JEFFREY D. SACHS
Harvard University

The Dollar and the Policy Mix: 1985

In 1971, Robert Mundell proposed a stunning solution to the three problems then affecting the U.S. economy: high inflation, high unemployment, and a weak currency. His essay *The Dollar and the Policy Mix: 1971,* from which I borrow my own title, called for a policy of fiscal expansion and monetary contraction.[1] Mundell argued that applying this policy mix, which has recently been derided as driving with one foot on the gas and one on the brakes, would extract the comparative advantage of the two instruments. In Mundell's view, formalized in his famous "assignment problem" for policy instruments, fiscal policy has a larger effect on output than on prices, while monetary policy affects prices more than output. Therefore, fiscal policy should be "assigned" to the output target and monetary policy to the price level target.[2] Ostensibly, the policy mix of fiscal expansion and monetary contraction

This work is based on an ongoing project of the author with Gilles Oudiz and Warwick McKibbin. I thank Warwick McKibbin for unflagging efforts in the face of tight deadlines and for useful comments throughout. I also thank Wing T. Woo for helpful discussion and for providing some of the data used in the empirical analysis.

1. Robert A. Mundell, *The Dollar and the Policy Mix: 1971,* Essays in International Finance, 85 (Princeton University, International Finance Section, May 1971). Mundell argued on page 24 that "the correct policy mix is based on *fiscal ease* to get more production out of the economy, in combination with *monetary restraint* to stop inflation." (Emphasis in original.)

2. Ibid., p. 17. To quote Mundell: "Monetary policy has its comparative advantage in controlling inflation and the balance of payments, and should be reserved for that purpose. *Financial instruments* [that is, money] *should be allocated to financial targets; real instruments* [that is, fiscal policy] *to real targets.*" (Emphasis in original.)

can work to raise output and cut prices, or at least slow inflation, at the same time. And both sides of the mix, asserted Mundell, would act to strengthen the currency, by raising interest rates and drawing in foreign capital. In 1971, it should be remembered, the dollar was tied to other currencies through fixed exchange rates and was under strong downward pressure, which forced a devaluation in mid-year.

One assertion of the 1971 essay that was considered surprising at the time was the notion that fiscal expansion could strengthen the currency. The traditional remedy for balance of payments difficulties under fixed exchange rates was a fiscal contraction, not an expansion. Mundell's own earlier work, however, had turned this idea upside down, at least as a short-run proposition. In his famous 1962 essay, "The Appropriate Use of Monetary and Fiscal Policy for Internal and External Stability," Mundell pointed out that in a world of high capital mobility, a bond-financed fiscal expansion would raise home interest rates, and attract more than enough foreign capital at the initial exchange rate to finance the current account deficit caused by the expansion.[3] Under fixed exchange rates the central bank would gain foreign reserves, while under flexible rates the currency would appreciate. In Mundell's model, the traditional argument that fiscal expansion weakens the currency in the short run is correct only if at least one of the following conditions holds: there is low international capital mobility, or the fiscal expansion is money financed, in which case the currency tends to weaken even with high capital mobility. Of course, Mundell's argument that fiscal expansion would strengthen the currency has become commonplace in the United States in the policy debate of the past two years. It is still regarded as dubious, however, by most European economists when applied to the effects of fiscal expansion in their own economies.

Mundell's policy advice was not pursued in 1971 or 1972. Instead, the Federal Reserve Board embarked on one of the most aggressively expansionary policy episodes in its history. In the event, the dollar was battered, losing 19 percent in value relative to a basket of currencies between July 1971 and March 1973.[4] During the past four years, however,

3. Robert A. Mundell, "The Appropriate Use of Monetary and Fiscal Policy for Internal and External Stability," *IMF Staff Papers*, vol. 9 (March 1962), pp. 70–79.

4. Throughout the paper the weighted-average exchange rate is the Multilateral Exchange Rate Model index of effective exchange rates, as calculated by the International Monetary Fund.

Mundell's experiment has been tried, probably more vigorously than he himself envisioned. Since 1981, the Reagan administration has pursued a course of large budget deficits, while the Federal Reserve Board has maintained a path of generally declining money growth rates. The macroeconomic results have in many ways been in accord with Mundell's analysis: a sharp rise in the dollar, apparently caused by a capital inflow attracted to high U.S. interest rates; a sharp drop in inflation; and an average rate of growth during 1981–84, composed of a sharp recession in 1982, followed by a vigorous recovery. A major side effect of the policy mix has been the worsening of the U.S. trade and current account positions, with both measures of external deficits reaching a proportion of GNP unprecedented in this century for the United States.

This paper asks the following question: has the macroeconomic performance since 1981 vindicated the Mundell-Reagan mix of fiscal expansion and monetary contraction? And if so, what then are the implications for the appropriate path of budget deficit reductions and monetary policy in the coming years? The major question to be asked is whether the policy mix has reduced the "sacrifice ratio," measured as the amount of GNP losses incurred in order to reduce the inflation that the Reagan administration inherited in 1981. To answer this question, I will look at the disinflation to date, as well as the future prospects for inflation, especially in view of the likelihood of a dollar depreciation.

My own analysis of the policy mix will stress the differential effects of monetary and fiscal policy on the value of the dollar, and thus on imported inflation. It is important to note, though, that there are many other reasons why monetary and fiscal policies might have different effects on inflation and output that would justify the use of a particular policy mix. Mundell, in fact, had additional mechanisms in mind in 1971, some in line with the views of today's supply-siders. He suggested that tax cuts stimulate output and reduce prices by increasing aggregate supply relative to aggregate demand. He also argued that money is, at best, neutral with respect to output except in the very short run; at worst, a money expansion may be contractionary, Mundell contended, because of nonneutralities in the tax system. Thus the policy mix that I will stress is actually based more on Mundell vintage 1962 than Mundell vintage 1971. Other mechanisms that might argue in favor of the Mundellian mix of fiscal expansion and monetary contraction in the process of disinflation are ignored henceforth.[5] The variety of the arguments in favor of a particular mix for disinflation stands in contrast with the rather simple textbook case in which output levels and past inflation alone determine current inflation. In those models, any mix of monetary and fiscal policy that yields a given output level has the same inflationary consequences. James Tobin has labeled such models as "funnel models," since the macroeconomic policies are funneled into output without any direct or differential effects on prices.

Among the questions examined in the paper, the following bear especially upon the exchange rate:

—Has the strong dollar contributed to the post-1980 disinflation, taking as given the overall level of GNP or unemployment in the economy, and if so, by a quantitatively important amount?

—Can the policy mix plausibly explain the movements in the value of the currency?

—Does the expected large real depreciation of the dollar, which could reverse the appreciation of the past four years, threaten to undo the benefits so far achieved by means of a strong dollar?

—In view of the expected depreciation in the value of the dollar, does the policy mix viewed from beginning to "end," if and when the dollar falls, make sense as an anti-inflationary strategy?

—Are such side effects on the U.S. economy of the strong dollar as the squeeze on tradables and the rise in U.S. foreign indebtedness too costly to justify the choice of policy mix?

—Are U.S. gains from the policy mix balanced by losses in the rest of the world, so that the policies are in fact beggar-thy-neighbor?

Questions about the longer term aspects of the policy mix are especially important in view of the fact that Mundell's arguments were based on short-run models that do not make allowance for the long-term effects of current account deficits and budget deficits. Notably, Mundell's canonical model of fiscal expansion under flexible rates allows for an "equilibrium" in which a country has an appreciated exchange rate and a current account deficit forever. More recent models have shown

5. For example, even in a closed economy, the high interest rate effects of the Mundellian mix could cause primary commodity prices to fall if inventories are de-stocked in response to the interest rates. Such a decline in inventories would provide a temporary, favorable "supply shock" to the economy, which could feed through to lower prices and wages.

that when the short-run effects of fiscal policy include a currency appreciation, the long-term effects typically involve depreciation.[6] The weaker long-run value of the currency helps to generate a trade account surplus that is used, in the long run, to service the external debt accumulated in the period of currency appreciation. Given that the benefits of the strong dollar may be lost over time, does the Mundellian strategy make sense when viewed over a reasonably long time horizon?

To be clear about purposes, one disclaimer should be made at the outset. Though I will analyze the current U.S. policy mix from the point of view of dynamic policy optimization, I do not want to pretend that the mix has been designed primarily, or at all, with the exchange rate arguments in mind. Indeed, the notion of inexpensive disinflation through currency appreciation was rarely, if ever, explicitly stated in 1981 as an argument on behalf of the Reagan tax cuts, though more recently the president has explicitly defended the strong dollar on these grounds. Supply-side advocates often rejected the demand-stimulus arguments that underlie many of my findings. My own view of the "design" of the policy mix is more Darwinian. Tax cut advocates did explicitly endorse the argument that a debt-financed fiscal expansion need not be inflationary, but they probably did not anticipate the enormous currency appreciation, and its anti-inflationary benefits, that would follow from the policy. However, once the noninflationary recovery got under way, the short-term success of the policy mix became evident, and the pressure to expand money or to contract the budget deficits was eliminated. Even if the policymakers fell onto a desirable path accidentally, the staying power of the strategy has resulted from the short-term, if not long-term, benefits that it is yielding.

The main finding of the paper is that the Mundell policy mix reduces the sacrifice ratio in the short run, but increases it in the long run. In the United States, the exchange appreciation has reduced inflation by 2 to 3 percentage points as of 1984. Given the strong likelihood of a depreciation of the dollar, those 2 to 3 points, and even more, will likely be lost in the future. Because of the foreign debt that the U.S. economy will accumulate in coming years, the eventual decline of the dollar, in real terms,

6. See, for example, Rudiger Dornbusch and Stanley Fischer, "Exchange Rates and the Current Account," *American Economic Review*, vol. 70 (December 1980), pp. 960–71; Jeffrey Sachs and Charles Wyplosz, "Real Exchange Rate Effects of Fiscal Policy," Working Paper 1255 (National Bureau of Economic Research, January 1984).

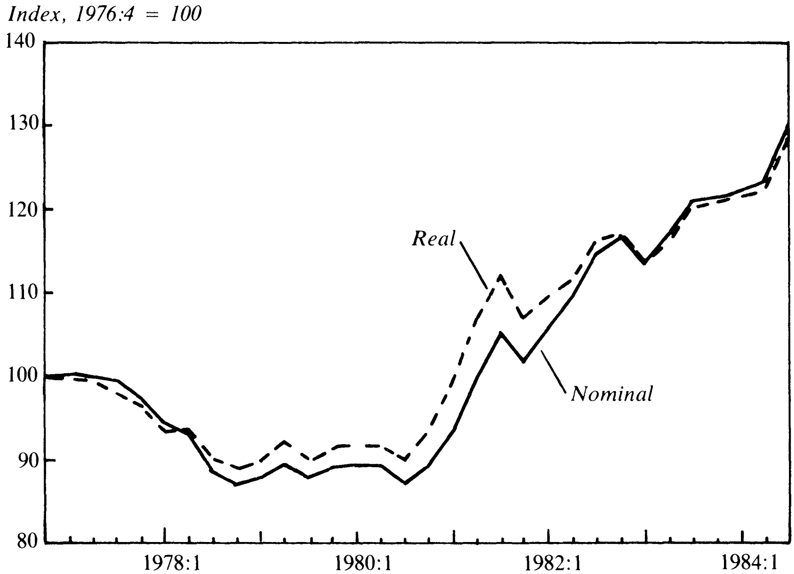
will likely exceed the appreciation since 1980. As I discuss later, the welfare calculus suggests that choosing a low sacrifice ratio in the short term for a higher long-run sacrifice ratio makes sense when there is a perceived need for a rapid reduction of a high initial inflation, which tends to be the case when inflation has rapidly rising marginal social costs.

The paper has four sections. The first examines the pattern of dollar appreciation and makes some estimates of its disinflationary consequences. The second section looks at the prospects for future movements in the dollar and projects future inflationary consequences from dollar depreciation. In the third section, I use a medium-scale structural model to assess the linkages between movements of the dollar and the underlying policy mix. I also examine the arguments for and against the Mundellian strategy from the point of view of dynamic policy optimization, first from the narrow U.S. point of view, and then from that of the world economy as a whole. The fourth section examines some of the risks in the current situation, particularly a sharp depreciation of the dollar.

The Value of the Dollar and the Disinflation Process

Figure 1 and table 1 document the remarkable movements in the value of the dollar over the past eight years, using, as does the rest of the paper, the following conventions for exchange rates. The dollar is measured in terms of the number of units of foreign currency that it purchases; a rise in the index therefore indicates appreciation. "Effective" rates indicate dollar values relative to a basket of currencies. "Real" exchange rates are nominal rates multiplied by a U.S. price index and divided by a comparable effective foreign price index. The real exchange rate may be thought of as the price of U.S. goods relative to foreign goods, with both expressed in a common currency. A rise in U.S. relative prices is termed a real appreciation of the dollar. As can be seen in both figure 1 and table 1, the nominal effective exchange rate appreciated by about 34 percent from 1976:4 to 1984:4, and by 50 percent from 1980:4 to 1984:4, using the International Monetary Fund's Multilateral Exchange Rate Model (MERM) to provide a weighted effective exchange rate for the U.S. dollar. The last quarter of 1980 will be the starting point for most of the analysis, since it marks the coming to power

Figure 1. The Effective Dollar Exchange Rate, 1976:4–1984:3[a]



Source: International Monetary Fund, *International Financial Statistics*, series amx and 63ey 110.
a. Effective nominal rate is the IMF Multilateral Exchange Rate Model index; real rate is the relative wholesale price index for manufacturing.

of the Reagan administration and the beginning of the Mundellian policy shift. In real terms, the appreciation has been equally dramatic, with increases during 1980:4–1984:3 of about 38 percent when measured by wholesale prices, 48 percent when measured by relative unit labor costs, and 39 percent when measured by relative consumer price indexes. Table 1 also shows the changes in the dollar relative to the major currencies. Note its sharp real appreciation relative to European currencies and the smaller appreciation relative to the Japanese yen. In fact, the yen itself has appreciated relative to a basket of currencies since 1980:4, a point that is sometimes ignored in assertions that the Japanese authorities have unfairly caused a yen depreciation.

The upward movement in the dollar began almost precisely upon Reagan's election victory in November 1980. Later, I will argue that the fiscal expansion since 1981 (anticipated after November 1980) has been a major factor in the currency appreciation. As documented by Olivier J. Blanchard and Lawrence H. Summers, the fiscal expansion in the United States has been accompanied by a fiscal contraction in the economies of other Organization for Economic Cooperation and Devel-

Table 1. Appreciation of the U.S. Dollar: 1976:4–1984:4[a]
Percent

Country or aggregate	Appreciation to 1984:4: Nominal, From 1976:4	Nominal, From 1980:4	Real, From 1976:4	Real, From 1980:4
Effective multilateral exchange rate	34.4	50.0	28.8	37.8[b]
Bilateral exchange rate				
Canada	32.9	11.4	16.0	1.5
France	87.8	111.8	50.0	51.8
Germany	26.8	59.7	51.3	50.2
Italy	119.1	108.6	32.9[b]	42.9[b]
Japan	−16.2	16.8	12.6	29.3
United Kingdom	35.8	96.2	3.8[b]	58.5[b]

Source: All data are from International Monetary Fund, *International Financial Statistics*, various issues.
a. Data are quarterly averages. The effective multilateral nominal rate is the MERM index (series amx). The effective multilateral real rate is the IMF measure of relative wholesale prices for manufacturing, which are adjusted by nominal exchange rates (series 63ey). The real bilateral rate is PE/P^*, where P, P^* are wholesale prices (series 63) in the United States and abroad, and E is the nominal bilateral rate (series rf) expressed as units of foreign currency per U.S. dollar.
b. Appreciation to 1984:3.

opment (OECD) countries.[7] In the period since 1980:4, the United States and the other six large OECD economies have had a major success in reducing inflation, but only the United States has reduced inflation and achieved a vigorous recovery from the 1982 recession. In the European countries, the inflation reduction has been accompanied by a protracted and serious rise in unemployment. The evidence suggests that the extent of recovery, or the change in unemployment since 1982, has been related to the extent of fiscal expansion. Of course, other factors, such as the flexibility in labor market adjustment, have also probably played a role in the differential employment adjustment during the 1980s.

Without question, a significant part of the U.S. disinflation can be attributed to the sharp recession from 1981:3 to 1982:4. According to Robert J. Gordon's estimates in 1984, the cumulative GNP gap (output loss relative to potential) during the recession was 9.9 percent of GNP.[8] Since the end of the recession, the economy has remained significantly below potential, with another 10.5 percent of cumulative GNP gap

7. Olivier J. Blanchard and Lawrence H. Summers, "Perspectives on High World Real Interest Rates," *BPEA, 2:1984*, pp. 273–324.

8. Robert J. Gordon, "Unemployment and Potential Output in the 1980s," *BPEA, 2:1984*, pp. 537–64.

between 1982:3 and 1984:4. These estimates make possible a rough measure of the sacrifice ratio in the recent disinflation. The inflation measure is the change in the personal consumption deflator of the national income accounts. The pre-Reagan inflation rate is the quarterly change in 1980:4 at an annual rate, or 9.6 percent. The current inflation rate is the quarterly rate for 1984:4, or 2.4 percent. The cumulative gap is taken from Gordon's estimates of potential GNP, and is measured from 1981:1 to 1984:4 to be 21.5 percent of output. The sacrifice ratio is the cumulative gap divided by the slowdown in inflation, or 21.5/(9.6 − 2.4), which equals 3.0. A similar measure results if the slowdown in inflation is calculated using the inflation rates of the entire years 1980 (10.2 percent) and 1984 (3.2 percent), and the same 21.5 percent cumulative output loss.

How does a sacrifice ratio of 3.0 compare with estimates that were made before and during the disinflation of the past four years? As Stanley Fischer has recently summarized, estimates of the ratio were surveyed by Arthur M. Okun in 1978 and were found to be in the range of 6 to 18.[9] Okun himself put the best guess at 10. On this basis, the outcome to date has been significantly better than was forecast. This conclusion holds up if the slowdown is measured using a "core" rate of inflation, rather than actual inflation. The change in average hourly earnings in nonfarm business (comparing 1984:4 with 1980:4), for example, results in an even larger slowdown in inflation, and therefore a lower sacrifice ratio of 2.9.

One reason why the sacrifice ratio, using the GNP gap, has been lower than forecast is that the relationship between the GNP gap and aggregate unemployment has apparently shifted since 1980 (that is, the coefficient in Okun's law has changed). The cumulative "excess" unemployment since 1980:4 (using 6 percent as the full-employment level) has been 10.8 percent, which is more than pre-1980 Okun's law equations would have associated with the 21.5 percent output gap during the period since 1980:4.[10] An unemployment-based sacrifice ratio therefore yields 1.7, which is below but close to the band of 2 to 6 that Okun surveyed in

9. See Stanley Fischer, "Real Balances, the Exchange Rate, and Indexation: Real Variables in Disinflation," Discussion Paper 1497 (National Bureau of Economic Research, November 1984.)

10. Okun used a multiplier of 3 to get the GNP gap from the unemployment rate. Gordon's equation yields a multiplier of about 2.

1978. Thus, on one measure—the output gap—the disinflation has been much more rapid than was considered plausible in 1978, while on another measure—the unemployment rate—the sacrifice ratio has been just below the low end of the suggested range.

There are of course a number of possible reasons for the favorable disinflation of the past four years. Rational expectations theory stresses that sacrifice ratios may not be stable, and indeed may depend on the policy regime. Perhaps Paul Volcker's nonaccommodative policies generated a newly found credibility for the Federal Reserve, along the lines urged by Phillip Cagan and William Fellner.[11] In George Perry's terms, the wage norm may have shifted in a favorable direction because of Reagan's resolve in firing Professional Air Traffic Controllers' Organization (PATCO) workers, or his apparent willingness to countenance a deep recession in 1982, or other reasons.[12] I believe, however, that much of the reason is more prosaic, and not so optimistic for the long run. Specifically, the strong dollar has played a major role in the disinflation process. Gordon and Stephen King showed in 1982 that allowing for such international influences as exchange rate effects, foreign price effects, and food and oil prices on the U.S. price dynamics reduces the estimated sacrifice ratio for the GNP gap from about 8.4 to 3, equal to the recent experience.[13] In the vector autoregressions in that study, Gordon and King estimated the exchange rate appreciation effects to be the natural consequence of tight monetary policies, and thereby foresaw the relatively low cost to the recent disinflation. Their estimates do not, however, very accurately capture the long-run depreciation of the dollar that may now ensue. Thus, while their estimates were accurate for the short term, they may prove too optimistic over the longer run, as discussed later.

How plausible is it to assume that the strong dollar has played a major role in the disinflation process? What is the best guess of its quantitative significance to date? To answer these questions, I consider three types of evidence: first, the existing range of estimates regarding the effects of

11. Phillip Cagan and William Fellner, "Tentative Lessons from the Recent Disinflationary Effort," *BPEA, 2:1983*, pp. 603–10.

12. See the wage norm concept in George L. Perry, "Inflation in Theory and Practice," *BPEA, 1:1980*, pp. 207–41.

13. Robert J. Gordon and Stephen R. King, "The Output Cost of Disinflation in Traditional and Vector Autoregressive Models," *BPEA, 1:1982*, pp. 205–42.

exchange rate changes on prices; second, estimates of the structural channels through which the exchange rate can influence prices; and third, a simulation model of the world economy, with a major block for the United States in which the general equilibrium effects of U.S. exchange rate changes can be considered.

EXCHANGE RATES AND INFLATION IN THE UNITED STATES

In a useful paper written in 1979, Peter Hooper and Barbara Lowrey surveyed the literature on the effects of a dollar depreciation on U.S. prices.[14] In most of the studies that they examine, a small model of wage and price dynamics is estimated, with wage and price inflation a function of output or unemployment, lagged inflation, changes in the exchange rate, and foreign prices. In some of the models, the dollar price of oil is held fixed when the depreciation is simulated, while in others, the dollar price of oil is modeled endogenously, and is therefore affected by exchange rate changes. In most cases, the studies investigate how wages and prices are affected by an exogenous change in the exchange rate, taking as given the path of output and the local currency prices of manufacturing imports, for example, the deutsche mark price of West German exports, the yen price of Japanese exports. The framework is a useful one for this paper, since we will want to see how inflation is affected by a change in policy mix that alters the exchange rate but not output. By taking as given the local currency prices in the rest of the OECD, however, the framework ignores the linkages from the U.S. exchange rate to local currency prices abroad and back to U.S. import prices. These linkages can be accounted for only in a global model, as presented later. In the partial equilibrium exercises that Hooper and Lowrey analyze, it is also crucial to assume that whatever are the shocks altering the exchange rate, whether portfolio shifts or a change in mix of fiscal and monetary policy, these shocks have no direct effect on prices except as they work through output or the exchange rate itself.

Hooper and Lowrey reach the following conclusion:

> The consensus estimate we propose . . . is that a given 10 percent real dollar depreciation, on a multilaterally weighted average basis, will result in a 1½

14. See Peter Hooper and Barbara Lowrey, "Impact of the Dollar Depreciation on the U.S. Price Level: An Analytical Survey of Empirical Estimates," Staff Study 103 (Board of Governors of the Federal Reserve System, April 1979.)

> percent increase in consumer price level, assuming an intermediate policy stance [fixed GNP target] if oil import prices are not affected by the depreciation; and it will result in a 1¾ percent increase if oil import prices rise by the same proportion as nonoil prices in response to the depreciation. Given the time frame of the various models considered, about half of the total impact is likely to take place within one year of the depreciation and the remainder within two to three years, although the timing of the oil price effects may be more variable because of the discontinuity of OPEC pricing decisions.[15]

In some of the studies, the price level effect of about 1½ percent in fact represents the two- or three-year effect, with greater effects present if a longer time interval is examined. This is true when the level change in the exchange rate gets built into a persistent change in the inflation rate. Note that persistent, even permanent, effects on inflation are logically possible after a one-time level depreciation, since the policy authorities are assumed to be holding real GNP fixed, and are therefore assumed in the experiment to be fully accommodating any increases in the domestic price level.

The estimates then are that the inflation rate is about 0.8 or 0.9 percentage point higher in each of the first two years after a 10 percent depreciation (and equivalently, about 0.8 or 0.9 percentage point lower in each year after a 10 percent appreciation), and perhaps somewhat higher in later years as well. For purposes of illustration, let us assume that the inflation rate is 0.3 percentage point higher in the third year, and zero thereafter. Given the Hooper-Lowrey estimate of 1¾ points on the consumer price index (CPI), divided evenly in the first two years, with a third-year effect of 0.3 point added on, how important has the strong dollar been for inflation in the period since 1980, taking the path of output as given? Using the same data as in figure 1, the effective nominal exchange rate appreciated 12.7 percent in 1981, 11.7 percent in 1982, 5.8 percent in 1983, and 7.9 percent in 1984. Applying the Hooper-Lowrey consensus, with the assumed third-year effect we find the following estimates of inflation (change in personal consumption deflator, in percentage points) with and without the appreciation since 1980:

	1981	*1982*	*1983*	*1984*
Actual inflation	8.7	5.9	3.7	3.2
Exchange rate effect	1.1	2.1	1.9	1.6
Inflation with fixed exchange rate since 1980	9.8	8.0	5.6	4.8

15. Ibid., pp. 51–52.

Thus, a substantial effect of the exchange rate is indicated, though by no means has the appreciation been the decisive factor, according to these estimates. My own estimates, later on, will show a larger effect, basically because I find the effect on inflation more persistent than implied here.

Several more recent estimates also imply a significant role for the exchange rate in the recent disinflation. In their 1982 study, Gordon and King consider the costs of disinflation under two alternative assumptions. One is that the tight monetary policy underlying the disinflation causes the dollar to appreciate, and thereby causes import prices and food and fuel prices to fall relative to baseline. The other is that the exchange rate, import prices, and food and fuel prices are unchanged by the path of disinflation.[16] In the first case, the authors estimate a sacrifice ratio of 3.0, that is, a 3 percent loss in output for each 1 percentage point reduction in inflation. In the case where the foreign variables are exogenous, the sacrifice ratio rises to 8.4. Dornbusch and Fischer have recently offered some estimates of the role of the exchange rate appreciation since 1980.[17] Their study is novel in allowing for a direct effect of exchange rate movements on wage settlements, above and beyond any indirect effects via consumer prices or output. The argument is that a strong dollar raises domestic labor costs relative to foreign labor costs, and thereby increases the pressure on domestic firms in the tradables sector to limit costs. Since this effect is presumed to hold at a given level of total output or employment, Dornbusch and Fischer appear to be arguing that the combination of a weak tradables sector and a strong nontradables sector is less inflationary than the reverse situation. They estimate that a 10 percent depreciation of the dollar, at given aggregate output levels, causes a 2.1 percentage point increase in prices over a two-year period. These estimates are higher than those reported by Hooper and Lowrey, perhaps because of the wage effect, though they might have been higher still, since Dornbusch and Fischer do not allow for any effect of exchange rate changes on the rate of change of oil and gas prices.

Finally, there are estimates from large-scale econometric models, such as the OECD interlink model or the Federal Reserve Board's

16. Gordon and King, "The Output Cost of Disinflation."

17. Rudiger Dornbusch and Stanley Fischer, "The Open Economy: Implications for Monetary and Fiscal Policy," Working Paper 1422 (National Bureau of Economic Research, August 1984).

Multicountry Model (MCM). Recent simulations on the MCM yield much smaller estimates of the effects of the exchange rate appreciation.[18] Note that the numbers shown below are for fourth quarter over fourth quarter CPI inflation rates (in percentage points):

	1981	*1982*	*1983*
Exchange rate effect	0.6	1.1	1.2

EXCHANGE RATE EFFECTS ON INFLATION

I now turn to my own structural estimates of the role of the dollar appreciation. There are several possible channels through which exchange rate changes may affect domestic wage and price formation. Most simply, at unchanged foreign currency costs of production, an exchange rate change should affect the domestic currency price of foreign imports. I term this the "direct" effect. In turn, changes in foreign import prices will affect consumer prices directly if the imports are consumer goods, or indirectly if the imports are inputs into production of consumer goods. As many analysts have noted, however, a change in exchange rates for given levels of foreign wages and prices may be used by foreign producers to expand profit margins on sales to the United States (in which case import prices in dollars do not change), instead of to cut prices in dollar terms (which preserves an unchanged markup over foreign costs). In general, a change in the exchange rate appears to cause a less than proportional change in import prices in the short run, as foreign producers react to the exchange rate change both by lowering prices and by expanding their markup over local currency costs.

A second possible effect comes as domestic producers react to lower import prices by cutting their own prices and profit margins. Even at unchanged domestic costs, domestic producers may cut prices and be forced, by reduced profit margins, to withdraw output supply, in view of lower competitors' prices. If this effect is important, the size of the exchange rate effect on consumer prices will be given not by the direct weight of imports in the price index, but by the weight of all highly tradable goods, including imports, exports, and import-competing home goods, in the price index. I term this the "competitiveness" effect.

18. Peter Hooper, "The Macroeconomic Effects of Exchange Rate Changes: Some Quantitative Estimates" (Board of Governors of the Federal Reserve System, April 1984), table 5.

There are at least two areas where the competitiveness effect surely applies. The impact of changes in world oil prices on the CPI is far higher than is indicated by the share of oil imports in consumption expenditure, since domestic producers must adjust their prices to shifts in world prices. As the United States produces roughly half of its petroleum consumption, the impact of changes in the world price of oil on the CPI might be roughly twice as large as the import share. A second area where the effect applies is in food. The CPI weight of food is of course far higher than the import component alone, since the United States produces the great bulk of its food consumption. Since world market prices have an important effect on domestic food prices, a given exchange rate change might show up in consumer prices with a far larger impact than the direct import share of food would predict. I stress below, moreover, that even though oil and many foods in international trade are priced in dollars, exchange rate changes should still be expected to have a large effect on dollar prices of those commodities. Where the competitiveness effect is harder to observe is in the area of manufactured goods. Wing T. Woo has recently argued that for manufactured goods, competitiveness effects are small, if not negligible.[19] Others too have found small, though significant, competitiveness effects for U.S. manufacturing.[20]

The "direct" and "competitiveness" effects will have a large impact on inflation only if changes in the CPI subsequently get built into wage dynamics. Merchandise imports are only about 9 percent of GNP, and are probably about the same direct share in the CPI, including the pass-through of imported intermediate product prices into final output. Even increasing this weight through competitive effects in food, fuel, and other goods to give a 15 percent weight to foreign prices in the CPI (a little larger than the estimate below), a 40 percent appreciation of the dollar would not have overwhelming inflation consequences, especially when spread out over several years. Suppose that each 1 percent appreciation results in a 0.75 percent drop in import prices, as in our estimates below. Then a 40 percent appreciation, spread out over four years, causes import price inflation to be about 7.5 percentage points ($40/4 \times 0.75$) higher per year. With a CPI weight of 0.15, the inflation

19. Wing T. Woo, "Exchange Rates and the Prices of Nonfood, Nonfuel Products," *BPEA, 2:1984*, pp. 511–30.

20. See Dean A. DeRosa and Morris Goldstein, "Import Discipline in the U.S. Manufacturing Sector," *IMF Staff Papers*, vol. 28 (September 1981), pp. 600–34.

effect of the appreciation would be about 1.1 percentage points per year. Since the overall reduction in inflation was about 7 percentage points by 1984, the exchange rate role would not have been large.

However, if the changes in the CPI get built into wage inflation, we can dramatically increase the inflation effect imputed to the dollar appreciation. Suppose, for example, that wage inflation $\pi_t^w = w_t - w_{t-1}$, with w_t the logarithm of wages, is a function of lagged consumer price inflation and lagged output gap:

$$\pi_t^w = \pi_{t-1}^c + \phi Q_{t-1}, \tag{1}$$

where $\pi_t^c = p_t^c - p_{t-1}^c$, and p_t^c is the (log) CPI. Suppose also that p_t^c is a weighted average of wages and import prices, p_t^m:

$$p_t^c = \lambda w_t + (1 - \lambda) p_t^m. \tag{2}$$

(The term $1 - \lambda$ might reasonably be expected to be between 0.1 and 0.15.) Combining equation 1 and equation 2, we have:

$$\pi_t^c = \lambda \pi_{t-1}^c + \lambda \phi Q_{t-1} + (1 - \lambda) \pi_t^m, \tag{3}$$

where π_t^m is the rate of import price inflation.

Consider a baseline path for π_t^c, and ask how the path will change for a one-shot rise in import price inflation at $t = 0$, denoted $\Delta\pi_0^m$. We examine the path holding fixed the baseline for output Q_t. If $\Delta\pi_t^c$ is the change in inflation relative to the baseline path, we can easily see from equation 3 that:

$$\Delta\pi_t^c = (1 - \lambda)\lambda^t \Delta\pi_0^m. \tag{4}$$

In every subsequent period, inflation is higher, by an amount that decays geometrically. Note that the total price level effect of the shock $\Delta\pi_0^m$ is given by $\sum_{t=0}^{\infty} \Delta\pi_t^c$, which simply equals $\Delta\pi_0^m$ upon substitution of equation 4. In other words, a 10 percent fall in import prices eventually causes a 10 percent fall in domestic prices, even if the direct weight of p^m in p^c is small, assuming that macroeconomic policy offsets any effects on output. The feedback from p^m to p^c to w, and back to p^c, multiplies the direct effect of import prices severalfold.

In this way, a 40 percent appreciation can plausibly have had a very large effect on U.S. inflation even though the economy has a relatively small import share. Assuming that each 1 percent appreciation leads to a drop in import prices of 0.75 percent within the year, and that the weight of tradables in the CPI is 0.15, the simple model just outlined delivers the following estimates of the exchange rate effect on consumer prices since 1980 (in percentage points), using the annual rate of exchange rate appreciation mentioned earlier:[21]

	1981	*1982*	*1983*	*1984*
Exchange rate effect	1.4	2.5	2.8	3.3

In this case, more than 3 percentage points of the inflation reduction since 1980 can be attributed to the rise in the dollar. The main difference between this estimate and the Hooper-Lowrey based estimate that I derived earlier is the third- and fourth-year effects of the exchange rate change on inflation. (Note that the effect in the first two years here is slightly higher.) Earlier, I assumed a 0.3 percentage point effect in the third year following a 10 percent appreciation; here, the effect is 0.7. And the fourth-year effect is 0.6.

As a preliminary step toward a structural model, it is useful to examine the composition of imports and consumption in the U.S. economy. The breakdown of imports by their end use is shown in table 2. Merchandise imports in 1984 accounted for 8.9 percent of GNP. Almost one-fifth of U.S. imports by value were oil imports, and another 18 percent were other primary or intermediate inputs to industry. Food imports were 6.5 percent of the total. The remaining imports were finished goods of various sorts. Taken together, imported inputs (food, fuel, and other industrial supplies) accounted for 44 percent of total imports. Eighteen percent of imports was nonautomobile capital equipment for industry, leaving only 18 percent of imports as nonauto consumer items. Automobile imports accounted for 17 percent of the total. Of course, auto imports should in principle be divided between consumer purchases and business purchases.

These data are illuminating for several reasons. First, the direct effect of lower prices on imported consumer items, other than food, fuel, and autos, is bound to be small. Such imports were a mere 2.6 percent of total personal consumption expenditure in 1984. And any potential sizable reductions in auto prices during 1981–84 were probably prevented

21. The percentage exchange rate changes are 12.7, 11.7, 5.8, and 7.9 in the years 1981–84. The assumed import price changes are given by 0.75 times the exchange rate changes. Then equation 4 is applied, noting for example, that the effect on the 1983 inflation rate will be the sum of the import price effects of 1981, 1982, and 1983.

Table 2. Composition of U.S. Merchandise Imports, 1984

Category	*Percent of total imports*	*Percent of GNP*
Primary and intermediate		
Food, feeds, beverages	6.5	0.6
Fuels	19.1	1.7
Nonfood, nonfuel industrial supplies	18.4	1.6
Finished		
Capital goods (less auto)	18.4	1.6
Consumption goods (less auto)	18.4	1.6
Automobiles, parts	16.9	1.5
Not elsewhere classified	2.4	0.2
Total	100.0	8.9

Source: Based on imports by end-use category, U.S. Bureau of Economic Analysis, *Survey of Current Business*, vol. 65 (March 1985), pp. 6, 44.

by the voluntary export restraints on Japanese autos, as I document below.

Thus, to the extent that there are sizable "direct" effects of lower import prices on consumption prices, these will show up to a significant extent as reduced costs of industrial inputs and as lower food and fuel prices. Contrary to simple models of international trade that emphasize only trade in final consumption goods, U.S. trade is heavily skewed to primary and intermediate commodities, or to capital goods. Indeed, 62 percent of imports were in these categories in 1984, and no less than 67 percent on average during 1980–84. (Changes in capital goods prices should not be expected to have any significant effects on short-run pricing. There will be a long-run effect, of course, as changes in capital goods prices alter investment expenditures and thereby change unit variable costs in the future.) The low share of significant nonfood, nonfuel consumer imports probably accounts for much of Woo's finding of small effects on consumer prices of nonfood, nonoil import prices.[22]

There is little doubt that the exchange rate appreciation has affected the prices of all categories of imports, except where trade barriers have substantially insulated the domestic market from world price effects. The price changes for a subset of the end-use categories are shown in

22. Woo, "Exchange Rates."

Table 3. Price Changes in the United States during Appreciation and Depreciation of the U.S. Dollar, Selected Periods, 1976:4–1984:3

Annual rates of change, in percent

Item	*Period of depreciation 1976:4–1980:4*	*Period of appreciation 1980:4–1984:3*
Effective multilateral exchange rate	−2.7	10.6
Overall import price deflator	11.6	−3.0
Consumption deflator	8.4	4.9
Food imports	12.1	−3.0
Fuel imports	27.4	−3.7
Imports of nonfood, nonfuel industrial supplies	13.0	−2.8
Consumer goods		
Imports[a]	7.8	−0.2
CPI[b]	9.6	3.9
Autos		
Imports	n.a.	3.8
CPI	7.2	3.3
Apparel		
Imports	6.1[c]	3.4
CPI	3.8[c]	2.0
Furniture		
Imports	n.a.	−1.8
CPI	6.3	3.7
Appliances		
Imports	4.8	−4.6
CPI	4.8	3.4

Sources: Effective multilateral exchange rate: MERM index from IMF, *International Financial Statistics*, various issues; overall import and consumption deflator: implicit price deflator from national income and product accounts; food, fuel, and nonfood, nonfuel industrial supplies: implicit price import deflator from national income and product accounts; imports of overall consumer goods excluding autos: implicit price deflator from national income and product accounts; overall consumer goods, CPI, U.S. Bureau of Labor Statistics; all data for detailed consumer goods category are from BLS, defined as follows: imports of autos: import price index, SITC 781; autos, CPI; urban, category 45; imports of apparel: import price index, SITC 84; apparel, CPI: urban, category 83200 (both exclude footwear); imports of furniture: import price index, SITC 82; furniture, CPI: urban, category 29; imports of appliances: import price index SITC 775; appliances, CPI: wage earners, category 30.

n.a. Not available.

a. Not including autos.

b. Commodities only.

c. 1977:3–1980:4.

table 3, for the period of dollar appreciation (1980:4–1984:3) and a preceding period of dollar depreciation (1976:4–1980:4). During the period of depreciation the prices of import items rose much more rapidly than did domestic prices, as measured by the consumption deflator, while the opposite is true after 1980:4. Two categories of consumer goods were subject to extensive trade restrictions during the early 1980s: textiles, which were governed by the multifiber agreement, and autos, which were governed by the voluntary export restraints on Japanese autos. It is noteworthy that those two categories of imports show little difference in pricing compared with domestic goods, while imports of unprotected consumer items, such as furniture and appliances, had price increases far below the overall price increases for those categories in the CPI.

Nearly half of consumption expenditure is on services rather than commodities. Since the services have a high input of nontraded goods (particularly for housing services, which are about 30 percent of total consumption expenditure, and about 60 percent of total services expenditure), we should expect a significant exchange rate effect only within about half of the consumption basket.[23] It is notable, indeed, that inflation in services significantly outpaced inflation in commodities during 1980:4–1984:4, by 6.9 percent per year compared with 3.9 percent per year. Fuel prices, among the commodities, increased particularly slowly during 1980:4–1984:4. Consumer food prices increased less rapidly than average consumer prices, but surprisingly rapidly (3.6 percent on average) in the period, in view of the sharp drop in U.S. food import prices and, as we shall see, world prices of primary food products. Part of the discrepancy results from the considerable processing of food that takes place between the farm and consumer level. As an example, part of the CPI food index includes "food away from home," which includes a large service component. As would be expected, "food away from home" increased in price much more rapidly (5.2 percent) than "food at home" (2.9 percent).

Among commodities, about half of expenditures are accounted for by food, beverages, and energy alone. Indeed, food and energy expenditures account for about 30 percent of the total consumption basket. (About one-half of energy consumption is categorized as energy commodities; the remainder, as energy services.) Thus, food and fuel effects will surely constitute an important share of exchange rate effects on the cost of living. I have already noted that direct imports of nonfood, nonfuel consumer goods are a rather small proportion of the consumption basket. From the consumption data alone it is impossible to determine much about the direct importance of nonfood, nonfuel primary commodities,

23. Based on data on expenditure weights in the CPI for urban consumers.

which would play a role as inputs into the production of other consumer items.

The framework for measuring "direct" and "competitiveness" effects is as follows. I assume an aggregate production function for domestically produced consumer goods, of the form $Q = Q(L^i, R^i, E^i, F^i, K^i)$, where L^i, R^i, E^i, F^i, K^i are the primary factor inputs: labor, raw materials (nonfood, nonfuel), energy, food, and capital, respectively. The first four inputs are treated as variable in the short run, while K^i is treated as predetermined. Markup pricing theory holds that the output price P should be a markup over standard unit variable costs, with productivity measured at a normalized or standard capacity level of output. In logs (using lowercase variables), and ignoring constants,

$$p = \alpha(w - \tau) + \beta p^r + \rho p^e + \delta p^f \qquad \alpha + \beta + \rho + \delta = 1, \tag{5}$$

with τ = (log) standard output per manhour. With a variable markup, as suggested by competitive pricing, equation 5 is rewritten with a term ϵq added, where $q = \log Q$.

To obtain consumer prices, p^c, we assume that p^c is a weighted average of p and import prices of nonfood, nonfuel consumer goods, p^m:

$$p^c = \eta p + (1 - \eta)p^m. \tag{6}$$

The role of p^m comes through the two possible channels already discussed. First, direct purchases of finished import goods by consumers should lead to a weight of p^m equal to the weight of such goods in the consumption basket, or about 2.5 percent. Second, domestic producers may reduce profit margins relative to the normal markup implicit in equation 5, in order to compete with foreign suppliers. In the end, the consumer price is written as:

$$p^c = \eta\alpha(w - \tau) + \eta\beta p^r + \eta\rho p^e + \eta\delta p^f + (1 - \eta)p^m. \tag{7}$$

Extensive econometric experience with estimation of price equations has shown that the link of p^c to the input prices may involve lags in adjustment. To allow for such lags, equation 7 is estimated allowing for polynomial distributed lags for the right-hand variables. In the notation that follows, $PDL(x,a,b)$ signifies a polynomial distributed lag on variable x, of order a, and length b. No end-point constraints are imposed in any of the estimates.

Equation 7 is estimated for the period 1970:1–1984:4. Importantly, p^e and p^f are measured by world indexes for primary inputs of energy and food rather than as indices for consumption expenditure on energy and food.[24] As noted, the consumption indices for energy and food already include a great deal of processing of the raw materials. For this reason, we should expect the weight on energy and food in the p^c equation to be far below the apparent weight of food (0.19) and energy (0.11) in the overall consumption basket.

Two estimates of equation 7 are shown below. The first equation is an Ordinary Least Square (OLS) estimate, allowing for first-order serial correlation in the residuals, without imposing the condition that the coefficients sum to 1.0. In the second equation the long-run condition is imposed, with the estimates also corrected for serial correlation. The sum of the weights for R^i, E^i, F^i, and M^i is shown below each equation. Observe that I proxy for the log of labor productivity, τ, by a time trend and (time)^2. The unconstrained estimate is as follows, with t-statistics in parentheses.

$$\begin{aligned} p_t^c = \underset{(4.0)}{0.78} &+ \underset{(7.3)}{1.08}\, PDL\,(w_t,3,8) + \underset{(2.4)}{0.04}\, PDL\,(p_t^r,3,6) \\ &+ \underset{(1.4)}{0.01}\, PDL\,(p_t^e,2,4) + \underset{(2.3)}{0.03}\, PDL\,(p_t^f,3,6) \\ &+ \underset{(2.0)}{0.06}\, PDL\,(p_t^m,3,6) - \underset{(6.7)}{0.2}\,\text{time} + \underset{(10.8)}{0.00008}\,(\text{time})^2 \end{aligned}$$

$\bar{R}^2 = 1.000$; Durbin-Watson $= 2.0$; rho $= 0.5$
Total tradables weight $= 0.14$.

24. The following variables are used in the regression:

p^e price of Saudi crude petroleum exports in U.S. dollars

p^f weighted average of *Economist* commodity indexes for primary food (weight 0.95) and beverages (weight 0.05)

p^r weighted average of *Economist* commodity indexes for primary nonfood agriculture (weight 0.45) and for primary metals (weight 0.55)

p^m implicit price deflator for U.S. consumer good imports, national income and product accounts

w hourly earnings index for nonsupervisory workers, nonfarm economy

p^c (dependent variable) personal consumption deflator, national income and product accounts

t a time trend, equal to 1 in 1960:1, and increasing by 1 each quarter.

The constrained version is as follows:[25]

$$
\begin{aligned}
p_t^c = {} & 0.49 + 0.88\,PDL\,(w_t,3,8) \\
& \quad (8.9) \\
& + 0.05\,PDL\,(p_t^r,3,6) + 0.02\,PDL\,(p_t^e,2,4) \\
& \quad\ (2.9) \qquad\qquad\qquad\quad (2.9) \\
& 0.02\,PDL\,(p_t^f,3,6) + 0.03\,PDL\,(p_t^m,3,6) \\
& (1.6) \qquad\qquad\qquad\quad (0.8) \\
& - 0.01\ \text{time} + 0.00007\ (\text{time})^2 \\
& (-11.4) \qquad\quad (9.3)
\end{aligned}
$$

$\overline{R}^2 = 0.995$; Durbin-Watson $= 2.04$; rho $= 0.83$
Total tradables weight $= 0.11$.

Note that the primary inputs plus foreign consumer prices represent a substantial share of the consumption price, 0.14 percent in the first equation, and 0.11 percent in the second. (The sum of the coefficients differs from 0.11 because of rounding error.)

The next step is to determine the effects of exchange rate movements on the primary input prices and imported final goods. When e (the logarithm of the effective exchange rate, measured as units of foreign currency per dollar) changes, how much will the input prices move? This is a difficult question, particularly in view of the special features of the world markets for food and energy. A good starting point, however, is to consider the effect of exchange rate movements on the dollar price of a homogeneous commodity that trades freely, without transport costs or trade impediments in world markets. As an idealization, consider the raw material R^i to be such a good.

The appendix derives an equation for the (log) dollar price p^r under the assumptions that: R^i is traded freely throughout the world, subject to the law of one price; the supply of R^i in each region is a positive function of the local currency price of R^i relative to the local currency output price; demand for R^i is a negative function of the same relative

25. The unit constraint is imposed in a manner suggested by Robert Gordon. Using the lag distribution from the unconstrained estimation, a weighted average wage variable is created, equal to $\tilde{w}_t = (\Sigma\lambda_i w_{t-i})/(\Sigma\lambda_i)$, where λ_i are the *PDL* weights on w. Then, the regression is re-estimated by subtracting $\tilde{w}_t$ from the left-hand and remaining right-hand side variables.

price; and developing countries outside of the OECD peg to a basket of OECD currencies. The resulting equation has the form:

$$dp^r = d\tilde{p} + \phi dy^w, \tag{8}$$

where $d\tilde{p}$ is the percentage change in an index of dollar output prices in the OECD, constructed by converting each country's local currency output price to dollars at the prevailing exchange rate, and then weighting these prices in an overall OECD basket; dy^w is the percentage change in weighted average of real incomes throughout the world; and dp^r is the percentage change in dollar price of R^i. The United States has a weight of γ in the OECD price index, and the rest of the OECD (ROECD) has a weight of $(1 - \gamma)$. In change form,

$$d\tilde{p} = \gamma dp + (1 - \gamma)(dp^o - de). \tag{9}$$

Note that from equations 8 and 9, at given levels of real activity and given domestic output prices in the United States (p) and the ROECD (p^o), an appreciation of the U.S. exchange rate causes dp^r to decline by $(1 - \gamma)de$.

The expression for γ is quite intricate, though the following rule of thumb applies. The larger the United States is in the OECD in the production and consumption of R^i, the smaller is $(1 - \gamma)$, that is, the smaller is the exchange effect of p^r. If the United States is perfectly small (see the appendix for technical conditions), $dp^r/de = -1$. If the United States constitutes the entire world market for the commodity, $dp^r/de = 0$.

In several studies the IMF has estimated commodity price equations of the form in equation 8 for commodities including food, beverages, agricultural raw materials, and metals.[26] The estimates for $(1 - \gamma)$ center on 0.75, suggesting that a 1 percent appreciation of the dollar leads to a fall in commodity prices of 0.75 percent. Specifically, "the results indicate that an appreciation of the U.S. dollar by 10 percent in a given quarter vis-à-vis other major currencies reduces the unit values by somewhat less than 7.5 percent during the same quarter, and by close to 7.5 percent within a year."[27]

26. These are reported in technical appendixes of "Nonoil Primary Commodity Price Developments and Prospects" of the International Monetary Fund, *World Economic Outlook* (May 1983, April 1984, and April 1985).

27. *World Economic Outlook* (April 1985), p. 138.

It is interesting to note that using a weight for the United States of 0.25 in equation 9, as suggested by the IMF studies, can account for much, though by no means all, of the decline since 1980:4 in the prices of primary inputs relative to U.S. consumer prices on the basis of the U.S. exchange rate movements alone. First, I construct an ROECD index of consumer prices, p^o, using MERM weights for 17 non-United States economies. Then I compute the change in real input prices in terms of U.S. goods, ROECD goods, and the OECD basket including U.S. goods and ROECD goods, with weights 0.25 and 0.75, respectively. The decline in terms of U.S. goods is of course always greater than the decline in terms of the OECD basket, the gap being due to the U.S. real appreciation. About one-half of the decline in real commodity prices is due to the dollar appreciation. The other half is due to the fall in real commodity prices in terms of the overall OECD basket, shown in table 4. Presumably the drop in real input prices vis-à-vis the overall OECD basket is due to: continuing world recession, particularly in Europe and Latin America; high world real interest rates, which have caused a reduction of primary commodity inventories; and favorable supply conditions for many agricultural commodities.[28]

A recent study of grain prices by the U.S. Department of Agriculture reached conclusions similar to those of the IMF studies, though the USDA study indicates several amendments to the model underlying equation 8 that must be made in the case of grain trade.[29] In the basic model, the USDA study found that a 10 percent appreciation of the U.S. dollar should reduce grain prices as follows: 7.3 percent for wheat; 6.7 percent for corn; and 6.3 percent for soybeans.[30] These elasticities are based on the U.S. consumption and production shares of the three grains and estimates of demand and supply elasticities, as in the appendix. The authors indicate, however, that protectionist restrictions in food trade should be expected to lower the transmission of the exchange rate since, effectively, the United States thereby becomes a larger proportion of the relevant trading area. As already noted, the larger the U.S. role for a commodity in demand and supply, the smaller is the exchange rate

28. See *World Economic Outlook,* April 1985, for a detailed discussion of nonoil and oil price developments and prospects.

29. Jim Longmire and Art Morey, "Strong Dollar Dampens Demand for U.S. Farm Exports," Foreign Agricultural Economic Report 193 (U.S. Department of Agriculture, Economic Research Service, December 1983).

30. Ibid., table 4.

Table 4. Change in World Commodity Prices, 1980:4–1984:3
Percent

Commodity[a]	Nominal price change[b]	Real price change[c]: United States	Real price change[c]: Rest of OECD	Real price change[c]: Overall OECD
Food	−34.6	−45.3	−25.7	−31.2
Fuel	−8.9	−23.8	3.6	−4.0
Materials	−20.0	−33.1	−9.0	−15.7

Sources: IMF, *World Economic Outlook* (April 1985), pp. 130–40, and previous issues, and author's calculations, based on data from the national income and product accounts for U.S. consumption deflator and on data from *International Financial Statistics* for exchange rates and consumer prices in the rest of the OECD (ROECD). Commodity prices are as defined in footnote 24.

a. World indexes for primary inputs.

b. Measured in U.S. dollars.

c. Deflated by consumer prices. In the United States, real price is defined as P^i/P^c for commodity i, where P^c is overall personal consumption deflator. In ROECD, real price is defined as P^iE/P^o, where E is the nominal exchange rate and P^o is an ROECD index for consumer prices using MERM weights for seventeen countries outside the United States. The real price in overall OECD is $P^i/[(P^c)^{0.25}(P^o/E)^{0.75}]$.

effect. The USDA accounted for these trade impediments in a rather general way, yielding the following lower price changes: −5.7 percent for wheat, −5.9 percent for corn; and −5.9 percent for soybeans.[31]

Last, there is the complicated issue of U.S. agricultural price supports and their interaction with the exchange rate effect. For some grains in some periods during 1981–84, U.S. price supports put an effective floor on prices. Exchange rate appreciation in that case causes a smaller decline in dollar prices and induces a rise in government stockpiling. The USDA study models these programs in a very general way but does not, unfortunately, analyze the recent experience with the price support programs. In the model, the support programs greatly reduce the short-run price responsiveness for those grains at the price floor, but not the longer run responsiveness. In the USDA model of the price support programs, the long-run effect of a 10 percent appreciation on prices still exceeds −5.0 percent, even with the government programs continuously applied.[32]

A model such as equation 8 can also be used to account for OPEC oil pricing, even though OPEC prices are set by cartel behavior rather than by perfect competition. A full model of OPEC behavior would involve some form of dynamic optimization of the large producers, taking account of the supply behavior of the competitive fringe. OPEC oil

31. Ibid., table 6.
32. Ibid., table 7.

prices should then in general depend on a basket of OECD prices, as in equation 9, where the weights in that basket depend on oil production and consumption shares of the various OECD economies and perhaps on OPEC consumption shares of OECD commodity exports. The U.S. share of oil consumption among industrial economies is about 50 percent and the share of production is about 75 percent.[33] On the other hand, the U.S. share of OECD exports to OPEC is 18 percent. Assuming that OPEC attempts to stabilize the level of oil demand when e changes, the exchange rate effect would be on the order of -0.5. Assuming instead that OPEC attempts to fix the real price of oil in terms of its consumption basket of OECD goods, the exchange rate effect should be as high as -0.82 $(1 - 0.18)$. The latter approximation seems closer to the mark. Real oil prices in 1984:4 in terms of OECD goods were only 4 percent below their 1980:4 level, when the United States has a weight of 0.18 in the OECD basket. In the United States, real oil prices, measured relative to the wholesale price index (WPI), fell by 25 percent during the period, while in the rest of the OECD, oil prices rose by 3 percent relative to the WPI.

In the model below, I will use a single estimate, $\delta = 0.25$, for all three primary commodities. In solving the model, the equations for p^r, p^f, p^e are then written as:

$$(10) \qquad p_t^i = \overline{p}_t^i + [0.25p_t^c + (1 - 0.25)(p_t^o - e_t)] \qquad i = r,f,e,$$

where p^c is measured as the U.S. consumption deflator, and p_t^o is an ROECD weighted-average consumer price index (MERM weights). The term $\overline{p}_t^i$ is the historical relative price of the input in terms of the OECD basket. I treat shifts in $\overline{p}_t^i$ as exogenous to exchange rate movements. Note, as already mentioned, that the choice of 0.25 implicitly attributes most, though not all, of the decline in real input prices in the United States to exchange rate movements.

The next step is an equation for p^m, the (log) price of consumer goods imported into the United States. In some initial experiments, I attempted to model p^m as a weighted average of U.S. consumer prices and ROECD consumer prices. The U.S. consumer prices never entered significantly into an equation explaining p^m. Consistently, ROECD consumer prices entered significantly into such an equation. Thus, in the simulations below, I treat p^m as a function of a distributed lag of the dollar-equivalent

33. The data refer to the International Energy Agency countries. See the Energy Information Administration, *Monthly Energy Review* (January 1984), pp. 101–3.

consumer price level of the ROECD. The specific equation, estimated for 1973:1–1984:4 is:

$$p_t^m = -3.3 + 0.89\,PDL\,(p_t^o - e_t,3,8)$$
$$(6.4)\quad(4.9)$$
$$\bar{R}^2 = 0.99;\ \text{Durbin-Watson} = 1.92,\ \text{rho} = 0.9.$$

Remember that p^o is the (log) MERM-weight CPI level in the ROECD. According to this equation, a 10 percent appreciation of the dollar translates into an 8.9 percent decline in prices of (nonauto) consumer goods imported into the United States.

To close the model, I estimate a wage equation of standard form, relating wage inflation to a distributed lag of price inflation, and to current and lagged values of the Perry demographically weighted unemployment rate, U_t. The estimated equation is:

$$\pi_t^w = 0.01 - 0.002U_t - 0.0001U_{t-1} + 0.98\,PDL\,(\pi_{t-1}^c,4,12)$$
$$(11.2)\quad(2.2)\qquad(0.2)\qquad\qquad(9.8)$$
$$\bar{R}^2 = 0.75;\ \text{Durbin-Watson} = 2.00;\ \text{rho} = 0.19.$$

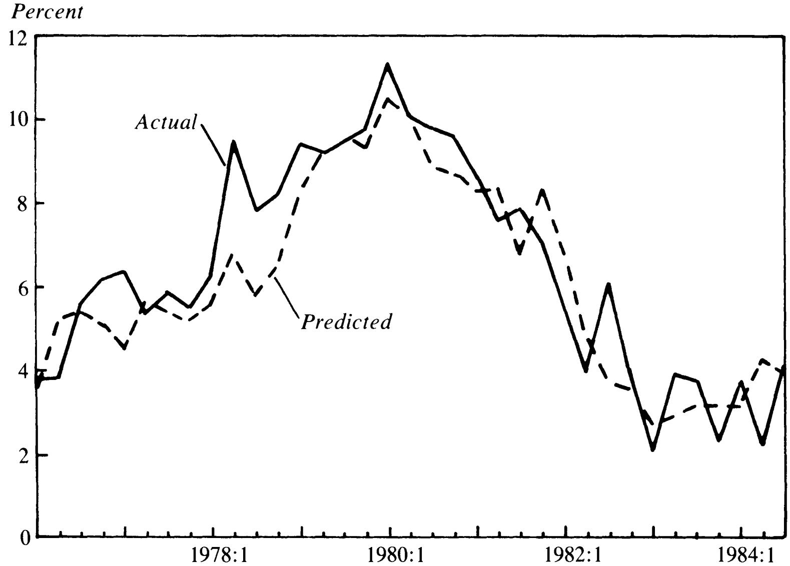
The entire model can be simulated for the exchange rate changes since 1980, assuming that the paths of output and foreign currency prices are the same for alternative paths of the exchange rate.[34] The model is solved in two versions, using the unconstrained and constrained equations for the consumer price level. As I have already noted, the unconstrained version of the model will show a significantly larger exchange rate effect than the constrained version, since the weight of tradable goods is higher in the former case. As a first exercise, we determine the pass-through of a 10 percent currency appreciation into lower price inflation expressed in percentage points. (The results for the structural model here and below are reported for fourth quarter over fourth quarter.)

	Year			
	1	*2*	*3*	*4*
Unconstrained	0.7	1.0	0.9	1.0
Constrained	0.5	0.8	0.6	0.5

The model as a whole tracks quite well in a dynamic simulation starting in 1976:1. In the dynamic simulation, the paths of output, the nominal

34. The model consists of the p^c equation, the wage change equation, and the input price equations.

Figure 2. Dynamic Simulation of U.S. Inflation, 1976:1–1984:3[a]



Sources: National income and product accounts and author's simulation as described in text.
a. Quarterly change in personal consumption deflator, at annual rate.

exchange rate, the real prices of primary inputs, and foreign currency consumer prices are taken as exogenous, so that the model effectively solves for the wage-price dynamics, with nominal wages, consumer prices, and primary input prices changing endogenously over time. The simulation in the unconstrained case is shown in figure 2. Basically, the model misses about 1 percentage point of the rise in inflation between 1979 and 1981, but is generally on track during 1981–84. For fourth quarter over fourth quarter, actual and predicted values of price change, in percentage points, are:

	1979	*1980*	*1981*	*1982*	*1983*	*1984 (3 quarters)*
Actual	9.5	10.2	7.8	4.9	3.1	3.4
Predicted	9.1	9.6	7.9	4.7	3.0	3.8

(The values for 1984 are for the first three quarters at an annual rate.)

When the partial effects of the actual exchange rate changes are simulated by comparing a path of no change in the nominal exchange rate after 1980:4 with the actual exchange rate path, we find the following reductions in price inflation coming from the exchange rate effect (in percentage points):

	1981	*1982*	*1983*	*1984 (3 quarters)*
Unconstrained	0.8	1.9	2.4	2.8
Constrained	0.6	1.5	1.7	1.9

To further examine the sensitivity of these results, I substitute a "Perry wage norm" equation for the wage equation in the model. In a wage norm model, the change in nominal wages is determined mostly by "norms," or rules of thumb, rather than by inherited inflation or expected price inflation. In that spirit, I replace the earlier wage equation with $(w_t - w_{t-4}) = 0.3\ (p^c_{t-1} - p^c_{t-5})$, which allows for a small (0.3) pass-through of lagged consumer price inflation into wages. The resulting estimates for the effect on price inflation from the dollar appreciation in the unconstrained case are:

	1981	*1982*	*1983*	*1984*
Exchange rate effect with Perry wage norm	0.7	1.5	1.4	1.1

Clearly, my own high estimates of the inflation effect as of 1984 depend on a significant effect of lagged prices on nominal wage change. In the Perry model, the exchange rate effects are largely dissipated by 1984. Of course, such a model must resort to some explanation for the downward shift in the wage norm after 1981.

Consider, finally, a decomposition of the causes of the disinflation into exchange rates, unemployment, and favorable exogenous "supply-price" shocks. First, the model is run for a constant nominal exchange rate after 1980:4, and the difference of that path from the full dynamic simulation path with actual exchange rate changes is the exchange rate component. Then the model is run with the unemployment rate held at the nonaccelerating inflation rate of unemployment (NAIRU) at the historical exchange rates. (The NAIRU level is 6.1 percent for the Perry unemployment rate in the estimated wage equations reported earlier.) The difference of that path from the original simulation is the output gap component. Third, the model is run assuming no fall in the real prices of primary inputs in terms of the OECD basket (that is, $\bar{p}^i$ is fixed at its 1980:4 level). The effect of this assumption relative to the baseline is termed the real-input price effect. The breakdown of the price disinflation is as follows (in percentage points):

	1981	*1982*	*1983*	*1984 (3 quarters)*
Total slowdown	1.8	4.7	6.5	6.2
Unconstrained version, sources of slowdown				
Exchange rate	0.8	1.9	2.4	2.8
Unemployment	−0.2	1.6	3.9	3.4
Real input price	0.9	1.9	1.5	1.4
Lagged inflation and residuals	0.3	−0.7	−1.3	−1.4
Constrained version, sources of slowdown				
Exchange rate	0.6	1.5	1.7	1.9
Unemployment	−0.2	1.4	3.2	2.3
Real input price	0.5	1.4	1.2	0.8
Lagged inflation and residuals	0.9	0.4	0.4	1.3

Thus, estimates of the exchange rate effect range between 1.9 and 2.8 percentage points for 1984. In both versions of the model, the exchange rate effect is slightly less than the unemployment effect.

Prospects for the Dollar and U.S. Inflation

If the real appreciation of the dollar could be attributed to a permanent shift in such underlying conditions as a restoration of confidence or a safe haven effect, then we could chalk up a permanent benefit in the disinflation process—perhaps almost 3 percentage points of inflation last year alone. The evidence is strongly to the contrary, however. In this section I show that the market's own forecasts continue to predict large dollar depreciations in the coming decade, depreciations that will have a significant effect on U.S. inflation.

In most interpretations of recent movements in the dollar, high U.S. interest rates are a major proximate cause. A standard story, based on Dornbusch's overshooting model, goes as follows. Assets denominated in different currencies are close substitutes in asset portfolios. Therefore, they must earn a nearly equal expected return when the returns are expressed in a common currency. Let i_n be the nominal yield (on an annual basis) of a riskless n-year asset denominated in dollars, and let i_n^* be the nominal yield on a foreign riskless asset of the same maturity. (Hereafter, an asterisk denotes a foreign variable.) With E_t the spot exchange rate, expressed as units of foreign currency per dollar, and ${}_tE_{t+n}$ the exchange rate expected to prevail in n years, the expected dollar denominated return of the foreign asset (on an annual basis) is $(E_t/{}_tE_{t+n})^{(1/n)}(1+i_n^*) - 1$.[35] With perfect substitutability of home and foreign assets, as would be implied, for example, by risk-neutral wealth holders and an absence of capital controls, home and foreign yields must be equalized. Thus, we would have i_n equal to this quantity, or:

$$(11) \qquad (1 + i_n) = (E_t/{}_tE_{t+n})^{1/n}(1 + i_n^*).$$

Below, I describe one simple model that is not too bad empirically. In it, the real exchange rate in the long run is presumed to be fixed at a given constant level though it might deviate from that level in the short run because of the slowness of prices to adjust to long-run equilibrium levels. Let R be the fixed long-run value of (PE/P^*), and R_t be its current value. Suppose also that, by whatever equilibrating mechanisms, the market expects R_t to return to R within a period of n years.

Now, let us define the term π_n as the average annual inflation rate expected over the n-year interval so that ${}_tP_{t+n} = (1 + \pi_n)^nP_t$ and ${}_tP^*_{t+n} = (1 + \pi_n^*)^nP_t^*$. Also, define the n-year real interest rates at home and abroad as $(1 + r_n) = (1 + i_n)\ (P_t/{}_tP_{t+n})^{1/n}$ and $(1 + r_n^*) = (1 + i_n^*)\ (P_t^*/{}_tP^*_{t+n})^{1/n}$. By these definitions, equation 11 may be restated as:

$$(12) \qquad \text{(a) } E_tP_t/P_t^* = R\,[(1 + r_n)/(1 + r_n^*)]^n,$$
$$\text{(b) } E_t = (P_t^*/P_t)R[(1 + r_n)/(1 + r_n^*)]^n,$$

or with a log approximation:

$$(13) \qquad \text{(a) } (e_t + p_t - p_t^*) = \log R + n(r_n - r_n^*)$$
$$\text{(b) } e_t = (p_t^* - p_t) + \log R + n(r_n - r_n^*).$$

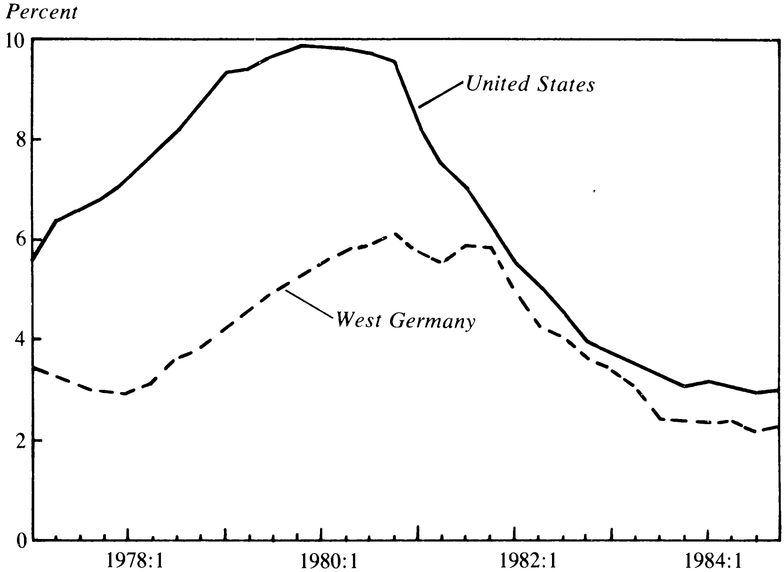
35. I commit the minor sin of setting $(1/E)^e = 1/E^e$, where "e" signifies expectations. This is for expositional ease, and is exactly correct only if the expectations are held with subjective certainty.

According to equation 12a, the current real exchange rate equals the long-term real exchange rate times the ratio of real interest rates to the nth power. In logs, the log real exchange rate equals a constant plus n times the n period real interest rate differential, as shown in equation 13a. According to equation 12b, the current nominal exchange rate equals the current price ratio, times the long-term real exchange rate, times the ratio of gross interest rates to the nth power. The log version of the equation is shown as equation 13b.

As we can see, small changes in the long-term real interest rate differential will have a large effect on the current exchange rate. Suppose that home and foreign prices can be taken as given in the current period, and that the real exchange rate is always expected to adjust to R within a ten-year period. Then, a 1 percentage point rise in the ten-year U.S. real interest rate relative to the foreign ten-year real interest rate will have a 10 percentage point effect on the spot exchange rate today.

The twin assumptions that interest rate differentials reflect expected exchange rate changes, and that the long-term real exchange rate is constant, go a long way towards tracking exchange rate movements in the past decade. To show this, let us apply the framework to the dollar–deutsche mark rate. This is a particularly useful rate to examine, since unlike France, Japan, and the United Kingdom, West Germany had no capital controls in the past decade, so the assumption of high substitutability of dollar and deutsche mark assets is plausible. For interest rates we take indexes of long-term government bonds in each country. The expected inflation variable is calculated as follows. For each year, I take the "long-term" inflation expectation to equal the actual two-year inflation rate centered on the quarter of the estimate (that is, the average of inflation in the personal consumption deflator one year ahead and one year behind). However, in the case of the United States, I allow for a shift in inflation expectations that depends on the 1980 election. For the four quarters of 1980, I assume that inflation forecasts were made conditional on the outcome of the election, with inflation expectations of 10 percent in the quarters after 1980 if President Carter were to win reelection, and inflation of its actual rate after 1980 if Reagan were to win the election. The probability assigned to Carter's reelection is set at 0.5. In this way, I build in a downward shift in inflation expectations upon President Reagan's election. This shift seems necessary to help explain the sharp appreciation of the dollar following the

Figure 3. Inflation Expectations, United States and West Germany, 1977:1–1984:4

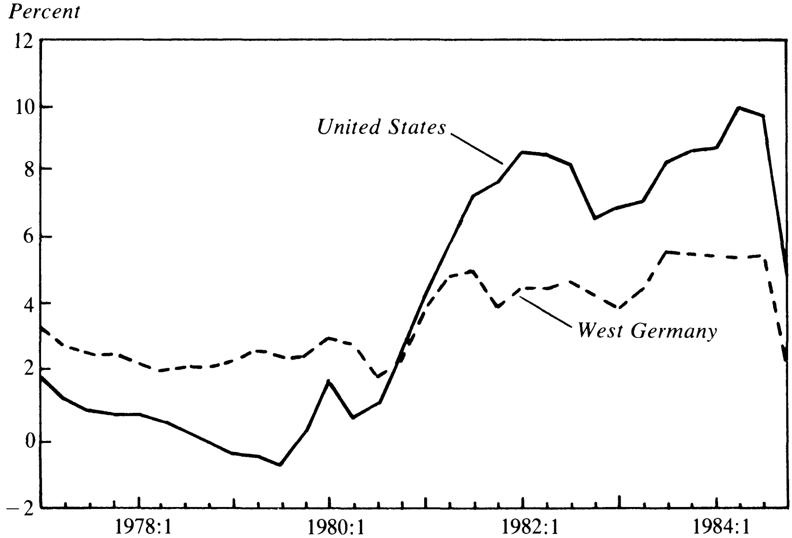


Source: See text description. The inflation expectation is the average of the actual change in the personal consumption deflator one year ahead and one year behind, centered in the quarter of the estimate.

election in November 1980. The resulting paths for inflation expectations are shown in figure 3. The long-term real interest rates are shown in figure 4.

An exchange rate equation as in equation 13 fits the data rather well for 1977:1–1984:4 for the deutsche mark–dollar rate. Estimating equation 13 using the real interest rate differential that we have calculated, we get the equations shown in table 5. In the first equation, equation 13a is estimated using OLS. The real interest rate differential is highly significant, with the coefficient value indicating an expectation of the return of R_t to R in 6.5 years. Note that because of the flatness of the yield curve for maturities greater than 5 years, $(r - r^*)$ can be interpreted as representing the interest rate differential over any long interval. The equation picks 6.5 as the maturity length that is most consistent with the maintained hypothesis that R_t returns to its long-run value R within the interval. Note the low Durbin-Watson statistic in the estimate, suggesting some misspecification of the equation. Data inspection reveals that the dollar was weaker than expected in the recession period in 1981:3–1982:4, and somewhat stronger than predicted in 1983. Similarly, the

Figure 4. Real Interest Rates, United States and West Germany, 1977:1–1984:4



Source: International Monetary Fund, *International Financial Statistics*, series 61, for long-term government bonds yields; inflation expectations series is the one plotted in figure 3.

mark was weak during periods of slow West German growth. This suggests that the real exchange rate strengthens, for a given interest rate differential, when the economy is experiencing above-average growth, which is confirmed in the second equation in table 5, which includes the difference in GNP growth rates in the United States and West Germany, $\hat{Q} - \hat{Q}^*$. This variable may be picking up shifts in expectations about the long-run real exchange rate (contrary to our simple model) or reflecting a rise in capital inflow that occurs when profits are high at the upswing of the cycle. In the third regression, an instrumental variable is used to help correct for errors in measurement of the real exchange rate differential. On the view that the differential fiscal stimulus in the United States and West Germany is the cause of the real interest rate differential, an index of this difference is created to serve as an instrument, based on an IMF measure of fiscal impulse in the two countries. The result of the instrumental variables estimation is shown in the third equation of the table. Note that the point estimate on the interest rate differential rises to 0.068.

Using the inflation forecasts and the actual path of interest rates, we

Table 5. Real Deutsche Mark–Dollar Exchange Rate Equations, 1977:1–1984:4

(1)
$$\log R_t = \underset{(309.4)}{4.62} + \underset{(11.52)}{0.065}\,(r_t - r_t^*)$$
$$\bar{R}^2 = 0.81;\ \text{Durbin-Watson} = 0.71$$

(2)
$$\log R_t = \underset{(418.0)}{4.60} + \underset{(13.6)}{0.056}\,(r_t - r_t^*) + \underset{(4.44)}{0.020}\,(\hat{Q}_t - \hat{Q}_t^*)$$
$$\bar{R}^2 = 0.90;\ \text{Durbin-Watson} = 1.44$$

(3)
$$\log R_t = \underset{(362.8)}{4.60} + \underset{(10.5)}{0.068}\,(r_t - r_t^*) + \underset{(2.77)}{0.015}\,(\hat{Q}_t - \hat{Q}_t^*)$$
with instrumental variable $(G - G^*)$ for $(r - r^*)$
$$\bar{R}^2 = 0.87;\ \text{Durbin-Watson} = 1.20$$

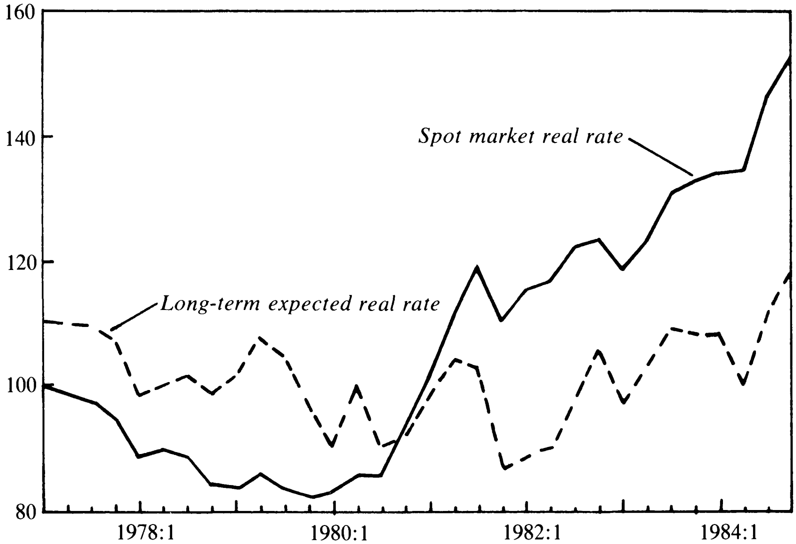
Source: Equation 13. R_t is EP/P^*, where E is deutsche marks per dollar, P is the consumption deflator in the United States, P^* is the CPI in West Germany, and r, r^* are long-term real interest rates, as calculated in the text. $\hat{Q}$, $\hat{Q}^*$ are real GNP growth rates, fourth quarter over fourth quarter. The instrument $(G - G^*)$ is the cumulative difference in the "fiscal impulse" (effectively, the difference in the full employment surpluses, as calculated by the IMF). Numbers in parentheses are t-statistics.

can also invert equation 13 to find the expectation of the long-term real exchange rate conditional on the assumption that the real interest rate measures the expected rate of real depreciation over the interval of the bond. This "long-term" real exchange rate may be calculated for each time period, as is done for the interval 1977:1–1984:4. As per the econometric estimates we assume that R_t returns to R in seven years. The result is shown in figure 5. According to these estimates, real appreciation of the dollar does not reflect the expectation of a long-term appreciation of the dollar, but rather of a short-run deviation from a fairly constant long-run rate. In 1977:1, the market projection was for a long-term real exchange rate of 110.7 (with the spot market real rate equal to 100 in 1977:1), and the average projection for 1984 was 110.0. The 53.2 percent real appreciation between 1977:1 and 1984:4 is consistent with *unchanged* long-term real exchange rate expectations and a rise in U.S. real interest rates relative to West German real interest rates of about 5.3 percentage points between 1977 and 1984.

If the expectations model is accepted, the fact that long-term real interest rates are far higher in the United States than in West Germany and Japan means that expectations are for a dollar depreciation at approximately the rate of interest rate differential for the next several

Figure 5. Real Exchange Rate and Long-Term Real Exchange Rate Expectation, Deutsche Mark–Dollar, 1977:1–1984:4

Index, 1977:1 = 100



Source: International Monetary Fund, *International Financial Statistics*, and equation 13. See text description.

years (the data suggest about a 30 percent real depreciation vis-à-vis the deutsche mark over the next seven years). A skeptic can argue that this interest rate differential has been present for the past four years, during which time the dollar has continued to appreciate, so that the "expectations" in the expectations model have never been borne out. The response to this observation in terms of the expectations hypothesis is that there have been continual surprises in terms of long-term real interest rate differentials over the period. U.S. long-term interest rates have stayed unexpectedly high, and the rate of U.S. inflation has dropped unexpectedly rapidly. The dollar has strengthened in each of the past three years because the real interest rate differential continued to rise, and most of that rise was probably unanticipated.

Let us assume that the analysis is correct, and proceed to investigate the inflationary consequences of a future depreciation of the dollar. As usual, we examine the partial effect for a fixed path of output and foreign inflation. Suppose, then, that the dollar will depreciate 30 percent in the seven years. If the drop is sharp and swift (the hard landing scenario in Stephen Marris's account elsewhere in this issue), the spike to domestic inflation will likewise be sharp. If the drop is slow, the inflationary consequences in any year will be muted, but the adjustment will take longer. According to our structural estimates, in the unconstrained case, the inflationary consequences of a hard landing, defined as 10 percent depreciation per year for three years, and a soft landing, defined as 5 percent depreciation per year for seven years, beginning in 1986, are as follows (in percentage points, fourth quarter over fourth quarter):

	1986	*1987*	*1988*
Hard landing	0.7	1.7	2.6
Soft landing	0.4	0.9	1.3

These are not forecasts of the price inflation following a decline in the dollar, since they assume for analytical purposes that the path of output is independent of the path of the exchange rate. As noted later, the policy authorities might well choose to respond to a sharp drop in the dollar with a mild recession, to mute the inflationary consequences.

The Strong Dollar as a Macroeconomic Strategy

It is time now to turn to the question raised at the opening of the paper. Does it make sense to pursue a policy mix aiming at a strong currency for the purpose of easing the costs of disinflation? Can the "sacrifice ratio" be reduced by a strong dollar in the early phase of a disinflation, or does the strategy merely push the costs into the future? If in fact the total costs of disinflation are unchanged over the long term, is there any justification left for pursuing such a policy? Finally, even if the policy makes sense from a single country's point of view, is the decision to pursue such a policy essentially a beggar-thy-neighbor decision? What happens if all countries try to pursue the strong currency approach?

I turn first to an extended discussion of the policy mix from a single country's point of view, and later to some of the multicountry issues.

Mundell's original notion in the 1971 essay is that a mix of tight money and expansionary fiscal policy can reduce inflation and maintain output at the same time. In principle, the short-term sacrifice ratio can be reduced to zero if all of the disinflation is brought about by currency appreciation, with fiscal policy being expansionary enough to offset the contractionary tendencies of tight money. A numerical illustration is shown in table 6.[36] The policy multipliers shown are from the Economic Planning Agency of Japan (EPA) model and are the average effects of shifts in monetary policy, M, and fiscal policy, G, over a two-year period. Below, I will offer independent estimates of these effects that display somewhat larger movements in the exchange rate for a given change in policy. (In the EPA model, exchange rate expectations are essentially backward-looking, while in the model below, they are forward-looking. That and my assumption of very high asset substitutability between currencies seem to be the major distinctions in the magnitude of the estimated effects.)

In every country, a normalized fiscal expansion is less inflationary than a normalized monetary expansion. (By "normalized expansion," I mean a change in G or M sufficient to raise output by 1 percentage point on average in the first two years). Consequently, a fiscal expansion with an exactly offsetting monetary contraction leaves output unchanged, but inflation lower. In Japan, for example, a 2.5 percentage point increase in discount rates, balanced by a 0.64 percent of GNP fiscal expansion, leaves output unchanged, but reduces inflation by 0.41 (0.59 − 0.18) percentage point—a zero sacrifice ratio. Is this the long sought anti-inflation machine? No, for two reasons. First, the policy works through a currency appreciation that raises prices abroad, in the countries with the counterpart depreciating currencies. Thus, while Japan's inflation is costlessly reduced by the policy mix, world inflation as a whole is left (approximately) unchanged. In the case of Japan, according to the EPA model, the repercussion effects on inflation rates in West Germany and the United States appear to be very small. Since Japan alone is a relatively small part of the OECD economy, a given inflation reduction in Japan translates into a much smaller inflation increase in the other OECD economies. For a very small country, a given reduction in inflation at home will be balanced by a negligible increase abroad, but an average of world inflation, which gives the small country very little weight, will show basically no change.

Second, the policy mix is probably not sustainable for long. Note that the proposed policy mix also worsens the current account, in this case

36. Gilles Oudiz and Jeffrey Sachs, "Macroeconomic Policy Coordination among the Industrial Economies," *BPEA, 1:1984*, pp. 1–64.

Table 6. Normalized Policy Multipliers for Output, Inflation, and the Current Account Ratio, Economic Planning Agency Model

Country acting, and policy	Size of policy	United States			Japan			West Germany		
		GNP	*Inflation rate*	*Current account ratio*	*GNP*	*Inflation rate*	*Current account ratio*	*GNP*	*Inflation rate*	*Current account ratio*
United States										
Monetary	4.08	1.00	0.09	−0.08	0.02	−0.22	0.06	−0.54	0.20	0.01
Fiscal	0.48	1.00	0.04	−0.16	0.14	0.00	0.04	0.27	0.05	0.06
Japan										
Monetary	2.50	−0.11	0.00	0.00	1.00	0.59	−0.02	−0.06	0.00	−0.02
Fiscal	0.64	0.00	0.01	0.01	1.00	0.18	−0.13	0.01	0.00	0.00
West Germany										
Monetary	1.11	−0.01	−0.01	−0.01	0.01	0.00	0.00	1.00	0.43	−0.05
Fiscal	0.51	0.01	0.01	0.00	0.09	0.03	0.02	1.00	0.14	−0.28

Source: Table 6 in Gilles Oudiz and Jeffrey Sachs, "Macroeconomic Policy Coordination among the Industrial Economies," *BPEA, 1:1984*, p. 21. Monetary policy is measured by the percentage point decrease of the discount rate. Fiscal policy is measured by the increase of government spending as a percentage of GNP. The policies are normalized so as to produce a 1 percent of GNP increase in the expanding country. The current account ratio is the current account balance as a percentage of GNP. The multipliers are averaged over two years. Original source is Economic Planning Agency of Japan, Economic Research Unit, "The Results of Exchange Rate Simulations" (EPA, 1983). This study was prepared for the 1983 Link International Conference, September 12–16, 1983. The document points out that the model is being revised, and the results must be regarded as tentative.

by (−0.13) minus (−0.02), or by 0.11 percent of GNP in Japan. Over time, those external deficits would cause foreign indebtedness to build, which would reduce real consumption opportunities of future generations, and, for a variety of reasons, eventually cause the currency to depreciate.

According to the EPA model, even the short-run usefulness of a shift to fiscal expansion and monetary contraction appears to be rather small in the United States, since there is little quantitative effect of either policy on inflation. Based on the evidence presented earlier in the paper, the opportunities for the United States have probably been much greater than shown in the EPA model.

It is useful to consider a single-period optimization problem of macroeconomic authorities presented with the opportunities just examined. Suppose that policymakers have a quadratic utility function in three targets: output (measured as a gap from potential), inflation, and the current account:[37]

$$U = -(1/2)(Q^2 + \psi\pi^2 + \mu CA^2). \tag{14}$$

Suppose further that the relationship between M and G and the three fiscal targets may be described in reduced form as:

$$\begin{aligned} Q &= M + G + Q_0 \\ \pi &= a_{M\pi}M + a_{G\pi}G + \pi_0 \\ CA &= -a_{MC}M - a_{GC}G + CA_0. \end{aligned} \tag{15}$$

Because fiscal expansion tends to appreciate the exchange rate, or at least to cause a smaller depreciation than monetary policy, we expect the value of $a_{G\pi}$ to be less than $a_{M\pi}$, and the value of a_{GC} to be greater than a_{MC}. That is, consistent with the results of table 6, fiscal expansion is less inflationary than is monetary expansion, and fiscal expansion is more adverse for the external balance than is monetary policy.

Now suppose that the economy has an inflation problem, in the sense that if it chooses to set $M = G = 0$ (these are policy settings as deviations from a baseline level), it achieves full employment and external balance, but has an inflation rate above the optimum. Specifically, we set the constants Q_0 and CA_0 to zero, and set $\pi_0 > 0$. What policy mix should

37. Ibid.

the country pursue? By setting $dU/dM = 0$ and $dU/dG = 0$, we find the following optimum choices for M and G:

$$(16) \qquad M = -\theta_M \pi_0 < 0$$

$$G = \theta_G \pi_0 > 0,$$

where
$$\theta_M = \frac{\psi(a_{M\pi} - a_{G\pi}) + \mu\psi a_{GC}(a_{GC}a_{M\pi} - a_{G\pi}a_{MC})}{\Delta} > 0$$

$$\theta_G = \frac{\psi(a_{M\pi} - a_{G\pi}) + \mu\psi a_{MC}(a_{GC}a_{M\pi} - a_{G\pi}a_{MC})}{\Delta} > 0$$

$$\Delta = \mu(a_{MC} - a_{GC})^2 + \psi(a_{M\pi} - a_{G\pi})^2 + \psi\mu(a_{M\pi}a_{GC} - a_{G\pi}a_{MC})^2 > 0.$$

As expected, the optimal policy is to choose M less than zero, and G greater than zero, and thereby reduce inflation at the cost of a larger external deficit. By substituting equation 12 back into the structural model, we find the selected levels of the three targets:

$$(17) \qquad Q = -\delta_Q \pi_0$$

$$\pi = \delta_\pi \pi_0$$

$$CA = -\delta_C \pi_0,$$

where
$$\delta_Q = \frac{\mu\psi(a_{MC} - a_{GC})(a_{GC}a_{M\pi} - a_{G\pi}a_{MC})}{\Delta} > 0$$

$$\delta_C = \frac{(a_{MC} - a_{GC})\,\psi\,(a_{M\pi} - a_{G\pi})}{\Delta} > 0$$

$$\delta_\pi = 1 - (1/\Delta)[\psi(a_{G\pi} - a_{M\pi})^2 + \mu\psi(a_{GC}a_{M\pi} - a_{G\pi}a_{MC})^2] < 1.$$

The built-in inflation is met by policy actions that reduce output, implicitly overvalue the exchange rate, and cause an external deficit.

Note that the policy mix may be reversed if the economy inherits an external balance problem in addition to an inflation problem. Suppose now that CA_0 is negative, while π_0 remains positive. Now a choice of $M = G = 0$ would leave the country with full employment, but with high inflation and an external deficit beyond the desired level. Optimizing once again, we find the following set of preferred policies:

$$(18)\qquad M = -\theta_M\pi_0 + \gamma_M CA_0$$

$$G = \theta_G\pi_0 - \gamma_G CA_0,$$

where $$\gamma_M = \mu(a_{GC} - a_{MC}) + \mu\psi a_{G\pi}(a_{GC}a_{M\pi} - a_{MC}a_{G\pi}) > 0$$

$$\gamma_G = \mu(a_{GC} - a_{MC}) + \mu\psi a_{M\pi}(a_{GC}a_{M\pi} - a_{MC}a_{G\pi}) > 0$$

θ_M, θ_G, Δ as in equation 16.

Note that the following four structural characteristics militate against the Mundell mix: a high structural external deficit (that is, a large value of CA_0); a high loss parameter μ on external deficits; a poor trade-off of output growth and external deficit, as given by the coefficient on G in the current account equation, a_{GC} (that is, a normalized fiscal stimulus causes a large worsening of external balance); and a small differential in the inflation effects of M and G (as measured by $a_{M\pi} - a_{G\pi}$).

So much for the static version of the model. We have seen in practice that the large appreciation of the dollar is expected to be reversed in the next ten years, so that the short-run gains to inflation will later be lost. What are the merits of the strategy given that real exchange rate gains tend to be temporary? Stanley Fischer has recently pointed out that these merits depend crucially on the type of wage-price process in the economy.[38] In settings where wages are "backward-looking" functions of inflation, the merits will tend to be qualitatively different than in economies with wage change depending on rational expectations of future policy actions. Fischer's analysis is extremely illuminating on this point, though his focus is on shifts in the sacrifice ratio when monetary policy and capital controls are the instruments available to the macroeconomic authorities, and he does not consider fiscal policy. The next section extends his analysis to the question of the policy mix of fiscal and monetary variables.

Consider first the case of backward-looking wage behavior. As a simple illustration, assume that wage change equals lagged CPI price change plus lagged output gap, and the CPI is a markup over domestic wages and foreign goods prices. The foreign currency price of foreign

38. Fischer, "Real Balances, the Exchange Rate, and Indexation."

output is fixed, and foreign producers fully pass exchange rate changes into domestic prices. In log levels, we have the following relationships:

$$\begin{aligned}(19)\qquad \pi_t^w &= \pi_{t-1}^c + \phi Q_{t-1}\\ p_t^c &= \lambda w_t + (1-\lambda)(p_t^* - e_t)\\ R_t &= p_t^c + e_t - p_t^*.\end{aligned}$$

This system yields the following equation for inflation:

$$(20)\qquad \pi_t^c = \pi_{t-1}^c + \phi Q_{t-1} - \theta(R_t - R_{t-1}), \qquad \theta = (1-\lambda)/\lambda.$$

Current inflation equals lagged inflation, plus an output effect, plus a negative effect for appreciations of the real exchange rate $(R_t - R_{t-1}) < 0$.

For the dynamic problem, the utility function is now written as the discounted sum of period-by-period utilities, with a discount factor β less than one (technically, I am assuming an additively separable intertemporal loss function). I also write utility directly as a function of R, rather than the current account balance (and drop the superscript on π for convenience):

$$(21)\qquad V = -1/2 \sum_{t=1}^{\infty} \beta^t (Q_t^2 + \psi\pi_t^2 + \mu R_t^2).$$

The economy inherits a given rate of wage inflation at $t=0$, and thereafter pursues an optimal path of policies of M and G, a path that minimizes V in equation 21. Instead of focusing on M and G, I more simply assume that these two instruments can be used to control the two targets Q_t and R_t in each period. At time zero I assume that the economy begins with the real exchange rate $R_0 = 0$. In this illustration, the government credibly commits itself to the entire future sequence of actions (an assumption to which I return, skeptically, later on).

Before solving for the optimum policy, let us examine the options actually open to the policymaker. By solving equation 20 forward for T periods, we see that inflation at time T is a function of inherited inflation, ϕ times the cumulative output loss between $t=0$ and $t=T$, and the level of the real exchange rate at T:

$$(22)\qquad \pi_T = \pi_0 - \phi\sum_0^{T-1} Q_t - \theta R_T.$$

Aside from the issue of whether the policy authority could actually commit to a permanent rise in R (and obtain sufficient foreign finance to run the implied current account deficits), it will not in fact be optimal for the policymaker to choose such a course in this example. Over time, optimal policy implies that inflation return to zero, output return to full employment, and R return to zero, given the utility function assumed here. Hence, as T gets large, we expect R_T to approach zero. From equation 22 we can see an important result, first shown by Willem Buiter and Marcus Miller.[39] In an economy with backward-looking wage setters, in which the long-term real exchange rate returns to its initial level, either perforce or given an optimal policy path, the cumulative output loss necessary to reduce a given inherited inflation to zero in the long run is fixed and independent of the path of the real exchange rate that is followed. To see this, simply let T get large in equation 22, let R_T tend to zero, and examine the case in which π_T goes to zero. Then we see that the cumulative output loss is simply given as:

$$\sum_0^\infty Q_t = -\pi_0/\phi. \quad (23)$$

The long-term sacrifice ratio, defined as the cumulative output loss from $t=0$ to $t=\infty$, divided by the reduction in inflation, π_0, is a constant that is independent of the exchange rate strategy. Specifically, the sacrifice ratio is $(1/\phi)$, where ϕ is the Phillips curve parameter in the wage equation.

Does this mean that Mundell is wrong, and that there is nothing to be gained from a strong currency policy? The answer is no. With reasonable assumptions on intertemporal utility, the policy mix of tight money and loose fiscal policy, or, equivalently, of increases in R, still may make sense in the beginning phase of disinflation. The short-run gains on inflation from raising R_t above zero may plausibly exceed the longer run costs of higher inflation when R_t returns to zero. The key assumption that can make this the case is that there are increasing marginal costs of inflation, so that on the margin a reduction in inflation from, say, 10 percentage points per year to 9 percentage points per year has a higher utility value, in terms of output that would be willingly forgone, than a reduction in inflation from 2 percentage points to 1 percentage point. This kind of effect is eminently plausible, most directly because the excess burden of taxes, including the inflation tax, can be described as a

39. Willem Buiter and Marcus Miller, "Real Exchange Rate Overshooting and the Output Cost of Bringing Down Inflation," *European Economic Review*, vol. 18, (May-June 1982), pp. 85–123.

function of the square of the tax rate. This assumption is clearly built into the quadratic utility function in equation 21.

Consider the formal optimization of V in equation 21 subject to the constraints in equation 20. Let Λ_t be the shadow cost in terms of intertemporal utility of an increment to inherited inflation at time t. The first-order conditions for the dynamic optimization are then given as:[40]

$$
(24) \qquad \begin{aligned}
&\text{(a) } Q_t = -\phi\Lambda_t \\
&\text{(b) } R_t = [\psi\theta/\mu]\pi_t \\
&\text{(c) } \Lambda_t = \Lambda_{t-1}/\beta - \psi\pi_t.
\end{aligned}
$$

In (a) we have the obvious result that the optimal output contraction in period t is greater the larger is the welfare cost on inherited inflation in period t, Λ_t. An optimal disinflation path begins with a steep recession, followed by a gradual return to full employment as the inflation rate ebbs to zero. More important for our purposes, note that (b) shows that R_t should be proportional to inflation along the optimal disinflation path. In other words, along an optimal path, there is an initial real exchange rate appreciation when inflation is high, and a declining real exchange rate as inflation returns to zero. This path does not gain anything in terms of the long-term sacrifice ratio, but it raises utility relative to a disinflation path with a constant real exchange rate. The reason is simple: raising R early in the process exports some of the inflation abroad without having to incur further costly output losses; later on, the same amount of inflation is imported as R falls. The welfare gain arises from the fact that the marginal utility gain from a unit of inflation reduction when inflation is high (early in the disinflation) exceeds the marginal utility loss from a unit of inflation increase later on, when the inflation rate is already low.

40. Set up the formal Lagrangian:

$$
\begin{aligned}
\pounds = {} & \textstyle\sum_{t=1}^{\infty} \beta^t (Q_t^2 + \psi\pi_t^2 + \mu R_t^2)/2 \\
& - \beta^t\Lambda_t [\pi_{t+1}^c - \pi_t^c - \phi Q_t + \theta(R_{t+1} - R_t)].
\end{aligned}
$$

Then the first-order conditions are found by setting $\partial\pounds/\partial\pi_t = 0$, $\partial\pounds/\partial Q_t = 0$, $\partial\pounds/\partial R_t = 0$ for $t > 1$.

Specifically,

$$
\begin{aligned}
\partial\pounds/\partial\pi_t = 0 &\rightarrow \psi\pi_t = \Lambda_{t-1}/\beta - \Lambda_t \\
\partial\pounds/\partial R_t = 0 &\rightarrow \mu R_t = \theta\Lambda_{t-1}/\beta - \theta\Lambda_t \\
\partial\pounds/\partial Q_t = 0 &\rightarrow Q_t = -\phi\Lambda_t.
\end{aligned}
$$

Combining the first two equations, we see also that $R_t = (\psi\theta/\mu)\pi_t$.

In broad outline, then, the Reagan disinflation has had some, but not other, characteristics of an optimal disinflation path. The process began with a deep recession, and was followed by a gradual return to full employment. The real exchange rate was increased in the early part of the disinflation, and will presumably fall in the later stages of the process. Of course, depending on the weights one attaches to inflation, output, and external balance in the utility function, different degrees of recession or real appreciation will be called for. The question we pick up later, however, is whether the continuation of current policies is likely to be appropriate as well. Note that an optimal path builds in a steady real depreciation after the initial appreciation. This model and the later results suggest that the actual U.S. fiscal expansion has been carried too far, too long, from the point of view of optimal disinflation. As inflation was reduced, the dollar should have depreciated in real terms, according to the model. Exactly the opposite has occurred to date.

In an economy with forward-looking wage setters, it may be possible to gain even more by the Mundell strategy. Indeed, in some not-implausible models, the sacrifice ratio can be reduced to almost zero by a policy of fiscal expansion and monetary contraction in the first phase of disinflation. As an extreme illustration, consider the earlier model, but now with a wage process in which the (log) wage for period $t + 1$ is set in t, but based on forward-looking expectations of the price level. The wage equation becomes:

$$w_{t+1} = {}_tp^c_{t+1}, \tag{25}$$

where ${}_tp^c_{t+1}$ signifies the expectation of consumer prices in period $t + 1$, held as of period t. In each period, the nominal wage is predetermined, so that macroeconomic policymakers retain period-by-period control over the output level in the economy. The change between periods in the wage, however, depends on expectations of future policies.

The remaining structure of the economy is as follows. Output is demand determined, with aggregate demand a decreasing function of R_t and an increasing function of G_t. Consumer prices are a weighted average of w and $p^* - e$ as in equation 19. Since $R = p^c + e - p^*$, we also have $R = \lambda(w + e - p^*)$. Foreign prices p^* are held constant and normalized at zero. The demand and price equations can therefore be written:

$$\begin{aligned} Q_t &= -\alpha(w_t + e_t) + G_t \\ p^c_t &= \lambda w_t - (1 - \lambda)e_t. \end{aligned} \tag{26}$$

We can think of the policymaker as choosing e_t and G_t in the period, with e implicitly controlled by monetary policy, which we hold in the background for the moment.

Now, suppose that the economy inherits some wage inflation, in that w_t exceeds w_{t-1}. The exchange rate at $t - 1$ is given as e_{t-1}. Thus, consumer price inflation in the current period is given by:

$$(27) \qquad \pi_t^c = p_t^c - p_{t-1}^c = \lambda(w_t - w_{t-1}) - (1 - \lambda)(e_t - e_{t-1}).$$

From the assumption of forward-looking wage behavior, wage setters note that expected p_{t+1}^c equals the nominal exchange rate expected in the following period. This is because $p_{t+1}^c = \lambda w_{t+1} - (1 - \lambda)e_{t+1}$, and with w_{t+1} equal to p_{t+1}^c, we have $w_{t+1} = -e_{t+1}$.

There is no fixed sacrifice ratio in this economy, either in the short run or in the long run. One strategy for policymakers is to absorb the current inflation with an accommodating exchange rate or fiscal policy, that is, with G_t high enough or e_t low enough to hold output fixed, and to announce a value of the future exchange rate equal to today's consumer price level. After one period of inflation, the inflation rate vanishes costlessly. More strikingly, using the Mundell strategy, the policymakers can eliminate current inflation as well, and still maintain full employment throughout. The idea is straightforward: the exchange rate today is set at a high enough level so that current inflation is zero. According to equation 27, e_t is chosen to equal $[\lambda(w_t - w_{t-1}) + (1 - \lambda)e_{t-1}]/(1 - \lambda)$. This involves a real appreciation in the long-run value R in the amount $\lambda(w_t - w_{t-1})/(1 - \lambda)$. Then fiscal policy is expanded sufficiently so that aggregate demand is not reduced by the high real exchange rate. For the next period, policymakers announce a value of the future exchange rate so that $e_{t+1} = p_t^c$, and a return of fiscal policy to zero. Wages for period $t + 1$ then revert to a noninflationary level, and the real exchange rate returns to zero. Note that workers get a big real wage increase in period t from the real exchange rate appreciation in period t, which they then willingly give up in period $t + 1$.

The Mundell mix, then, allows for a complete elimination of inflation at zero output cost. Suppose that policymakers instead reduce the current inflation through exchange rate policy alone, that is, through tight money, without the benefit of fiscal expansion. In that case, e_t would be moved to the level we just found, but now output would fall because of the real appreciation. The decline in output would be given by $-[\alpha/(1 - \lambda)](w_t - w_{t-1})$. Obviously, the Mundell strategy has improved the path of output, even when viewed over the entire future horizon. As before, the announcement of future e would be sufficient to hold inflation to zero in the future.

Stepping back and comparing this model with the case of backward-looking wage setting, we can make the following points. In this model with anticipatory wage setters, inflation can be talked away in the future merely by credible announcements of tight control over such nominal variables as the exchange rate or the money supply. The only problem with eliminating current inflation is that wage contracts build in some wage stickiness over the duration of the contracts. One possible policy is to reduce inflation at the same pace as contracts expire, so as not to jeopardize output. But another more aggressive policy is to use an exchange rate overvaluation to reduce inflation in the time period in which current contracts remain in force. The potentially contractionary effects coming from the real appreciation are then offset by a temporary fiscal expansion. The Mundell strategy does not need to last longer than the longest contracts, assuming that wages are set on the basis of future prices, rather than on an average of wages as in John Taylor's staggered contracts models.[41] A temporary appreciation is the way around a set of preexisting wage settlements. Importantly, in this model, the economy does not really reabsorb the inflation that it exports in the initial period. When the real exchange rate falls, workers accept the implicit real wage reduction without demanding a catch-up in nominal wages. Because the real appreciation itself in the first period drives the real wage above its long-run target level, workers are willing to see the real wage fall back to the target.

To summarize the arguments of this section, the Mundell mix of loose fiscal policy and tight monetary policy can reduce the sacrifice ratio in the short run, and may or may not reduce the sacrifice ratio in the long run. In the case of backward-looking wage setting, the real appreciation is a method of redistributing the burden of adjustment over time, in order to make more rapid gains against inflation when inflation is high, and accept the costs of higher imported inflation when inflation is low. In the

41. John B. Taylor, "Rational Expectations and the Invisible Handshake," in James Tobin, ed., *Macroeconomics, Prices, and Quantities: Essays in Memory of Arthur M. Okun* (Brookings, 1983), pp. 63–77.

case of forward-looking wage behavior, the strategy might actually reduce the sacrifice ratio to zero, in that it provides a vehicle for cutting inflation and maintaining output in the short period in which existing wage contracts remain in force. Long-term, painless disinflation is no problem in the model, under the (strong) assumption that governments can make credible commitments to future noninflationary policies.

THE POLICY MIX IN THE MULTICOUNTRY SETTING

In a world economy in which individual countries pursue policies in a noncooperative setting (that is, without supranational controls, IMF surveillance, or economic treaties), the previous analysis will apply on a country-by-country basis. If many countries are simultaneously attempting to disinflate, each will have an incentive to pursue a tight money, loose fiscal policy in order to strengthen the currency. Of course, differing concerns in each country regarding public deficits or external deficits may vary the vigor with which the policy mix is pursued.

In an earlier study, Gilles Oudiz and I described in some detail how the resulting noncooperative global equilibrium is likely to be inefficient, in the sense that all countries can come closer to their targets if they make some cooperative adjustments to their policies.[42] The reason for inefficiency in this particular case should be clear. In a closed world system, not all countries can simultaneously appreciate their currencies vis-à-vis the other countries. Indeed, in a fully symmetric setting, all real exchange rates between identical countries would be constant over time in equilibrium, even though from the perspective of each policy authority, the country's own real exchange rate would appear to be a choice variable. The common attempt of all countries to appreciate will simply cancel out.

To the extent that there are side costs to running large budget deficits and a tight monetary policy, the (failed) attempt of each country to appreciate will impose pure deadweight losses on the world economy. The policy mix can produce undesirably high world interest rates, or too rapid growth in public indebtedness, without achieving any inflation gains for any individual country.

Even if some countries pursue the mix more aggressively than others,

42. Gilles Oudiz and Jeffrey Sachs, "Macroeconomic Policy Coordination."

as is certainly true for the United States vis-à-vis Europe and Japan in recent years, the world equilibrium is still likely to be Pareto inefficient, with a bias towards excessive budget deficits throughout the world. One could surmise, for example, that in the absence of the recent U.S. policy mix, the European and Japanese economies would have maintained looser monetary policies, and even tighter fiscal policies, but were constrained from doing so by fears of further currency depreciation. In the earlier paper, Oudiz and I used an optimization framework to show that if the United States were to begin following a policy mix of fiscal contraction and monetary expansion, the optimal response of Japan and West Germany would be to follow with similar changes.[43] Similarly, using formal techniques of dynamic optimization, Warwick McKibbin and I have given an extended illustration of how noncooperative policymaking within the OECD is likely to lead to excessive budget deficits and real interest rates in a period of disinflation.[44]

Thus, the Mundell mix is most justifiable from an individual country's perspective, and is perhaps actually pernicious when viewed from the global perspective. My welfare evaluation of alternative policies in the next section must therefore be viewed from a strictly national perspective, taking as given the policy actions in the rest of the world.

POLICY OPTIMIZATION IN A SIMULATION MODEL

This section draws together the pieces of the analysis by estimating optimal policies for disinflation in the United States within a structural model of global macroeconomic adjustment. The model, designed and refined in joint work with Warwick McKibbin and Gilles Oudiz, is a dynamic model of the world economy with four regions, the United States, the ROECD, nonoil less developed countries (LDCs), and OPEC; it was specially designed for policy optimization studies. I use the model here for three purposes: to see whether, in broad outline, the movements of the dollar can be explained in a structural model in terms of shifts in macroeconomic policies in the United States and the ROECD; to see whether, from the vantage point of 1980, the mix of fiscal expansion and

43. Ibid., table 14.

44. Jeffrey Sachs and Warwick McKibbin, "Macroeconomic Policies in OECD and LDC External Adjustment," Working Paper 1534 (National Bureau of Economic Research, January 1985).

monetary contraction had merit for the United States; and to assess the prospects for future developments of the U.S. price level and external balance, in view of the large appreciation of the dollar since 1980.

A complete description of the simulation model is available elsewhere.[45] Here, an outline of the model will suffice. As a general matter, the model has several features that make it particularly attractive for the type of policy analysis undertaken here. First, the important stock-flow relationships and intertemporal budget constraints are carefully observed, so that the long-run properties of the model are reasonable. Budget deficits, for example, cumulate into a stock of public debt that must be serviced, while current account deficits cumulate into a stock of foreign debt. Second, the asset markets are forward-looking, so that the exchange rate is conditioned by the entire future path of policies rather than by a set of short-run expectations. This model differs in this fundamental regard from all of the large-scale world econometric models.

In the model, only the developed country bloc (the United States and the ROECD) has an internal macroeconomic structure; the LDCs and OPEC are modeled only with respect to their international trade and financial linkages. Each region produces a single output, which is an imperfect substitute in consumption for the outputs of the other regions. Every region therefore exports and imports to the other regions, with the extent of trade parametrized on the baseline to correspond to a direction-of-trade matrix for 1983. Importantly, it is assumed that potential growth of GDP is fixed at 3 percent per year in both the United States and the ROECD, so that I do not examine at all the long-term growth effects of alternative policy mixes. In any event, there would be no easy way to pursue the more ambitious task of building in endogenous growth of potential GDP as a function of policy variables as crudely defined as government aggregate expenditure and taxation. A cut in tax revenues, for example, can be detrimental to the growth of potential GDP if the tax cut finances increased consumption, while it might spur growth if the tax cut is made in order to subsidize capital expenditures, as with much of the Reagan tax cut on capital income.

In the United States and the ROECD, output is demand determined along conventional lines. In any period, the nominal wage is predeter-

45. Ibid. The main modification to the model in Sachs and McKibbin is the money demand function, which is now written in the form: $m_t - p_t = 0.5(0.9Q_t - 0.8i_t) + 0.5(m_{t-1} - p_{t-1})$.

mined, and domestic prices are written as a fixed markup over wages. While domestic prices are given, consumer prices can of course vary within a period because of movements in the nominal exchange rate. Aggregate demand is the sum of private domestic absorption, exports net of imports, and government spending, which is assumed to fall, on the margin, entirely on home goods. Private absorption combines personal consumption expenditure and investment expenditure in one behavioral relation. The level of total absorption is written as a function of disposable income, defined as GDP net of taxes; the real interest rate r; and the stock of financial wealth of households. The real interest rate is the nominal interest rate minus the rationally anticipated change in domestic goods prices in the next period. In the version of the model reported here, each period signifies one calendar year. Note that current absorption is written as a function of current disposable income rather than permanent income. This specification, of course, builds in a strong presumption that the time path of taxes affects the time path of private absorption, even for a given discounted value of the total tax burden.

International financial flows are assumed to be completely dollar denominated, with ROECD, LDC, and OPEC residents holding dollar denominated assets and liabilities, but with U.S. residents not holding any claims in nondollar currencies. Thus all current account imbalances are settled by changes in net U.S. dollar claims and liabilities. Dollar assets are assumed to be imperfect substitutes for ECU denominated assets (the ROECD currency bundle will be termed the ECU), with the required risk premium a function, à la Tobin, of the relative stocks of ECU and dollar assets in the ROECD portfolio. In practice a very high degree of substitutability is assumed, in line with the suggestive evidence on real interest rates and the dollar described earlier.

A few of the key parameter values in the behavioral equations can help in understanding the effects of policies in the model. At the point of linearization the following elasticities are assumed:

—the effect of a 1 percentage point increase in the short-term real interest rate on private absorption expenditure: decline of 0.4 percent of absorption

—the effect of a \$1 increase in income on private absorption expenditure: increase of 70¢

—the effect of a \$1 increase in financial wealth on private absorption expenditure: increase of 10¢

—the effect of a 1 percent real appreciation of the dollar vis-à-vis the ECU on U.S. imports from the ROECD: increase of 1.5 percent

—the effect of a 1 percent real appreciation of the dollar on U.S. exports to Europe: decline of 1.5 percent

—the effect of a 1 percent increase in OECD imports from the LDCs on LDC terms of trade (that is, on the relative price of LDC commodities): increase of 0.5 percent

—the effect of a 1 percent increase in OECD imports from OPEC on the relative price of OPEC exports: increase of 0.5 percent.

The role of the exchange rate on domestic inflation is based on a pricing model that is somewhat different from the structural model derived earlier in the paper. In the global modeling for the simulation model it was convenient to distinguish goods by country of origin rather than by class of commodity. Goods from the ROECD and the LDCs are assumed to enter the consumer price level with a weight equal to the ratio of U.S. imports from each region as a percentage of U.S. GNP. The weight for OPEC is set at 0.04, to reflect both the import and domestic production effects of a change in world oil prices. In particular, in the United States the following consumer price index equation is specified:

$$(28) \qquad p^c = 0.89\, w + 0.05\, p^{ROECD} + 0.02\, p^{LDC} + 0.04\, p^{OPEC}.$$

It is assumed that for given local currency prices in the ROECD, an exchange rate change is passed through 100 percent within the year into U.S. import prices of ROECD goods. Thus, from equation 28, the direct effect of a 10 percent depreciation of the ECU on the U.S. price index is 0.5 percent. It is also assumed that the prices of LDC goods and OPEC goods are fixed as markups over price indexes of OECD goods from the other regions, where the markups are a rising function of X, the level of total exports. In other words, the dollar price of OPEC exports is given as:

$$(29) \quad p^{OPEC} = 0.09\, p^{US} + 0.43\, p^{ROECD} + 0.48\, p^{LDC} + 0.5 \log X^{OPEC}.$$

The weights here are based on OPEC import shares in 1983. This may be regarded as an OPEC supply curve, making the supply of exports a rising function of the relative export price. The weights attached by OPEC to U.S. prices and ROECD prices are assumed to be fixed by the proportion of OPEC spending in the two areas. (They could also have been based on the extent of U.S. and ROECD purchases from OPEC, depending on the underlying model of supply.) There is a similar equation for LDC pricing, given by:

$$(30) \quad p^{LDC} = 0.20p^{US} + 0.50p^{ROECD} + 0.30p^{OPEC} + 0.5 \log X^{LDC}.$$

Taking equations 29 and 30 together, we can calculate the direct and indirect first-period effect of a 10 percent currency appreciation of the dollar relative to the ECU to be 1 percent.

As described earlier, the wage equation may be specified as forward- or backward-looking, or some combination of the two. The specification chosen allows for level and rate-of-change effects of output on wage inflation. Note that Q in this equation is to be regarded as the deviation of output from trend, that is, as a GDP gap measure.

$$(31) \qquad \pi^w_{t+1} = \alpha\pi^c_t + (1 - \alpha)_t\pi^c_{t+1} + \phi Q_t + \zeta(Q_t - Q_{t-1}).$$

Note that ${}_t\pi^c_{t+1}$ is the period t expectation of consumer price inflation in period $t + 1$, $({}_tp^c_{t+1} - p^c_t)$. For the backward-looking wage behavior, $\alpha = 1$. I also set $\phi = \zeta = 0.2$. With ϕ equal to 0.2, the long-run sacrifice ratio is approximately 5, or 1/0.2.

Under the assumption of backward-looking wage behavior ($\alpha = 1$), the system just outlined has properties that are very close to those estimated earlier. In particular, consider the effects of a 10 percent appreciation of the dollar in the model, and compare them with the annual average reduction in price inflation of the quarterly model (unconstrained version) estimated earlier (in percentage points):

	Year		
	1	*2*	*3*
Quarterly model	0.7	1.0	0.9
Simulation model	1.0	0.9	0.8

The dynamic effects of U.S. fiscal and monetary policies are shown in tables 7 and 8. The fiscal policy is a sustained, bond-financed U.S. fiscal expansion. The monetary policy is a 1 percent increase in the money supply, expected to be permanent. The fiscal expansion begins as a 1 percent of GNP rise in government expenditures on home goods, with no initial change in taxes. Over time, the higher expenditure level is left unchanged, but taxes are raised in line with rising debt-servicing charges, in order to keep the deficit equal to 1 percent of GNP.

Table 7. Effects of U.S. Fiscal Expansion, 1984–87[a]
Deviations from baseline

Category	*1984*	*1985*	*1986*	*1987*
U.S. GDP in 1984 prices (percent)	0.7	0.9	0.6	0.4
U.S. GDP in 1984 prices (billions of dollars)	27.0	35.7	24.1	17.1
U.S. price inflation (percentage points)	−0.3	0.0	0.2	0.2
U.S. interest rate (percentage points)	0.7	0.8	1.0	1.2
U.S. current account (percent of U.S. GDP)	−0.5	−0.5	−0.6	−0.6
U.S. current account (billions of dollars)	−16.8	−18.9	−21.6	−23.6
U.S. effective exchange rate (percent)[b]	3.8	4.0	4.2	4.3
OECD GDP (percent)	0.7	−0.1	−0.1	−0.3
OECD price inflation (percentage points)	0.2	0.4	0.2	0.2
OECD interest rate (percentage points)	0.6	0.9	0.9	0.9

a. Bond-financed fiscal expansion of 1 percent of GNP rise in government expenditures. Over time, higher level of expenditure is kept constant, but taxes are raised.
b. Units of basket of foreign currencies per U.S. dollar.

Table 8. Effects of U.S. Monetary Expansion, 1984–87[a]
Deviations from baseline

Category	*1984*	*1985*	*1986*	*1987*
U.S. GDP in 1984 prices (percent)	2.0	−0.5	0.0	−0.4
U.S. GDP in 1984 prices (billions of dollars)	−73.4	−20.1	0.9	16.7
U.S. price inflation (percentage points)	0.1	0.7	0.2	0.3
U.S. interest rate (percentage points)	−0.4	0.4	0.2	0.3
U.S. current account (percent of U.S. GDP)	−0.1	−0.1	−0.1	−0.1
U.S. current account (billions of dollars)	−3.5	−5.4	−2.7	−3.1
U.S. effective exchange rate (percent)[b]	−0.8	−0.3	−0.6	−0.7
OECD GDP (percent)	0.0	0.1	0.0	−0.1
OECD price inflation (percentage points)	0.0	0.0	0.1	0.0
OECD interest rate (percentage points)	0.0	0.1	0.1	0.1

a. One percent increase in the money supply.
b. Units of basket of foreign currencies per U.S. dollar.

In the case of a U.S. fiscal expansion, we find a rise in GDP of 0.7 percent relative to the baseline in the first year, and a fall in inflation of 0.3 percentage point. The inflation reduction has two sources, one of them spurious: on the one hand, the fiscal expansion causes the exchange rate to appreciate by 3.8 percentage points, which has a direct pass-through effect on import prices, and from them to consumer prices. More dubiously, the Phillips curve effect of higher output on prices operates with a full year lag. In the second year of the shock, inflation is the same as in the baseline. U.S. short-term interest rates rise by 70 basis points in the first year, and by 100 basis points in the third year. The U.S. current account worsens by about 0.5 percentage point of GDP and then continues to worsen in the next three years. Note that a 4.0 percent of GNP swing of fiscal policy causes a current account swing of about 2.0 percent of GNP. This is about the order of magnitude of the swing in fiscal policy and the current account since 1980: the model is on track here.

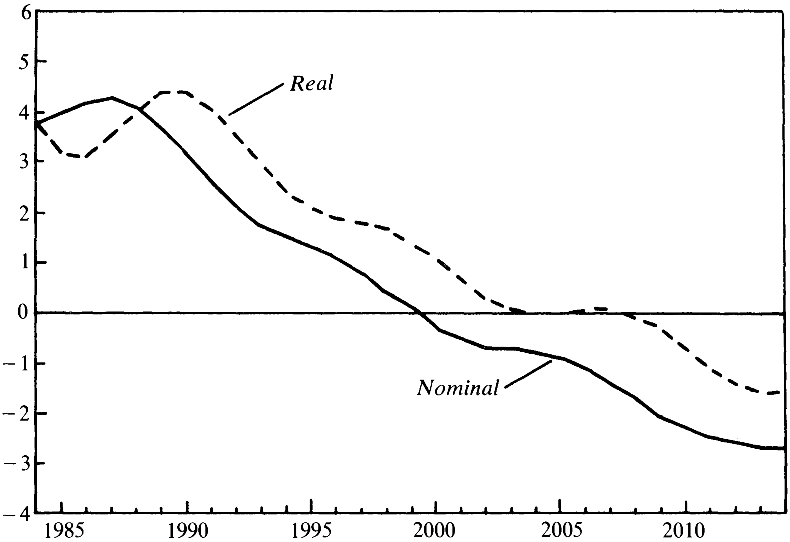
As explained in one of my earlier studies with Wyplosz, the short-run appreciation of the dollar is reversed in the long run, for several reasons.[46] The persistent current account deficits of the United States cause a shift in world wealth, which tends to diminish demand for U.S. goods. The share of dollar denominated assets in ROECD portfolios rises and over time induces a growing risk premium on U.S. denominated claims. U.S. interest rates rise, and the dollar tends to weaken. Importantly, the model does not signal any need for a rapid reversal of the appreciation, as shown in figure 6. The nominal exchange rate does not return to its initial level until about fifteen years after the expansion.

As shown in table 8, a U.S. monetary expansion causes a more inflationary boom than does fiscal policy, since the exchange rate depreciates on impact. Per unit of GDP gain, monetary policy is more inflationary, but also less adverse to the current account balance. The differential effects of monetary and fiscal policy have the following implications. A mix of fiscal expansion (G rising by 2.0 percent of GNP) and monetary contraction (M falling by 0.7 percent relative to trend) causes: no output change; an inflation reduction of 0.7 percentage point in the first year; and a worsening of the current account of about 1.1 percent of GNP.

46. Sachs and Wyplosz, "Real Exchange Rate Effects."

Figure 6. Projected Effects of Fiscal Stimulus on ECU-Dollar Exchange Rates, 1984–2014[a]

Deviations from baseline, in percent



Source: Simulation described in table 7 and text.
a. ECU is the currency bundle for the rest of the OECD.

Can this model hope to reproduce the essential quantitative aspects of the U.S. disinflation and strong dollar of the past four years? The answer is yes. Suppose that the United States and the ROECD were on a particular adjustment path until the policy changes of 1981. The changes relative to that old baseline are as follows: a sustained U.S. debt-financed fiscal expansion of 4 percent of GNP; a sustained ROECD fiscal contraction of 2 percent of ROECD GNP; a substantial tightening of U.S. monetary policy; and no change in ROECD monetary policy. The degree of U.S. monetary tightening is calibrated so that the net effect of monetary contraction and fiscal expansion is a recession with a GNP gap of 7.5 percent in the first year, and then a gradual recovery. This involves a sharp fall in money growth (3.0 percentage points relative to the baseline), and then a path of nominal money growth nearly equal to inflation for the next three years. This policy setting yields the path of variables shown in table 9. The dollar appreciates by 39.4 percent relative to the ECU, and U.S. short-term real interest rates rise by 8.0 percentage points relative to abroad. A protracted period of unemployment ensues, with the United States returning gradually to full employment. The U.S.

Table 9. Simulated Effects of Shift in Policy Mix in the United States and the Rest of the OECD (ROECD) after 1980
Deviations from baseline, in percent

Policy and variable	*1981*	*1982*	*1983*	*1984*
Real exchange rate	39.4	32.6	29.8	27.1
Policy shift				
U.S. fiscal deficit as proportion of GNP	4.0	4.0	4.0	4.0
U.S. monetary policy[a]	−3.0	−7.1	−6.5	−6.7
ROECD fiscal deficit as proportion of GNP	−2.0	−2.0	−2.0	−2.0
ROECD monetary policy[a]	0.0	0.0	0.0	0.0
Other variables				
U.S. GNP gap[b]	−7.5	−6.1	−5.1	−4.3
U.S. price inflation	−3.7	−6.2	−7.0	−7.6
U.S. interest rate	10.0	8.8	7.7	6.9
ROECD GNP gap[b]	3.7	−5.5	−4.5	−4.6
ROECD price inflation	1.4	1.9	0.0	−0.5
ROECD interest rate	2.0	2.1	0.5	−0.6

a. Monetary policy is defined as the percentage growth in M1.
b. A negative sign indicates output below potential.

inflation rate falls from 10 percent in the year before the shift to 6.3 percent in the first year of the policy, 3.8 percent the next, and so on gradually to zero inflation. (The table records the drop in inflation relative to the 10 percent per year inflation of the baseline.) This simulation does not attempt to capture the precise timing of exchange rate movements. For that we would have to assess the expectations of the market with respect to future policies in every period since 1980. Rather, it illustrates that movements in the value of the dollar of the magnitude observed since 1980 can be captured in simulation exercises with plausible shifts in policy.

Now, it is time to examine the specific properties of optimal disinflation paths in the model. One brief word must be said about the optimization technique. Unlike the illustration of optimal control policies pursued earlier, the calculations described below are for so-called "time consistent" policies, in which the optimization is made under the assumption that the government *cannot* commit itself at a given moment to the entire future path of its actions. Rather, it optimizes today with the understanding that it will have the opportunity to reoptimize at each date in the future. The government therefore optimizes today, taking as given that it will be optimizing in the future. To solve the problem, backward recursion is used; in each period the government computes its best policy, taking as given the policies that it will be pursuing in the future. Technically, the solution technique is dynamic programming, rather than optimal control.[47]

For the utility function, I employ a quadratic function in the output gap, the inflation rate, an adjusted budget deficit relative to GDP, and an adjusted current account deficit relative to GDP. Let $b_t = B_t/\overline{Q}_t$ be the ratio of public debt to potential GDP ($\overline{Q}$). The adjusted budget deficit measure used is $(b_{t+1} - b_t)$. Similarly, the adjusted current account measure is the change in net foreign liabilities per unit of potential GDP, denoted $d_{t+1} - d_t$. In long-run equilibrium, both b_t and d_t reach a constant. This requires that the actual level of public debt and of foreign indebtedness grow at the rate of potential GDP, which I take to be 3 percent per year.

The instantaneous utility function in period t is written simply $u_t = -[\phi_1(Q_t - \overline{Q}_t)^2 + \phi_2\pi_t^{c2} + \phi_3(b_{t+1} - b_t)^2 + \phi_4(d_{t+1} - d_t)^2]$. The bliss point in each period is characterized by output at potential ($Q_t = \overline{Q}_t$), zero inflation ($\pi_t^c = 0$), and no change in the two debt-GDP ratios ($b_{t+1} - b_t = d_{t+1} - d_t = 0$). At the bliss point, $u_t = 0$; at all other points, $u_t < 0$. The intertemporal utility function is an infinite discounted sum of all present and future u_t, of the form:

$$U_t = \sum_{s=t}^{\infty} (1 + \delta)^{-(s-t)} u_t, \tag{32}$$

where δ is the pure rate of time preference (set at 0.10 in the simulations that follow). In all of the simulations that follow, ϕ_2 is set at 1.0, ϕ_3 at 0.1, and ϕ_4 at 0.5. The value ϕ_1 is given three alternative values, signifying a "high" welfare weight on output ($\phi_1 = 2.0$); a "medium" welfare weight on output ($\phi_1 = 1.0$); and a "low" welfare weight on output ($\phi_1 = 0.5$). The low welfare weight is selected to yield roughly a path of disinflation of about the rate in effect during 1981–84. In particular, it produces a recession in the early stage of disinflation with a GNP gap of 8.5 percent.

47. Gilles Oudiz and Jeffrey Sachs, "International Policy Coordination in Dynamic Macroeconomic Models," in Willem H. Buiter and Richard C. Marston, eds., *International Economic Policy Coordination* (Cambridge University Press, 1985), pp. 274–319. For an earlier illustration of the technique, see Sachs and McKibbin, "Macroeconomic Policies."

The intertemporal utility function is maximized using dynamic programming techniques, under the alternative utility assumptions. I assume that as of 1981 the United States inherits a wage inflation rate of 10 percent, zero output gap, and zero adjusted current account and budget deficits. The policy controls are specified in three alternative ways. In Case I, the optimal policy mix of M and G is selected to maximize U_t. In Case II, the policy path is restricted to choices of monetary policy alone, with government spending fixed at a baseline level. These two cases allow us to examine the advantages of using two policy instruments rather than one instrument alone. In a closed economy, Cases I and II would yield almost identical results (in Tobin's ''funnel'' theory, there would be no advantage, in terms of the output-inflation trade-off, to having both instruments). In Case III, both M and G vary, but the policy authority is obliged to maintain a policy mix that keeps the exchange rate constant. This alternative is implemented by making G_t the policy instrument, fixing the real exchange rate, and making M_t adjust endogenously to the level consistent with the exchange rate target. In comparing Cases III and I, we find the gains that can be achieved through manipulation of the real exchange rate.

Table 10 shows the optimal policy paths for disinflation from a 10 percent inflation rate for backward-looking wage behavior and for a variety of utility functions and policy options. The results are striking. In Case I, where both M and G are freely employed, the optimal path is to use expansionary G and contractionary M. (Monetary policy is contractionary in the sense that nominal money growth is far below the inflation rate, which, in the model with backward-looking wage behavior, tends to produce a decline in output relative to potential.) In all cases, the three-year sacrifice ratio is lower given this policy mix than with M alone, and much lower than with a constant real exchange rate policy. However, in all cases, the infinite-horizon sacrifice ratio is higher with the Mundell policy mix than with M alone, or with a constant real exchange rate. This latter effect results from the fact that in all cases the long-run real exchange rate is more depreciated in Case I. Since the Mundell mix causes a sharp initial appreciation, and an accumulation of foreign debt, it also involves a greater long-run depreciation.[48]

48. Compare this result with my earlier illustration of the Buiter-Miller model, in which the long-run sacrifice ratio is fixed. In that case I ruled out long-run changes in the real exchange rate.

Table 10. Optimal Policy Paths for Disinflation, United States, Alternative Utility Weights[a]

Utility weight, policy path, and variable	Year			Sacrifice ratio[b]	
	1981	1982	1983	Three-year	Long-run
Low output weight					
Case I. Optimal policy mix				3.47	5.20
Fiscal policy	5.7	3.7	3.1		
Monetary policy	0.6	1.3	3.5		
Output gap[c]	−8.5	−7.0	−5.8		
Inflation rate	7.5	4.7	3.9		
Real exchange rate	27.1	18.7	15.5		
Case II. Monetary policy alone				3.93	5.00
Fiscal policy	0.0	0.0	0.0		
Monetary policy	2.0	2.3	4.0		
Output gap[c]	−9.5	−7.5	−6.1		
Inflation rate	8.5	5.1	4.1		
Real exchange rate	15.1	10.7	8.5		
Case III. Fixed real exchange rate				4.55	4.97
Fiscal policy	−6.1	−5.1	−4.1		
Monetary policy	3.6	4.3	5.1		
Output gap[c]	−9.8	−7.8	−6.3		
Inflation rate	9.8	5.9	4.7		
Real exchange rate	0.0	0.0	0.0		
Medium output weight					
Case I. Optimal policy mix				3.12	5.30
Fiscal policy	5.9	4.5	4.1		
Monetary policy	1.8	2.3	4.0		
Output gap[c]	−5.9	−5.2	−4.6		
Inflation rate	7.5	5.6	4.9		
Real exchange rate	26.8	20.0	17.5		
Case II. Monetary policy alone				3.88	5.00
Fiscal policy	0.0	0.0	0.0		
Monetary policy	3.1	3.6	4.9		
Output gap[c]	−6.8	−5.8	−5.1		
Inflation rate	8.8	6.3	5.4		
Real exchange rate	12.1	9.1	7.7		
Case III. Fixed real exchange rate				4.61	4.97
Fiscal policy	−4.4	−4.0	−3.4		
Monetary policy	4.1	5.2	5.9		

Table 10 (*Continued*)

Utility weight, policy path, and variable	*Year* 1981	1982	1983	*Sacrifice ratio*[b] Three-year	Long-run
Output gap[c]	−7.1	−6.0	−5.2		
Inflation rate	9.8	7.0	6.0		
Real exchange rate	0.0	0.0	0.0		
High output weight					
Case I. Optimal policy mix				2.65	5.40
Fiscal policy	6.0	5.2	4.8		
Monetary policy	2.8	2.9	4.6		
Output gap[c]	−4.0	−3.6	−3.4		
Inflation rate	7.6	6.4	5.9		
Real exchange rate	26.5	21.0	19.0		
Case II. Monetary policy alone				3.83	5.00
Fiscal policy	0.0	0.0	0.0		
Monetary policy	3.9	4.8	5.9		
Output gap[c]	−4.7	−4.2	−3.8		
Inflation rate	9.1	7.4	6.7		
Real exchange rate	9.1	7.2	6.4		
Case III. Fixed real exchange rate				4.67	4.97
Fiscal policy	−3.0	−2.8	−2.5		
Monetary policy	4.6	5.9	6.8		
Output gap[c]	−4.8	−4.3	−3.9		
Inflation rate	9.9	8.0	7.2		
Real exchange rate	0.0	0.0	0.0		

a. Entries are deviations from baseline. The economy is assumed to inherit a 10 percent wage inflation rate in 1981, with all other target variables at zero. Fiscal policy deviation is expressed as deficit as percent of GNP; monetary policy, as percent growth in M1; output gap, as percent; inflation rate, as percent; real exchange rate (ECU-dollar), as percent.

b. Percent-years output loss per percentage point of inflation reduction.

c. A negative sign indicates output below potential.

In all examples, the optimal policy is an early recession and a gradual recovery. In Case I, the recession is always brought about by slow money growth and a rise in G. The case with the low weight on output is closest to the U.S. experience. Note that the deficit initially rises to 5.7 percent of GNP, and the current account deficit is 1.4 percent of GNP. The exchange rate appreciates by 27 percent on impact, and then depreciates steadily over time, to a new long-run equilibrium level below the initial baseline. As the utility weight on output increases, the optimal amount of fiscal expansion also grows. Note that in the "high" case the initial deficit is 6.0 percent of GNP.

The Mundell mix is attractive because it allows for a quick disinflation at low output cost, that is, a low sacrifice ratio, even though it raises the sacrifice ratio in the long run. Why such a trade-off is desirable in the model is important. The desirability of exploiting the short-run benefits of appreciation result from quadratic costs of inflation, or at least rising marginal costs of inflation, and the implicit assumption that the indirect costs of the policy mix, including budget deficits and current account deficits, are small when measured at a zero policy change baseline. In other words, as in the static model of the previous section, the economy must have more of an "inflation problem" than a "budget deficit problem" or "current account problem" on the baseline.[49] Because of quadratic costs of inflation, it pays to reduce inflation quickly; because of small welfare costs on the margin of budget deficits and current account deficits, it is worth pursuing the Mundell mix for the sake of inflation control.

The results of the simulation really focus, then, on the output-inflation trade-off, without seriously trying to measure the welfare costs of running large budget deficits or large current account deficits. Some critics of the mix have argued that it has imposed large costs by restricting investment expenditure, though Barry Bosworth's analysis in this volume calls that view into question. Others have worried about the political and economic ramifications of a large external U.S. indebtedness. Still others have asserted that for given aggregate output levels, there are major costs to building the nontradables sectors at the expense of tradables, particularly since that buildup will likely have to be reversed over time. Such assertions are plausible, but so far unquantified. I have included a weight for them by weighing the welfare costs of budget deficits and current account deficits in the social welfare function. To the extent that they are to be more highly credited, the result would be to weaken further the case for the strong dollar policy mix. In any event, all of the optimal policy paths call for a steady real depreciation after the initial appreciation. However much the Mundell mix is pursued, it must be reversed over time.

49. As shown earlier, this statement can be given precise technical content for a specific optimization problem.

Finally, I reiterate the point that the welfare discussion is based entirely on a national welfare function, taking as given the actions abroad. A global analysis of global disinflation would likely argue against the attempt of any particular country to engineer a large currency appreciation.

Conclusions and Problems Ahead

Without the strong dollar in recent years, the United States either would have had much higher inflation or would still be languishing, as is Europe, with double-digit unemployment. But the future looks somewhat bleaker, now that the U.S. economy has already enjoyed the benefits of the strong dollar and faces the higher inflation built into the process of unwinding the dollar. As long as the depreciation is gradual, the actual inflation rate does not have to rise as the dollar falls, assuming that domestic price inflation continues to fall, which is likely if there is continued (and declining) slack in the economy. As shown in Case I above, with "low" output weight, the unwinding of the dollar takes place in the context of steady declines in inflation and a steady rise of output to full employment.

The risks from the current situation come from the possibility either of a sharp drop in the dollar or of a real appreciation that is sustained too long. Note that the optimal policy packages involve high but steadily falling budget deficits, and certainly not a path of continuing high and rising deficits, as now appears possible in the United States. What happens, in fact, if the Mundell mix gets stuck, and the deficits remain inappropriately high? To investigate this case, the model is simulated for a permanent exogenous path of deficits of 4 percent of GNP, with optimum monetary policy that takes the deficit path as given. The major effects of this undesirable fiscal policy are a sustained path of current account deficits and a large long-term decline in private absorption. The economy experiences an enormous increase in external indebtedness, and real consumption is squeezed in the long run to make room for the net exports needed for debt servicing.

A final case to consider is the implication of a shift in portfolio preferences against the dollar, starting from a situation of large real appreciation. Many analysts, such as Stephen Marris, believe that when

Table 11. Effects of a Shift in Portfolio Preferences Away from U.S. Dollar, 1985–88[a]

Case and variable	*1985*	*1986*	*1987*	*1988*
Baseline: no portfolio shift				
Real exchange rate[b]	18.0	14.1	12.1	10.4
Output gap (percent)[c]	−4.8	−4.0	−3.4	−2.8
Inflation rate (percent)	3.3	2.6	2.2	1.8
Assumed portfolio shift, with policies unchanged				
Real exchange rate[b]	−9.5	−4.3	−5.7	−5.8
Output gap (percent)[c]	0.5	−7.5	−5.5	−6.3
Inflation rate (percent)	5.0	6.5	3.6	2.9
Assumed portfolio shift, with optimal policy response				
Real exchange rate[b]	0.2	−1.5	−2.7	−3.6
Output gap (percent)[c]	−6.1	−5.0	−4.1	−3.4
Inflation rate (percent)	4.9	3.6	2.0	2.4

a. Low output weight case.
b. Departure from long-run equilibrium, in percentage points.
c. A negative sign indicates output below potential.

the dollar begins to depreciate, the "luster" on the currency will diminish, and a flight from dollars will ensue. What is the appropriate response of policy in that case, given that adjustments to such a shock will inevitably be painful?

To study this case, suppose that inherited inflation is 5 percent at the time of the portfolio shift, and that the preceding period's GNP gap was 5 percent. Suppose further that an exogenous and permanent ROECD portfolio shift occurs that would result, with unchanged U.S. policy, in a 27.5 percent depreciation of the dollar. Optimal monetary and fiscal policies are then applied in response to this shock. Table 11 compares output and inflation in three cases: no portfolio shift, a portfolio shift but no policy response, and a portfolio shift with optimal policy response. The utility function settings are for the case of low weight on output.

By itself, the portfolio shift causes a rise in output in the first year and a sharp increase in inflation. In principle the direction of effect of a portfolio shift on output is ambiguous. When the portfolio shift occurs, U.S. interest rates rise and the real exchange rate depreciates. The first effect tends to reduce output, while the latter tends to raise output. In the model as specified, the exchange rate effect dominates the interest rate effect, as is true of most large-scale econometric models as well. However, by the second year the effect turns negative. Optimizing policymakers are forced to tighten sharply in the face of the portfolio shift, as shown in the bottom of table 11. The economy is pushed into a mild recession (comparing the portfolio shift cum policy response with the baseline), with the output gap about 1 percent higher, and inflation 1 percent higher, for four years. Thus, even with an optimal response to the portfolio shift, the net result is a spurt in inflation and a mild recession.

APPENDIX

Commodity Prices and the Exchange Rate

THIS APPENDIX describes the derivation of equation 8, the equation for the dollar price of primary commodities used in the structural model in the text.

The world is divided into the United States, the rest of the OECD (ROECD), and the less developed countries (LDCs), including the nonoil LDCs and OPEC. The exchange rate measures the ECU-dollar rate, where the "ECU" is the weighted average currency of the ROECD. I assume that LDCs peg their currency to maintain a constant real exchange rate vis-à-vis the total OECD area, with the United States receiving a weight α and the ROECD, $(1 - \alpha)$ in the LDC currency basket. The term E^L denotes the nominal exchange rate of the LDC currency vis-à-vis the dollar, and $e^L = \log(E^L)$. Letting p, p^O, and p^L be the fixed (log) output prices in local currencies in the three areas, assume:

$$e^L = p^L - [\alpha p + (1 - \alpha)(p^O - e)]. \tag{A.1}$$

Furthermore, by the assumption of competitive world trade in R^i, I specify the local currency price of R^i as:

(A.2)
$$\begin{aligned} &p^r \text{ in the United States} \\ &p^r + e \text{ in the ROECD} \\ &p^r + e^L \text{ in the LDCs.} \end{aligned}$$

Now, a useful model makes supply of R^i in each country an increasing function of the local relative price of R^i. Assuming a constant supply elasticity ϵ^s:

(A.3) $R_s^U = \alpha_U(P^R/P)^{\epsilon s}$ in the United States

$R_s^O = \alpha_O(P^R E/P^O)^{\epsilon s}$ in the ROECD

$R_s^L = \alpha_L(P^R E^L/P^L)^{\epsilon s}$ in the LDCs.

Demand for R^i is written as a negative function of the relative price of R^i, and as an increasing function of real national income, with a demand elasticity ϵ^D in each area:

(A.4) $R_D^U = \beta_U(P^R/P)^{-\epsilon^D} Y_U^{\phi}$ in the United States

$R_D^O = \beta_R(P^R E/P^O)^{-\epsilon^D} Y_O^{\phi}$ in the ROECD

$R_D^L = \beta_L(P^R E^L/P^L)^{-\epsilon^D} Y_L^{\phi}$ in the LDCs.

Equilibrium requires that the world supply $R_s^W (= R_s^U + R_s^O + R_s^L)$ equal world demand $R_D^W (= R_D^U + R_D^O + R_D^L)$:

(A.5) $$R_s^W = R_D^W.$$

The conceptual experiment asks how a percentage change in E affects the dollar price P^R of commodity R^i, holding fixed the output prices P and P^O. To solve this problem, we logarithmically differentiate A.3 and A.4 and note that the percentage changes in world supply and demand may be written as:

(A.6) $$\mathrm{d}r_s^W = \theta_s^U \mathrm{d}r_s^U + \theta_s^O \mathrm{d}r_s^O + (1 - \theta_s^U - \theta_s^O)\mathrm{d}r_s^L$$

$$\mathrm{d}r_D^W = \theta_D^U \mathrm{d}r_D^U + \theta_D^O \mathrm{d}r_D^O + (1 - \theta_D^U - \theta_D^O)\mathrm{d}r_D^L,$$

where θ_s^U and θ_s^O are the shares of the United States and the ROECD in supply of R^W (θ_D^U and θ_D^O are analogously defined) at the initial equilibrium. Remember, finally, that by assumption $\mathrm{d}(e^L - p^L) = (1 - \alpha)\mathrm{d}e$. The equality follows from equation A.1. A bit of algebra yields a general expression for $\mathrm{d}p^r$:

(A.7) $$\mathrm{d}p^r = [\gamma \mathrm{d}p + (1 - \gamma)(\mathrm{d}p^O - \mathrm{d}e)] + \phi \mathrm{d}y^W,$$

where $$\mathrm{d}y^W = \theta_O^U \mathrm{DY}_U + \theta_D^O \mathrm{d}y_O + (1 - \theta_D^U - \theta_D^O)\mathrm{d}y_L, \text{ and}$$

$$\gamma = \{\epsilon^D[\theta_D^U(1 - \alpha) + (1 - \theta_D^O)\alpha] + \epsilon^s[\alpha\theta_s^O + (1 - \alpha)(1 - \theta_s^U)]\}/(\epsilon^D + \epsilon^s)$$

$$0 < \gamma < 1.$$

Note that p^r changes in proportion to a weighted average of changes in p and $(p^O - e)$, and also in response to changes (weighted) in world income y^w. The term γ is the weight attached to U.S. prices and $(1 - \gamma)$ is the corresponding weight for ROECD prices.

According to equation A.7, the effect of an exchange rate change on p^r is given by $\mathrm{d}p^r/\mathrm{d}e = -(1 - \gamma)$. It is easy to compute $\mathrm{d}p^r/\mathrm{d}e$ for a number of special cases. If the United States is "small" in the world, in the sense that $\theta_s^U = \theta_D^U = \alpha = 0$, then $\mathrm{d}p^r/\mathrm{d}e = -1$. This is the standard case that for a small country, an exchange appreciation lowers traded good prices one for one. If the United States is dominant in the OECD, with $\alpha = 1$ and $\theta_s^U = \theta_D^U = 1$, then $\mathrm{d}p^r/\mathrm{d}e = 0$. In this case, an exchange depreciation would have no effect on dollar commodity prices. Third, if the U.S. shares of the OECD production and consumption of R^i are equal, and are in turn equal to α (the weight of the United States in the LDC exchange basket), then $\mathrm{d}p^r/\mathrm{d}e = 1 - \alpha$. The larger is the U.S. weight, the smaller is the exchange rate effect on dollar commodity prices.

Comments and Discussion

Stanley Fischer: Every year at this time the youngest child present stands up and asks four questions.[1] They are: How much did the dollar appreciation contribute to disinflation? Can the policy mix explain changes in the exchange rate? Should we expect a depreciation that will offset the effects of the appreciation? Was the optimal strategy followed even so?

The answers to the four questions are very long. They begin with a reference to our forefathers, in this case Robert Mundell. A series of interesting stories—in all likelihood based on fact—is presented to interest us in the problem. For instance, the generally declining money growth rate since 1981 is almost a fact, though difficult to find in the data.

The Mundell article is indeed brilliant, and it does suggest the tight money, easy fiscal policy mix, but it certainly does not justify that mix by its effects on the exchange rate. Mundell simply announces that monetary policy determines the inflation rate and fiscal policy determines output, and that is it. But it would be churlish to object to slight inaccuracies in interpreting the historical sources, because it is a sign of a living religion when the disciples reinterpret the prophets in meaningful ways that appeal to the modern generation.

Now to substance. Jeff Sachs gives more or less conventional answers to the four questions. First, he argues that the dollar appreciation did contribute substantially to the disinflation between 1980 and 1984. Both the successive Phillips-curve-type models in the first part of the paper and the McKibbin-Oudiz-Sachs (MOS) model, which incorporates a similar Phillips curve, at the end attribute about 30 to 40 percent of the disinflation to the exchange rate appreciation. Second, the MOS model—an enlarged multi-regional Mundell-Fleming model—implies that the

1. The paper was delivered on the day before Passover 1985.

policy mix was largely responsible for the exchange rate appreciation. Third, Sachs argues that there will be a dollar depreciation back to the level of 1977. And finally, the U.S. strategy was almost optimal. The error is that fiscal tightening did not begin earlier.

As a preliminary comment, let me note that thinking in terms of the policy mix can be slightly misleading. If a stabilization program is to reduce the inflation rate, the growth rate of money has to be reduced, sooner or later. The policy mix question is whether both monetary and fiscal policy should start out restrictive, or whether one should be restrictive and one expansionary, and if so, which? But there is no way of reducing the inflation rate in the long run without eventually cutting the growth rate of money. The long-run equivalent of short-run "easy money" is not a high growth rate of money, but rather a high ratio of money to bonds in the economy.

It is worth drawing attention to Sachs's interesting finding that the long-run sacrifice ratio is larger with real exchange rate appreciation than without. This is because the interest on the external debt accumulated during the disinflation period has to be repaid through a real depreciation larger than the initial appreciation. Since Sachs uses only backward-looking expectations in the Phillips curve, there is no long-run benefit, in terms of lost output, from a quick initial disinflation.

I will direct my remaining remarks to four issues: first, the Sachs estimates of the sacrifice ratio; second, the model of the role of the exchange rate in the disinflation; third, the predictions of dollar depreciation; and fourth, the question of optimal policy.

Sachs's calculated sacrifice ratios are too low. With unemployment still above the natural rate, the output loss of 21.5 percent of GNP is low; the slowdown in inflation to 2.4 percent is exaggerated. On the assumptions that the stabilization effort began at the end of 1979 and that full employment will be restored in mid-1986, the sacrifice ratio is about 4.5. But however the sacrifice ratio is calculated, the loss in output in the current disinflation is at the low end of earlier estimates. An estimate of 4.5 is consistent with Okun's lower bound estimate of 6, when adjusted for the shift in the Okun's law coefficient.

In 1982, Robert Gordon and Stephen King anticipated a low sacrifice ratio in a vector autoregressive model that included the exchange rate.[2]

2. Robert J. Gordon and Stephen R. King, "The Output Cost of Disinflation in Traditional and Vector Autoregressive Models," *BPEA, 1: 1982*, pp. 205–42.

In his paper in this volume, by contrast, Gordon finds no special role for the exchange rate. A correct deduction is that exchange rate effects are difficult to pin down statistically. In a paper referred to by Sachs, Rudiger Dornbusch and I find relatively large exchange rate effects on wages, but those effects are statistically significant only when the post-1980 period is included in the regression.[3] Our interpretation is that during the post-1980 period there was a sectoral effect of foreign competition on wages in particular industries, such as automobiles, that were suffering from foreign competition.

Now why should the path of the exchange rate matter? Sachs points to a direct effect of import prices on consumer goods prices, a direct effect of import prices on input prices, and a competitiveness effect by which lower import prices squeeze domestic profit margins. The dynamics of adjustment to a change in policy will thus not be independent of the path of the exchange rate.

All these mechanisms are included in Sachs's Phillips curve estimates at the beginning of the paper and in the MOS model at the end. However, they are not directly relevant to the issue of whether the path of the exchange rate affects the long-run sacrifice ratio. Dornbusch[4] and Willem Buiter and Marcus Miller[5] have shown that the path of the exchange rate has no effect on the sacrifice ratio in a disinflation if the Phillips curve is linear, if expectations in the Phillips curve are backward-looking, and if the real equilibrium is the same after the disinflation as before. Sachs demonstrates that result in this paper too.

Put simply, in such models it takes a specific amount of unemployment to reduce the inflation rate permanently by 1 percentage point. The Sachs model has a linear Phillips curve and backward-looking expectations, and thus has the same property. In what sense, then, can the path of the exchange rate matter for the costs of disinflation? In the first place, the model may be missing some ingredient. Franco Modigliani and Lucas

3. Rudiger Dornbusch and Stanley Fischer, "The Open Economy: Implications for Monetary and Fiscal Policy," Working Paper 1422 (National Bureau of Economic Research, August 1984).

4. Rudiger Dornbusch, "Inflation Stabilization and Capital Mobility," Working Paper 555 (National Bureau of Economic Research, September 1980). Dornbusch in private conversation attributes this result to Franco Modigliani.

5. Willem Buiter and Marcus Miller, "Real Exchange Rate Overshooting and the Output Cost of Bringing Down Inflation," *European Economic Review*, vol. 18 (May-June 1982), pp. 85–123.

Papademos looked for direct effects of the growth rate of money on inflation, effects that were over and above any operating through aggregate demand.[6] Another possibility is that expectations are forward-looking, so that the expectation of restrictive policy reduces the inflation rate.[7] Or perhaps the world is nonlinear. Or there may be a permanent change in the real exchange rate—for instance, as in Sachs's model at the end of the paper, when the real exchange rate has to depreciate to generate the interest on the debt incurred in the disinflation process. I believe that expectations are to some extent forward-looking, and that the path of the exchange rate therefore does affect the sacrifice ratio, by producing quick results on the inflation front.

Alternatively, the sacrifice ratio may be a poor utility function. When Sachs, at the end of the paper, calculates optimal policies, he does so using a quadratic utility function with a target inflation rate of zero and with discounting. In that situation, there is a utility gain to reducing a high inflation rate quickly, and that is why optimal policy starts with an exchange rate appreciation.

The third issue is that of the dollar depreciation. Sachs's exchange rate equation is for the deutsche mark-dollar rate. He explains the real exchange rate by the relative cyclical positions of the United States and West Germany, and by the long-term real interest rate differentials between the two countries. The interest rate differentials do most of the work, but they are extremely problematic, because the expected inflation rate is not observable. The proxy for the expected inflation rate is the average of inflation one year ahead and one year behind. This is simply not credible when the period over which expectations are being formed is about six years. Sachs has the long-term expected inflation rate in the United States down to about 4 percent already by the beginning of 1983. It is doubtful indeed that that was the typical market expectation; nor is a long-term inflation rate expectation of 3 percent by the beginning of 1984 plausible.

Accordingly, the exchange rate equation is hard to trust. Suspicions should be reinforced by the low Durbin-Watson, to which Sachs modestly

6. Franco Modigliani and Lucas Papademos, "Targets for Monetary Policy in the Coming Year," *BPEA, 1:1975*, pp. 141–65.

7. Stanley Fischer, "Real Balances, the Exchange Rate, and Indexation: Real Variables in Disinflation," Discussion Paper 1497 (National Bureau of Economic Research, November 1984).

points. The serial correlation of the errors is entirely consistent with changing expectations of the long-term real exchange rate. Thus, the exchange rate equation brings very little evidence to bear on whether the real exchange rate will return to its 1977 level.

The U.S. current account deficit is too large to be sustainable. The dollar will at some stage depreciate. But equations like those in table 5 do not tell us how far it will go. We currently have no good basis for predicting how large are sustainable U.S. deficits. The deficit is small as a percentage of total foreign wealth, and foreigners may for some time want to continue adding substantially to their holdings of dollar assets.

The final issue is that of optimal policy. Using the MOS model, Sachs finds policy to have been close to optimal, because the starting point was a time of high inflation. I think that conclusion is right, as is the qualifier that fiscal policy should have turned restrictive sooner.

But there are some doubts. First, the MOS model is very much a black box. It is a generalized Mundell-Fleming model with large interest rate and wealth effects on aggregate demand, and strong exchange rate effects on trade flows. Whether a particular policy mix is optimal depends very much on dynamics—for instance of the J curve—but we are not given much information on this score.

Second, as Sachs appreciates, the strategy of overvaluing the currency is not for everyone. Every LDC that has had a debt crisis has tried at some earlier stage to stabilize inflation by overvaluing the currency. Those that did not succeed—and that means all of them—found themselves in deep trouble, the results of which we are still seeing around the world.

Maurice Obstfeld: Jeffrey Sachs argues that the early stages of an optimal disinflation policy are characterized by tight monetary policy, fiscal ease, and a steep appreciation of the currency. Nominal appreciation buys a rapid fall in inflation early on, when inflation is most costly, while fiscal expansion softens the effect of monetary contraction on output. Subsequently, the currency should depreciate as full employment and price stability are regained. Sachs suggests that the dollar's appreciation has played a key role in the decline of U.S. inflation since 1980, but he foresees a significant and possibly inflationary depreciation in coming years.

The logic leading to the Mundellian policy mix is appealing, and it is no surprise that the mix emerges as an optimal policy in various simulation models employed in this paper. Sachs's analysis of the dynamic implications of Mundell's short-term view is a useful theoretical contribution. Loosely speaking, quadratic policymaker preferences imply that it is optimal to "borrow" low inflation when the marginal disutility of inflation is high, and to repay that loan later when inflation and its marginal disutility have come down. Borrowing, in this context, takes the form of a sharp exchange rate appreciation that is paid back later, as lower fiscal deficits, looser money, and the unwinding of any initial overshooting depreciate the currency. It is worth repeating Sachs's point—a point not really pursued in this paper—that lower inflation is, quite literally, borrowed from abroad, in the sense that a sharp dollar depreciation leads to an initial rise in inflation in the rest of the OECD. Presumably, the short-term disinflationary benefits of the policy mix are negated if foreign countries are unwilling to make the initial loan and respond by adopting a similar fiscal-monetary stance.

It is also worth noting that Mundell's game, if played at all, is one that should be played by large countries only, or by a large coalition of countries. I will argue shortly that a small country might well wish to couple monetary contraction with fiscal contraction.

Sachs does not push the claim that U.S. macroeconomic policy has been in any sense optimal in recent years, although he implies that the initial policy mix was correct in its orientation. Sachs's analysis also implies significant policy overkill. Consider the model leading to his equation 24b, which can be written as

$$R_t = \theta\Omega\pi_t,$$

where Ω is the ratio of the weights that the policymaker places on inflation and the real exchange rate. This expression equates the marginal rate of substitution between real appreciation and inflation to the marginal rate of transformation of θ. Take $\theta = 0.15$ and assume an optimal policy in 1981, with a real exchange rate 15 percent higher than a 1980 base and an inherited CPI inflation rate of 10 percent. Revealed preference implies a Ω value of 10. Using the inflation rates for 1982–1981 and 1983–1982 of 5.9 percent and 3 percent, respectively, the optimal real appreciations in 1982 and 1983, relative to 1980, are 8.9 percent and 4.5 percent. In fact, the real exchange rate, rather than declining, was 24.1 percent higher in 1982 than in 1980, and 28.4 percent higher in 1983. Clearly, the government budget deficit as a percentage of GNP has not yet begun to decline, as prescribed by Sachs's simulations.

Another implication of the foregoing arithmetic is that policymakers will opt for a large initial appreciation only when they weigh the costs of inflation heavily relative to those of real exchange rate change or current account deficits. Is this a reasonable presumption? Sharp movements in the exchange rate may entail severe losses for the economy as resources move out of the tradable goods sectors into sectors favored by government demand. If the temporary nature of the real appreciation were understood, exporting and import-competing firms could borrow to cover costs in anticipation of the exchange rate reversal. But this is not always possible in practice, and a more likely outcome is a rising clamor for protection from imports. Indeed, this is one of the most dangerous consequences of the current real exchange rate configuration among OECD countries.[1]

This brings me back to the applicability of Sachs's analysis to small countries. Here, fiscal expansion is likely to have quite small effects on overall aggregate demand but significant effects on the allocation of that demand among industries. To minimize the sectoral dislocations following an exchange rate appreciation caused by monetary tightening, it may be best to *reduce* government spending so as to hold the real exchange rate steady.

Mundell's 1971 policy mix was, in fact, prescribed for a world of exchange rates pegged to the dollar. Under that regime, fiscal expansion in the United States would have led to no sudden real appreciation, but instead to a sharp reduction in the rest of the world's money supply and a gradual rise in the U.S. price level relative to those in other countries. In addition, Mundell envisioned loose fiscal policy as taking the form of a tax cut, which presumably would have caused less sectoral dislocation than an equivalent fiscal stimulus that shifts aggregate demand toward defense-related industries. Neither Mundell nor Sachs considers the effect of the policy mix on capital accumulation at home and abroad.

Sachs's case for a "strong-currency" approach to disinflation hinges

1. Since the early 1970s, changes in real exchange rates, rather than aggregate employment fluctuations, seem to have served as the main pretext for pressures within the United States to restrict foreign trade. C. Fred Bergsten discusses the case of U.S.-Japanese trade in "What to Do about the US-Japan Economic Conflict," *Foreign Affairs*, vol. 60 (Summer 1982), pp. 1059–75.

in an important way on the linkage between the dollar's value and the U.S. price level. In the absence of this link, fiscal policy might still furnish a means of cushioning real output (the main point of Mundell's analysis), but it would certainly be less attractive. Much of the paper is therefore devoted to empirical evidence on the inflationary effects of exchange depreciation.

The question one would like to answer is: how would the time path of inflation have differed if the policy mix of 1981 had been implemented under fixed exchange rates? I am not sure how the partial-equilibrium model in the first part of the paper throws light on this question. Aside from some obvious problems of specification and identification, the interpretation of the simulations is unclear. It is hard to envision an "exogenous" shock to an endogenous variable—the exchange rate—that leaves unchanged all other endogenous variables except prices. In general, the relation between an exchange rate change and subsequent price movements will depend on the fundamental exogenous change perturbing the economy. For example, an adverse shift in world consumption preferences will cause depreciation and a fall in domestic goods' prices, while monetary expansion will cause depreciation and domestic inflation. It would be interesting to use the Sachs-McKibbin model to compare the effect of fiscal policy on inflation under fixed and floating nominal exchange rates. This simulation would make the foreign price level an endogenous variable, and one which generally behaves differently under the two exchange rate regimes.

Much discussion at this meeting has focused on whether the dollar will drop, how far, and how fast. Sachs presents his evidence and concludes that market expectations entail a dollar depreciation against the deutsche mark of roughly 30 percent over a period of about seven years. The chief analytical tool underlying the calculation is the expectations theory of international nominal interest differentials, also known as the interest parity condition. A now extensive body of econometric research rejects the hypothesis that nominal interest differentials equal expected depreciation rates, but no competing theory has received strong empirical support. Nominal interest parity implies that international *real* interest differentials equal expected *real* exchange rate depreciation rates; if the expectations theory holds, as Sachs assumes, real interest differentials can be used to forecast real exchange rates.

I fully agree with the conclusion that the market should expect an eventual real depreciation of the dollar, essentially because everything that one might reasonably anticipate happening points in that direction. In the long run, the real exchange rate depends on technology, private sector preferences, fiscal policies, and the world distribution of wealth. Technological and taste changes are probably impossible to forecast. That leaves the U.S. current account deficit and the likely future evolution of OECD fiscal stances, both of which point to a long-run real depreciation.

I differ with Sachs concerning the extent of the real depreciation. His calculation requires assumptions both about the time required for the world economy to reach long-run equilibrium and about the nature of inflation expectations. He estimates the length of the long run by assuming that the expected long-run real exchange rate has been a constant since 1977, and then regressing the current real exchange rate on his measure of the real interest differential. Jeffrey Shafer and Bonnie Loopesko have run a very similar regression on monthly data for the sample period August 1973 to March 1982, finding a coefficient less than half the size of those reported by Sachs.[2] What these conflicting results suggest is that one cannot justifiably interpret the correlation between the real interest differential and the real exchange rate as a structural parameter measuring the length of the transition period. Sachs's assumption that the expected long-run real exchange rate was constant over the sample is troublesome. That assumption would certainly be invalid now. Future reductions in U.S. federal spending, as they occur, should bring a fall in the dollar's real long-run value; surely the markets anticipate this.

Sachs's modeling of inflation expectations is worrisome as well. A two-year centered moving average of actual inflation rates may not capture inflation expectations over the longer term, and casual evidence from the bond markets suggests that Sachs's measure of long-run expected U.S. inflation is an underestimate. A corollary of the expectations theory of nominal interest differentials is an expectations theory of

2. Jeffrey R. Shafer and Bonnie E. Loopesko, "Floating Exchange Rates after Ten Years," *BPEA, 1:1983*, pp. 1–70. Shafer and Loopesko do not interpret their estimated coefficients as adjustment speeds. More recent estimates similar to Sachs's are reported in Peter Hooper, "International Repercussions of the U.S. Budget Deficit," International Finance Discussion Paper 246 (Board of Governors of the Federal Reserve System, September 1984).

the term structure of nominal interest differentials: international interest rate parity at all maturities implies that the interest differential between T-period bonds denominated in different currencies is approximately an average of the differentials on one-period bonds expected to prevail between today and date T. At present, long-term nominal interest differentials between the United States and West Germany are roughly 200 basis points above short-term differentials. Under the expectations theory, this implies an expected rise in the U.S.-West German short-term real interest differential, an expected future increase in relative U.S. inflation, or some of each. Given the probable future evolution of fiscal positions within the OECD, I find the expected-inflation explanation of the current international term structure most plausible. While the real value of the dollar should be expected to fall, I am not convinced that markets expect it to fall as far as its 1977 level.

General Discussion

Several Panel members discussed Jeffrey Sachs's model of policy reaction. Christopher Sims emphasized the possible weakness of modeling wage behavior in a way that prevents it from reacting to policy changes. He suggested that the result be compared with results that would come from relaxing this restriction. Sims also noted that the utility function that Sachs assumes is separable, so that the smoothness of the inflation path does not matter. A plausible, perhaps superior, alternative that attributed disutility to changes in the inflation rate might, in general, show quite different optimal policies. Sims agreed that Sachs's formulation might be adequate in the present episode; inflation had run up quickly, creating a political consensus to reduce it. Martin Baily added that squaring inflation in the utility function produces Sachs's main policy finding favoring reduced inflation now at the expense of higher inflation later. He could see no presumption that reducing inflation from 11 to 10 percent added several times more utility than reducing it from 2 to 1 percent, which is what the squared term implies.

William Nordhaus suggested that Sachs's analysis should focus more on the important findings of an earlier paper by Gilles Oudiz and Sachs comparing cooperative and noncooperative policies among nations (*BPEA, 1:1984*). The earlier paper stressed that, in a noncooperative setting, policy reactions abroad would move all countries toward a mix in which monetary policy was too restrictive and fiscal policy too easy. This mix results because each country tries to export its inflation, though collectively they cannot do so. Nordhaus also noted that it is very difficult to reverse an easy fiscal policy, as recent U.S. experience shows. Allowing for costs of changing policy could substantially attenuate Sachs's prescription.

Nordhaus questioned the use of long-term real interest rate differentials to explain exchange rate movements. He noted that short-term real interest rate differentials were near zero, so that they would predict no movement in exchange rates in Sachs's model. Thus the explanatory power of the long-term interest rate differentials rests on the steepness of the yield curve in the term structure of interest rates. If the term structure is taken to represent expectations of sharply rising short-term rates, the long-term rate is appropriate for Sachs's purpose. But that interpretation is supported neither by surveys of interest rate expectations nor by the demonstration by Robert Shiller, John Campbell, and Kermit Schoenholtz (*BPEA, 1:1983*) that the term structure has no predictive value for future short-term rates. If, instead, the term structure represents a risk premium on long-term bonds, then bonds are inappropriate for Sachs's analysis, and the short-term interest rate differential should be used instead, with very different results.

Nordhaus doubted Sachs's assumption that before the 1980 election, inflation expectations were near 10 percent if Carter won but, if Reagan won, could be represented by the actual inflation rates that ensued. He pointed out that surveys of inflation showed little impact of the election on inflation expectations. Furthermore, to explain the dollar appreciation that has occurred, Sachs's model indicates that expected real interest rates must have been lower in the United States than abroad; the implication is that expected inflation in recent years has been much higher than experienced inflation.

George von Furstenberg showed that so long as the inflation rate depends on the exchange rate, expectations about inflation and exchange rates must be determined simultaneously. When exchange rates move in an unpredicted way, inflation rates will do likewise, making it impossible to use observed inflation rates to infer expected real interest rates as Sachs does. Von Furstenberg offered, as an example, a case in which nominal interest rates and expected inflation were both three points higher in the United States than in West Germany, so that expected real interest rates were equal and, according to Sachs's model, no real exchange rate change would be expected. If the dollar were then to appreciate by 10 percent and if, as a consequence, the inflation differential were to turn out to be zero instead of 3 percent, it would appear ex post that U.S. real interest rates were three points higher than those in West Germany. But this difference cannot be used to explain the exchange rate movement because, ex ante, the expected real interest difference was zero.

George Perry objected to Sachs's method of calculating the experienced sacrifice ratio. Sachs chose late 1980 as his starting point because foreign exchange markets began to recognize the U.S. disinflation at that time; but the disinflation policy had actually started in October 1979, and its effects on unemployment and output had been felt soon thereafter. By late 1980, unemployment was already up a couple of points and inflation was just starting to slow, making a sacrifice ratio calculated starting from that time artificially low.

Edmund Phelps suggested two possible effects through which the fiscal-monetary mix could play a special role in improving the disinflation-output mix, in addition to the role assigned to the mix by Sachs. The first effect rests on the assumptions that monetary policy can bring down inflation without recession if it has full credibility and that this credibility depends on the rate of money growth. In this case, if policy reduces inflationary expectations by reducing the money supply, interest rates will fall, thus increasing the demand for money at the initial level of output. If the money supply expands to meet this higher demand, credibility may be lost; if it is not allowed to expand, output will fall. An expansionary fiscal policy can, in this case, restore the level of output without losing the anti-inflation credibility that depends on money growth. Phelps's second effect rests on getting a positive labor supply response to tax cuts. If the response is significant, adding tax cuts to monetary restraint will raise the unemployment rate, and hence the disinflation, that is associated with any level of output.