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No. 165, October 1986

INFLATION, EXCHANGE RATES,
AND STABILIZATION

RUDIGER DORNBUSCH



INTERNATIONAL FINANCE SECTION

DEPARTMENT OF ECONOMICS
PRINCETON UNIVERSITY
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ESSAYS IN INTERNATIONAL FINANCE

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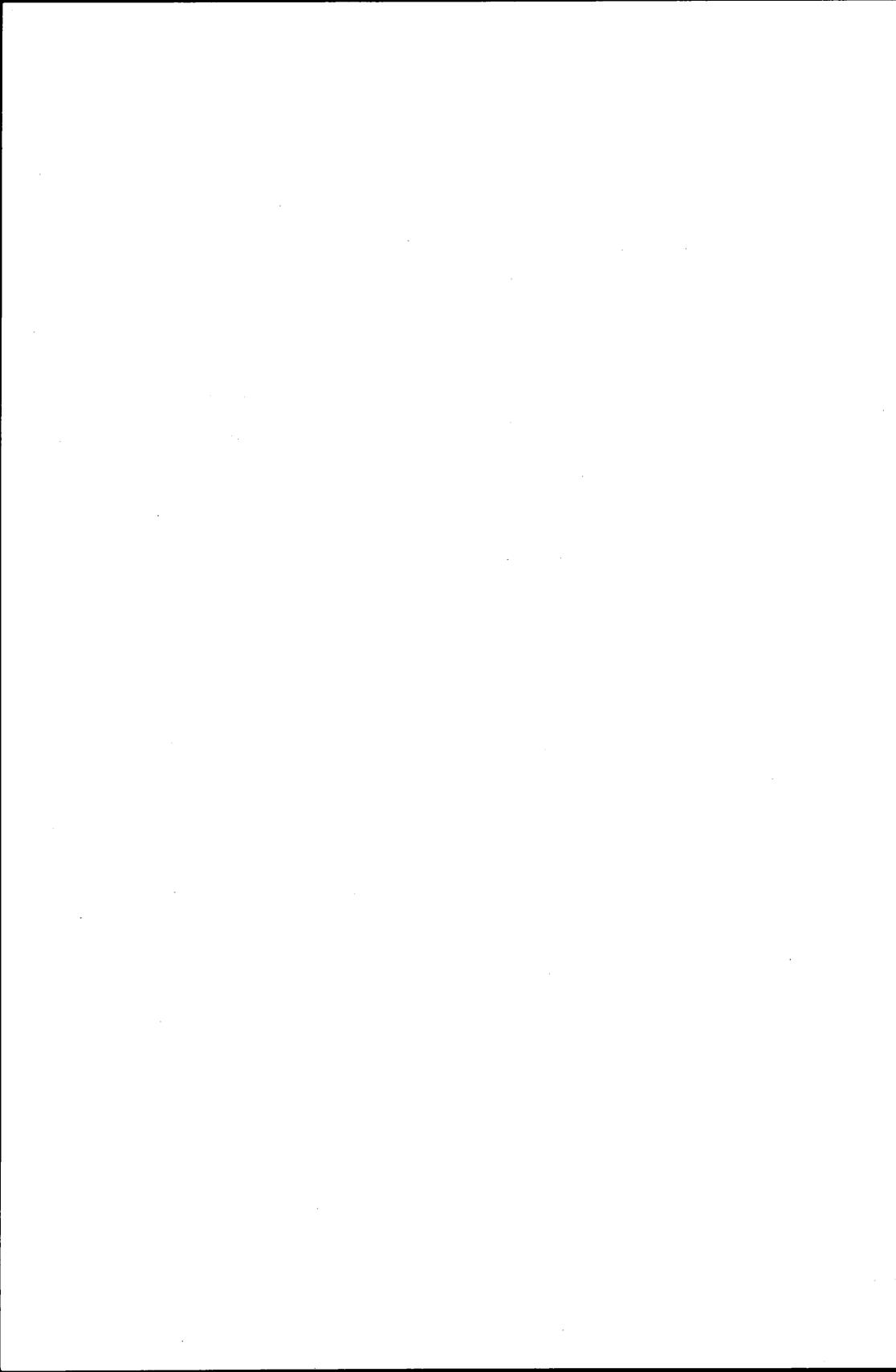
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INFLATION, EXCHANGE RATES, AND STABILIZATION

Frank Graham's interest in the relationship between the monetary standard, exchange rates, and prices spanned his entire professional career. From his 1920 Harvard dissertation on "International Trade under Depreciated Paper" to "Cause and Cure of the Dollar Shortage" in 1949, his work continually touched on the implications of alternative monetary arrangements and the interpretation of actual developments. His most outstanding writing in this area is no doubt *Exchange Rates, Prices and Production in Hyperinflation Germany*, a book that is required reading for anyone who wants to understand the characteristics of extreme monetary experience. International monetary issues were only one of Graham's interests: his work on protection and on general equilibrium can claim as much importance. But his favorite must have been the issue of exchange rates and prices, to which he returned so frequently. It is appropriate to honor his memory with further discussion of this topic.

This essay considers the role that exchange rates play in inflation stabilization. Four different settings are used to examine that role: the experiments with exchange-rate overvaluation in the Southern Cone to which Carlos Diaz Alejandro first drew attention; exchange-rate depreciation in the transition from high to even higher inflation illustrated by the Brazilian experience; exchange-rate fixing and the resulting real appreciation during inflation stabilization in the 1920s; and, finally, the real appreciation of the U.S. dollar from 1980 to 1985. The common thread of the argument is that exchange-rate policy can make an important contribution to stabilization but that it can also be misused and will then lead to persistent deviations from purchasing-power parity (PPP), with devastatingly adverse effects.

The four applications are chosen to highlight quite different issues. In section 1, dealing with Latin America, I direct attention to the trade and capital-account effects of exchange-rate overvaluation. Even though exchange-rate policy can help stop inflation, at least for a while, the resulting overvaluation can become very costly as capital flight and import spending soar in anticipation of the program's collapse. In section 2, I consider the synchronization of wages, prices, and the exchange rate in two contexts. First, I discuss the problem of budget and trade correction in an economy with wage indexation and PPP-based currency depreciation. I then examine attempts to stop hyperinflation by fixing the exchange rate, which is another application of the same set of ideas and is illustrated by the German and Argentine cases. Finally, in section 3, dealing with the U.S. disinflation, I look at the impact of the exchange rate on the prices of commodities and manufactures, analyzing the microeconomic channels through which exchange-rate movements af-

fect relative prices and the inflation process. The essay concludes with quantitative estimates of the contribution of dollar appreciation to U.S. disinflation and the likely inflation cost that must be borne as the dollar comes down again.

1 The Latin American Experiments

In order to bring down inflation in the late 1970s, the authorities in Chile and Argentina used fixed exchange rates or a deliberate reduction in the rate of depreciation relative to the prevailing inflation rate. In Chile's case, the exchange rate was fixed outright even though the prevailing inflation rate was still 30 percent. In Argentina's case, a timetable for pre-fixed disinflation—the *tablita*—was adopted. In both countries, inflation was indeed brought down, but at the cost of destructive overvaluation. The experiments were encouraged by the belief that inflation is in part the result of a vicious cycle: inflation requires depreciation for external balance, but depreciation causes cost inflation both directly and indirectly (via increases in wages), and therefore requires renewed depreciation, and so on. The only means to escape from the inflation trap is to cut the recurrent feedback of currency depreciation.¹

Chile

In March 1979, having achieved a balanced budget, the Pinochet regime in Chile decided to round out its classical stabilization program by putting the country on a fixed dollar exchange rate. Even though the inflation rate was still 30 percent, the peso was pegged at 39 to the dollar forever after, or so the government announced.

Exchange-rate pegging was thought to help bring inflation under control through at least two channels. First, international prices would exert an immediate tight discipline on domestic price increases, perhaps not by the literal operation of the law of one price, but still in a very effective manner. This would be all the more true because extensive trade liberalization had been under way, clearing the road for international competition to play its role. Second, exchange-rate pegging would contribute to inflation stabilization by affecting expectations, particularly in sectors that are price setters rather than price takers. The recognition that the exchange rate would be fixed forever would shift expectations from an inflationary setting to a new regime of price stability.

The disinflation strategy was almost successful: inflation fell from 30 percent to zero over the next two years. But the disequilibria that accumulated

¹ On these Southern Cone experiments, see Corbo and de Melo (forthcoming), Diaz Alejandro (1981), Dornbusch (1985a), Edwards (1985), and Harberger (1983, 1985).

in the process undermined the experiment completely. The standard of living in Chile today is below even the 1970 level, mostly as a result of policy blunders. The problem arose from the fact that wages were indexed *backward*: each year's wage increases were determined by the preceding year's consumer-price inflation. This real-wage policy was one of the tools the military dictatorship used to sustain its support, since it led to a rising real wage. Wage increases exceeded the current inflation rate, which was being held down by the fixed exchange rate in 1978-80. As a result, the purchasing power of wages increased sharply in terms of traded goods, causing a loss of competitiveness and a deterioration of the trade balance. The gain in real wages was all the more significant in that complete trade liberalization had contributed to reducing import-price inflation.

The mechanics of overvaluation can be described in a model of cost-determined price inflation. Let p , w , and e be the rates of consumer-price inflation, wage inflation, and exchange depreciation. For simplicity I assume zero productivity growth. The world inflation rate (in dollars) is given and is denoted by p^* . The consumer-price inflation rate is a weighted average of wage inflation and international inflation measured in pesos:

$$p_t = aw_t + (1-a)(e_t + p^*), \quad (1)$$

where a is the share of labor in total costs. Next I use the indexing rule $w_t = p_{t-1}$ and the exchange-rate rule $e_t = 0$ to rewrite equation (1):

$$p_t = ap_{t-1} + (1-a)p^*. \quad (2)$$

Equation (2) shows that the wage and exchange-rate policies combine to yield a gradually declining inflation rate that ultimately converges on the world inflation rate, p^* . The smaller the weight of wages and the larger the weight of international prices in determining the home inflation rate, the more rapid is the convergence. Equation (2) thus bears out the view that exchange-rate policy can be used for disinflation and that the openness of the economy speeds up and reinforces this disinflation strategy.

The problem with the strategy is brought out by equation (3), which shows the rate of growth of the real wage, $w_t - p_t$:

$$w_t - p_t = p_{t-1} - p_t = (1-a)(p_{t-1} - p^*). \quad (3)$$

The real wage rises for as long as lagged inflation exceeds the international inflation rate. Home inflation gradually comes down (without overshooting), but the real wage steadily increases with no correction at any stage for the cumulative overvaluation. Thus, even as the war on inflation is being won, a se-

rious overvaluation problem is developing. The trade balance deteriorates, and the loss in competitiveness also exerts an increasingly adverse effect on employment and profitability. This model of the inflation process is, of course, highly simplified and leaves out potentially important channels (in particular, demand). Even so, it captures the basic contradiction contained in the wage and exchange-rate policies.²

The disequilibrium implied by fixing too many variables did become a problem in Chile. The real exchange rate appreciated by more than 70 per cent from the third quarter of 1979 to the second quarter of 1982. In every such instance of gross overvaluation, there will always be an attempt to rationalize the overvaluation, commonsense notwithstanding, as a change in *equilibrium* relative prices. In the Chilean case, three arguments were advanced: (1) that trade liberalization and extremely high productivity growth had changed the equilibrium price structure; (2) that the basket of Chilean tradables was very special compared with the basket represented by world inflation; and (3) that the real appreciation was merely a response of equilibrium relative prices to a sharp increase in the rate of capital inflow.

The tendency to rationalize overvaluation may stem from the fact that overvaluation is very popular, at least in the initial stages. Diaz Alejandro (1963) and Krugman and Taylor (1978) have emphasized that devaluation can be deflationary, because it cuts the purchasing power of wages in terms of tradables. The same effect is at work in the opposite direction in periods of increasing overvaluation. The first impact is to raise the purchasing power of wages and thus create a period of prosperity, usually called "the miracle." The miracle can last only as long as the central bank can afford to put foreign exchange on sale. But the income effect of higher real wages comes to be dominated by classical substitution away from overpriced domestic labor, and this may happen even before the central bank's reserves are depleted.

Substitution effects on the demand and supply sides lead to bankruptcy and unemployment, which is always the second stage of an overvaluation experiment. The third stage involves paying the bill: the central bank no longer has reserves, but external debt has been incurred to finance the overvaluation and now needs to be serviced. This calls for a trade surplus generated by austerity and sharp real depreciation. The excessive standard of living of the initial stage is now paid for by a long period of deprivation. The predicament is often aggravated by a differential impact of the policy on rich and poor, because they are not equally able to take advantage of the overvaluation. Workers will almost always pay in the end by a cut in their real wage. The cut is

² The contradiction is worth highlighting, since Chicago graduate students, including the Chilean policy makers, had been brought up on Harberger's classic "The Case of the Three Numeraires," which made the basic point that separate exchange-rate and wage targets are incompatible. See, too, Mundell (1968, Chap. 8) and Swan (1960).

necessary to generate the gain in competitiveness required to service the foreign debt. But workers may not have benefited fully in the first stage, when shifting into foreign assets or purchasing imported durables was the name of the game.

The adverse substitution effects are reinforced by real-interest-rate effects. The expectation of depreciation raises nominal interest rates on peso loans. But because the government does not in fact allow the currency to depreciate, real interest rates remain high, imposing financial difficulties on all those firms which are already unprofitable and whose debts are growing relative to assets and earning potential.

In Chile, the overvaluation played itself out through the trade balance. The combined effects of overvaluation and trade liberalization cheapened imports in real terms to an unprecedented extent. There was thus growing doubt that the overvaluation was sustainable, and the public came to believe that access to cheap imports would ultimately disappear via devaluation, tariffs, or quotas. As a result, the level of imports exploded in 1980-81. This was particularly the case for durables; automobile imports doubled, imports of consumer appliances increased nearly 60 percent, and imports of breeding stock more than tripled.

Needless to say, devaluation did take place in the end, inflation is back to above 20 percent, tariffs and quotas are back, the budget has deteriorated, the debt crisis is on, and unemployment has been at record levels for a few years. The exchange-rate experiment has proved to be a terrible mistake, because the effects of wage indexation were ignored. The mistake was compounded by the arrogant stupidity of policy makers, who watched growing overvaluation without recognizing the fatal flaw early on or preparing for the inevitable collapse.

Argentina

The attempt to stabilize the Argentine economy by means of the *tablita* was initiated by Economics Minister Martinez de Hoz in December 1978. Because the inflation rate stood at 120 percent, an outright fixing of the exchange rate seemed implausible. Instead, the government committed itself to a preset declining rate of currency depreciation. The exchange-rate timetable was seen as an important instrument for stabilizing expectations in line with a declining inflation trend.

As in Chile, however, domestic inflation did not decline as rapidly as the rate of depreciation, and the reasons are still debated. The heavily protected Argentine economy and the persistently large budget deficit must certainly be important elements of any explanation. A huge real appreciation took place between 1978 and 1980 and undermined the attempt at disinflation. The inflation rate fell from 120 percent in 1978 to only 60 percent in early

1981. But the system of pre-fixed exchange rates broke down in early 1981, leading to a rapid escalation of inflation that ultimately reached hyperinflation in 1985.

The important difference between the Chilean and the Argentine cases is the channel through which exchange speculation took place. In Chile, trade had been completely liberalized, so flight into importables was the rule. In Argentina, the capital account had been completely opened, so flight into foreign assets was the rule.

Estimates of the magnitude of capital flight are available from a variety of sources. They can be built up from balance-of-payments statistics and increases in gross external debt or from recorded asset holdings. Table 1 shows estimates of the capital flight from three countries from 1979 to 1982 and the increase in their nationals' holdings of deposits or securities with U.S. banks.

Estimates of the amount of capital flight from Argentina from 1978 to 1982 vary, but \$20-\$25 billion is certainly conservative (see *World Development Report*, 1985, pp. 63-65, and Dornbusch, 1985a). Argentine residents, fully aware that the overvaluation of the real exchange rate ultimately had to come to an end, fled into dollar assets, U.S. currency, and real estate in Brazil or Uruguay. The capital flight was financed by the central bank's borrowing from abroad; the proceeds were used to sustain the *tablita* against domestic speculation.

The Chilean and Argentine cases teach the same lesson. If rates of depreciation are to be set below the prevailing inflation rate for some period in order to achieve disinflation, at least three conditions are necessary for success: (1) the monetary and fiscal fundamentals must be consistent with the exchange-rate target; (2) a maximum effort must be made to pursue an incomes policy consistent with the exchange-rate policy rather than rely passively on economic slack and expectations to influence the inflation rate; (3) the government must actively block losses of reserves occasioned by speculation in

TABLE 1
CAPITAL FLIGHT AND INCREASES IN HOLDINGS
WITH U. S. BANKS, 1979-82
(in billion of U. S. dollars)

	Total Capital Flight	Increased Holdings with U. S. Banks
Argentina	19.2	1.9
Mexico	26.5	5.3
Venezuela	22.0	4.6

SOURCE: *World Development Report*, 1985, p. 64,
and *Treasury Bulletin*, various issues.

durables or foreign assets. Transitory taxes on durables can prevent the sort of speculation that occurred in Chile under an open trading system; complete capital mobility should certainly not have been a feature of the Argentine stabilization plan. There is not much of a case to be made for free capital outflows from a developing country at the best of times. During stabilization, it definitely is not a priority.

Other Experiences

I have singled out the experiences of Chile and Argentina because they are particularly clear-cut. But there were other instances of this policy approach in the 1978-83 period. By allowing the peso to become overvalued in 1980-82, Mexico provoked massive imports and capital flight, as shown in Table 1. Venezuela, Peru, and Israel pursued overvaluation policies until they collapsed. In every case, the exchange rate was fixed in order to decelerate inflation and reap political benefits. Without exception, the policy *ultimately* imposed fantastic costs because of the large increases in foreign indebtedness and the massive devaluations that were finally required.

2 Exchange Rates and High Inflation

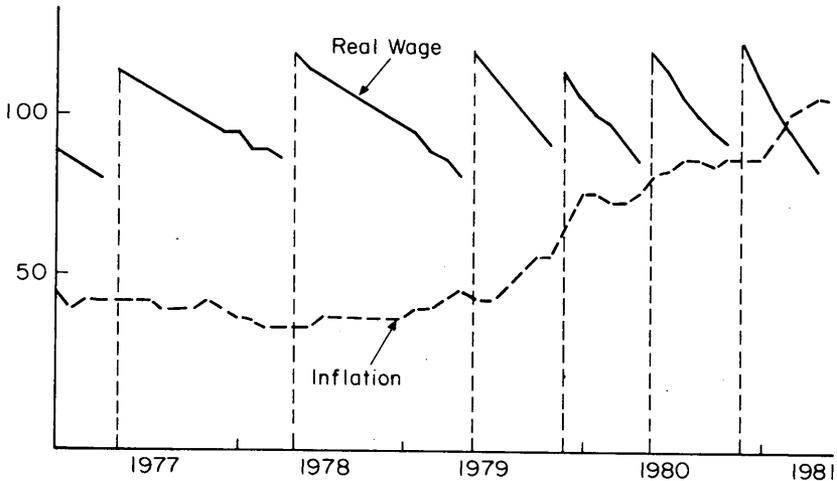
In this section, dealing with the role of exchange rates in episodes of extremely high inflation, I make two points. First, in a context of institutional wage setting, accelerating inflation ultimately leads to a shift from backward-looking pricing decisions to exchange-rate-based pricing. Second, in the stabilization of extreme inflation, fixing the exchange rate may be a strategic measure that establishes immediate support for a drastic program.

The Simonsen-Pazos Mechanism

Institutional wage-setting mechanisms often rely on a contract, with wage adjustments at specified intervals over the fixed life of the contract. Each adjustment will be based on the accumulated increase in prices since the last adjustment. A good example is the Brazilian wage mechanism: wage earners received full compensation for past actual price increases at regular intervals—yearly until 1980, and at six-month intervals thereafter, until 1986. The question of what happens when the frequency of adjustment increases has been considered by Simonsen (1983) and Pazos (1972). The point is of interest here because it highlights the characteristics of an accelerating inflation and the role of exchange-rate depreciation in that context.

With periodic wage adjustments, the real wage follows the sawtooth pattern shown in Figure 1. On each adjustment date, the real wage is increased to offset the decline caused by inflation since the preceding adjustment, say 50 percent. It declines again over the next interval as the ongoing inflation

FIGURE 1
 THE REAL MINIMUM WAGE AND INFLATION IN BRAZIL
 (1977-78 = 100 for wages; inflation in % per annum)



erodes the purchasing power of the constant nominal wage payment. By the end of the interval, the real wage has declined below its period average. The higher the inflation rate, moreover, the lower the average real wage, given the length of the adjustment interval.

In a system of full but lagged indexation, the real wage can be cut only by moving to a higher inflation rate. A once-and-for-all depreciation of the currency immediately raises the inflation rate and erodes existing contracts. But the catch-up through indexation inevitably pushes inflation to an even higher rate, so that some group of wage earners is always lagging behind the increasing rate of price rises. The same principle applies to the removal of subsidies to correct the budget. Measures imposed to correct competitiveness or the budget can be effective only if they achieve a cut in the real wage. Because of full indexation, however, the real wage can be cut only by allowing inflation to run at a higher rate. This mechanism often sets the stage for inflation explosions.

Consider a country that requires budget adjustments and an increase in external competitiveness. The government does not have the political force to suspend full indexation, so that the removal of subsidies or depreciation of the currency will speed up the inflation rate. Workers in the middle of their contracts or three-quarters of the way toward the next adjustment will find that their real wages fall below what they consider a minimum standard of living. Since they cannot borrow, even in perfect capital markets, they will demand

a shorter interval between wage adjustments in order to recover the real wage losses imposed by inflation. They will ask for an advance of what they think is due. If the economy shifts from, say, six-month to three-month indexation intervals, the inflation rate will simply double (see Simonsen, 1983). But once wage setting has moved to a three-month scheme, two facts are clear: (1) It is extremely unlikely that indexation will return spontaneously to a longer interval, even if shocks are favorable. (2) There is nothing to make the three-month interval more stable than the six-month interval that was just abandoned. Renewed shocks will shift the economy to even more frequent adjustments and hence to correspondingly higher inflation rates. This is the stage at which the exchange rate becomes critical.

In his seminal study of inflation in Latin America, Pazos (1972, pp. 92-93) describes the dynamics as follows:

When the inflation rate approaches the limit of tolerance, a growing number of trade unions ask for raises before their contracts become due. And management grants them. These wage increases give an additional push to inflation and bring about a further reduction of the adjustment interval. Probably the interval is initially shortened to six months, and then, successively, to three months, one month, one week, and one day. At first the readjustment is based on the cost-of-living index; but since there is a delay of one or two months or more in the publication of this index, it must soon be replaced by another. The best-known and more up-to-date of the possible indicators in Latin America is the quotation of a foreign currency, generally the U.S. dollar.

This description makes clear that the dramatic escalation of inflation, seemingly disproportionate to the disturbance, arises from the endogeneity of the adjustment interval. Changes in that interval are due not so much to the direct impact on inflation of corrective exchange-rate or price policies as to minor but highly visible increases in inflation, such as a 10 percent devaluation over and above a PPP rule or the removal of bread subsidies. These straws break the camel's back, leading to an increase in the frequency of wage adjustments and a much higher inflation rate. The endogeneity of the adjustment interval is the mechanism that connects a small inflationary disturbance with a large shift in the inflation rate, such as the shift from 50 to 100 percent inflation in Brazil in 1980.

Figure 1 shows the real wage in Brazil from 1977 to 1981, as well as the inflation rate over the previous twelve months. Readjustments occurred annually in May until 1979. In November 1979, the new Minister of Planning, Antonio Delfim Neto Filho, halved the indexation interval and devalued the currency. With little delay there ensued a very rapid increase in the inflation rate to well over 100 percent.

The exact sequence of events that leads to more frequent indexation will differ: the government may cave in under the impact of a strike, business may

find it is easier to give an "advance" on the real wage adjustment than to risk labor unrest in the middle of a recovery or boom, or a planning minister may seek the popularity that comes from a wage policy apparently favoring labor. One way or another, the frequency will increase, and once it happens in a large part of the economy it cannot fail to become generalized.³

It is immediately clear from the Simonsen-Pazos analysis that the optimal incomes policy in this context is one that monitors the frequency of adjustments above all. An entirely different view emerges with respect to exchange-rate and budget policy. As long as there is full indexation, even seemingly small corrections are a dramatic threat to the stability of the inflation rate and hence may not be worth undertaking.

Stopping Hyperinflation

Once frequencies have been shortened to a weekly or daily interval, hyperinflation conditions exist such as those experienced in Central Europe in the 1920s and again in the immediate post-World War II period, and more recently in Argentina, Bolivia, and Israel. Now the exchange rate comes to play an important role in stabilization.

The case of Germany is perhaps the clearest. In the final month of the hyperinflation, October-November 1923, the inflation rate reached 30,000 percent per month. Prices were adjusted more than once a day to the official exchange rate, which was also changing more than once a day. As hyperinflation developed, the dollar quotation moved from the financial pages to the front page. It became the central front-page feature for the same synchronization reasons that the *New York Times* displays the shift from daylight-saving to standard time.

If everyone watches the exchange rate as the signal for setting wages and prices, it becomes natural to exploit that signal to end the inflation. Fixing the exchange rate outright, at 4.2 trillion Reichsmark or 0.8 australes per dollar, becomes a critical first move in bringing inflation to a screeching halt. Of course, exchange-rate fixing cannot substitute for budget correction. But even with the budget corrected, it may be a needless gamble on the perfect functioning of markets to rely exclusively on the credibility of the commitment to keep the budget corrected. This is all the more true in that no policy is truly exogenous: budget correction works if it successfully stems inflation without exceptional cost. If a lack of credibility raises the cost of a disinflationary policy, the attempt may go under even if it could have survived with more favorable expectations.

The use of exchange-rate fixing and wage-price controls is therefore a help-

³ Note that the dynamics of the transition between intervals have not been modeled. Schelling's (1978, Chap. 3) analysis of group choices, placed in a macroeconomic setting, might be a start.

ful and probably indispensable complement to fiercely orthodox budget correction. Those who argue that budget correction is essential and exchange-rate fixing redundant or even counterproductive need to provide evidence for their contention. For the time being, they can only invoke the properties of equilibrium models with perfect information and rational expectations, and then only when government policies are modeled as fully exogenous. The jump from there to policy recommendations is straight off the cliff. It is interesting that in 1922 a commission of experts that included Cassel and Keynes advised the German government to start its stabilization policy with a fixed exchange rate (see Dornbusch, 1985a).

There is an important immediate benefit from simultaneous exchange-rate fixing and wage-price controls. During high and accelerating inflation, tax indexation and collections can never catch up with the inflationary erosion of government revenue. While high inflation clearly arises from fiscal problems, it gives rise to fiscal problems in turn by undermining the real value of tax collections. Price stabilization therefore yields an immediate increase in their real value and makes an outright contribution to budget balancing even before any new tax laws are passed. The magnitude of that effect may be on the order of 2 to 3 percent of GDP or even more.

Using a fixed exchange rate as the tool for stabilization necessarily involves risks. We saw above that exactly this kind of policy led to overvaluation and ultimate instability in Chile and Argentina from 1978 to 1982. Why then recommend it to end hyperinflation? One reason is that the currency will have depreciated in real terms during the period of accelerating inflation. It is not unusual for high-inflation countries to show trade surpluses and corresponding capital exports. This real depreciation will act as a cushion in case the stabilization of the exchange rate does not halt the inflation instantaneously. But care must clearly be taken not to let the real exchange rate move beyond a narrow margin of about 10 percent. A safe way to do this is to devalue the currency at the outset of the stabilization program, just before pegging the exchange rate, and to use wage-price controls to prevent any corrective inflation for a while.

The German stabilization was accompanied by a sustained real appreciation and gains in real wages in excess of 30 percent. It is difficult to determine whether the appreciated real rate would have been sustainable without the Dawes loans that started a year after stabilization. Real appreciation also featured in the stabilization of the Austrian crown and in the Poincaré stabilization of 1926. In the Argentinian stabilization of June 1985, a 30 percent devaluation was imposed as part of the program before the rate was fixed. The low inflation rates in the immediate post-stabilization period—6.2 for July, 3.1 for August, and 2.0 for September—were still eroding the initial gain in competitiveness, though a danger threshold had not been reached at that

point. Since early 1986, a policy of mini-devaluations has been pursued to maintain competitiveness in the face of a moderate resumption of inflation.

3 The U.S. Disinflation: 1980-85

The typical pattern for U.S. inflation is that in each period of recovery inflation comes to exceed the average in the preceding recovery. Measuring the business cycle from peak to peak, we likewise find that the average inflation rate in each successive cycle exceeds that of the preceding cycle. This ratcheting upward of inflation, in combination with unfavorable supply shocks, pushed inflation into the double-digit range in the 1970s. Since then, inflation has declined to a comfortably low level and has remained there even four years into the current recovery. The argument to be made here is that the sharp dollar appreciation played an important role in the disinflation.

The dollar appreciation, which was due primarily to the monetary-fiscal mix in the United States (or even to bubbles and fads), helped disinflation through two separate channels. First, it reduced the nominal prices of commodities and their real prices in terms of the U.S. GNP deflator. Second, the large nominal appreciation of the dollar reduced foreign firms' costs measured in dollars and therefore reduced import prices and, to some extent, the domestic prices of competing products.

The combined effect of these two developments is quite apparent in the behavior of the U.S. GNP deflator and the deflator for imports. In 1979-80, the preceding depreciation of the dollar was still reflected in import-price increases that outpaced the GNP deflator. But from 1980 on, the sharp appreciation of the dollar caused import prices to fall absolutely while domestic prices kept rising. By early 1985, domestic prices had increased 45 percent, but import prices were only 13 percent above their 1979 level. In the period from 1981:4, when the dollar appreciation was underway, to 1985:1, import prices declined more than 10 percent while domestic prices increased more than 14 percent.

While the magnitude of the import-price effect is quite apparent, it is still necessary to explain why movements in the nominal dollar exchange rate should bring about these effects. Strict PPP theory would lead us to believe that movements in the nominal exchange rate typically reflect divergent trends in price levels, which in turn reflect divergent trends in monetary expansion. (See Dornbusch, 1985b, for a review of PPP theory and evidence.) But the vast size of the change in relative prices and in relative unit labor costs describes a large real appreciation. In what follows, I explore its implications.

I first look at the impact of dollar appreciation on the prices of homogeneous commodities. Then I ask whether dollar appreciation can be expected to lower, absolutely and relatively, the prices of imported manufactures. I also

ask to what extent domestic producers reduce their prices in response to increased import competition. The section concludes with a discussion of aggregate estimates of the impact of the appreciation on U.S. inflation.

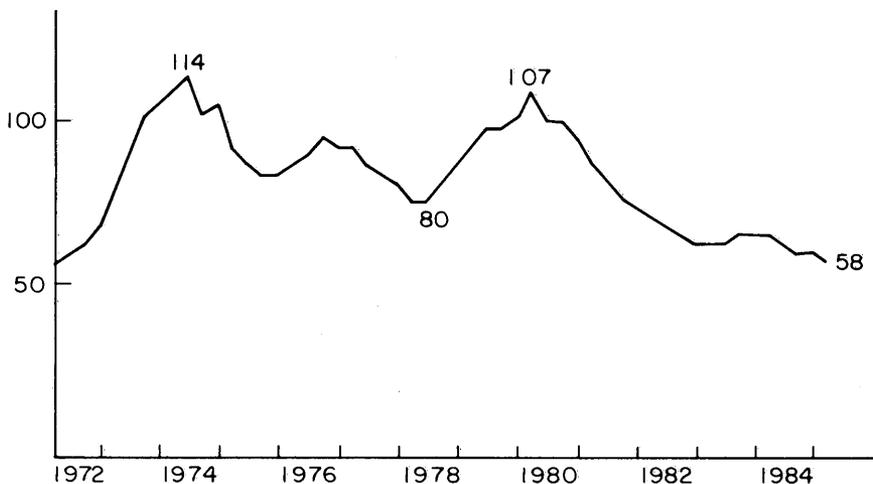
Real Commodity Prices

Figure 2 shows the real price level for primary commodities, which is measured by the *Economist* index of non-oil commodity prices divided by the U.S. GNP deflator. The striking fact is the magnitude of the decline in real commodity prices since 1980—by 46 percent!

Much of this decline can be explained by the behavior of the U.S. real exchange rate. The argument hinges on the fact that, for commodities as opposed to manufactures, the law of one price holds strictly. Let q and q^* be commodity prices in dollars and in foreign currency. The law of one price then requires that $q = Eq^*$, where E is the nominal exchange rate. But the law of one price does not apply to goods in general. Defining P and P^* as the national price levels measured, say, by GNP deflators, the real exchange rate is $R = P/EP^*$, and it can change. What, then, are the links between the recorded change in the real exchange rate and the decline in the real prices of commodities?

Suppose the price level (GNP deflator) is given, both in the United States and abroad. If the dollar prices of commodities were fixed, an appreciation of

FIGURE 2
THE REAL PRICE OF COMMODITIES IN TERMS OF THE U.S. GNP DEFLATOR
(1980 = 100)



the dollar would raise their prices in foreign currencies. Since the general foreign price level is given, the *real* prices of commodities would increase abroad, which would reduce foreign demand and thus world demand for commodities. Therefore, the dollar prices of commodities cannot remain fixed. They must fall to reduce the real prices to U.S. users and thus restore commodity-market equilibrium.

The argument is readily formalized in terms of the equilibrium condition in the world commodity market. With S the supply and D and D^* the U.S. and foreign demands, we have:

$$S = D(q/P, Y) + D^*(q^*/P^*, Y^*) . \quad (4)$$

Demand in each country depends on the real price and on activity (Y, Y^*). Substituting the law of one price $q = Eq^*$ and the definition of the real exchange rate $R = P/EP^*$, we can solve for the equilibrium real commodity price in the United States:

$$q/P = f(R, Y, Y^*, S) . \quad (5)$$

From equation (5), an increase in activity in either of the regions will raise the real price of commodities. This is the well-known cyclical effect on commodity prices. But the real exchange rate of the dollar also appears as a determinant of real commodity prices. A real appreciation of the dollar (an increase in R) must reduce the real price of commodities. The extent of the reduction can be shown to be a fraction of the real appreciation; the smaller the U.S. share in total commodity demand, the larger the fraction. The exact magnitude depends on the elasticities of demand but will be a decreasing function of the real exchange rate.

The model also yields the nominal price level of commodities in dollars simply by writing equation (5) in the form

$$q = Pf(R, Y, Y^*, S) . \quad (5a)$$

It is thus apparent that commodity prices in dollars follow the trend in the U.S. price level, as measured by the deflator, but with adjustments for changes in activity and in the real exchange rate. For a given U.S. price level, a real appreciation will reduce the dollar prices of commodities.

This very simple model of the determination of real commodity prices performs well in empirical tests. (See Dornbusch, 1985c, for a development and empirical test of this model.) The cyclical effect is strongly present. A 1 percent increase in world industrial production raises real commodity prices by 2 percent. But an uncomfortable finding emerges with regard to the real ex-

change rate. The coefficient is negative as the model predicts, but once lags are allowed it is much too large, being bigger than unity in absolute value rather than, say, -0.5 . This oversized impact remains a puzzle. It must be due to an omitted variable or possibly a failure to specify the supply side correctly. Even if this problem were remedied, however, the important finding would remain. The real exchange rate has a very sizable impact on real commodity prices.

The argument so far has dealt with prices of non-oil commodities. But it is clear that exactly the same forces work on petroleum prices, even if those prices are administered. The dollar appreciation has raised the real price of oil to the non-U.S. world and has therefore reduced demand, exerting downward pressure on the real price. The real price must decline in response to oversupply, which is what has been happening in the past few years.

A decline in commodity prices has a favorable effect on domestic inflation. Lower commodity prices reduce costs to firms and hence are reflected in reduced rates of price inflation. They also affect inflation directly via food prices. While agricultural programs introduce discrepancies between U.S. prices and prices abroad for many commodities, the impact of sharply lower food prices in the world market tends to reduce U.S. food prices. The reduced rate of food-price inflation then dampens wage demands and contributes to disinflation.

The impact of reduced real prices of commodities, whether food or copper, leaves U.S. producers of these commodities in the same position as producers in developing countries. Crop prices have declined more than 15 percent relative to prices paid by U.S. farmers for nonfarm commodities. The financial difficulties of agriculture and of agricultural financial institutions as a result of high interest rates and low real commodity prices are the domestic counterpart of the adverse impact that the strong dollar has had on commodity-producing developing countries.

Imperfect Competition in Manufactures

The effects of dollar appreciation on the prices of manufactures are particularly interesting. Here is where we have to explain why the prices of manufactures in the United States can diverge from those in other countries by nearly 40 percent. The law of one price would preclude *any* such movement except as a result of real disturbances that call for changes in the equilibrium terms of trade. Even with real disturbances, moreover, the relative prices of close substitutes or even identical goods would not be expected to move appreciably, contrary to what appears to have happened.

Table 2 shows trade-weighted aggregate measures of the U.S. loss in competitiveness. The two measures are the relative prices of U.S. manufactures and cyclically adjusted relative unit labor costs. The two measures tell very

TABLE 2
RELATIVE PRICES AND RELATIVE UNIT LABOR COSTS
IN THE UNITED STATES
(cumulative percentage change)

	1976-80	1980-85:1
Relative value-added		
deflator in manufacturing	- 14.7	49.3
Relative unit labor cost	- 12.6	59.8

SOURCE: IMF.

much the same story: a massive loss of competitiveness since 1980, much more than offsetting the gains in the preceding period of real dollar depreciation. The magnitude of the change in competitiveness reflects the fact that superior foreign wage and productivity performance was reinforced, *per-versely*, by the strengthening of the dollar.

We can try to make some headway in understanding how changes in relative labor costs affect relative prices by assuming a very simple framework in which labor is the only factor of production, there are constant returns to scale, and firms in the United States and other countries have fixed unit labor costs in their respective currencies equal to W and W^* respectively. Relative unit labor costs are then given by W/EW^* , and the second row in Table 2 shows how this ratio has moved. We assume markets that are geographically separated and, for concreteness, focus on the U.S. market. Competition is imperfect, so that each firm is a price setter. But each firm competes with other firms in the U.S. market. The only thing that sets domestic and foreign firms apart is the fact that the former have unit costs fixed in dollars while the latter have costs fixed in foreign currency. The dollar equivalents of those foreign-currency costs decline as the dollar appreciates. We want to see what different market structures imply about the adjustment of prices to cost disturbances.

Industrial organization offers a variety of models with which to approach that question. Two critical dimensions of the problem are the degree of competition and the extent of product homogeneity or substitutability. The flavor of the analysis is conveyed by two examples: the Dixit-Stiglitz model and the Cournot model.

In the Dixit-Stiglitz model, there are many firms in an industry, each producing a differentiated product (a brand of toothpaste or tires, for example). Each firm faces a demand curve for "its" brand. Quantity demanded depends negatively on the price of that particular variant relative to the average price for the industry. If firms face constant marginal costs and a constant elasticity of demand, each firm will set a price that is a constant markup over cost. As the home and foreign firms both behave in this way, the dollar prices set by the typical producer are

$$P = kW, P^* = kEW^* \quad (6)$$

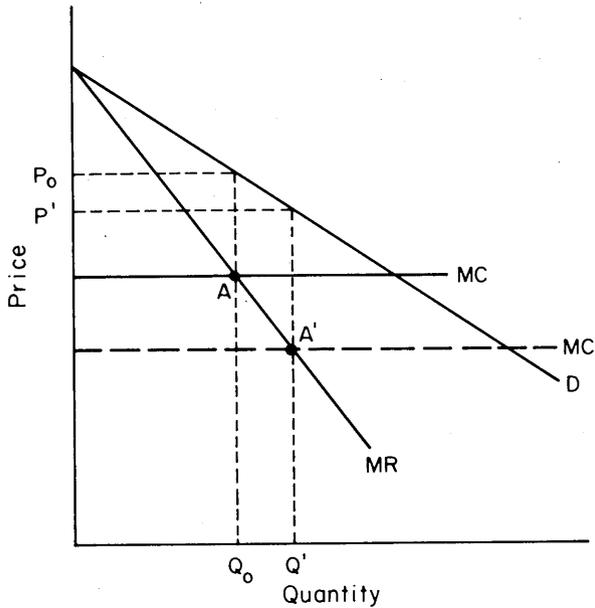
It is immediately clear from equation (6) that a change in the exchange rate will not affect the price set by the home firm. But dollar appreciation (a decrease in E) will reduce the price charged by the foreign firm in proportion to the appreciation. This model accordingly predicts that dollar appreciation reduces the absolute and relative prices of foreign goods in proportion to the movement in unit labor costs and in the exchange rate that converts them to a common currency. Domestic firms do not change their prices, but their relative prices change, because the prices of all imported varieties come down. Thus home firms experience a leftward shift of their demand curves which, at unchanged prices, leads to a decline in home output. The same occurs on the export side. Dollar export prices remain constant, but prices increase in foreign currency, so that relative prices rise, reducing the competitiveness and sales of U.S. firms.

The Cournot model considers a group of oligopolists who share a market for a homogeneous product without colluding. The strategic assumption is that each firm believes that the other firms will not react to its decisions but will maintain their sales volume. In equilibrium, each firm charges the same price, and the market is divided in a manner that depends on the firms' relative costs.

Figure 3 shows the impact of a dollar appreciation on the typical foreign firm. The initial equilibrium is at output level Q_0 with price P_0 . Dollar appreciation reduces marginal cost expressed in dollars from MC to MC' and induces the firm to move from point A to point A' , lowering price and raising output. But this is not the end of the story, since all other firms will react. At their initial output levels, domestic firms find their profits reduced because of the decline in the market price, and they will cut back production to raise the price; foreign firms will react in turn. The resulting equilibrium will show a decline in the industry price that is proportional to the appreciation. The factor of proportionality is the product of two fractions: the relative number of foreign to domestic firms, and the cost-price ratio in the initial equilibrium, which is itself a measure of the degree of departure from perfect competition. The larger the relative number of foreign firms and the more competitive the industry (i.e., the larger the total number of firms), the more nearly will the dollar appreciation translate into a one-to-one fall in dollar prices. When instead the market is very uncompetitive or when foreign firms are few relative to the total number, the passthrough may be only 20 or 30 percent. For example, if one of four firms is foreign and the cost-price ratio is 70 percent, then a 50 percent dollar appreciation will lower the industry price by only 8.75 percent.⁴ The same model can be applied to the dollar export prices of

⁴ See Dornbusch (1985d) for a development of alternative industrial-organization models explaining the impact of exchange rates on the prices of manufactures.

FIGURE 3
THE RESPONSE TO COST REDUCTION

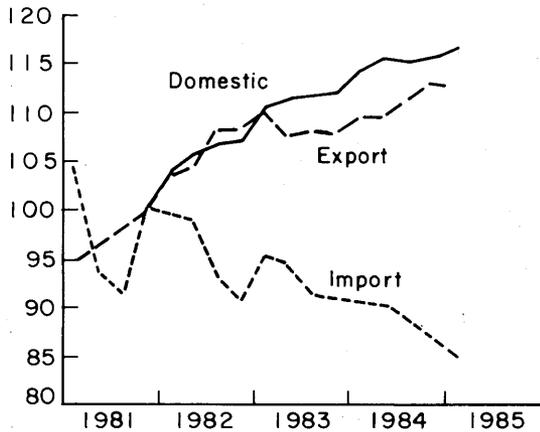


U.S. firms. Dollar appreciation shifts their marginal-revenue curves downward, causing cuts in production and price. With prices declining in export and home markets, however, the change in the ratio of export to import prices cannot be predicted.

These industrial-organization models are highly suggestive of patterns that should be traceable in the data. After all, the U.S. exchange-rate experience from 1976 to 1985 was so extreme as to swamp many of the factors that normally cloud a clear view of industrial structure. Unfortunately, no good data are available as yet to make comparisons of export, import, and domestic prices of narrowly defined product groups. But Figure 4 gives an idea of the pattern found in the available data. Two features are worth noting: (1) export prices almost invariably move more nearly in line with domestic prices than with import prices; (2) domestic and export prices increase, but import prices decline absolutely.

These two findings suggest that the Dixit-Stiglitz model captures well the behavior of export prices. The model is also suggestive for imports, although the extent of the decline is often quite small. Perhaps the product differentia-

FIGURE 4
COMPARATIVE PRICES OF CURRENT-CARRYING WIRING DEVICES



tion of the Dixit-Stiglitz model must be put together with the strategic interactions of the Cournot model to obtain more limited price cuts.

Aggregate Effects

The preceding discussion has spelled out the potential impact of dollar appreciation on the U.S. price level via the prices of commodities and manufactures. In this concluding section, we look at empirical evidence on the aggregate impact.

The recognition that exchange-rate changes affect inflation in the United States is certainly not new. There was abundant discussion of the issue in the literature during the 1950s and again during the 1960s. But with the advent of flexible and fluctuating exchange rates, the issue became more important. The oil-price shock highlighted the role of supply disturbances, of which the exchange rate is perhaps the most important. As a result, macroeconomic models of the U.S. economy now include an exchange-rate or import-price term in their inflation equations.

The rule of thumb is that a 10 percent dollar depreciation caused by an exogenous portfolio shift rather than a policy disturbance will increase the U.S. price level by a full percentage point. The extent of further feedback via wages will depend crucially on the extent to which monetary policy is accommodating. The more accommodating is monetary policy, because of the use of an interest-rate target rather than a monetary-aggregate target, for example, the stronger the additional feedback from higher wage demands.

More recently, Woo (1984), Dornbusch and Fischer (1984), and Sachs

(1985) have reassessed the evidence. The important question is whether the exchange rate works only by way of the direct effect of import prices on domestic prices or whether there are additional effects to reckon with. Any additional effects could, of course, significantly raise the impact of exchange-rate movements on the inflation rate. Woo concludes that there are no additional exchange-rate effects. Specifically, he concludes that foreign manufacturing firms actually price for the U. S. market, a practice that diminishes the full direct impact on import prices. Most of the action, in his view, occurs by way of the reductions in the dollar prices of oil and food that occur when the dollar appreciates.

In contrast, other research finds important effects that go beyond the earlier estimates. Dornbusch and Fischer (1984) find that the exchange rate not only affects the consumption deflator directly but also affects wage settlements and, through that channel, enters the Phillips curve. Table 3 shows the impact of a 10 percent real appreciation of the dollar, indicating the channels and lags.

TABLE 3
THE IMPACT OF A 10 PERCENT REAL DOLLAR APPRECIATION
ON WAGES AND THE CONSUMPTION DEFLATOR
IN THE UNITED STATES

	Percent Change	Mean Lag (quarters)
Direct effect on prices	- 1.25	4.03
Effect on wages	- 1.26	2.87
Total effect on prices	- 2.09	n. a.

SOURCE: Dornbusch and Fischer (1984).

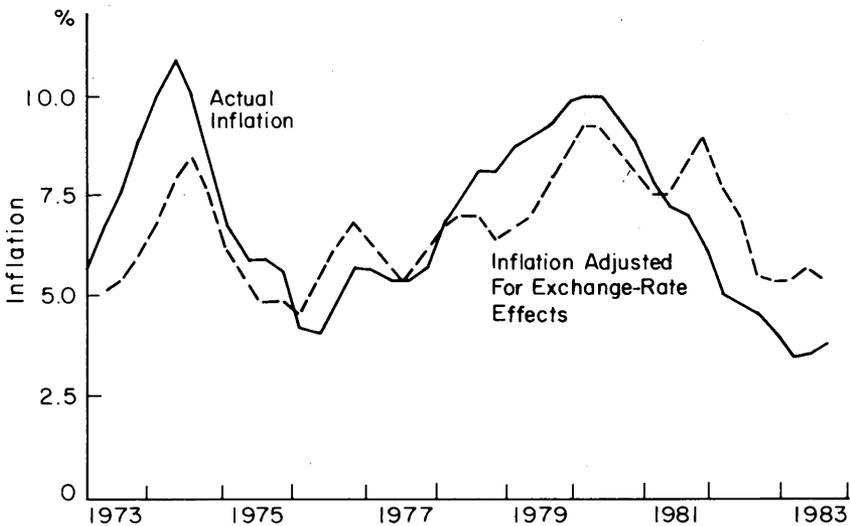
The interesting point in Table 3 is that exchange-rate changes appear to affect wage settlements at a given rate of unemployment rather than affecting the unemployment rate itself. The argument must be that firms exposed to foreign competition are in a better position to exert wage discipline when their profitability is reduced by an appreciation of the real exchange rate. Conversely, following an episode of real depreciation, it is harder to make the case for wage discipline. The presence of this wage effect significantly increases the impact of the exchange-rate movement, since wages have large coefficients in the price equation. Note that these estimates do not include the third-round effects, higher price inflation feeding back into wages, which would raise the estimates still further. When Sachs (1985) considers these effects as well, he finds that the appreciation of the dollar accounts for between 1.9 and 2.8 percent of the total cumulative 6.2 percent reduction in inflation from 1981 to 1984.

There are very few periods of major change in the exchange rate, and these episodes coincide with large changes in commodity prices and oil prices, in part by accident but in part for the systemic reasons already explored. At the same time, the weakening of unions in the United States has changed the U.S. wage-price process. The combination of circumstances makes it exceptionally difficult to determine exactly the impact of dollar appreciation and depreciation on the inflation rate. The divergence of estimates from different approaches reflects the fact that the data cannot be made to reveal a simple, sturdy message. Even so, it is worthwhile looking at Figure 5, which uses the estimates reported in Table 3 to determine the impact of exchange-rate movements on the U.S. inflation rate.

It is apparent from Figure 5 that the three episodes of large movements in the dollar—1973-74, 1976-80, and 1980-83—are identified with a significant effect on inflation, raising it in the first two and reducing it in the last one. Furthermore, Figure 5 immediately draws attention to the fact that a disinflation “borrowed” by overvaluation must be paid back in the course of the subsequent real depreciation—the process that has now set in. Accordingly, wage and price inflation should be expected to speed up at each level of unemployment.

Uncertainty about the quantitative effect of exchange rates on prices extends to the question of the impact of the depreciation now under way. Specifically, is it likely that inflation will be driven back up to nearly 10 percent,

FIGURE 5
THE IMPACT OF EXCHANGE-RATE MOVEMENTS ON U.S. INFLATION



as was the case during the large depreciation of 1976-80? There are several reasons why this is unlikely though not impossible. First, one should not expect as strong a decline in the dollar this time. The 1980 exchange rate was an all-time low, and a decline to that level would certainly activate policy responses because of U.S. concerns about inflation and European concerns about unemployment. Second, conditions are more favorable in both the labor and commodity markets. Not all of the decline in real commodity prices was due to the strong dollar (remember the oversized effect in the estimates discussed above), so all of it need not be paid back. Furthermore, the sharply reduced role of unions rules out a major wage offensive in the wake of a depreciation. These factors lead to the judgment that a dollar depreciation to, say, the 1982 level will raise prices on the order of 2 to 2.5 percent. This moderate effect is in large measure conditioned on a limited, gradual decline of the dollar. In the event of a large dollar collapse, a really sizable bout of inflation is quite likely, although the data cannot support that judgment firmly.

Although the inflationary impact is judged to be minor, there will be significant changes in relative prices and in the terms of trade. The real appreciation raised the U.S. standard of living by strongly improving the U.S. terms of trade, and much of that gain must be given up. The terms of trade will improve for agriculture, and sales will increase for manufactures. Services will be the losers.

In introducing his study of the German hyperinflation, Graham (1928, p. vii) notes: "Cliffe-Leslie once remarked that in social matters the greatest scientific progress is made when economic disorders raise vexing questions as to their causes." The German hyperinflation helped Graham and other scholars to understand the monetary economics of deficit finance, and research still continues today. The large real appreciation of the U.S. dollar in the past few years is serving much the same purpose. The sheer magnitude and persistence of the movement has raised questions about exchange-rate determination and international price linkages that we simply cannot dismiss.

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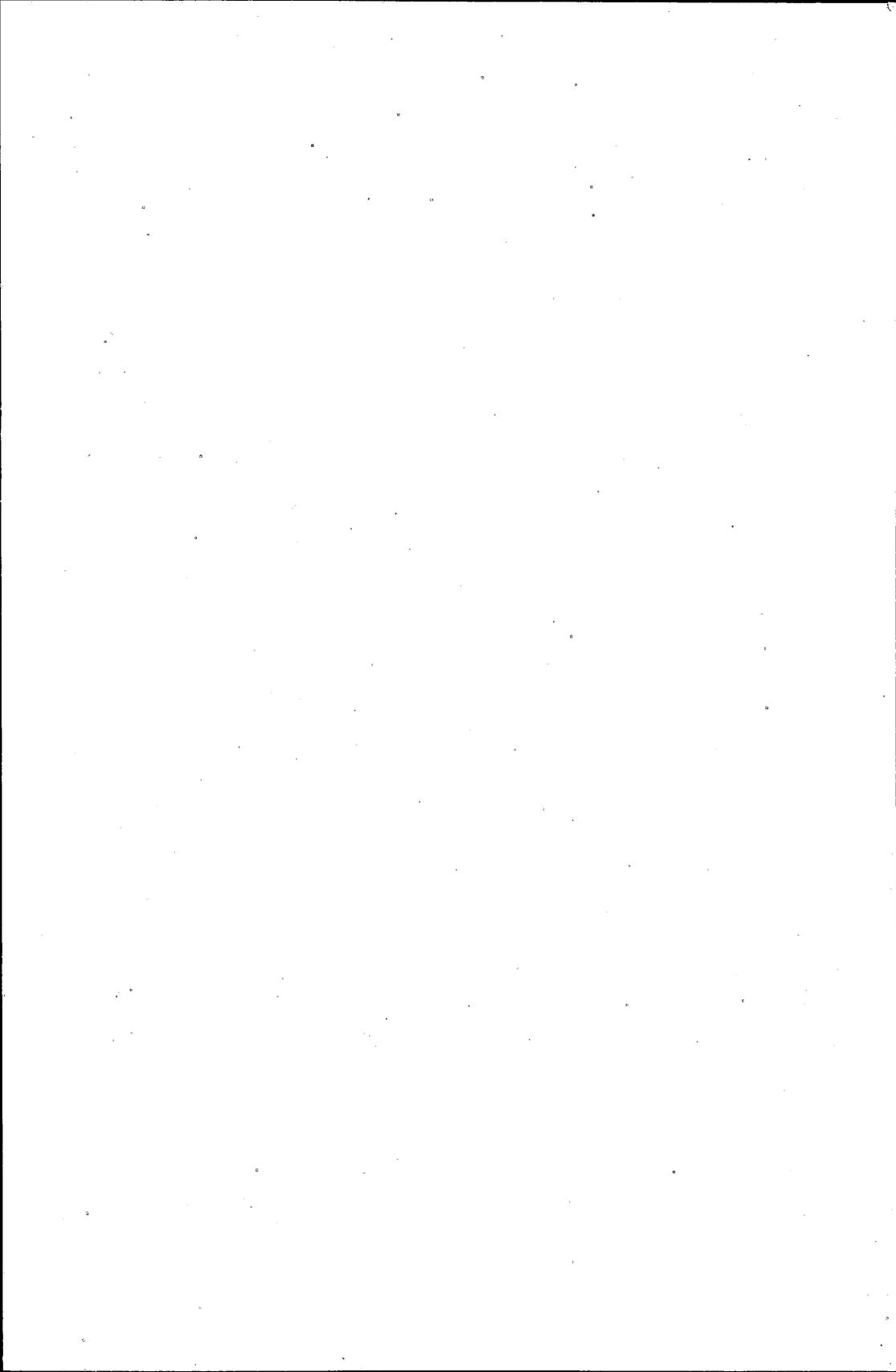
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