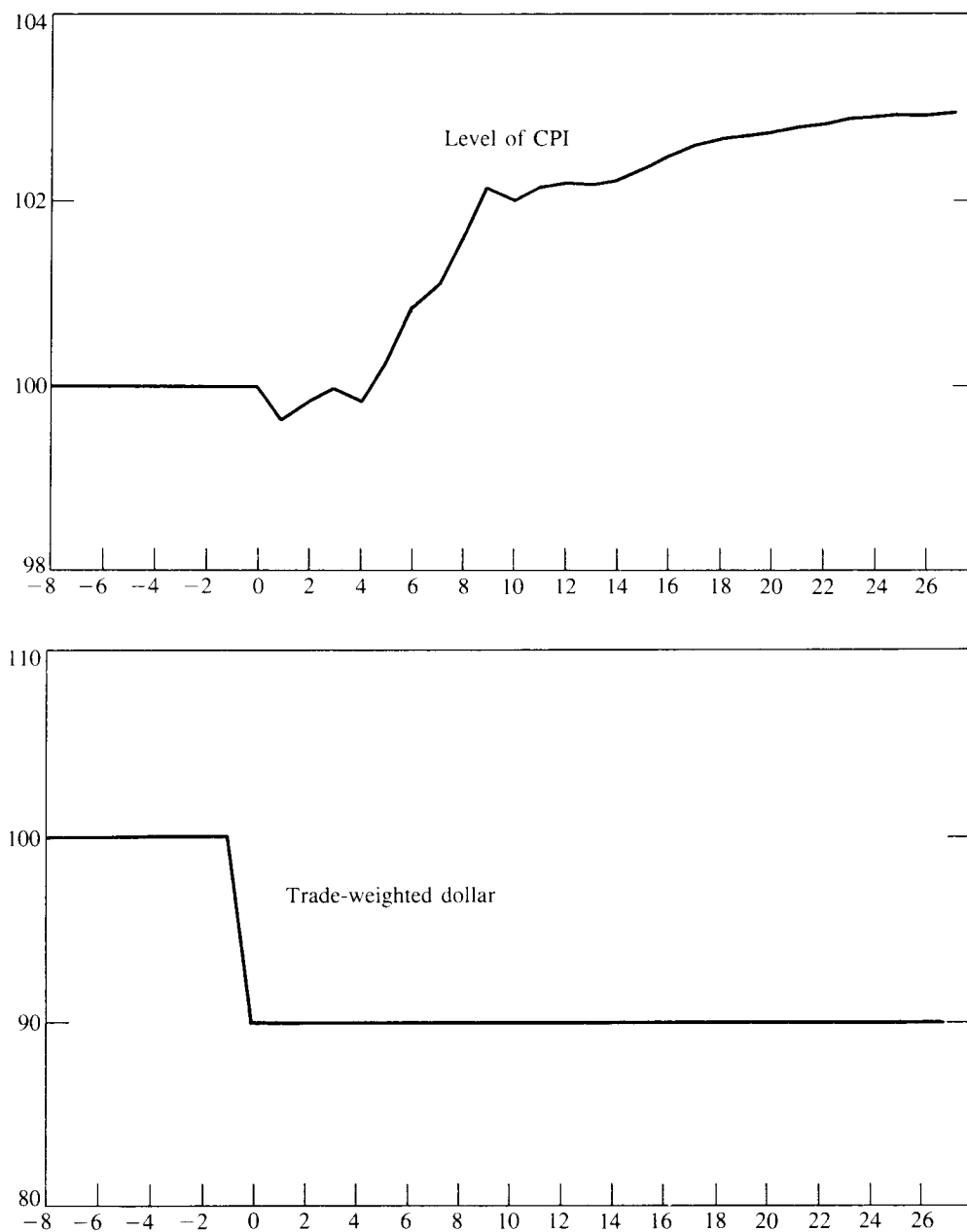
<sup>19</sup> The effect of the dollar on the price level is determined by cumulating the inflation effects, starting with an initial price level of 100.

<sup>20</sup> Any supply effects would have left the price level unchanged in the long run, assuming that long-run production possibilities are unaffected. Therefore, on the basis of the price level alone, it is impossible to determine to what extent aggregate supply was affected.

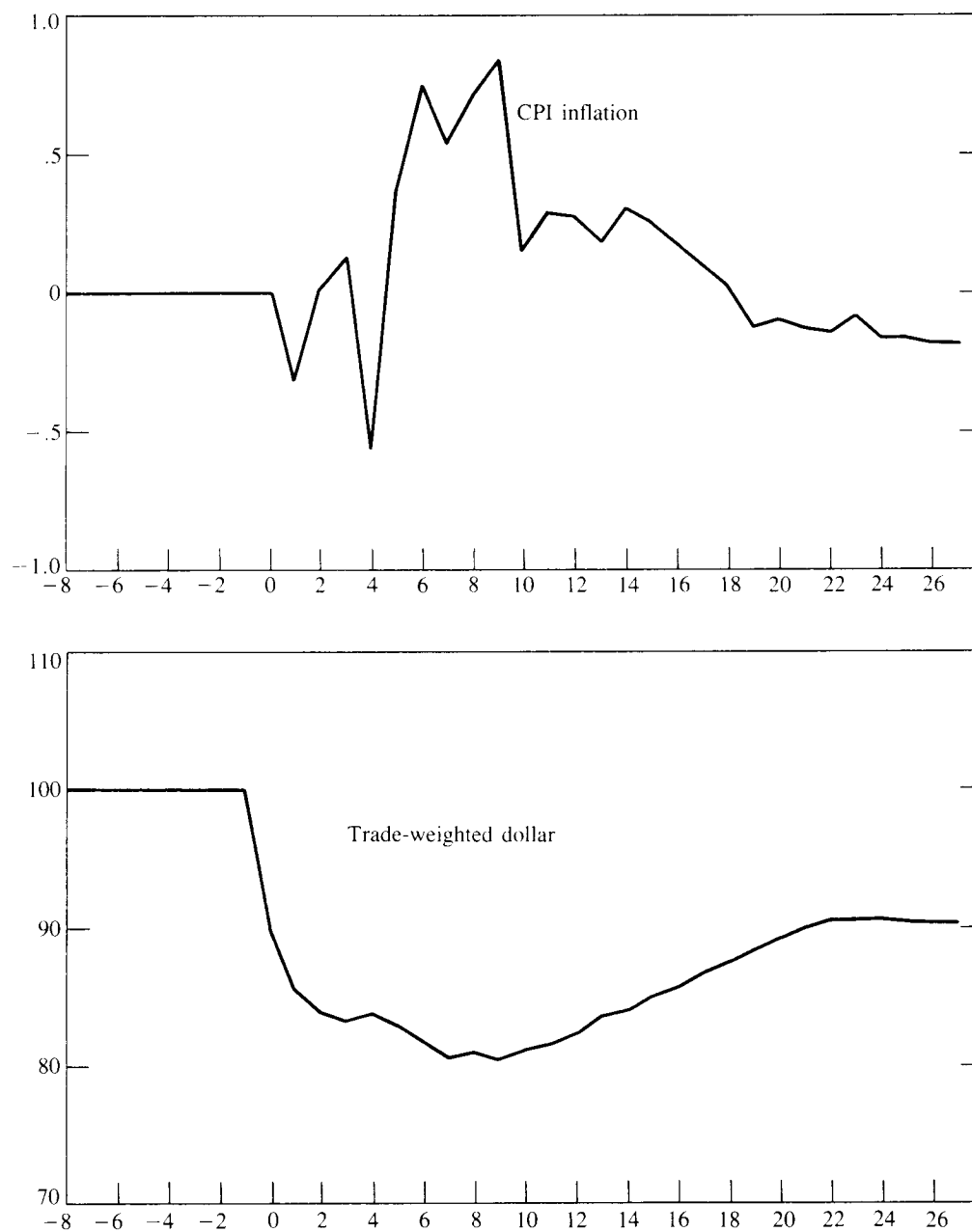
<sup>21</sup> Part of the recent decline in the dollar might have been induced. Thus, this result does not necessarily imply that the dollar will continue to fall.

**CHART 3**

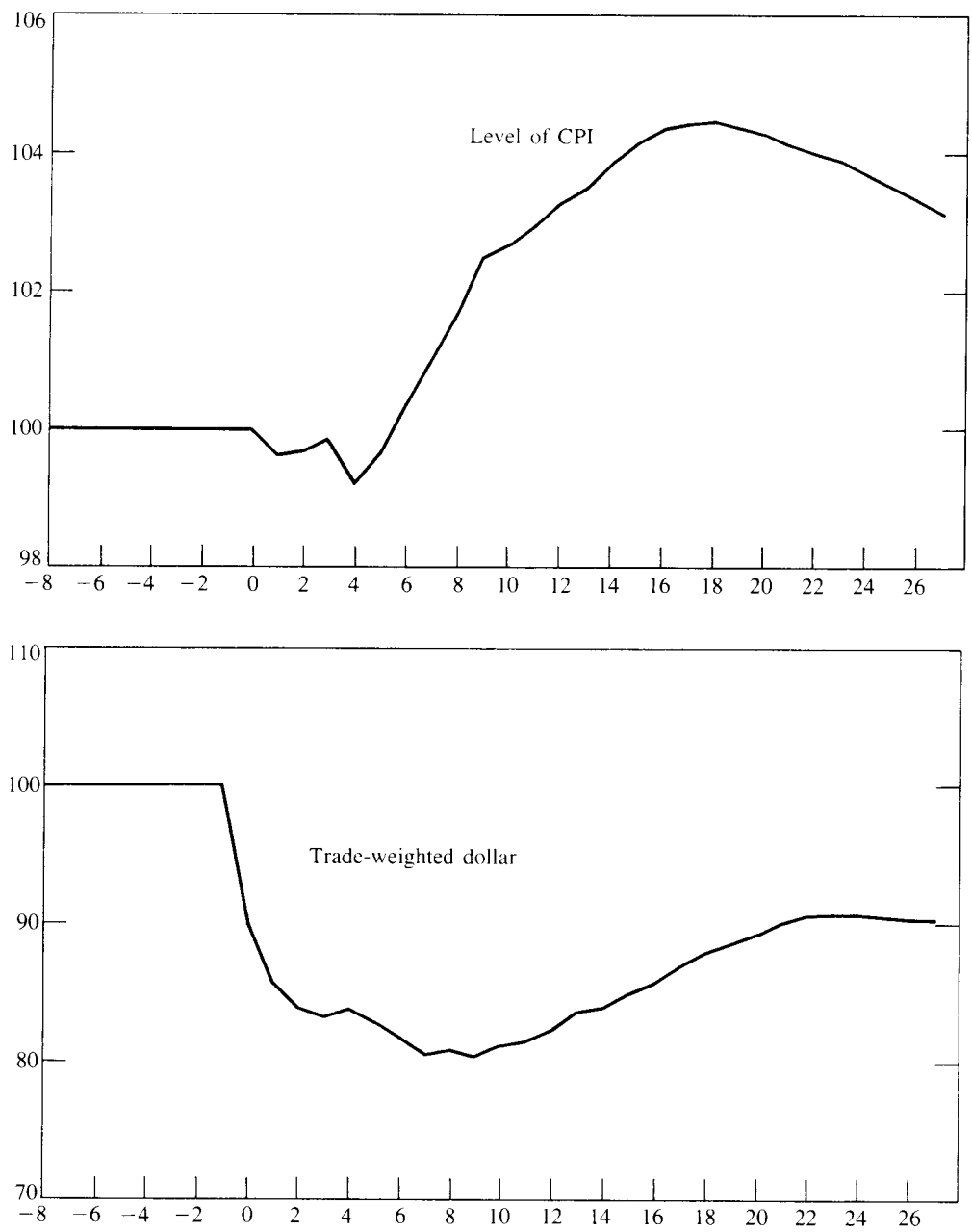
**Effect on the price level of a permanent drop in the dollar—without feedback**



**CHART 4**  
**Effect on inflation of a drop in the dollar—with feedback**



**CHART 5**  
**Effect on the price level of a drop in the dollar—with feedback**





decline in the dollar by four.<sup>22</sup> Thus, if all other factors are held constant, the recent 40 percent decline in the dollar will eventually cause the price level to rise by about 12 to 16 percent. If the dollar now stays around current levels, estimates from the first experiment will more closely apply, and prices will likely rise by an amount closer to 12 percent. If, on the other hand, the dollar falls further, perhaps in response to its own inertia and feedback from other variables, the second experiment will more closely apply, and prices will rise by an amount closer to 16 percent.<sup>23</sup> In either case, the increase in prices will take many years and, therefore, the effect on inflation will be relatively small. Inflation will temporarily increase by, at most, three to four percentage points.

Given the estimated lag structure, which suggests that a fall in the dollar begins to increase prices after four quarters, the decline in the dollar since early 1985 should by now be raising the level of consumer prices in the United States. However,

the recent fall in the dollar followed an unprecedented rise in the value of the dollar. Assuming the estimated lag structure applies to increases as well as decreases in the value of the dollar, the rise in the dollar in the early 1980s may still be having a moderating influence on consumer prices, although by now these influences should be dying out. As these influences die out and the effects of the recent declines in the dollar take hold, consumer prices may begin to register more pronounced increases, other things equal. As determined by the empirical model, however, these increases should remain moderate.

*Results from other studies.* The estimated effects of the dollar on inflation—both their size and their timing—are broadly consistent with estimates from other studies. These estimates of the cumulative impact of a 10 percent depreciation of the dollar on the level of consumer prices range roughly from zero to 1.5 percent after one year, with most studies estimating about a 0.5 percent increase. Estimates reported in this article for the first-year impact of a 10 percent depreciation fall toward the low end of the range of estimates from other studies.<sup>24</sup>

Estimates from other studies of the cumulative long-run rise in the level of the CPI vary much more widely. Roughly, the range is from zero to 5 percent. Studies estimating a relatively large cumulative long-run effect typically fail, however, to control for energy price changes, macroeconomic policy changes, and other third-variable effects. Thus, it is not surprising that, when these influences are held constant, a smaller long-run effect of the dollar is estimated. In the first

<sup>22</sup> One important difference between the experiments and recent history is that, while the experiments assume the decline in the dollar occurs over one quarter, the historical decline in the dollar occurred over many quarters. Thus, it may take longer than the experiments predict for the actual dollar depreciation to raise prices to their new equilibrium level. The actual increase in inflation may be less, but also may persist longer, than predicted by the experiments. Another potential problem with the experiments is that the recent decline in the dollar falls outside the bounds of historical experience. Thus, using historical relationships as a basis for prediction may be risky. Nevertheless, in obtaining quantitative estimates, the only way to proceed is to assume history is a reliable guide to the future.

<sup>23</sup> A difficulty in applying the second experiment to the current situation is knowing where to start or, in other words, knowing how much of the decline is exogenous and how much is induced. If, for example, recent dollar declines are the result of feedback from inflation and other variables to the dollar, rather than the result of an exogenous shock, the starting point for predicting the impact on inflation of the dollar decline may be at some interval after the initial forecast period. It would then be appropriate to multiply the implied effect on inflation by an amount less than four. Thus, at best, the second experiment provides an upper bound for the long-run effect of the recent dollar decline on the price level.

<sup>24</sup> For a review of the empirical literature on the dollar-inflation relationship, see Joseph A. Whitt, Jr., Paul D. Koch, and Jeffrey A. Rosensweig, "The Dollar and Prices: An Empirical Analysis," *Economic Review*, Federal Reserve Bank of Atlanta, October 1986, pp. 4-18.

experiment reported in this article, the effect of a once-and-for-all 10 percent decline in the dollar is a cumulative long-run increase in the level of the CPI of roughly 3 percent. For this experiment, therefore, estimated results fall in the middle of the range of estimates from other studies.

In the second experiment reported in this article, a 10 percent decline in the dollar initially leads to almost a 5 percent increase in the price level. However, because the dollar is treated endogenously, it also leads to a further, temporary decline in the dollar of roughly 10 percent. The permanent part of this decline in the dollar is 10 percent. It is associated with a permanent increase in the price level of 4 percent. Although the estimated long-run impact of a decline in the dollar in the second experiment is on the high side of the range of estimates from other studies, the impact is spread over many quarters. Thus, the effect on inflation in any particular quarter remains relatively small.

Although the results reported in Charts 2 to 5 are subject to estimation errors, their general consistency with the results of other studies lends a degree of confidence to the analysis. Further confidence results from the consistency of the empirical findings with the theoretical analysis. Although reported forecasts should not be interpreted as highly precise, they do provide a sound

characterization of the effect of dollar fluctuations on inflation.

## Conclusions

It is a foregone conclusion that recent declines in the foreign exchange value of the dollar will raise prices. If historical experience is an accurate guide to the future and if other influences on inflation are ignored, the 40 percent decline in the dollar since 1985—to the extent that it is real—will increase the level of consumer prices by about 12 to 16 percent over a period of five or more years. But because the impact on the price level is spread over so many years, the short-run inflation effect will be small. As long as the Federal Reserve does not permanently increase money growth in response to a lower dollar, the higher price level need not lead to a permanent increase in inflation. Thus, the impact on inflation of a lower dollar should be temporary. Both theory and evidence support this conclusion. While concern that a lower dollar will result in higher prices is not misplaced, it should not, in itself, lead to fear of a return to an inflationary era. While the falling dollar may be a signal of underlying inflationary policies, it does not in itself imply a future of permanently higher inflation.