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THE ADJUSTMENT MECHANISM

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ABSTRACT

This paper studies the mechanisms of international payments adjustment at work under the Bretton Woods system of fixed exchange rates, 1945 to 1971. I argue that two market failures, imperfect international capital mobility and imperfect wage-price flexibility, are central to understanding the adjustment problems of that period. Imperfect capital mobility implied that even intertemporally solvent governments could face international liquidity constraints. Wage-price inflexibility implied that countries suffering from simultaneous reserve loss and unemployment might need to undergo lengthy transitions before returning to balance. By the 1960s, when trade had been substantially liberalized and partial convertibility restored, the main remaining adjustment weapon was currency realignment: devaluation could eliminate an unemployment-*cum*-deficit dilemma in a stroke, while revaluation could relieve the inflationary pressures in surplus countries. The currency-realignment option proved incompatible with the growing efficiency of the international capital market, however. Under the classical gold standard, high capital mobility had supported the credibility of fixed exchange rates. Under Bretton Woods fixed gold parities did not have primacy among other economic objectives; and increasing capital mobility undermined the regime as governments proved unwilling to stand by key systemic commitments.

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Can we afford to allow a disproportionate degree of mobility to a single element in an economic system which we leave extremely rigid in several other respects? If there was the same mobility internationally in all other respects as there is nationally, it might be a different matter. But to introduce a mobile element, highly sensitive to outside influences, as a connected part of a machine of which the other parts are much more rigid, may invite breakages.

John Maynard Keynes, *A treatise on money*, 1930

1. Introduction

It is a common claim that the Bretton Woods system had no effective "adjustment mechanism." Thus, Yeager (1976, p. 404) asserts that "the IMF system lacks any 'automatic' international balancing mechanism." Williamson (1983, pp. 343-344) argues that the primary means of adjustment up to the 1960s was variation in the pace of trade and payments liberalization, but that once liberalization had been substantially achieved, "Nothing else took its place." And Johnson (1970, pp. 92-93) pillories

> the lack of an adequate adjustment mechanism, that is, a mechanism for adjusting international imbalances of payments toward equilibrium sufficiently rapidly as not to put intolerable strains on the willingness of central banks to supplement existing international reserves with additional credits, while not requiring countries to deflate or inflate their economies beyond politically tolerable limits.

Any retrospective assessment of the adjustment mechanism operating--or absent--during the Bretton Woods period must address five basic questions:

1. *Adjustment of what?* What external accounts were to be balanced?

2. *Adjustment to what level?* What is the right definition of external "balance" or "equilibrium" in the historical context of Bretton Woods?

3. *Adjustment by which means?* Was there a natural and automatic adjustment mechanism? If so, what were its main channels, and did it operate with sufficient power and speed to eliminate imbalances before political or financing constraints began to bite? Was discretionary policy a necessary accompaniment to adjustment, or did policy instead impede whatever natural equilibrating forces were present?

4. *Adjustment to which disturbances?* Did the adjustment mechanism operate with differential efficiency depending on the source or size of the initial imbalance?

5. *Adjustment by whom?* Did deficit and surplus countries face asymmetric pressures toward adjustment? Did the two main reserve centers--the United States and United Kingdom--face special constraints or privileges?

A definitive response to all of these question would itself fill a thick volume, rather than a slim chapter. In what follows, I therefore set myself the more modest goal of placing these questions within a unifying analytical context and presenting some supporting evidence for my interpretations.

I argue below that the celebrated trio of Bretton Woods problems--the adjustment problem, the liquidity problem, and the confidence problem (see Machlup and Malkiel 1964)--not only are inseparably connected, but also are irrelevant in an idealized world of price flexibility, information symmetry, nondistorting taxes, and full enforceability of commitments.

These points are not new; but a preliminary look at a hypothetical frictionless world yields a sharper understanding of the very real obstacles to smooth adjustment during Bretton Woods, as well as a sense of the features of the post-war world economy that engendered those obstacles.

The main obstacles were two: inflexibility, particularly in the downward direction, of wages and prices; and a degree of external capital mobility too low to provide governments with reliably stabilizing liquidity inflows but at the same time high enough to threaten foreign reserves. Given these factors, the discretionary escape clauses built into the IMF Articles of Agreement--the adjustable exchange-rate peg and the option to impede cross-border capital movement--undermined government credibility and thereby promoted instability in international financial markets. As these markets became more efficient, and as major governments, at the same time, revealed themselves as unwilling or unable to maintain key systemic commitments, the system inevitably unraveled.

The remainder of this chapter is organized as follows.

Section 2 discusses in general terms how the related problems of adjustment and liquidity arose in the historical context of Bretton Woods. Section 3 underscores this discussion by describing the problems of adjustment, liquidity, and confidence in an imaginary world free of market frictions. A brief discussion of adjustment mechanisms under the classical gold standard occupies section 4. Section 5 then describes how the central economic and financial features of the postwar world mandated rapid adjustment for deficit countries and at the same time made that adjustment difficult to achieve in many cases. The section also takes up the long-term

implications of international differences in trend productivity growth under rigid nominal exchange rates.

Probably the most powerful adjustment instrument available to IMF under members was the realignment option offered by the IMF Articles' fundamental disequilibrium clause. Section 6 examines why governments became increasingly reluctant to exercise this option, and why the U.S. sought all along to avoid devaluing the dollar in relation to nondollar currencies.

The next two sections discuss some empirical evidence on rigidities in capital and product markets during the Bretton Woods era. Section 7 presents evidence of imperfect, but increasing, international capital mobility. Section 8 conducts a preliminary empirical comparison of price rigidity during the 1880-1914 gold standard period and during Bretton Woods.

Were design flaws in the Bretton Woods adjustment mechanism responsible for its collapse, or does the primary fault lie instead with government policy errors--with the inept operation of an otherwise sound system for managing international payments? Section 9 explores the implications of my analysis for this central question. While identifiable policy mistakes certainly occurred, the question of design versus operation is not really well posed. A well-designed international payments system must recognize the incentives of member governments and modify those incentives to deter beggar-thy-neighbor behavior. Indeed, the fundamental intent of the founders of the Bretton Woods system was to achieve exactly that goal. Their success was incomplete, however, and new stresses became evident as world capital markets evolved in the 1960s. Eventually, the mismatch between the system's rules and the incentives of some major participants proved fatal.

2. Adjustment and liquidity in historical perspective

Any discussion of the need for and mechanisms of external adjustment must start by defining adjustment, along with the closely related concepts of international liquidity and confidence. All three concepts have counterparts in the theory of banking. They are best understood with reference to world in which markets for risks and credit function imperfectly, so that ready access to a sufficient supply of liquid means of payment becomes a prime aim of asset management.

The world that emerged from World War II conformed all too well to this picture of fragmented--indeed, often paralyzed--national financial markets. Apart from the United States and Canadian dollars, major currencies remained inconvertible; and controls on financial transactions were rife. Both political instability and an overhang of war debts were additional brakes to private capital flows. The twin institutions set up at Bretton Woods in 1944, the IBRD and IMF, had been designed, respectively, to help finance postwar investment needs and to provide loans to member countries endeavoring "to correct maladjustments in their balance of payments without resorting to measures destructive of national or international prosperity."[1] But the scale of resources needed in the late 1940s went far beyond what these agencies could provide, and United States Marshall Plan aid (1948-1951), on the order of 1 per cent of U.S. GNP per year, played the key role in bridging recipients' payments gaps.[2]

IMF members were expected to eschew both discriminatory currency practices and restrictions on current-account payments, as well as to establish limited convertibility of their currencies. Exceptions were, however, the rule. Controls on capital movement were sanctioned quite explicitly in Article VI, Section 3, of the IMF Articles of Agreement. Section 1 of that

Article forbade using resources borrowed from the Fund "to meet a large or sustained outflow of capital."[3] The Fund's founders, recalling the often destabilizing "hot money" flows of the interwar period, were in no hurry to encourage the growth of an efficient world capital market.

Only in December 1958--far later than most people would have guessed in 1944--did European currencies generally become *externally* convertible (that is, convertible by nonresidents) in current-account transactions.[4] Prodded by the United States, and provided with loans of $3.75 billion from American and $1.25 billion from Canada, Britain had attempted, on July 15, 1947, to return to external convertibility. Massive private conversions of sterling balances into gold and dollars forced the British authorities to abandon their efforts after little more than a month. Britain's reversion to a complex and discriminatory set of sterling conversion arrangements was a blow to hopes that the world as a whole would soon return to a market-based multilateral payments mechanism. With its expertise, traditions, and location, London in 1947 would have been, as it is even now, the natural hub for a global convertible-currency system. The pace of international financial integration, and with it the potential for speculative capital flows, quickened after 1958. But even by 1971 national financial markets remained somewhat more insulated from external forces than they are today.

Membership in the IMF entailed a central policy constraint: to prevent one's exchange rate from moving more than 1 percent away from an agreed par value relative to the July 1, 1944 gold content of the U.S. dollar. Only "to correct a *fundamental disequilibrium*"--a term that was nowhere defined--could a member propose a parity change to the Fund.[5]

With this background, one can better appreciate the requirements of external balance and adjustment in the context of the early Bretton Woods system. Countries on the whole lacked

regular access to foreign sources of credit, and therefore were constrained to lower levels of investment and higher levels of saving than probably would have prevailed with full private capital mobility. The implied limit to the feasible current-account deficit was only one consequence of the credit rationing countries faced. In addition, countries needed to have on hand a buffer stock of internationally liquid assets--essentially gold or dollars--available to smooth consumption or stabilize investment in the face of unexpected income shortfalls or deteriorations in trading opportunities. This type of behavior is familiar from models of precautionary money demand by households and firms (Foley and Hellwig 1975; Bewley 1983). Credit constraints grew less stark, but did not disappear, as the system evolved.

The standard precautionary need for international liquidity was reinforced by the obligation of fixed exchange rates.[6] A country facing an excess flow supply of its currency in the foreign exchange market might have no choice but to renege on its IMF parity and allow a depreciation. The sclerotic condition of domestic and world financial markets in the early postwar years ensured that remedial policies would work with an uncertain lag to loosen the reserve constraint. A constant additional motive for holding a sizable reserve stock was to inspire confidence in the peg. This motive flowed directly from the Bretton Woods ground rules, under which markets could never be certain when payments restrictions would be imposed or exchange parities altered. Even limited speculative flows, operating through leads, lags, and similar avenues, could place governments under unwelcome pressure. The confidence-building role of reserves (and of credit lines from central banks issuing convertible currencies) increased in importance as world financial linkages expanded during the later Bretton Woods years.

The individual country's need for an adequate stock of international liquidity, both as a buffer and to peg exchange rates, motivates the definition of external equilibrium that is probably most relevant for the Bretton Woods period: a target on changes in net government holdings of a widely accepted international means of payment, or of foreign assets quickly convertible into such at low cost. Even this definition is incomplete, as it does not account for the possibility that certain private liabilities to foreigners rapidly become a direct or indirect drain on national reserves. Thus, to focus on what is essentially the official settlements balance is to highlight a very inexact, but nonetheless informative measure of the change in an economy's liquidity position.[7]

The emphasis on liquidity and the adjustment of liquid asset stocks should not obscure the basic point that in an ideal world the purpose of all international trade, whether in goods and services, in assets, or over time (that is, in dated goods and services) is to exploit the potential gains afforded by differences in preferences, endowments, or technologies. From this perspective, a nation's external balance could be identified with the optimal level of its current account balance, that is, the excess of national saving over domestic investment that maximizes some national intertemporal social welfare function.[8] Balance-of-payments equilibrium in the sense of the last paragraph is in principle neither a necessary nor a sufficient condition for the more fundamental goal of optimal current-account balance. Rather, the need for liquidity arises from inescapable trading frictions which, if they are sufficiently severe, may sharply curtail the gains from international trade.

To a greater or lesser extent, liquidity is a prerequisite for trade; and we judge an international monetary system by its success in promoting socially productive transactions in

home and foreign markets alike. The problems of international liquidity and adjustment that beset real economies in the Bretton Woods era can be placed in relief by consideration of a hypothetical ideal economy.

3. A benchmark model economy

The benchmark world economy is one in which markets are complete and competitive, prices adjust instantaneously to clear those markets, information is complete and perfect, and private contracts can be costlessly enforced. There is only one departure from the Arrow-Debreu assumptions: Some feature of individuals' preferences or constraints induces them to hold monies that are issued by national governments. Money demand is conventionally modeled in various ways, some of which imply a departure from the underlying Arrow-Debreu equilibrium when nominal interest rates are positive. In the present context, the "shoe-leather" inefficiency implied by a nonzero opportunity cost of holding money is a second-order issue that will be ignored.[9]

Governments are committed to a regime of fixed exchange rates, which could take one of several institutional forms. The precise form is relevant only because of its possible implications for the international distribution of the seigniorage from money creation (Helpman 1981; Persson 1984). To be concrete, and to capture features of Bretton Woods, I will imagine that there is a center country to whose currency all other central banks peg theirs. The center country holds its international reserves in the form of gold, while other countries hold gold and interest-bearing deposits denominated in the center currency.

Governments provide public goods and finance this expenditure with lump-sum taxes which may differ across income groups. There are no political obstacles to varying these levies. Distorting taxes therefore are not used. This feature, along with the flexibility of all prices (including wages), implies that most standard motivations for exchange-rate adjustment are absent. From the perspective of public finance, an unanticipated devaluation would act as a lump-sum tax on the government's nominal liabilities; and even a higher rate of anticipated devaluation might augment the flow of seigniorage. With alternative lump-sum taxes available, however, these incentives to alter exchange rates are absent. From the perspective of private-sector resource allocation, there is no incentive for unexpected realignments that offset entrenched distortions, or for realignments that hasten relative-price adjustment.

The main motivation to adjust exchange rates, in the present rarefied setup, would be to offset an excessive trend inflation rate in the center country. I have relegated this consideration to the ranks of second-order effects (although inflation costs could be high in a world where markets and institutions are less perfect than I am assuming in this example).

The absence of monitoring and enforceability problems implies that households and firms can benefit to the maximum possible extent (given their endowments) from the available opportunities to trade internationally across time and states of nature. Because intertemporal budget constraints are always honored by individuals and governments, and because the resource allocation is Pareto optimal, problems of current-account imbalance cannot arise. This is not to deny that certain fiscal policies may alter the net foreign asset stock and impoverish (or enrich) future generations to the benefit (or at the expense) of those currently alive. In the present setting, however, these possibilities raise questions of ethics rather than of economics.

Finally, observe that because households and governments are solvent at all dates and in all states of nature, liquidity problems, which presuppose at least the possibility of insolvency, will not arise. Individuals needful of means of payment can commit to repay their debts and thus can always obtain instantaneous credit. Governments can do the same, and need never intervene to help smooth out private-sector fluctuations.

In particular, the commitment to fixed exchange rates has *no* implications about the need for international reserves. Any level of international reserves--including arbitrarily high negative levels--is consistent with an exchange-rate peg, and the rate of change of the reserve stock (the balance of payments) has no intrinsic welfare significance. Only the government's general solvency matters.[10]

Because this last point is so important to understanding the adjustment and liquidity problems of the Bretton Woods era, it is worth underscoring it with a simple model.[11] The center country is labelled America and the aggregate of noncenter countries labelled Europe. America's money supply M is backed by a stock of gold G, valued at the dollar price P^g, and domestic credit D:

$$(1) \qquad M = P^g G + D.$$

Europe's money supply M^* is backed by gold G^*, domestic credit D^*, and interest-bearing dollar reserves F. Let E denote the price of the dollar in terms of Europe's currency. Then:

$$(2) \qquad M^* = EP^g G^* + D^* + EF.$$

Real money demand in America depends on the nominal interest rate and a vector k of real variables; the nominal interest rate, in turn, is the sum of the real interest rate r and the expected inflation rate π. Under a credibly fixed nominal exchange rate, Europe's nominal interest rate must equal America's. With P denoting America's price level, monetary equilibrium in the center country can be expressed as:

$$(3) \qquad M/P = L(\pi + r; k).$$

To simplify matters, and with no loss in generality, I assume a *stationary* situation in which the real exchange rate $q = P^*/EP$ is constant over time.[12] Under this assumption $\pi = \pi^*$ (implying $r = r^*$), so that monetary equilibrium in Europe is described by:

$$(4) \qquad M^*/P^* = L^*(\pi + r; k^*).$$

In the classical setting of this section, it is reasonable to suppose that the real variables r, k , and k^* are determined independently of monetary ones. Monetary neutrality is an expository simplification, not a prerequisite for the conclusion that reserves are irrelevant. (Instead, as discussed below, the crucial ingredient is perfect international capital mobility.) But, given neutrality, equations (1)-(4) lead to some illuminating conclusions.

Suppose, to start, that Europe holds all its reserves in dollar assets, and never trades them to America for gold.[13] Equations (1) and (3) imply that American monetary conditions are insulated from European monetary conditions: the American price level P, American inflation

π, and the world nominal interest rate are set *entirely* in the American money market (given the underlying real equilibrium). Since q is determined on the model's real side, $P^* = q \times E \times P$ also is independent of European monetary conditions.

Now combine (2) and (4) to obtain

(5) $EP^eG^* + D^* + EF = P^* \times L^*(\pi + r; k^*)$.

The key point is that the right-hand side of (5) is independent of European monetary policy; and this implies that the left-hand side of (5) is a residual variable of the model. To fix the exchange rate, Europe must adjust its monetary base to accommodate the equilibrium established in goods markets and the American money market. Europe has full discretion only over the *composition* of its base--whether to adjust through transactions in newly-mined gold, dollar reserves, or domestic assets.

This discretion is of no consequence in the present setting. If Europe wants more reserves, a reduction in D^*, e.g. through an open-market sale of government securities, immediately raises dollar reserves by an equal amount if no gold is purchased. Private Europeans short on cash merely borrow foreign exchange abroad and sell it to their central bank for money. America undergoes an instantaneous balance-of-payments deficit, Europe an instantaneous surplus, but the balance of indebtedness between the two regions does not change.

Furthermore, commitment to a fixed exchange rate places no limit on the level of Europe's reserves. The variable that must be set correctly is the total supply of European money. Government solvency is the key issue: foreign reserves are only a single component of

government assets, and these can decrease without bound provided other government assets increase commensurately. If solvency does not require seigniorage revenue beyond what is implied by the inflation rate America chooses, there are no fiscal obstacles to prevent Europe from choosing a money-supply path consistent with a fixed exchange rate. Obviously there can be no international reserve shortage in this kind of world, first, because there is no well-defined demand for international reserves, and second, because reserves are anyway in infinitely elastic supply.[14]

An assumption of perfect capital mobility, which allows governments always to borrow reserves provided overall solvency is maintained, is behind the foregoing results. As noted above, the flexibility of prices is not critical. Even the standard Keynesian two-country, mobile-capital model has a recursive structure in which European dollar reserves are a residual, accommodating quantity; and that model therefore has implications about reserves identical to those just derived.

The analysis seems to imply, also, that changes in Europe's dollar reserves due to shifts in its money market are of no consequence for America. For example, a rise in Europe's money demand, like a fall in its domestic credit, leads to a private capital inflow and an equal central-bank outflow as Europe acquires reserves in America. The American position apparently is unaffected.[15]

But doesn't this shift reduce confidence in the real value of the reserve assets supplied by America? In his classic critique of the Bretton Woods system, Triffin (1960) argued that world dollar reserves could not grow forever on a limited base of United States gold. Inevitably, nervous foreign central banks would exercise their right to exchange dollars for gold,

possibly initiating a reprise of the 1931 sterling collapse. Assume in our model that America's fiscal stance is consistent with a constant world price level. Can the system nonetheless collapse, simply because foreign dollar reserves are growing relative to America's gold stock?

I would argue that in a world of perfect capital mobility, the level of F is irrelevant to this issue as well. Notice first that an attempt by Europe to exchange dollar reserves for American gold brings about a fall in the world price level and therefore a *multiple* contraction in world dollar reserves:[16]

$$dF = -(1 + M^*/EM)P^*dG^* < -P^*dG^*.$$

This multiple contraction in itself reduces the degree of reserve overhang. But more important is the finding that remaining dollar reserves increase in real value by the same percentage as official gold reserves. Central banks that exchange dollars for gold are no better off.

More fundamentally, Europe needn't wait to attack until market forces push its reserves to some trigger level; in principle it could wipe out the American reserve stock at any moment simply by borrowing dollars abroad and demanding American gold. There is no incentive to do so, and therefore no confidence problem, as long as America maintains the real value of the dollar.[17] This it can do simply by controlling the domestic money supply.[18]

4. Credibility and capital mobility under the gold standard

World economic performance under the classical gold standard (roughly 1880 to 1914) is quite different from the idealized picture sketched in the last section. Yet in two crucial

respects the gold-standard had a coherence that contributed to a remarkably high degree of international economic integration and stability. First, as has been stressed by Kindleberger (1973), Bordo and Kydland (1990), and others, Britain provided a firm and credible economic leadership based largely on free-trade principles. Second, international financial markets displayed a degree of resilience and efficiency that is impressive even by modern standards.

These two factors behind the gold standard's successes were not independent; on the contrary, they reinforced each other. Britain's commitment to the gold convertibility of sterling, its willingness to lend unreservedly in crises, its financial expertise, all facilitated international capital transfers of a magnitude that remains unrivalled. In turn, capital mobility was a critical ingredient in the system's adjustment mechanism, and it enabled the Bank of England in particular to operate with a low level of gold reserves. According to Harrod (1952, p. 3):

> The free gold in the Bank of England was usually of the order of £20 million. It is instructive to compare this with the present reserve (September 30th 1951) of £1,167 million, which is deemed to be so low as to spell perdition. Even after allowing for the change in the value of gold, this present-day reserve is gigantic by nineteenth century standards.

Central banks of other European were unable to operate on so slender a base of gold. Latin America saw frequent lapses into inconvertible fiat money regimes. And even sterling was subject to confidence crises, as in the Baring panic of 1890. But as Eichengreen (1989) observes, by the late nineteenth century an implicit international commitment to defend the gold

standard had emerged. In the Baring crisis, for example, the Bank of England was able to arrange a large loan of gold from the Bank of France and the government of Russia.[19] (In contrast, the international Gold Pool, set up in 1961 to defend the $35 official price, disbanded in 1968. It left behind a two-tier setup under which the private gold price was free to rise without limit while the official price remained as a fictitious central-bank transfer price.)

Bordo and Kydland (1990) argue that the 1880-1914 gold standard system entailed commitment mechanisms that, despite some lapses, ensured gold convertibility for most major currencies. One feature promoting adherence to the standard was the fear that departures from convertibility might impede future access to world capital markets. The significant trade gains offered by those markets made this a heavy price to pay. Swiftly-reacting capital markets provided a deterrent even to less blatant lapses from financial orthodoxy.

The financial markets of the gold-standard era achieved levels of international capital transfer that have rarely been matched in postwar experience. Cairncross (1953, pp. 3-4) portrayed a vigorous stream of lending next to which the flows of the early postwar years were meager indeed:

> The forty or fifty years before 1914 was clearly an exceptional period in economic history. It was symptomatic of the period that western Europe had invested abroad almost as much as the entire national wealth of Great Britain, the leading industrial country, and a good deal more than the value of the capital physically located in Great Britain. It was also symptomatic that Britain herself had invested abroad about as much as much as her entire industrial and

> commercial capital, excluding land, and that one-tenth of her national income came to her as interest on foreign investments. These conditions can hardly recur. Translated into the circumstances of 1951, and applied to the United States, they would imply American investments overseas of no less than $600 billion and an annual return on those investments of some $30 billion (or the equivalent of the British national income). Private investment abroad, in recent years, has not exceeded $1 billion per annum, and even this total has only been sustained by very large investments undertaken by the American oil companies. But if the same proportion of American resources were devoted to foreign investment as Britain devoted (out of a far smaller national income) in 1913, the ... entire Marshall Plan would have to be carried out twice a year. The very extravagance of such a hypothesis shows how little there is in common between the perspectives of the Victorian era and those of to-day.

Before World War I substantial resource inflows financed investment in America, Argentina, Canada, and other rapidly-growing countries. But private capital followed other routes as well. Japan, for example, was a major participant in the world capital market, both as borrower and lender. Figure 2a in Hayashi (1989) indicates that Japan was able to run a current-account deficit exceeding 10 percent of GNP during the Russo-Japanese war of 1905. (Foreign lenders, if not the Russian government, probably anticipated Japan's victory.) As a nonbelligerent during World War I, Japan had large current-account surpluses which peaked in

1917 at around 10 percent of GNP. This number is several times the magnitude of Japan's late twentieth-century surplus ratio.

Evidence on asset-market arbitrage reinforces this picture of a capital market working surprisingly smoothly. Officer (1985) finds that by the last two decades of the nineteenth century the Anglo-American gold-standard link was extremely efficient: gold points were narrower than the Bretton Woods 1 percent parity bands, and exchange-rate variations from parity were on average well within the gold points. Officer attributes the strength of arbitrage in this market to technological innovations, such as the trans-Atlantic cable (1866) and the introduction of steamship travel, and to financial-market developments, such as lower rates for insuring specie shipments.[20]

Early descriptions of the gold-standard adjustment mechanism, epitomized by Hume's classic account of 1752, left capital movements on the sidelines. Hume emphasized relative-price adjustment, and its effect on the trade surplus, in describing how a balance-of-payments disturbance is automatically corrected by market forces.[21] According to this paradigm, an excessive domestic stock of precious metals raises commodity prices via the quantity theory of money and weakens the competitive position of the home tradable sectors. The resulting imbalance sets off Hume's adjustment mechanism. A higher trade deficit immediately begins to drain specie from the economy, pushing domestic prices down. Symmetrically, foreign competitors' prices are pulled up by the counterpart specie inflows. Over time the home country's continuing terms-of-trade deterioration shrinks the balance-of-payments deficit to zero, and at this point the international redistribution of specie comes to a halt.[22]

The empirical relevance of Hume's adjustment model has been questioned by subsequent researchers. But before turning to these criticisms, I want to stress that Hume's purpose in writing his essay was as much political as scientific, and that his adjustment mechanism is best understood as an example demonstrating a more general point. Hume was really arguing for the main conclusion of section 3--that the level of international reserves is irrelevant--and inferring the corollary that governments can only damage national welfare through mercantilistic restrictions on trade. Market mechanisms will automatically ensure an adequate supply and international distribution of liquidity; gold is not the only or even the most important component of national wealth; and the appropriate policy target for governments has nothing to do with international reserve flows *per se*, and everything to do with the optimality of the underlying real resource allocation:

> [A] government has great reason to preserve with care its people and its manufactures. Its money, it may safely trust to the course of human affairs.... (Hume 1985, p. 48)

Early empirical work on the gold standard, notably that of Taussig and his students, found remarkably little clear evidence that gold flows played the central role in external adjustment predicted by Hume's model. In particular, specie movements in the British case were small relative to the volume of trade.[23] Trade volumes seemingly were adjusting to capital transfers, and capital flows financing trade imbalances, with surprising ease.

Writers on the gold standard after Hume had posited several modifications of his symmetrical adjustment mechanism that might explain these results. Most importantly, they observed that capital flows may be a natural concomitant to adjustment: for example, the specie outflow induced by a rise in imports raises domestic interest rates (perhaps incipiently), attracting a capital inflow that partially (or fully) offsets the specie loss. Another factor modifying the relevance of Hume's mechanism, at least by the end of the gold-standard period, was the growing practice of holding foreign currencies as official reserves.

It would lead too far afield to review in any detail the vast literature on the gold-standard adjustment mechanism, including studies on the various authorities' observance or nonobservance of supposed "rules of the game."[24] My main point is that despite the prominence of Hume's example, the reality of the late gold standard seems to have been that potential adjustment problems were overcome rather smoothly, without large reserve movements, by the main players. Crises, when the occurred, often were headed off by credible displays of central-bank solidarity.[25] The picture that emerges is one in which international reserve movements on the whole accommodated developments in the real economy rather than constraining them.[26] The prevailing liberal ideology, the high mobility of capital, the credibility of the key central banks--and perhaps a century of comparative peace in Europe--all combined to create this favorable environment. Two world wars and the time of troubles they bracketed shattered it.

5. The postwar adjustment environment

Postwar economic conditions made international balance-of-payments adjustment a pressing matter for most countries, yet at the same time, a goal that could be difficult to achieve.

Pressure to adjust came from factors described in section 2: precautionary asset accumulation and the obligation to peg exchange rates. One obstacle was rigidity, particularly in the downward direction, of wages and prices. Another was the limited capacity of international credit markets. The main tool of adjustment allowed by the Bretton Woods agreement was the adjustable peg; countries also had the option of tightening capital controls. Once convertibility was restored, the potential that these tools would be used undermined policy credibility, and prevented stabilizing cross-border capital flows from reliably providing adjusting countries with a breathing space. Market expectations were informed by the reality that postwar governments would be held politically accountable for maintaining high employment and growth.

This section examines main aspects of the international adjustment problems countries faced under Bretton Woods. Section 5.1 reviews the options available for attaining external balance. Section 5.2 describes the asymmetric position of surplus countries. In section 5.3 I focus on the special position of the United States. Section 5.4 looks at the long-term question of the adjustment to secular productivity-growth differentials.

5.1 Maintaining external balance: Options and tradeoffs

The efficiency of international capital markets and the flexibility of wages and prices are key factors in the postwar adjustment environment. Resilient capital markets helped buttress exchange-rate credibility under the gold standard by providing necessary liquidity while imposing financial discipline; a similar phenomenon may characterize the most recent phase of the European Monetary System, in which exchange-rate changes and controls have been all but

abjured. World capital markets could not fulfill this stabilizing role in the early postwar years. Instead, official credits were supposed to aid countries to maintain both agreed exchange parities and the pace of trade liberalization. Section 7 offers evidence that despite a trend of growing financial integration, imperfect mobility persisted after the return to convertibility. It is important to recognize that the process through which a country's external liquidity and its government's credibility interact is a circular one, and that the relation between capital mobility and credibility may not always be monotonically increasing. Limited capital mobility may do little to aid a government in defending an exchange rate; if the underlying motives for realigning are strong, even limited capital mobility may allow damaging destabilizing money flows.

In theory, at least, limited price flexibility provides one of the major rationales for exchange-rate adjustment. Numerous econometric studies conclude that in the postwar United States, wages and prices have been imperfectly responsive to cyclical pressures. On two other questions central to an understanding of the Bretton Woods system, however, there is less agreement. Did similar wage and price sluggishness characterize countries outside the U.S. during the first 25 postwar years? And is there a persuasive case for asserting generally that wages and prices were more sticky after World War II than before World War I?

In section 8 below I summarize briefly the current debate on these questions and develop some additional international evidence. The historical record indicates that wages and prices displayed considerable inertia even under the gold standard. There is an apparent increase in the rigidity of some price indicators after World War II, but the increase may be smaller, and less universal, than is often imagined.

Even if many countries' wages and prices were only moderately less flexible after 1945 than under the classical gold standard, at least one drastic shift in the policy environment clearly had occurred. Postwar governments, unlike their pre-1914 predecessors, were politically responsible for (or even legally committed to) the maintenance of high employment and economic growth. The founders of Bretton Woods, recognizing the primacy of domestic employment objectives, hoped that IMF credits would allow countries to wait out transitory shocks while avoiding the uncertainty and possible beggar-thy-neighbor effects of frequent exchange-rate changes.

The changing economic setting was reflected in a new generation of Keynesian international-adjustment models that placed income and employment determination at center stage. In these models, the main factor limiting imbalances was the multiplier process rather than relative-price adjustments or reserve flows. Thus, a fall in foreign demand reduces output and with it, import spending, softening the trade-balance effect of the initial disturbance. A rise in domestic absorption spills onto imports, raising foreign income and imports in its wake. Metzler (1948, p. 220) provides a revealing discussion of the new doctrines:

> In the modern view, a country with a deficit in the balance of payments is likely to eliminate this deficit, *in part at least*, through a low level of income and employment. The conflict between domestic stability and international equilibrium, which has long been a familiar part of classical monetary theory, is thus shown to be much more important than had formerly been supposed. In an unstable world, the choice confronting an individual country is not merely

> between price stability and international equilibrium, but between stability of employment and international equilibrium.

I have italicized a crucial clause in this passage to prevent it from being misconstrued. Metzler was not suggesting here that additional forces, such as relative-price changes, could make a noticeable contribution to adjustment. To his mind, both price rigidity and elasticity pessimism made this unlikely, except over the long run. Thus, "the adjustment of a country's balance of payments by means of income movements is likely to be incomplete." The new view "accounts for only part of the adjustment and thus constitutes a theory of disequilibrium as well as a theory of equilibrium."[27] This was a revolutionary departure from classical modes of thought. No strong forces were operating automatically to correct payments imbalances. A country hit by a negative trade shock would experience an ongoing reserve hemorrhage; it would then face an agonizing choice between stanching the flow at the cost of higher unemployment, or sooner or later exhausting its reserves and foreign credit lines.

This Keynesian paradigm differs not only as to the nature of the international mechanism, but as to the likely source of problems. Monetary shocks, so central to Hume's own thinking, are not featured. In Metzler's words (p. 212), the monetary system "has been relegated to a somewhat secondary position...." Equally secondary are other financial-market disturbances. Autonomous aggregate demand shocks, foreign as well as domestic, are the focus of attention.

Subsequent writers, notably Meade (1951), reintegrated monetary factors into the Keynesian open-economy model. But their techniques were essentially static, and thus could not fully address the possibility, raised by Metzler, of prolonged or even perpetual disequilibrium.

Mundell (1961) achieved a dynamic synthesis, showing that even in a sticky-price model, an "income-specie-flow" mechanism might substitute for Hume's "price-specie-flow" mechanism and ensure a stable approach to external equilibrium. According to Mundell, the gold losses accompanying a trade deficit would raise interest rates, discouraging absorption and reducing the deficit; a corresponding rise in net imports would be occurring abroad. Assuming a stable parameter configuration, the payments imbalance would ultimately converge to zero. Adding mobile capital to the model only speeded and stabilized this process.

Mundell's automatic adjustment mechanism, however, entails no automatic return to *internal* balance. If the shock behind the initial deficit is a fall in world demand a recession ensues; as reserves drain away, driving interest rates higher, output falls further and unemployment grows. Political realities are unlikely to leave the income-specie-flow mechanism enough time fully to unfold. This shortcoming led Mundell to examine additional policy weapons that might help push the economy simultaneously to internal and external balance. His idea of an optimal "policy mix" (Mundell 1962) exploited the idea that fiscal expansion and monetary expansion have similar effects on output but divergent effects on interest rates, and hence, assuming sufficient capital mobility, on the balance of payments. Thus, fiscal policy can be assigned to preserve internal balance while the money supply adjusts to a level consistent with balance-of-payments equilibrium.

Despite its intellectual elegance, the theory of the policy mix was almost completely impracticable. In a detailed study of the policies of nine industrial countries during the postwar period to the mid-1960s, Michaely (1971, p. 33) found only two episodes--one each for the Netherlands and the United Kingdom--in which the policy-mix prescription was consistent with

the authorities' actions. Indeed, fiscal policy seemed to have been largely unresponsive to stabilization needs. "Most often," Michaely concluded, "budgetary policy seems to be excluded from the list of instruments available for the correction of domestic as well as balance-of-payments disequilibria."[28]

There are several reasons why fiscal policy could not be deployed in the manner Mundell proposed. To start, bureaucratic and legislative delays made it a cumbersome weapon. Leaving these issues aside, there was still the problem that capital mobility might be insufficient to allow the policy mix to work. And capital flows might well behave perversely. The need for policy intervention would be greatest in the face of a permanent disturbance, such as a permanent fall in foreign demand. But in such cases, markets would anticipate the possibility of a parity change, and private capital would flow outward, not inward. As Triffin (1960, p. 33) observed, commenting on a more general phenomenon:

> [I]nternational flows of private capital can no longer be relied upon as a major source of cushioning for current account disequilibria. Fears of currency depreciation and exchange restrictions often indeed tend to stimulate private capital flows from deficit countries to surplus countries, and to aggravate, rather than cushion, the impact of current account imbalance.

A fundamental problem was the possibility that an aggressive fiscal expansion would cause structural problems later on. Domestic investment might be crowded out. At the same time, a country borrowing abroad to maintain high employment and conserve reserves after an

adverse demand shock would be building up a foreign debt to be serviced in the future. In the case of a permanent shock, this might be an unwise strategy. Finally, the accumulation of government debt in the hands of the public could undermine government credibility and complicate adjustment.

There is abundant evidence that at least some government officials were aware of the strain on policy credibility that a large public debt might engender. The French stabilization of 1958-1959 involved deep budget cuts plus some significant confidence-building measures: an issue of gold-indexed government debt, and the restoration of external convertibility in step with other European countries.[29] In the U.K., a large public-sector debt sharply limited the room for maneuver of monetary policy. According to Goodhart (1973, p. 513), the debt was one of several factors that "gave the monetary authorities cause for concern about their ability to prevent a massive exodus of holders from long-term debt and an associated explosive increase in the money supply." The worry to avoid the "twin disasters of internal and external collapse of the value of the pound sterling"[30] meant that the Bank of England could not have viewed fiscal expansion as an attractive response to payments deficits.[31] The main point is a familiar one. An intertemporally balanced government budget is a prime requirement of overall equilibrium, and seemingly unsustainable fiscal shifts are unlikely to be well received by financial markets. This constraint limits the scope for activist fiscal policy, particularly under a fixed exchange rate.

The Keynesian assumption of strict wage-price rigidity leads to a bleaker picture than was warranted in reality. Consider again a country that suffers a permanent fall in foreign demand for its goods. In the long run, this country's terms of trade must fall, and with a fixed exchange

rate, the price change can be effected only through a fall in domestic prices and wages relative to foreign. Domestic unemployment, and an unsterilized reserve drain, eventually can bring about the required price-level decline. Prices are more rigid downward than upward, however, and in an environment of some secular inflation, appropriate relative price changes may take place, not through home deflation, but by a slowdown in home inflation. Furthermore, secular labor-productivity growth may limit the need for an absolute decline in money wages, as is discussed in subsection 5.4.[32]

In practice, then, the adjustment process was a race. Would these natural forces of relative-price change work swiftly to restore internal and external equilibrium? Or would foreign reserves and political patience run out first? Fiscal policy was in many cases disabled; and the use of monetary policy posed a dilemma, whether to move toward full employment at the cost of risking an external crisis.[33] A country that could not preserve adequate growth and full employment without continually hitting its reserve constraint was generally accepted to be in fundamental disequilibrium.

This left the ultimate weapon, devaluation. Devaluation has the advantage that it can bring about the needed relative-price change at a stroke, bypassing the need for an extended period of reserve loss and unemployment. (Appendix 1 presents a simple formal model of the adjustment process and devaluation.) But in common with all capital levies, devaluation, when anticipated, leads to private behavior likely to undermine even a benevolent government's aims. If the economy is relatively free of financial leakages, an adjustable-peg system may work tolerably well. The possibility of open or disguised capital outflows, however, can create violent

instability. Fears that a government will block cross-border financial flows may lead to similar instability.

It is noteworthy that almost every major devaluation of the Bretton Woods period was instigated, not by an authority's cool-headed perception that the economy was in fundamental disequilibrium, but by a reserve crisis.[34] It is true that many of these crises were set off by governments' attempts to escape disequilibrium through means other than devaluation. It is also true that some crises were averted by shows of central-bank solidarity in which generous inter-governmental credits were extended. But the bet could only go one way--heads, I win; tails, I don't lose--and continuing balance-of-payments problems were certain to provoke future attacks on the currency.

The devaluation option thus created severe problems of its own, and these grew acute as financial markets became more interdependent. For this reason (as I will argue in section 6) policymakers were increasingly reluctant to resort to realignment. As far as deficit countries are concerned, it is indeed no exaggeration to assert that the Bretton Woods system contained no reliable mechanism of adjustment.

5.2 The asymmetric position of surplus countries

Surplus countries were in a completely different position, in the first place because they faced no reserve constraint. Nothing in principle limited the volume of reserves they could accumulate, and to the extent that reserves could be prevented from affecting prices and interest

rates, adjustment could be postponed indefinitely.[35] This central asymmetry in the Bretton Woods adjustment mechanism shifted a disproportionate burden to deficit countries.

Germany's example illustrates the absence of forces pushing surplus countries toward balance-of-payments equilibrium. After a devaluation scare early in 1951, Germany embarked on a path of massive foreign reserve accumulation that continued, with only sporadic interruption, until the collapse of Bretton Woods. As Yeager (1976, p. 487) observes, German reserve acquisitions over 1951-1960 exceeded the total growth of the M1 measure of money supply. Had market forces been allowed to function freely, these inflows would have pushed up Germany's wages and prices, reducing competitiveness and reserve inflows in the manner Hume had described. Sectoral productivity trends also argued for higher German inflation. But Germany was unwilling to accept it. Instead reserve inflows were sterilized--mopped up through open-market sales of domestic securities, or bottled up through increasing reserve requirements on domestic banks.

Figure 1 plots the paths of Germany's international reserves (left axis) and M1 money supply (right axis), showing quarterly data from 1950:I to 1971:II. (Appendix 2 contains a full description of all data used in this paper.) Until the late 1960s, there is no indication that reserve growth influences the money growth target. A number of detailed econometric studies have confirmed Germany's high propensity to sterilize reserve inflows.[36] Sterilization had an important *magnification effect* on these flows, since restrictive domestic monetary measures leave the interest rate higher than it otherwise would have been. Existing evidence shows, however, that world capital markets were not so perfect as to push this magnification effect to infinity, making sterilization infeasible.[37] Germany also resorted to restrictions on capital inflows, such

Figure 1


Germany: Reserves and Money Supply
(billions of marks)
International Reserves
70
60
50
40
30
20
10
0
-10
120
100
80
60
40
20
0
Money Supply (M1)
1952
1955
1957
1960
1962
1965
1967
1970
Year
Reserves
Money (M1)

as prohibiting interest payments on deposits from abroad; these became more important as the speculative elasticity of capital inflows rose over the 1960s.

Germany's reserve growth slowed in the mid-1960s following a small revaluation in 1961. The deutschemark came under much heavier speculative pressure in 1968-1969 than it had in 1961, and it was again revalued (and by a larger percentage) in October 1969. The action followed a brief interlude of floating. All during this period controls on capital inflow escalated, but in May 1971 speculators nonetheless took up the one-way bet and forced the German authorities to retreat for a second time to a floating rate. The float lasted until the ill-fated Smithsonian realignment of December.

Germany's experience shows how limited were the incentives for surplus countries to adjust. Her deficit-ridden trading partners arguably would have benefited from a smoother and more prompt adjustment in German competitiveness than the revaluations of the 1960s allowed. Sterilization and financial controls were the main devices allowing Germany to postpone for long periods the choice between domestic inflation and revaluation.

5.3 The U.S. position and the role of gold

As the main reserve-currency center, the United States derived certain benefits in adjusting and faced special problems. Here was another asymmetry in the system's adjustment mechanism.[38] (Sterling's much diminished world role implied smaller benefits, and more serious problems, for Britain.) In principle (section 3), the U.S. faced no liquidity constraints. As long as foreign central banks were willing to accumulate more interest-bearing dollars, there

was no natural limit to its official settlements deficit. This practice could also relieve the U.S. of the burden of adjusting its deficit: reverse official capital inflows *automatically* sterilized U.S. deficits, forcing all necessary price-level adjustment onto others. Furthermore, with U.S. dollar liabilities elastically supplied and willingly held, no global liquidity shortage was possible.[39]

The year 1949 is an early milestone in the Bretton Woods system. In September, Britain's 30.5 percent devaluation of sterling set off a wave of devaluations involving 31 countries.[40] Although the outbreak of the Korean War in 1950 unleashed inflationary forces that obscure the devaluation's effects, the early 1950s mark the end of the postwar "dollar shortage" and the start of a period of rapid growth in global dollar reserves. As Kindleberger (1965) pointed out, much of this growth merely represented growth in foreign money demands--witness the German example cited above--and posed no objective threat to U.S. liquidity, let alone solvency. Indeed, the reserve growth was inevitable and healthy. Nervousness nonetheless set in by the late 1950s, the result of continuing U.S. gold losses and continuing growth in the country's official short-term dollar liabilities. Central banks thought it prudent to diversify, to some extent, into gold.

Waning confidence, then, was the factor placing a limit on U.S. deficits and, by implication, on global reserve growth. Over the 1960s, the U.S. enacted a series of increasingly desperate restrictions on capital outflow in an attempt to cure its payments deficit. To the extent these had any effect at all, they probably weakened the dollar's international position. (Similarly, the U.K.'s 1957 decision to ban its banks from providing sterling finance for non-British trade served mostly to hasten that currency's decline as an international money.) In

practice, U.S. monetary policy became more responsive to the payments position, at least episodically.[41]

The United States had no statutory obligation to limit the extent of its official settlements deficits. A key systemic obligation, instead, was to prevent the price of gold from rising above $35 dollars an ounce; and this the U.S. could do by controlling its money supply, independently of the size of its gold reserve. A full account of gold's role in the Bretton Woods system would require (and is worth) a chapter of its own. Here I can only summarize some of the key developments.[42]

In the early postwar years private holding of gold remained illegal in many countries and organized gold markets, including London's, were closed. Black markets functioned, however, and unofficial gold prices as high as $55 dollars an ounce are reported.[43] The London market reopened in 1954 during a period of weak gold prices. Prices remained stable until the decade's end, but began rising in 1960. One month before the 1960 U.S. presidential election the London gold price reached $40 per ounce. Parity was restored by U.S. open-market sales, backed up by reassuring statements from the president-elect. In 1961 the U.S. organized the Gold Pool, which coordinated central-bank gold intervention under a U.K. executive; but in March 1968 the Gold Pool surrendered to speculative gold-buying and simply severed the dollar's link to the metal. Gold's price was now free to rise in the private tier of the market.

In this way the Bretton Woods system's nominal anchor was jettisoned, just a few months after the November 1967 devaluation of the pound. In retrospect, the step was of immense significance. Even if the two-tier gold market didn't signal a U.S. abnegation of its responsibility to safeguard the dollar's real value, it demonstrated how easily the commitments

of reserve-currency countries could be discarded. Diminishing confidence in authorities, coupled with a growing scope for international hot money movements, proved to be an unstable mixture. The stage was set for the collapse of Bretton Woods. Triffin's prophecy finally came to pass on August 15, 1971 when the U.S. discontinued gold sales to official buyers.

5.4 Implications of unbalanced productivity growth

An assessment of adjustment mechanisms during the Bretton Woods period must recognize that differential national trends in productivity growth may necessitate trend differences in national inflation rates and long-term shifts in equilibrium real exchange rates. If the necessary price movements somehow are impeded while nominal exchange rates remain fixed, both external and internal imbalances may result. At the same time, underlying productivity trends help determine the flexibility of an economy's response to various shocks--the speed with which the long-run equilibrium path is regained. How did the system cope with the international and intersectoral productivity-growth differentials that inevitably arose?

A useful analytical framework is a small flexible-price economy that produces tradable and nontradable goods. Tradable-goods prices are determined in a world market, and all investment demand is assumed (for simplicity) to fall on tradables. Let π be the percent rate of increase of the GDP deflator, π_T^* the world inflation rate for tradables, and ν the weight of nontradables in domestic product. Let Y_T and Y_N denote real per capita outputs of tradables and nontradables; let C_T and S denote the per capita levels of tradables consumption and national saving; let ε be the elasticity of consumption substitution between tradables and nontradables;

and let circumflexes (ˆ) signify proportional changes.[44] Then under a fixed exchange rate, the inflation rate π is related to global inflation in tradable goods by

$$(6)\quad \pi = \pi_T^* + (\nu/\varepsilon)[(Y_T/C_T)\hat{Y}_T - \hat{Y}_N - (S/C_T)\hat{S}],$$

a formula involving the growth differential between tradables and nontradables, the growth rate of national saving, and the national saving ratio.

There is clearly no need for trend inflation to be equal across countries, fixed exchange rates and the law of one price for tradables notwithstanding. For example, it is plausible, looking at (6), that countries with the highest growth differentials in favor of tradables will also have the highest long-run inflation rates. The reason was explained by Balassa (1964), among others.[45] A higher relative growth rate in tradables causes a greater ongoing incipient excess demand for nontradables; quicker inflation in the prices of nontradables is the result. But notice that government policies that spur national saving may temporarily slow the pace of price increases in nontradables.[46] Even though the law of one price does not hold exactly for many tradable goods, the core message of (6), that sectoral productivity-growth imbalances influence the gap between countries' trend inflation rates under fixed exchange rates, remains valid.

Data on international inflation differentials and productivity growth support this claim. Table 1 presents evidence on inflation rates and sectoral productivity growth rates for the United States, Germany, and Japan. The table shows that the U.S. had the lowest average inflation rate of the three countries over the period 1950-1971; Japan's average rate was much higher, while Germany's is not far above that in the U.S. This inflation ranking is not

Table 1

Inflation Rates and Productivity Growth

Inflation

	United States	Germany	Japan
	(annual average compound rate)		
1950-1960	2.6	2.8	5.3
1960-1971	3.4	4.1	5.5

Labor Productivity Growth by Sector, 1950-1973

	United States	Germany	Japan
	(annual average compound rate)		
Services	1.4	2.8	4.0
Industry*	2.2	5.6	9.5
Agriculture	5.4	6.3	7.3

Capital Productivity Growth, 1950-1973

United States	Germany	Japan
(annual average compound rate)		
0.34	0.57	1.39

*Including construction.

Note: Inflation rates are based on GNP deflators. See appendix 2 for a full description of data sources.

surprising given equation (6) and the labor productivity behavior summarized in the second part of table 1. An approximate identification of nontradables with services would imply that Japan shows the sharpest differential between tradable and nontradable labor productivity growth over the period 1950-1973; Germany is next, followed by the U.S. To the extent that tradables are capital-intensive compared with nontradables, the behavior of capital productivity, shown in the table's last part, implies that the same ranking applies when intersectoral differences in total factor productivity growth are considered.

The data in table 1 underscore a first reason why productivity trends might lead to external imbalance and eventual currency realignment. Given world inflation in tradables, the intersectoral productivity differential may imply an unacceptably high domestic inflation rate. Japan readily accepted higher inflation, but Germany did not: despite a much higher intersectoral productivity differential than in the U.S., German inflation is not much higher than U.S. inflation, and is virtually identical to U.S. inflation over the 1950-1960 decade. Particularly in the first half of the Bretton Woods period, German authorities were able to restrain inflation through sterilization and a high interest rate policy; the country's ongoing foreign reserve accumulation was the external counterpart to this policy. This strategy became harder to implement after the return to convertibility, and, as noted above the deutschemark was revalued in 1961, 1969, and 1971. Japan, in contrast, did not change its official parity of ¥360 per dollar until 1971, several years after a marked trend toward external surplus had emerged.

Differing national productivity trends may also affect the ease with which countries adjust to shocks. For example, a large productivity-growth differential in favor of tradables eases the adjustment to expenditure-reducing policies requiring a fall in the relative price of nontradables.

Since the equilibrium level of that price is rising rapidly, a decline in its rate of increase, rather than a more painful absolute decrease, may be sufficient for adjustment. Similarly, a country with low overall labor-productivity growth will face a general disadvantage in undertaking adjustments requiring lower real wages. This is one reason why Japan appears to have adjusted more readily to adverse shocks than did the United States or most other countries.[47]

Figures 2 through 4, which show real and nominal exchange-rate indexes for the United States, Germany, and Japans over the years 1950-1974, place the conclusions from table 1 in the context of a broader sample of countries. Each real exchange rate (symbolized by a solid line) is the country's price level in U.S.dollars, divided by an equally-weighted geometric average of the dollar price levels of itself and eleven other OECD countries.[48] The data come from the Penn World Table (Mark V), as described by Summers and Heston (1991). An advantage of the Summers-Heston data is that the real exchange-rate indices can be interpreted in absolute terms, that is, as relative prices of similar national output baskets. The *nominal* exchange rate indexes (symbolized by broken lines) are defined analogously to the real indexes, but they are arbitrarily normalized and thus carry no absolute interpretation. An increase in either exchange-rate index is a currency appreciation (real or nominal) for the country to which the figure applies; a decrease is a currency depreciation.

Figure 2 shows a trend decline in the dollar's real exchange rate over the Bretton Woods period, an inevitable result of the processes of reconstruction and development in the postwar world. After the large-scale currency realignments of September 1949, the U.S. price level was more than 40 percent higher than the average price level in the twelve countries entering the index. This discrepancy, only a fraction of which had disappeared by 1960, helps account for

Figure 2

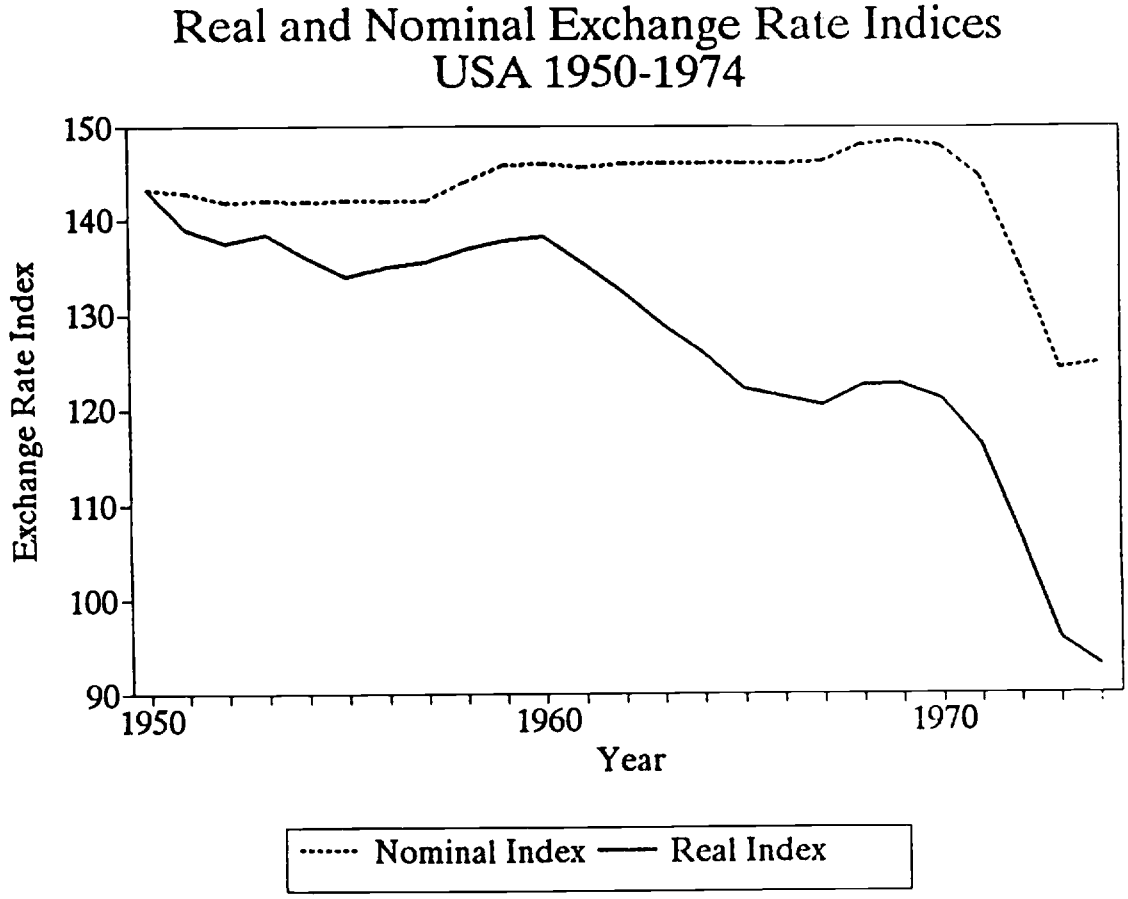

Real and Nominal Exchange Rate Indices
USA 1950-1974
Exchange Rate Index
150
140
130
120
110
100
90
1950
1960
1970
Year
Nominal Index
Real Index

Figure 3

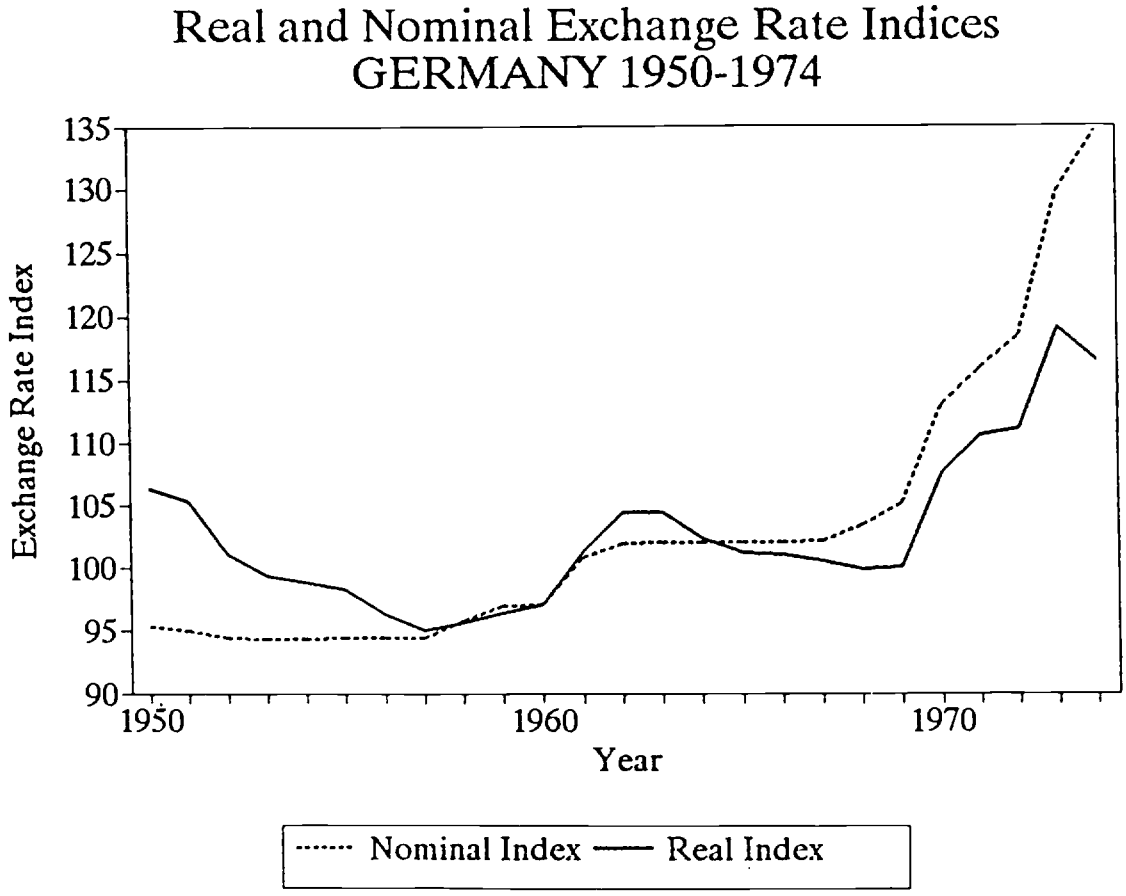
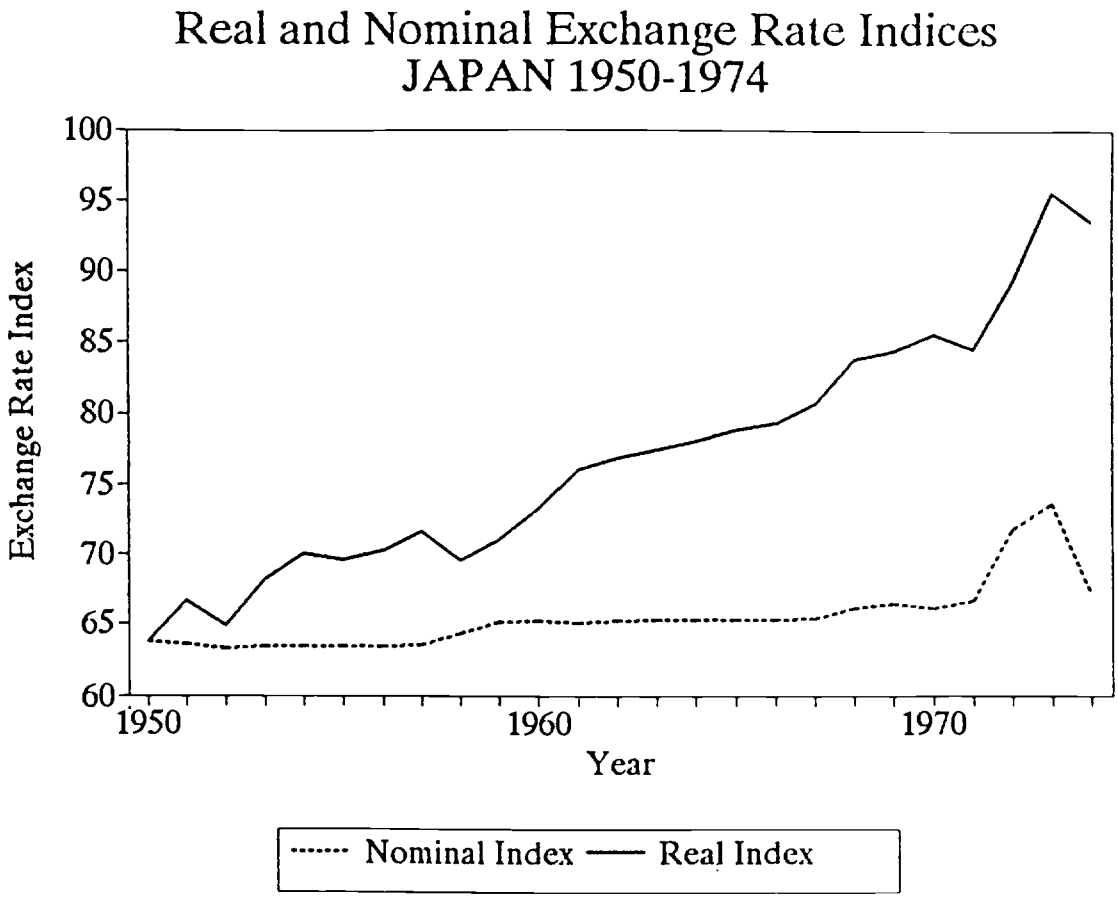

Real and Nominal Exchange Rate Indices
GERMANY 1950-1974
Exchange Rate Index
135
130
125
120
115
110
105
100
95
90
1950
1960
1970
Year
Nominal Index
Real Index

Figure 4


Real and Nominal Exchange Rate Indices
JAPAN 1950-1974
Exchange Rate Index
100
95
90
85
80
75
70
65
60
1950
1960
1970
Year
Nominal Index
Real Index

Europe's ability to reduce substantially its current account deficit with the U.S. over the next decade. Even in 1970 the dollar was still overvalued by around 20 percent according to a crude purchasing-power-parity criterion. Only with the start of generalized floating in February 1973 did the dollar's real exchange rate, for the first time, fall below the group average.[49]

The deutschemark's real exchange rate, which is shown in figure 3, actually falls between 1950 and 1957 before reversing course. It reaches a local peak in 1963 and then falls again through 1968. This pattern reflects both the Bundesbank's efforts to resist inflation and the cyclical experience of the German economy. Only in 1969 does the deutschemark appreciate decisively in real terms in line with the underlying pattern of German productivity growth.

Japan's experience, summarized in figure 4, shows clearly the strong upward trend in the real exchange rate of the yen. Despite relatively high rates of overall inflation, Japan's exports remained competitive. For example, Japan's export prices were roughly stable over the decade 1959-1969.[50] Ongoing trade competition from Japan was an additional factor behind the dollar's secular real depreciation.

Figure 2, on the dollar, offers clues about the objective basis for the exchange-rate expectations that helped bring down the Bretton Woods system between 1971 and 1973. The figure shows a real appreciation of the dollar starting in 1967, and fueled by the combination of excessive U.S. fiscal and monetary expansion from 1965 to 1968, a cyclical downturn in Europe, and the sterling devaluation. In 1970, with gloomy trade-balance prospects and an exchange rate overvalued relative to its apparent trend, the U.S. entered a recession. Burdened with an overall productivity growth rate below that of its main trading partners, the U.S. was badly positioned to adjust without a sharp slowdown in wage and price inflation; yet by 1970,

inflation expectations were becoming entrenched. The dollar's link to market gold prices had already been severed. Market participants understood that a dollar devaluation relative to currencies was the next logical step.

6. Currency realignment in practice

After the round of sharp currency devaluations in 1949, the major industrial countries became exceedingly reluctant to realign. The founders of Bretton Woods had provided realignment as a major tool of adjustment--indeed, as the only feasible tool in cases of "fundamental disequilibrium." Any evaluation of the Bretton Woods adjustment mechanism must understand why existing parities were defended so tenaciously, usually at great expense to the public purse.[51]

The major realignments after 1949 were the two French franc devaluations--one "disguised," one overt--in August 1957 and December 1958; the franc devaluation of August 1969; the sterling devaluation of November 1967; and the deutschemark revaluations of March 1961 and October 1969. These realignments were matched by some trading partners; in the U.K. case, roughly twenty countries in all (including British dependencies, but not including any of the major industrial countries) followed sterling down.

6.1 Devaluation as a last resort: The British case

Britain is the country that resisted realignment longest and at greatest cost in terms of both budgetary expense and foregone economic growth. The British case therefore gives a very

clear picture of the forces pushing policymakers to avoid devaluation despite apparently strong justifying circumstances. Britain's 1949 devaluation had been traumatic, in part because it represented partial expropriation of the large stock of sterling balances built up during World War II and after. Harrod (1952, p. 29) characterized the devaluation, not only as unnecessary, but as "a disaster of the first magnitude." Britain's reputation was injured; and the series of competitive depreciations that rapidly followed limited the benefits for British trade.[52] The succeeding Conservative governments of Churchill, Eden, Macmillan, and Home sought to avoid the charges of economic mismanagement that would inevitably follow a second devaluation. Indeed, the fear that devaluation will signal incompetence appears more generally to be a powerful deterrent.

When Harold Wilson's Labour government took power in October 1964, it faced a gathering exchange crisis and a Treasury memorandum suggesting three possible responses, one of them a devaluation of sterling. At so early a date, the political opprobrium could easily have been shifted onto the departing Conservative government. Wilson's (1971, p. 6) explanation of his opposition to devaluation at that time is revealing:

> Politically, it might have been tempting and we were not unaware of the temptation. But I was convinced, and my colleagues agreed, that to devalue could have the most dangerous consequences.
>
> The financial world at home and abroad was aware that the postwar decision to devalue in 1949 had been taken by a Labour Government. There would have been many who would conclude that a Labour Government facing

> difficulties always took the easy way out by devaluing the pound. Speculation would be aroused every time that Britain ran into even minor economic difficulties--or even without them. For we were to learn over the years that it was all too easy for those so minded to talk the pound down on the most frivolous of pretexts....
>
> But there were other considerations. We might well have started off an orgy of competitive beggar-my-neighbour currency devaluations--similar to those of the 1930s--which would have plunged the world into monetary chaos, and left us no better off--even, perhaps, stimulating economic nationalism and blind protectionism abroad.
>
> There were also strong reasons in terms of the domestic, economic and political scene. I had always argued--and continued to argue for the next three years--that devaluation was not an easy way out; that, by its very nature in cheapening exports and making imports dearer, it would require a severe and rapid transfer of resources from home consumption, public and private, to meet the needs of overseas markets. This would mean brutal restraints in both public and private expenditure over and above what was required by the domestic situation we had inherited.

In this account one can discern four distinct reasons for avoiding devaluation, reasons which no doubt informed the decision processes of other governments:

1. *Reputation.* Only by establishing a reputation for defending the official parity to the end could a country avoid the destabilizing capital flows that would otherwise blow the economy off course.

2. *Retaliation.* Trading partners might respond with punitive trade barriers or with devaluations of their own, thus stripping the devaluer of part of its competitiveness gains.

3. *The terms of trade.* The accompanying fall in the terms of trade would itself be costly.

4. *Expenditure reduction.* To offset possible inflationary effects of devaluation and rapidly liberate resources for export, a severe compression of domestic absorption would be needed. This in itself was a political cost. But a delayed improvement in trade figures not only would strain international reserves, it also would create a period of heightened vulnerability to the political opposition.

In the British case there were other considerations. One was a reluctance to depreciate official sterling balances. Another was the view that Britain's trade was being damaged by industrial problems and low labor productivity, problems that a devaluation would not cure.[53]

6.2 Realignment, the current account, and relative prices

Another possible reason for resisting devaluation might be a belief that its trade-balance effects are small. Several authors, for example, Laffer (1977), Salant (1977), and Miles (1979),

argue that devaluations of the 1950s and 1960s generally were ineffective in promoting trade-balance or current-account adjustment. For example, devaluation may feed rapidly into domestic prices, neutralizing competitiveness gains that might otherwise encourage net exports. Salant and Miles offer evidence, however, that devaluation leads to subsequent balance-of-payments surpluses. These surpluses could be due to the liquidity shortage caused by a rise in prices or to a reversal of prior capital flight, but not to an improved trade balance. If this interpretation is correct, devaluations do not effectively shift demand toward domestic products; and while devaluations may attract reserves in the short run, they would have been of little help in combating domestic unemployment in deficit-*cum*-deflation dilemmas.

A definitive assessment of the effects of a devaluation would have to analyze not only the accompanying macroeconomic policy measures, but also any additional endogenous and exogenous influences. No studies this conclusive exist; but the available evidence suggests that the major Bretton Woods devaluations did lead to trade-balance improvements. Britain's current-account balance indeed worsened sharply in the first half of 1968, but entered onto a sustained improvement in the year's second half as the government's incomes policy (removed in 1969) was backed up by tight monetary and fiscal policies. In a detailed partial-equilibrium study, Artus (1975) argues that the devaluation was instrumental in attaining this improvement. France's 1957-1958 devaluations were followed by a long-lasting improvement in its current-account balance (Dieterlen and Durand 1973, p. 136). In both countries, though, devaluation preceded a period of relatively high inflation.[54] The August 1969 franc devaluation, coupled with the October 1969 deutschemark revaluation, also was followed by an improved French trade balance (*ibid.*, p. 158; Yeager 1976, p. 483).

One way to judge the plausibility of the hypothesis that Bretton Woods realignments had lasting relative-price effects is simply to examine time series of real exchange rates over the relevant period. These data cannot disclose why particular nominal realignments had the relative-price effects they did. Nor can they reveal the effects of the relative-price changes on trade balances. But a systematic pattern of relative-price effects would suggest a fundamental regularity deserving further study.

Figures 5 and 6 plot annual data on real and nominal exchange rates for France and the United Kingdom over the period 1950-1974. As was the case in figures 2 through 4 above, the real exchange rates (solid lines) are based on the Summers-Heston (1991) data, and can be interpreted as relative prices. The nominal indexes (broken lines) have no absolute interpretation, and serve mainly to indicate the timing and proportional magnitude of nominal parity changes. As before, an upward movement is a (real or nominal) currency appreciation.

Real exchange rates as defined in the figures are only imperfectly correlated with competitiveness. Nonetheless, a devaluation-induced real depreciation, for example, will be due in part to a fall in the price of domestic relative to foreign tradables. Furthermore, any resulting change in the relative price of tradables and nontradables will shift resources in a manner that supports trade-balance adjustment. Figures 5 and 6, and figure 3 above (for Germany), suggest that all of the realignments had fairly persistent relative-price effects.

Between 1956 and 1959 the French real index in figure 5 moved from 131.8 to 110.2 as a result of the unofficial 16.7 percent devaluation of August 1957 and the 14.9 percent devaluation of December 1958. It stayed in a close neighborhood of the latter number until

Figure 5

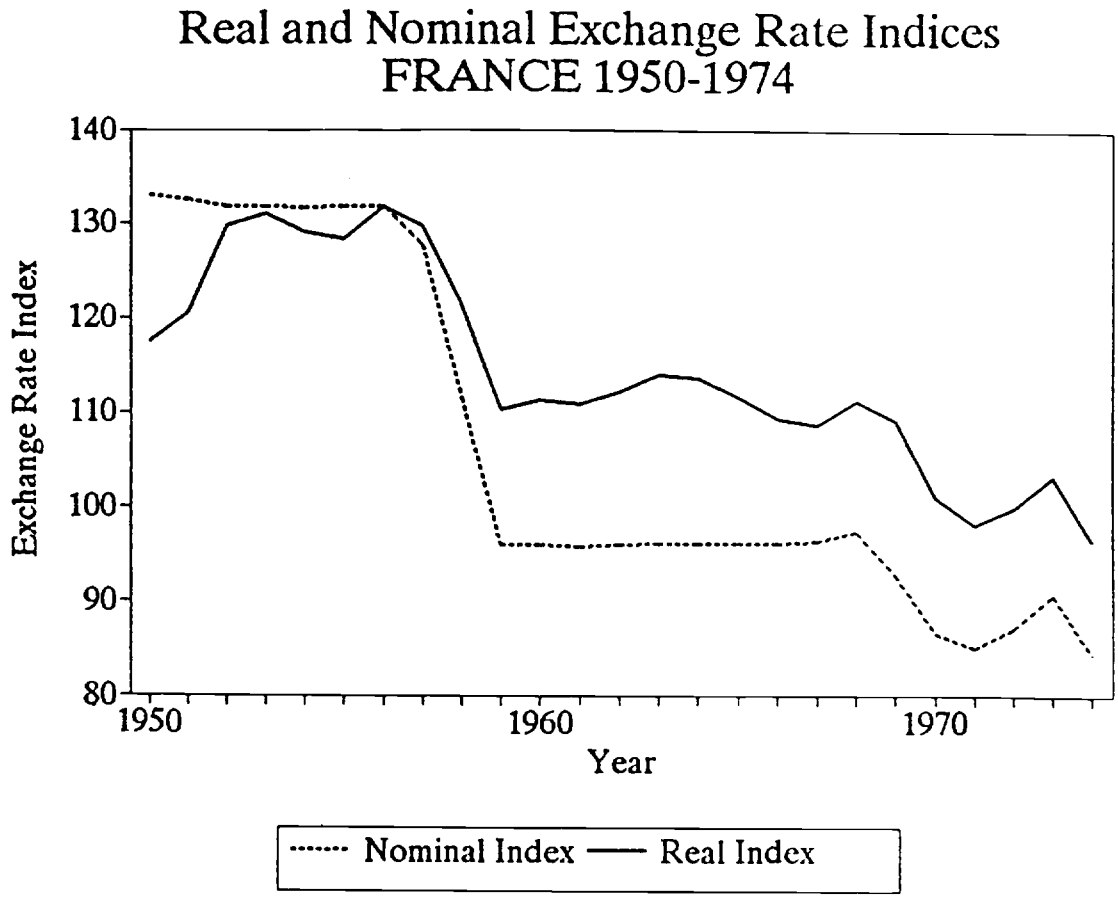
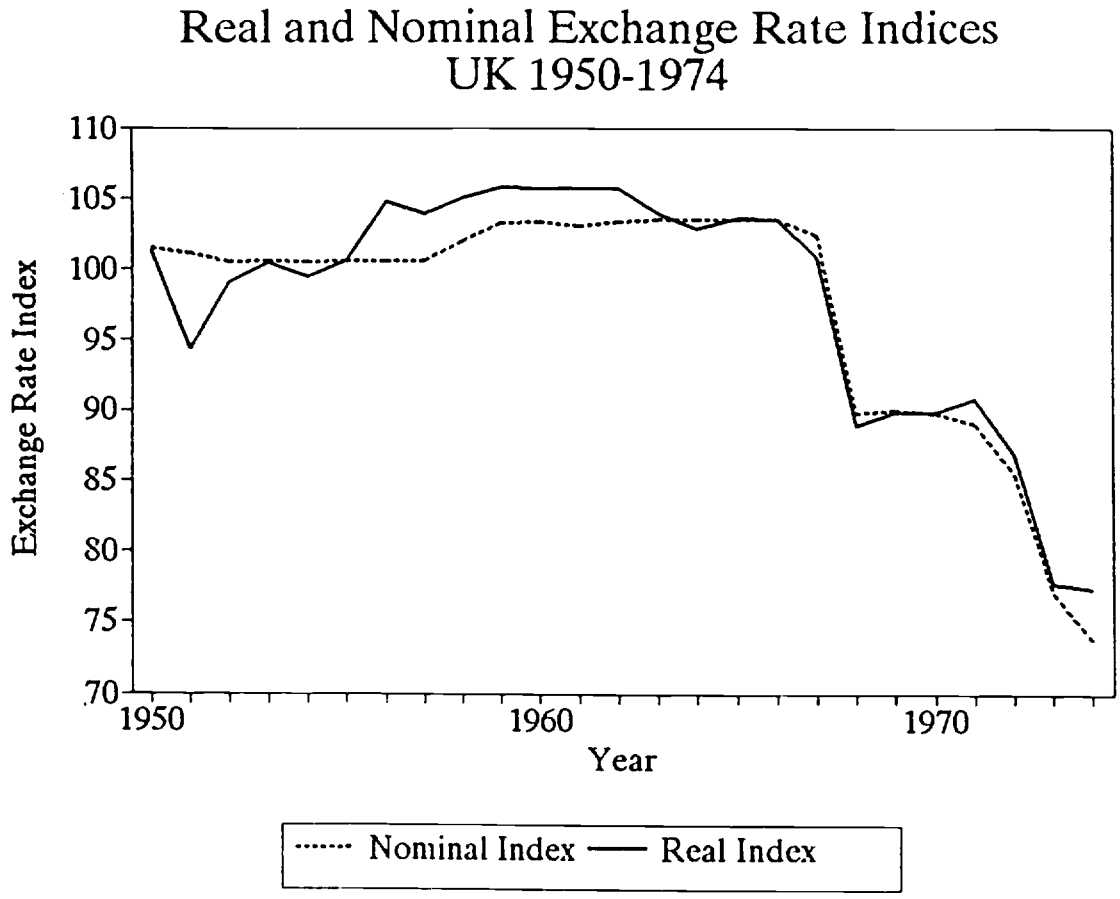

Real and Nominal Exchange Rate Indices
FRANCE 1950-1974
Exchange Rate Index
140
130
120
110
100
90
80
1950
1960
1970
Year
Nominal Index
Real Index

Figure 6


Real and Nominal Exchange Rate Indices
UK 1950-1974
Exchange Rate Index
110
105
100
95
90
85
80
75
70
1950
1960
1970
Year
Nominal Index
Real Index

1969, when a further 10 percent devaluation occurred in August. From 1968 to 1970 the real index dropped from 111.3 to 100.9.

Similarly, figure 6 shows a drop in the U.K.'s real exchange rate index from 103.5 in 1966 to 88.8 in 1968 (14.2 percent), which closely matches sterling's 14.3 percent nominal devaluation in November 1967. The index remained close to that level until the 1973 float, at which point sterling depreciated further.

The deutschemark's 5 percent revaluation against the dollar in March 1961 is reflected in a 4.4 percent rise in Germany's real exchange rate between 1960 and 1961 (figure 3). In 1967 the real exchange rate was still near its 1961 value. Between 1969 and 1970 the real index rose by 7.5 percent as the deutschemark was revalued by 9.3 percent in October 1969; and further increases followed as the currency was floated in May 1971 and realigned again in December.

6.3 Other considerations

A general consideration in deciding whether to resist realignment was the chance that a disequilibrium might not be "fundamental" at all, but instead a transitory payments gap that could be financed with no parity change. Thus, a multilateral credit facility arranged in March 1964 allowed Italy to avoid devaluing the lira.[55] Wilson (1971) argues that only by 1967 was there broad acceptance within foreign official circles that Britain's imbalance was fundamental. A package of international credits possibly large enough to have postponed devaluation was discussed; but it would have carried a level of conditionality unacceptable to the Labour government.

Surplus countries were reluctant to revalue for some of the same reasons as deficit countries, and for different ones. As in the case of deficit countries, reputation posed a problem. In the late 1960s, the German authorities learned painfully that hot money inflows sparked by speculative expectations might leave no choice but an upward adjustment of the deutschemark. Revaluation would remove external inflation pressures even if some other trading partners emulated the move; but the resulting decline in the competitiveness of exports was an important political deterrent.

The U.S. faced a special problem--similar to Britain's, but on a larger scale--because of the dollar's reserve-currency status. Both American prestige and future confidence in the dollar would, it was believed, be undermined by a devaluation relative to nondollar currencies. And while such a devaluation was not unthinkable under Bretton Woods rules, the sheer complexity of the multilateral negotiations such a step would entail loomed as a significant deterrent.

Given the long list of drawbacks, reputational and otherwise, it is not surprising that governments avoided realignment, despite the benefits it could bring if accompanied by complementary macroeconomic policies. Most governments lacked the political will or foresight to adopt policies that would have obviated eventual realignments. In this setting, the increasingly efficient world financial market was at best an unreliable adjunct to adjustment and at worst a threat to exchange-rate stability.

7. Some evidence on international capital mobility

Earlier sections of this paper have argued that imperfect capital mobility during the Bretton Woods era confronted deficit countries with liquidity constraints while giving surplus

countries the ability to sterilize reserve inflows over considerable periods. It was suggested that exchange and political risks destabilized private capital flows, and that destabilizing flows undermined credibility further, in a circular process.

Because the behavior of capital flows is so central to the adjustment problems of the Bretton Woods system, I turn in this section to evidence from financial markets. This discussion is selective, and concentrates on Germany and the United Kingdom.

The Bretton woods period as a whole shows a more limited variability of current-account imbalances than did the gold-standard era. In the first postwar years, when the need for reconstruction investment was most desperate, resource transfers into Europe were based largely on aid from North America and were not overly large by pre-World War I standards. The OEEC's current-account deficit was 4.8 percent of its output in 1947 (mostly financed by $5.3 billion in U.S. and Canadian aid) and 2.7 percent in 1948; but only 0.8 percent in 1949, 0.2 percent in 1950, and 0.7 percent in 1951.[56] The deficit dropped so sharply after 1948, despite the continuance of substantial Marshall Plan support, in part because European countries were accumulating reserves and in part because of higher private capital outflows from Europe. Only in the 1980s did the current-account ratios of major industrial countries again reach levels even comparable to those seen in the late nineteenth century.

Use of *ex post* current-account flows for inferences about capital mobility is perilous. I therefore turn to a more direct indicator of capital mobility, the relation between rates of return on comparable assets issued within different national jurisdictions.

Monthly data on German and U.K. treasury-bill interest rates, going back to 1950 and 1947, respectively, are plotted in figures 7 and 8. The German securities have a 60-90 day

Figure 7

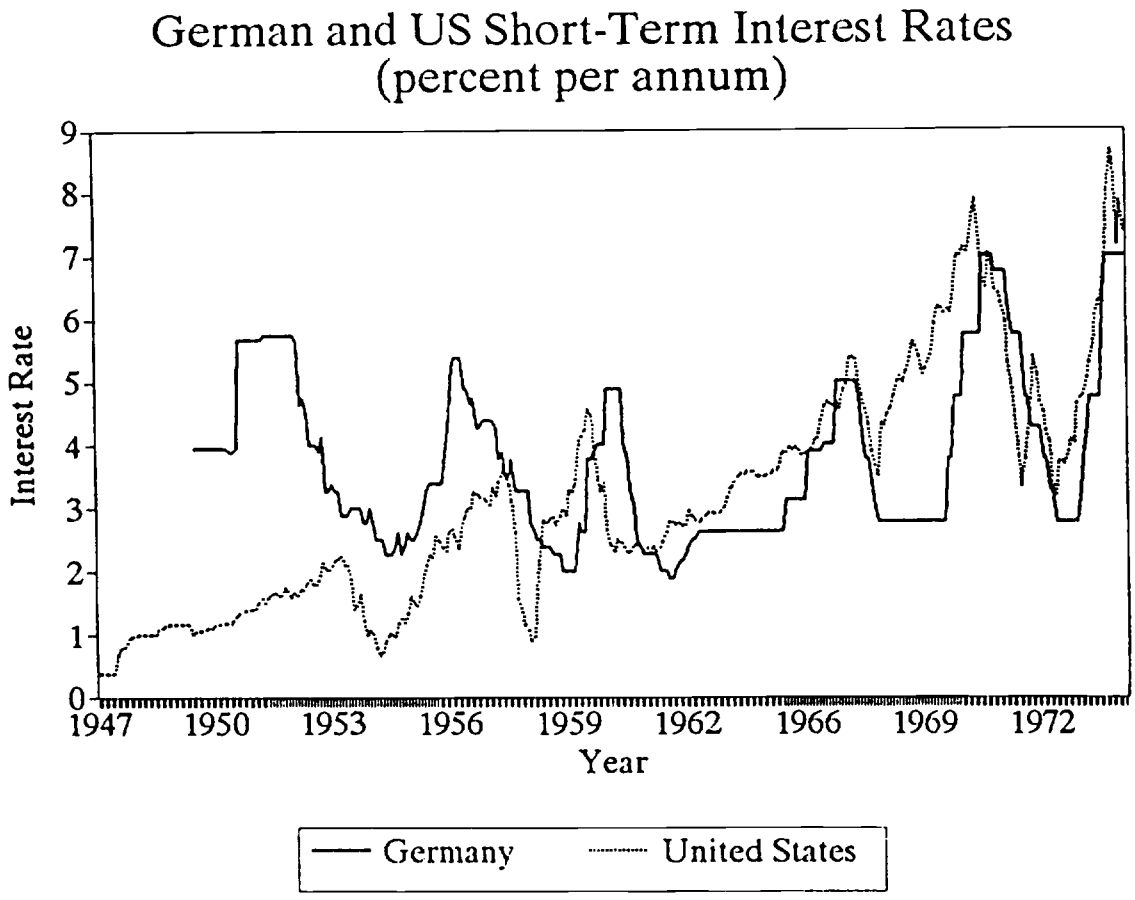
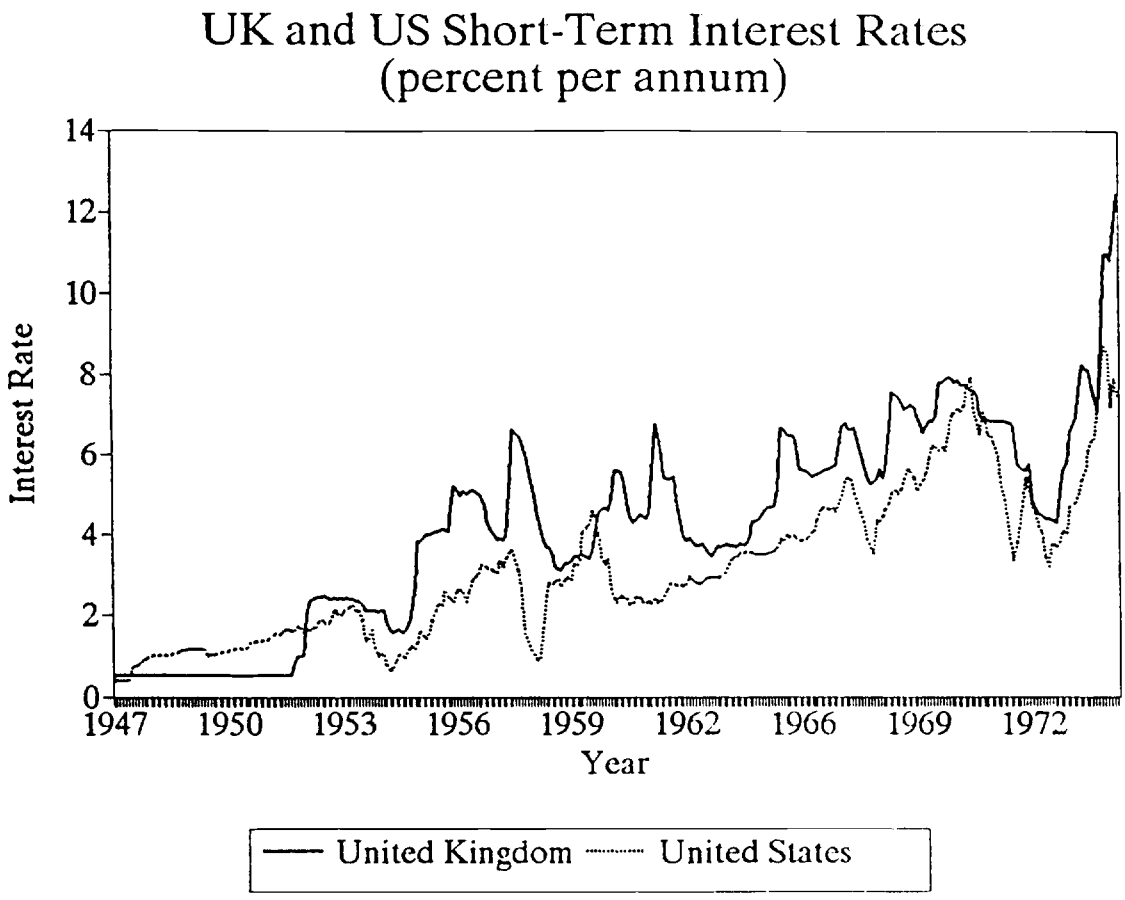

German and US Short-Term Interest Rates
(percent per annum)
Interest Rate
0
1
2
3
4
5
6
7
8
9
1947
1950
1953
1956
1959
1962
1966
1969
1972
Year
Germany
United States

Figure 8


UK and US Short-Term Interest Rates
(percent per annum)
Interest Rate
14
12
10
8
6
4
2
0
1947
1950
1953
1956
1959
1962
1966
1969
1972
Year
United Kingdom
United States

maturity, the U.K. bills a 91-day maturity, so these assets may plausibly be compared with 90-day U.S. treasury bills. There are two obstacles to interpreting such a comparisons, however. First, the German rates obviously are imperfectly flexible. This is not a serious problem on the assumption that bills were indeed being sold at these "selling" rates. Second, and more importantly, the fixed-exchange-rate provision of the IMF Articles did not literally fix exchange rates; it permitted fluctuations of ± 1 percent from parity. Thus, dollar exchange rates were free to move by as much as 2 percent.

To appreciate the importance of this second factor, observe that a 2 percent exchange rate change over three months is equivalent to a change of 8.24 percent at a compounded annual rate. Thus, even if exchange-rate margins were expected to hold with certainty, annualized three-month interest rates between dollars and other currencies could *in principle* diverge by as much as 8.24 percent per year. The divergences in figures 7 and 8 are generally much smaller, but this finding provides little information about capital mobility. Domestic monetary authorities simply had considerable flexibility at the short end of the term structure.

An inspection of medium- and long-term government bond rates is more informative. Figure 9 graphs the interest rates on both two-year German government bonds and three-year U.S. government bonds; figure 10 presents a similar comparison of long-term U.K. and U.S. government bond rates. Even moving to a two-year horizon greatly reduces the problem of the parity margins, since the maximum interest-rate deviation--under the hypotheses of credible exchange-rate bands and perfect capital mobility--now is only about 1 percent per annum. Both figures show deviations that at times are considerably in excess of those allowed by these hypotheses.

Figure 9

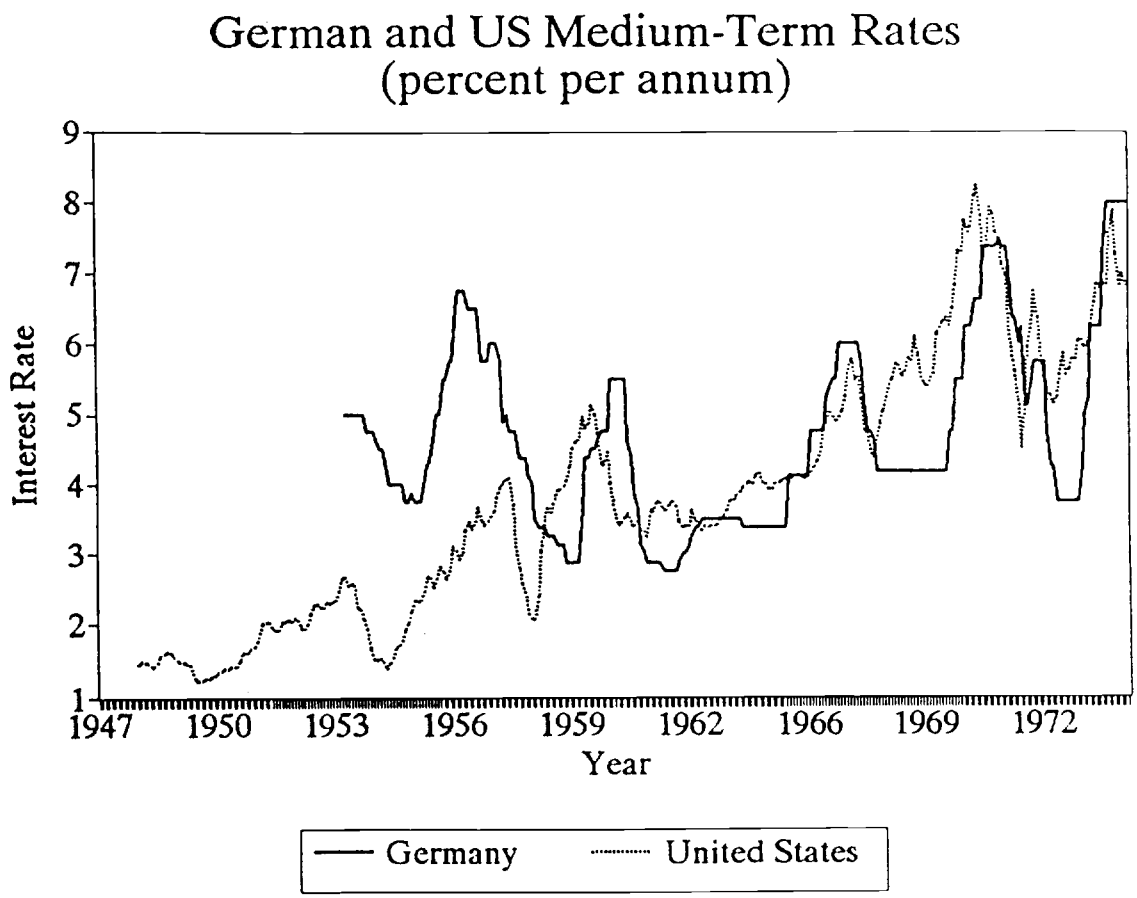
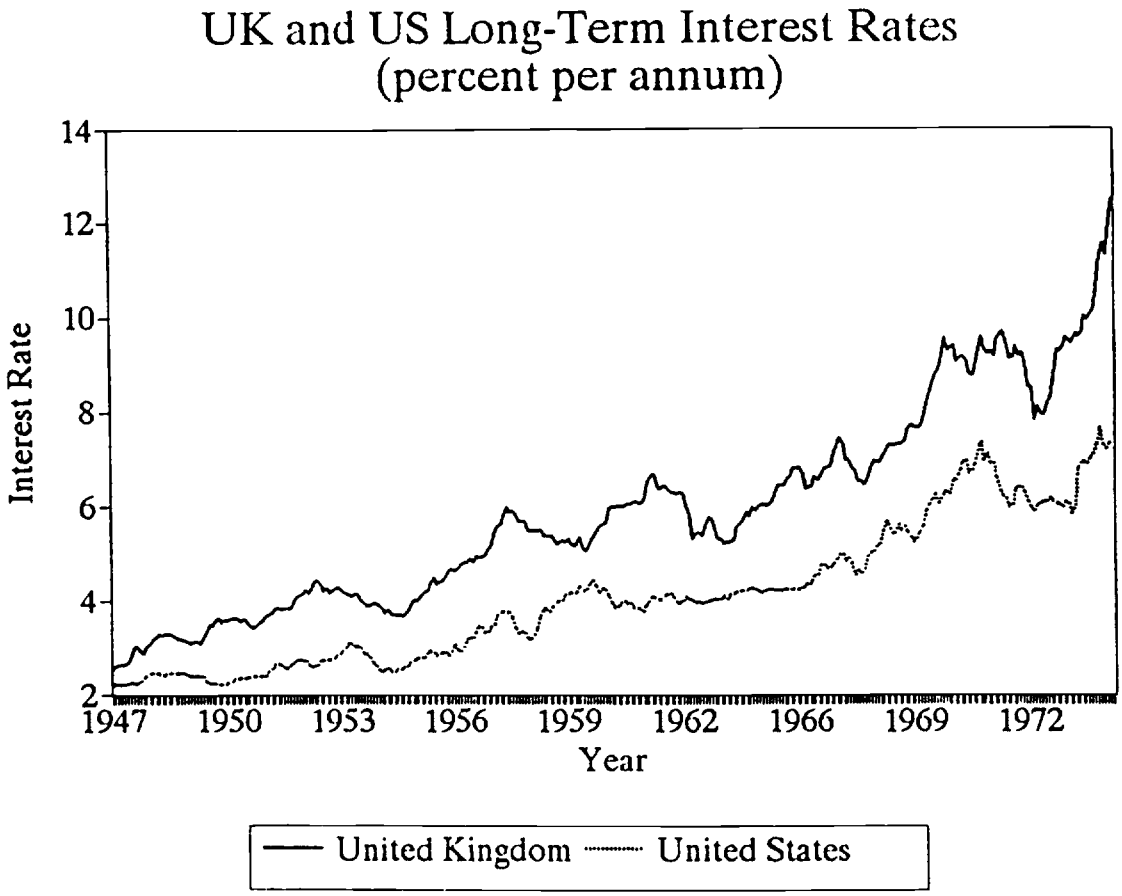

German and US Medium-Term Rates
(percent per annum)
Interest Rate
9
8
7
6
5
4
3
2
1
1947
1950
1953
1956
1959
1962
1966
1969
1972
Year
Germany
United States

Figure 10


UK and US Long-Term Interest Rates
(percent per annum)
Interest Rate
14
12
10
8
6
4
2
1947
1950
1953
1956
1959
1962
1966
1969
1972
Year
United Kingdom
United States

In the case of Germany, the bond rates appear to move in step over the longer run. But some of the larger and more persistent differentials can be explained by the policy goals of the German government. For example, the large excess of German over U.S. interest rates at the start of the sample is in part a legacy of the speculative attack of 1951; but it persists long after the crisis has passed. (Figure 7, with its longer data series, makes this clearer than figure 9.) The large increase in the German-U.S. spread in 1955-1956 reflects the Bank Deutscher Länder's response to gathering inflationary impulses. Finally, the drop in German interest rates below U.S. rates in 1967 corresponds to a period of sharp domestic economic slowdown.

The U.K. long-term bond yields in figure 10 consistently exceed U.S. yields, sometimes by more than 300 basis points. These numbers would be close to equality if the exchange-rate commitment were credible and capital were mobile. The strikingly large differential reflects some combination of expected devaluation and capital market separation--but the components cannot be separately identified without further information.[57]

One way of throwing light on the question is to combine data on short-term interest rates with data on forward exchange premia. The covered interest parity theorem predicts that if i_t^{US} is the three-month U.S. treasury-bill interest rate (measured at a quarterly rate), i_t^* the corresponding foreign rate, F_t the three-month forward dollar price of foreign currency, and E_t the corresponding spot price, then in a perfect capital market

$$(7) \qquad 1 + i_t^{US} = (F_t/E_t)(1 + i_t^*).$$

Condition (7) reflects arbitrage that would be feasible and riskless in the absence of transaction costs, existing impediments to capital movement, and political risk--defined by Aliber (1973, p. 1453) as "the probability that the authority of the state will be interposed between investors in one country and investment opportunities in other countries." On the assumption that transaction costs are not too large, the (annualized) covered interest differential d_t, defined as

$$(8) \qquad d_t = 100 \times \{(1 + i_t^{US})^4 - [(F_t/E_t)(1 + i_t^*)]^4\},$$

can be taken as a measure of financial-market segmentation due to actual international investment barriers or political risks.[58]

Figure 11 plots the differential (8) for Germany and figure 12 plots it for the United Kingdom; both figures show monthly data running from January 1960 to December 1973. Notice that the start of the sample postdates the restoration of external convertibility by more than a year. The rates used in constructing the figures are all end-of-month rates, a choice that hopefully minimizes problems of data misalignment.[59] Large discrepancies remain, however, in both cases. Since these cannot now be ascribed to expected exchange-rate changes, the results confirm the existence of obstacles to the international movement of funds.

It is useful to go beyond this observation and see if the data reveal anything more. Are the deviations in figures 11 and 12 different from zero on average? Are they short-lived shocks, or do they show persistence? Is there any change over time in the stochastic properties of the deviations? Answers to these questions might give clues about the factors impeding international arbitrage.

Figure 11

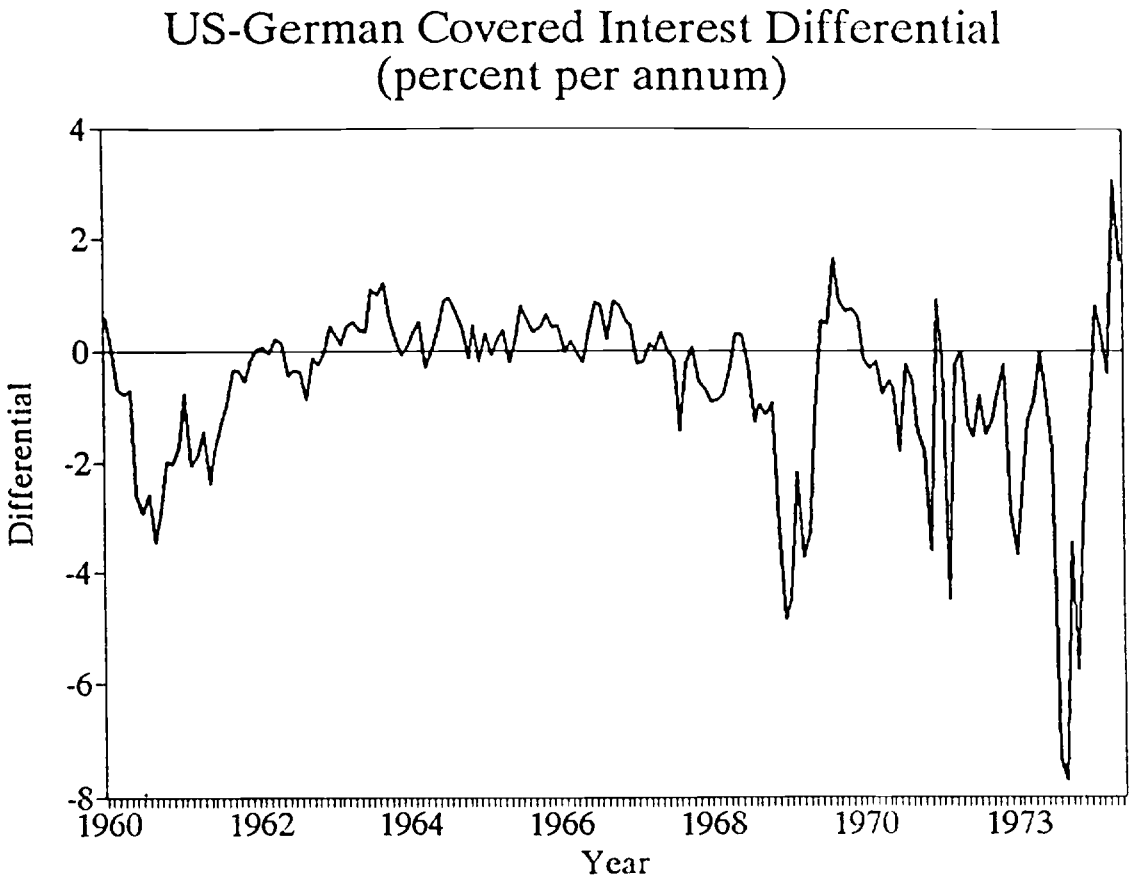
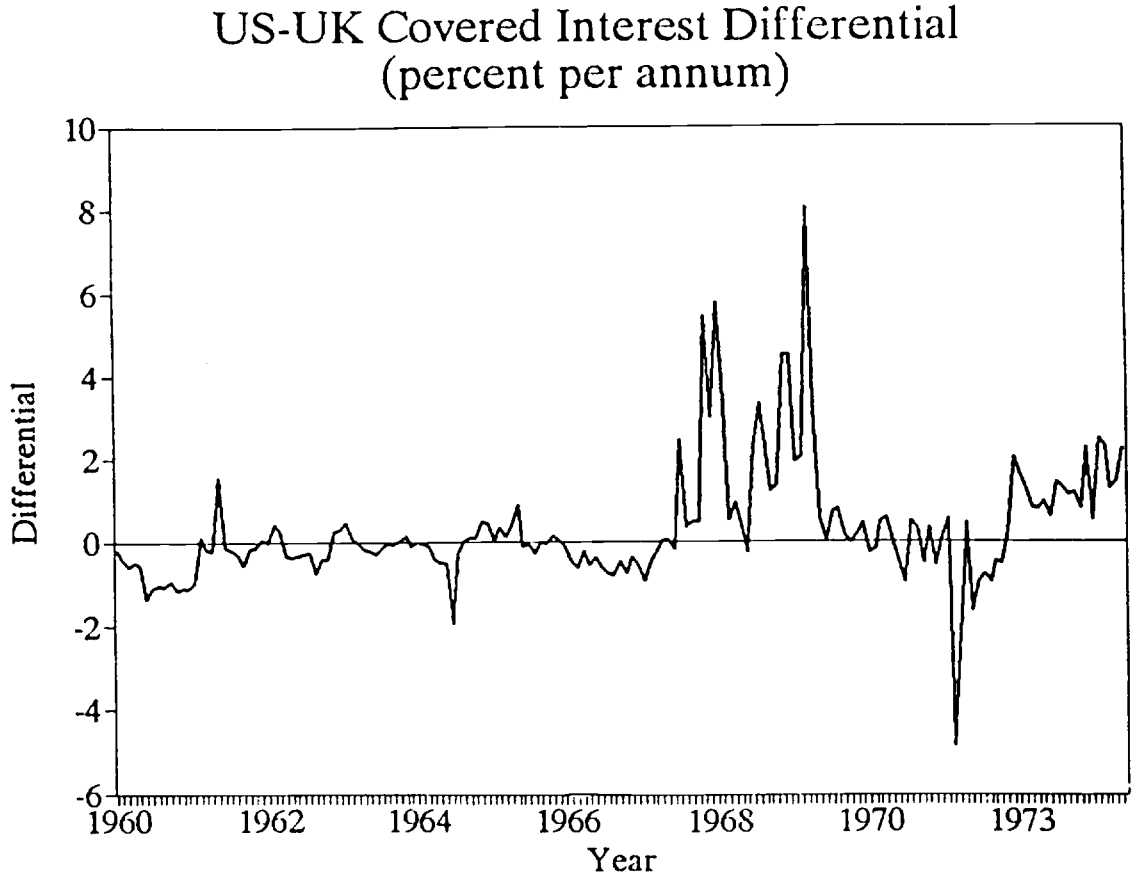

US-German Covered Interest Differential
(percent per annum)
Differential
4
2
0
-2
-4
-6
-8
1960
1962
1964
1966
1968
1970
1973
Year

Figure 12


US-UK Covered Interest Differential
(percent per annum)
Differential
10
8
6
4
2
0
-2
-4
-6
1960
1962
1964
1966
1968
1970
1973
Year

To answer the foregoing questions I postulate a simple statistical data-generating process for the deviations d_t:

$$(9) \qquad d_t = \kappa + \gamma t + \sum_{i=0}^{\infty} \phi_i \zeta_{t-i}.$$

Equation (9) has the following interpretation. The deterministic term $\kappa + \gamma t$ is the unconditional mean deviation from covered interest parity; this deviation has a trend change of γ basis points per month. I will refer to $-(\kappa + \gamma t)$ as the "country premium" relative to the United States. The infinite stochastic sum in (9) represents a random and possibly persistent deviation from the unconditional mean deviation. Each term ζ_t in this sum is unpredictable given its own past history. To economize on free parameters I make the simplifying assumption that $\phi_i = \rho^i$, for all i, where $0 < \rho < 1$. Then (9) can be written in the easily estimated form:

$$(10) \qquad d_t = \kappa(1 - \rho) + \gamma\rho + \gamma(1 - \rho)t + \rho d_{t-1} + \zeta_t.$$

The parameter ρ can be interpreted as a measure of the geometric rate at which capital flows eliminate covered interest differentials. A rationale for this process is that arbitrageurs are credit-constrained and unable to borrow enough to eliminate even a sure profit opportunity in the short run. If the opportunity persists, however, other assets can eventually be liquidated to obtain more funds for investment in the high-return market. The country premium is the portion of the arbitrage opportunity that is not ultimately eliminated; the gradual arbitrage process is a symptom of capital-market rigidities.

aggregate price rigidity. In essence, the approach is designed to measure the momentum or inertia in the price level that cannot be explained by persistent fundamentals.

A wide class of macroeconomic models leads to the following simple account of how a sluggish (log) price level, p_t, adjusts through time. Let $\wp_t$ denote a "forward-looking" shadow equilibrium price that depends exclusively on the current and discounted expected future values of some exogenous fundamentals, but not on the current price level. Then if $E_{t-1}\{\cdot\}$ denotes an expected value conditional on time $t-1$ information, price adjustment is described by

$$(11) \qquad E_{t-1}\{p_t - \wp_t\} = \beta(p_{t-1} - \wp_{t-1}).$$

Above, $\beta \in [0,1]$ measures the year-to-year persistence of price disequilibria; the case $\beta = 0$ corresponds to perfect price flexibility. If ω_t is the rational error made in predicting p_t at time $t-1$, equation (11) can be written as

$$(12) \qquad p_t = \beta p_{t-1} + [E_{t-1}\{\wp_t\} - \beta\wp_{t-1}] + \omega_t$$

$$= \beta p_{t-1} + b'z_{t-1} + \omega_t.$$

In equation (12), b is an unknown coefficient column vector and z_t is a column vector of variables that are themselves fundamentals, and thus influence $\wp_t$ directly, or that aid in forecasting future fundamentals.

Table 2

Estimates of $d_t = \kappa + \gamma t + \sum_{i=0}^{\infty} \rho^i \zeta_{t-i}$

A. February 1960 – August 1971

Country	κ	γ	ρ	S.E.E.	h
Germany	-0.315	-0.003	0.779	0.826	1.440
	(0.469)	(0.425)	(13.206)		(0.150)
U.K.	-0.486	0.009	0.600	1.146	1.108
	(0.965)	(1.519)	(7.821)		(0.268)

B. February 1960 – December 1965

Country	κ	γ	ρ	S.E.E.	h
Germany	-2.051	0.043	0.728	0.478	-0.472
	(4.366)	(4.118)	(9.975)		(0.637)
U.K.	-0.633	0.011	0.473	0.431	-1.151
	(3.097)	(2.374)	(4.452)		(0.250)

C. December 1965 - August 1971

Country	κ	γ	ρ	S.E.E.	h
Germany	2.937	-0.033	0.642	1.031	2.213
	(1.520)	(1.881)	(6.305)		(0.027)
U.K.	1.397	-0.008	0.610	1.579	0.842
	(0.509)	(0.298)	(5.558)		(0.400)

Note: Point estimates are calculated by nonlinear least squares; absolute t-statistics are below them in parentheses. Durbin's h-test for first-order serial correlation is reported above; the test statistic's marginal significance level appears in parentheses. See appendix 2 for data description.

end of the period, as German capital-account restrictions escalate, the premium has shifted partially in the reverse direction. The estimates are less precise than in panel B, and the large value of Durbin's *h*-statistic is evidence that the adjustment process may be misspecified.[60] No significant premium relative to the U.S. is disclosed by the U.K. estimates; this is not surprising in view of the somewhat similar balance-of-payments problems that the U.S. and U.K. were experiencing. Once again, random deviations from covered interest parity show some month-to-month persistence.

The results on the whole support the interpretation of the Bretton Woods period as one in which capital mobility was still imperfect, but increasing. Country premia, negative and positive, certainly existed; together with additional financial-market shocks, they contributed at times to large deviations from covered interest parity. Unusually high excess returns provoked arbitrage, but its operation, while relatively swift in the German and U.K. cases, was far from instantaneous. Thus, two distinct factors--jurisdictional risk and slow asset-market adjustment--combined to separate national financial markets.

8. Changes in the cyclical responsiveness of prices

A large body of empirical work concludes that nominal United States wages and prices do not fit the paradigm of instantaneously-clearing labor and product markets.[61] There is less agreement on wage and price stickiness outside the U.S., as well as on changes over time in the degree of wage-price flexibility. These unresolved issues are central, however, to understanding the Bretton Woods system's performance in comparison with other international monetary regimes.

In an influential study, Cagan (1975) concludes that nominal U.S. wholesale prices were significantly more flexible before World War II than after. Sachs (1980) reaffirms Cagan's findings for wholesale prices, and reached a similar conclusion concerning nominal U.S. wages. Several reasons for this apparent change in price flexibility have been put forward, among them, the U.S. government's formal responsibility to pursue full employment, growing industrial concentration, and changes in the nature of wage bargaining and contracts.

Schultze (1981) finds, however, that the U.S. nonfood consumer price index and private nonfarm GNP deflator did not become significantly less flexible in the postwar era. He argues further that the studies by Cagan and Sachs exaggerate the prewar-to-postwar change in the cyclical responsiveness of wholesale prices and wages.[62] Gordon (1983), applying a Phillips curve methodology to wage and GNP-deflator data reaching back to the nineteenth century, concludes (p. 90) that "wages and prices are less sticky and inertia-bound in postwar U.K. and Japanese data than in the postwar United States, and the inertia in U.S. wage and price behavior is purely a postwar phenomenon."

It is well established (e.g., Taylor 1987; Alogoskoufis and Smith 1991) that nominal U.K. and U.S. wages and prices have become more *persistent* in the postwar period. Persistence alone is not evidence of stickiness, however: perfectly flexible prices will display persistence if the exogenous "fundamentals" they depend on are themselves persistent. Any econometric methodology for measuring price stickiness must somehow disentangle the intrinsic inertia in prices from the inertia imparted by the fundamental determinants of prices: relatively little can be learned from the univariate time-series properties of prices alone.[63] The remainder of this section therefore pursues a multivariate methodology for quantifying a central aspect of

aggregate price rigidity. In essence, the approach is designed to measure the momentum or inertia in the price level that cannot be explained by persistent fundamentals.

A wide class of macroeconomic models leads to the following simple account of how a sluggish (log) price level, p_t, adjusts through time. Let $\wp_t$ denote a "forward-looking" shadow equilibrium price that depends exclusively on the current and discounted expected future values of some exogenous fundamentals, but not on the current price level. Then if $E_{t-1}\{\cdot\}$ denotes an expected value conditional on time $t-1$ information, price adjustment is described by

$$(11) \qquad E_{t-1}\{p_t - \wp_t\} = \beta(p_{t-1} - \wp_{t-1}).$$

Above, $\beta \in [0,1]$ measures the year-to-year persistence of price disequilibria; the case $\beta = 0$ corresponds to perfect price flexibility. If ω_t is the rational error made in predicting p_t at time $t-1$, equation (11) can be written as

$$(12) \qquad p_t = \beta p_{t-1} + [E_{t-1}\{\wp_t\} - \beta\wp_{t-1}] + \omega_t$$

$$= \beta p_{t-1} + b'z_{t-1} + \omega_t.$$

In equation (12), b is an unknown coefficient column vector and z_t is a column vector of variables that are themselves fundamentals, and thus influence $\wp_t$ directly, or that aid in forecasting future fundamentals.

Equation (12) can be estimated by ordinary least squares once the variables in z_t are specified. This line of reasoning leads to essentially the same econometric specification used in some other tests of aggregate price stickiness, such as Rotemberg's (1982) more tightly structural study of postwar U.S. prices.

The empirical approach taken above does not try to assess the response of prices to contemporaneous information. The nominal price level could be quite flexible, even with β near 1, if only a small proportion of its variability were due to predictable factors. As will be shown below, this is certainly not true in the postwar era, nor is it generally true in the gold-standard era.[64]

Two assumptions must be valid if (12) is to yield reliable results. First, the vector z_t can omit no relevant variables that are correlated with p_t. Second, the lagged price level, p_{t-1}, must not aid significantly in forecasting future values of the shadow equilibrium price, $\wp_t$, conditional on z_{t-1} being known. These assumptions are strong--perhaps unpalatable--and clearly merit investigation in future work. In particular, if the second assumption fails, the estimated value of β will reflect not only price rigidity, but also the incremental information about future fundamentals contained in prices.

Table 3 reports the results of estimating β in equation (12) with annual data from two time periods, 1882-1913 and 1952-1971. The price index is the GNP deflator, and the results cover France, Germany, Italy, Japan, the U.K., and the U.S. The variables comprising z_t are the period t and t - 1 logarithms of the money supply and real GNP; all regressions contain a constant and a time trend.

Table 3

Price Rigidity: The Gold Standard versus Bretton Woods

1882-1913	1952-1971
France	
$\hat{\beta}$ = 0.551 (2.971)	$\hat{\beta}$ = 0.232 (1.245)
$\bar{R}^2$ = 0.535	$\bar{R}^2$ = 0.994
$Q(15)$ = 7.52 (0.94)	$Q(10)$ = 12.99 (0.22)
$F(4,25)$ = 2.08 (0.11)	$F(4,13)$ = 4.53 (0.02)
Germany	
$\hat{\beta}$ = 0.552 (3.559)	$\hat{\beta}$ = 1.022 (2.869)
$\bar{R}^2$ = 0.916	$\bar{R}^2$ = 0.984
$Q(15)$ = 9.90 (0.83)	$Q(10)$ = 7.03 (0.72)
$F(4,25)$ = 3.96 (0.01)	$F(4,13)$ = 0.13 (0.97)
Italy	
$\hat{\beta}$ = 0.611 (3.658)	$\hat{\beta}$ = 0.933 (3.785)
$\bar{R}^2$ = 0.867	$\bar{R}^2$ = 0.983
$Q(15)$ = 10.29 (0.80)	$Q(10)$ = 3.60 (0.96)
$F(4,25)$ = 1.55 (0.22)	$F(4,13)$ = 3.13 (0.05)

(continued on next page)

Japan*	
$\hat{\beta} = 0.406$ (2.115)	$\hat{\beta} = 0.327$ (1.070)
$\bar{R}^2 = 0.852$	$\bar{R}^2 = 0.995$
$Q(13) = 14.50$ (0.34)	$Q(9) = 19.48$ (0.02)
$F(4,20) = 0.88$ (0.49)	$F(4,11) = 2.10$ (0.15)
United Kingdom	
$\hat{\beta} = 0.575$ (3.443)	$\hat{\beta} = 1.363$ (4.189)
$\bar{R}^2 = 0.710$	$\bar{R}^2 = 0.993$
$Q(15) = 17.54$ (0.29)	$Q(10) = 2.76$ (0.99)
$F(4,25) = 2.36$ (0.08)	$F(4,13) = 4.02$ (0.02)
United States	
$\hat{\beta} = 0.888$ (9.836)	$\hat{\beta} = 1.056$ (9.026)
$\bar{R}^2 = 0.947$	$\bar{R}^2 = 0.997$
$Q(15) = 27.50$ (0.02)	$Q(10) = 11.65$ (0.31)
$F(4,25) = 5.69$ (0.00)	$F(4,13) = 3.30$ (0.04)

*Japanese data cover the periods 1887-1913 and 1954-1971.

Note: Based on estimates of the equation $p_t = a + \tau t + \beta p_{t-1} + \mathbf{b}'\mathbf{z}_{t-1} + \omega_t$, where p_t is the log of the GNP deflator and $\mathbf{z}_t$ contains two lags of the log money supply and log real output. See appendix 2 for data sources. *t*-statistics appear in parentheses below the estimates of β. Q is the Box-Ljung serial-correlation test statistic and F is the test statistic for the hypothesis $\mathbf{b} = 0$; their significance levels appear in parentheses.

Taken together, the results suggest significant nominal price inflexibility over the earlier period, and provide some evidence of greater inflexibility in the later period. Apart from Japan and the U.S., all the countries show a β of around 0.6 during the gold-standard period. (Japan's price level appears more flexible than that of the other countries, while U.S. prices appear less flexible.) For most of the countries, β is estimated to increase in the Bretton Woods period. Surprisingly, however, this is not a universal phenomenon. The French and Japanese coefficients drop, and becomes statistically insignificant, in the later sample. Both of these GNP deflators therefore show behavior consistent with considerable price flexibility. For the other countries, β is estimated to be close to, or even above, 1 over 1952-1971. In the U.S. case, the estimated increase in β is small, and disappears entirely if one lengthens the early sample.

The fit of these equations, as measured by the adjusted R^2, appears to be closer in the second sample period, regardless of country. This could be interpreted as indicating lower predictability, and hence greater flexibility, in prices. There are other equally plausible interpretations, however. The variances of the underlying unpredictable shocks may simply have been greater in the gold-standard period, as suggested by Taylor (1987). (Flexible prices will be predictable if the fundamentals are predictable as well.) Alternatively, the quality and coverage of the price indexes may differ systematically across the two periods.

There is some evidence of specification error in the equations. Over the early sample period the U.S. price equation shows strong evidence of residual autocorrelation, as indicated by a high Q-statistic. Similarly, Japan's price equation displays significant autocorrelation over the later period. The lagged fundamentals fail to be jointly significant in several of the equations, suggesting possible omitted-variables biases. Finally, the likely presence of a unit

root in some of the price indexes (see Barsky 1987 on the U.S. and U.K.) would require an estimation strategy different from the one used here. Given the small samples available, it is not clear which strategy would yield more reliable inferences.

The preceding results are in line with the somewhat ambiguous and contradictory findings of earlier empirical studies. Nominal prices in most industrial countries display symptoms of stickiness even in the gold standard period. Nominal price inflexibility seems to have increased after World War II, but the evidence favoring this hypothesis is not overwhelming and the extent of the increase may not be large. Characteristics of wages and prices other than flexibility *per se* may be more important for understanding the Bretton Woods period. Examples might include asymmetries in wage and price adjustability or real rigidities. These topics should be high on the agenda for future research.

9. Conclusion

Under the Bretton Woods system two key economic frictions impeded adjustment by deficit countries: limited wage-price flexibility and, for much of the period, limited recourse to international credit both by individuals and by most governments. Nominal wage and price rigidities ensured that nominal exchange rate stability would be impracticable in the face of long-lived shocks. Imperfect capital mobility made country's reserve constraints tighter than they would have been in today's world, while still providing ample scope for destabilizing speculation. Surplus countries, naturally under less pressure to adjust, were able to exploit imperfect capital mobility to sterilize reserve inflows over long periods and to slow the upward adjustment of their price levels.

International credit markets evolved substantially over the years as wartime controls were progressively dismantled and private financial networks re-established. Given the other rigidities in the system and the importance of governments' domestic goals, imperfect government credibility, with respect both to exchange rates and payments barriers, ensured that the evolution of credit markets would undermine rather than support governments in their attempts to maintain fixed rates.

The process was a circular one. The adjustment mechanisms built into the Bretton Woods system, other than currency realignment, were slow and costly in political terms. Without stabilizing capital flows these mechanisms would have little chance of having time to run their course. As national asset markets became more integrated after the return to convertibility in December 1958, government ministers thus were forced to foreswear realignment ever more vigorously. These promises often were not believed, and in part because they were not believed, often could not be kept.

Was the Bretton Woods regime doomed by inherent design flaws or by faulty operation? In a sense, the question is badly framed: a well-designed system should provide incentives that ensure successful operation. Bretton Woods was originally intended to function in a world characterized by sticky nominal prices and very low capital mobility. Its design fully recognized the new primacy of domestic employment objectives, and attempted to reconcile this political reality with a rules-governed exchange rate system and a return to free multilateral trade. To this end, the Bretton Woods agreement provided official credits to allow breathing space for adjustment. The powerful instrument of currency realignment was also made available, but only

as an escape from "fundamental disequilibrium." World price-level stability was supposedly ensured by the system's central nominal anchor, the $35 an ounce price of gold.

This system served reasonably well until the early 1960s to accommodate national goals within a framework of orderly exchange-rate adjustment and expanding trade. Its design proved increasingly incompatible with changes in the world economy over the 1960s, however; and a critical modification to the original plan--the two-tier gold market--undermined stability further.

Two destabilizing design characteristics were the lack of effective adjustment incentives for surplus countries and the peculiar difficulty of devaluing the dollar. Germany's aversion to inflation, for example, shifted more of the burden of relative-price adjustment onto its trading partners. The need for a dollar devaluation became increasingly apparent over the 1960s, particularly in the light of relatively low U.S. productivity growth. But the dollar's central role as a reserve currency made devaluation problematic.

The Triffin problem would not have arisen had the U.S. been willing to gear monetary policy to maintaining the market price of gold at $35 per ounce. Perhaps a third design flaw of Bretton Woods was its failure to provide a nominal anchor better suited both to stabilize the general price level and to command widespread public support. Electorates had little understanding of gold's role in the Bretton Woods system: to them, the price of gold was an esoteric aspect of international finance, with little impact on everyday life. A more visible, more consequential anchor might have served better to brake the damaging expansionary policies the U.S. followed after the mid-1960s.

The main problem, however, was the absence of a practicable adjustment mechanism other than the exchange rate itself. An adjustable exchange-rate peg can work in a world of

strictly limited capital mobility; but as world capital markets evolved after the return to convertibility, this increasingly anachronistic design feature of the Bretton Woods system proved fatal. The system collapsed in stages in the early 1970s as speculative capital flows promoted unmanageable worldwide reserve growth. In Keynes's words (1971, p. 299), the presence of a "mobile element, highly sensitive to outside influences," proved explosively incompatible with the rigidities and political realities of the first postwar international monetary system.

Appendix 1 A model of adjustment

Here I briefly sketch a dynamic sticky-wage model of adjustment for a small open economy with a fixed exchange rate. The model illustrates (1) the adjustment to long-run balance from a position of "fundamental disequilibrium" and (2) how a devaluation can shorten the process.

In this appendix, all variables other than the domestic and foreign nominal interest rates (i, i^*) are expressed as natural logarithms. Those variables are the domestic-currency price of foreign exchange (e); the domestic and foreign GDP deflators (p, p^*); the domestic money wage (w); real domestic output (y), potential domestic output (y^f); and the domestic nominal money supply (m). The exchange rate is fixed, and the equations of the model are as follows (where the operator D denotes a time derivative and perfect foresight is assumed):

(A1) $y(t) = \delta[e + p^* - p(t)] - \sigma[i(t) - \alpha Dp(t)] + u$

(equality of aggregate demand and output),

(A2) $p(t) = \chi w(t) + (1 - \chi)(e + p^*) + \mu[y(t) - y^f]$ (markup equation),

(A3) $Dw(t) = \theta[y(t) - y^f] + \alpha Dp(t)$ (expectations-augmented Phillips curve),

(A4) $m(t) - \alpha p(t) - (1 - \alpha)(e + p^*) = \psi y(t) - \lambda i(t)$ (money-market equilibrium),

(A5) $i(t) = i^*$ (perfect capital mobility with exchange-rate credibility).

Assumption (A5) makes the model a limiting special case; but I will point out how relaxing this assumption would change the results. The model assumes that the money wage, w, is sticky in the short run; it thus allows short- as well as long-run fluctuations in the real wage. The key to the model is the pricing equation (A2), which states that the price of domestic output is a procyclical markup over the costs of labor and imported intermediate goods. Equation (A2) allows the specification of a Phillips curve, (A3), with two vital properties. It is free of money illusion (unlike the specification of gradual price adjustment in Dornbusch 1976); and it implies unconditionally (saddle-path) stable dynamics (as does the specification of price adjustment in Mussa 1977). Both α, the elasticity of the consumer price index with respect to the price of domestic output, and χ, the long-run share of labor cost in the price of domestic output, are strictly between 0 and 1.

To solve the model, start by computing the steady state values:

(A6) $p^f = e + p^* - (\sigma/\delta)i^* + (u - y^f)/\delta,$

(A7) $w^f = e + p^* - (\sigma/\delta\chi)i^* + (u - y^f)/\delta\chi,$

(A8) $m^f = e + p^* - (\lambda + \alpha\sigma/\delta)i^* + \alpha u/\delta + (\psi - \alpha/\delta)y^f.$

Then, rewrite (A1) in the form

(A9) $Dp(t) = (\delta/\alpha\sigma)[p(t) - p^f] + (1/\alpha\sigma)[y(t) - y^f]$

and differentiate (A2):

(A10) $Dp(t) = \chi Dw(t) + \mu Dy(t)$.

Define

(A11) $\Gamma \equiv \theta + (1 + \mu\delta)/\sigma$

and

(A12) $\Omega \equiv \delta\chi/\sigma$.

Combine (A3) with (A9) and (A2) to obtain

(A13) $Dw(t) = \Gamma[y(t) - y^f] + \Omega[w(t) - w^f]$.

Substitution of (A9), (A2), and (A13) into (A10) yields:

(A14) $Dy(t) = (1/\alpha\mu)[(1 - \alpha\chi)\Gamma - \theta][y(t) - y^f] + (\Omega/\alpha\mu)(1 - \alpha\chi)[w(t) - w^f]$.

The dynamic system consisting of (A13) and (A14) is linear. Because the product of its characteristic roots is $-\theta\Omega/\alpha\mu < 0$, the system is saddlepath stable, i.e., it is characterized by

a unique convergent path. Figure A1 depicts the dynamics of the model for the case in which $(1 - \alpha\chi)\Gamma - \theta < 0$. (When the opposite inequality holds, the locus $Dy = 0$ has a negative slope.) The stable saddle-path SS is described by the equation:

$$(A15)\quad y - y^f = [(\xi - \Omega)/\Gamma](w - w^f),$$

where ξ is the negative root of the characteristic equation:

$$x^2 - \{\Omega + (1/\alpha\mu)[(1 - \alpha\chi)\Gamma - \theta]\}x - (\theta\Omega/\alpha\mu) = 0.$$

An exogenous permanent fall in aggregate demand [u in (A1)] reduces the long-run domestic-output price level, money wage, and money supply--see (A6)-(A8)--but it leaves long-run output unchanged at y^f. The long-run real wage falls as well. In terms of figure A2, the long-run equilibrium moves from point 1 to point 2 and there is an immediate fall in output, to $y(0)$. The money stock falls discretely as well, since p and y have fallen. (With imperfect capital mobility, the money stock and output would drop less on impact, and the domestic nominal interest rate would fall in the short run.)

If no further changes occur, wages will decline and output will rise over time. The money price of domestic output may undershoot or overshoot its eventual level in the short run. Overshooting occurs when the impact contraction of output is sharp and the markup is highly responsive to aggregate demand; in this case, p rises, despite falling wages, as the economy

Figure A1

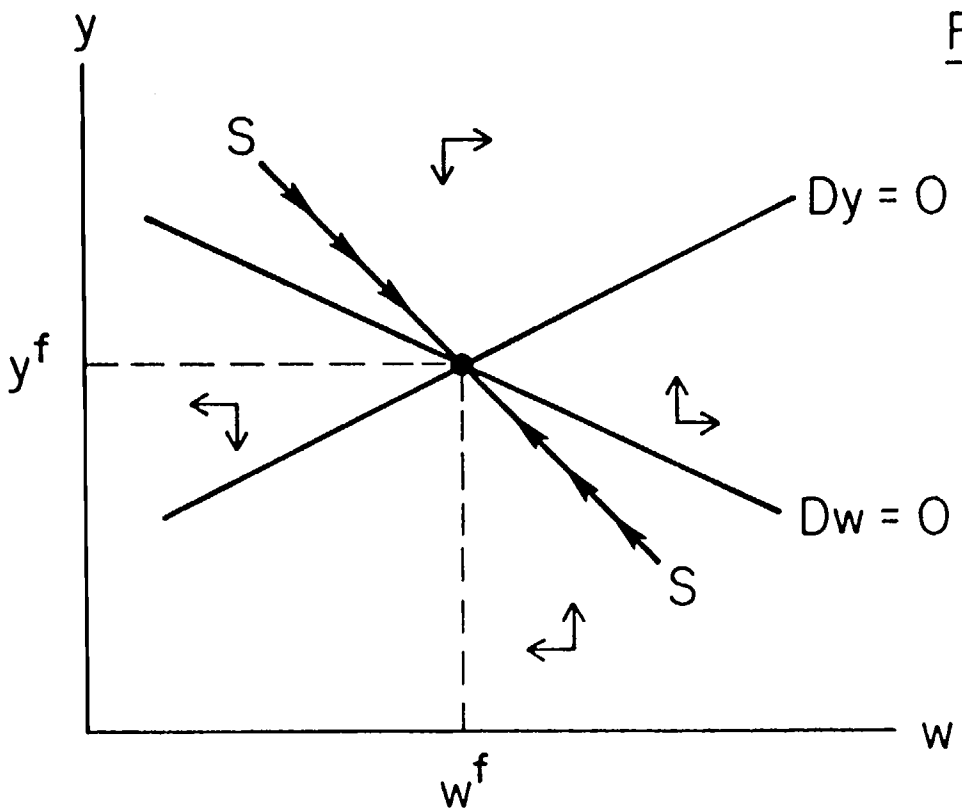
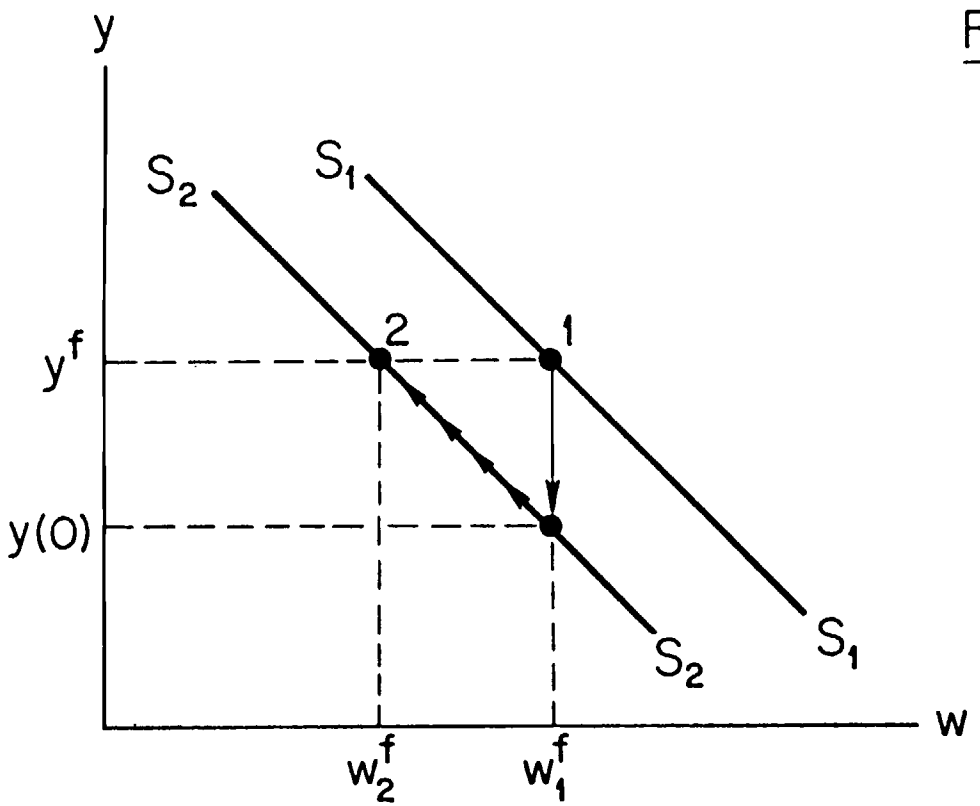


Figure A2



adjusts following the shock. In the more plausible undershooting case, however, p falls during the adjustment process, albeit more slowly than the money wage falls.

The nominal money supply m also falls on impact. If m doesn't overshoot its long-run level, it will continue to fall as the economy travels toward its stationary point. A necessary (but not sufficient) condition for m to undershoot in response to an aggregate-demand shock is that p undershoot. Under imperfect capital mobility, however, the nominal money supply will be "stickier" in the short run, and it therefore is more likely that the money supply will fall during the transition from the immediate post-shock short-run equilibrium to the new long-run position. That is, it is more likely that, absent contractionary domestic-credit policies, the transition process will entail a continuing balance-of-payments deficit.

We can think of the economy in figure A2 as being in a state of fundamental disequilibrium, particularly if the adjustment process is slow. Consider, however, the effects of devaluing the currency, i.e., raising e by the amount $\Delta e = -\Delta u/\delta\chi$ (a positive quantity, because $\Delta u < 0$). This action leaves the long-run money wage at its pre-shock level, w'_1, but it jumps the price of domestic output by $-(1 - \chi)\Delta u/\delta\chi > 0$; it thus leaves the economy in long-run equilibrium with a higher stock of reserves. (With imperfect capital mobility there would be an adjustment period with high domestic interest rates.)

Notice that the devaluation brings a one-time increase in the *overall* price level of $(1 - \alpha\chi)\Delta e$ percent, but it does not set off a period of domestic-price inflation. The reason is that the money supply is being increased, not when the economy is at full employment, but at a time when it would otherwise suffer a reserve drain.

Appendix 2 The data

This appendix describes sources for the data underlying the paper's tables and figures.

Table 1: Inflation rates are annual average compound rates of change in GNP deflators. The United States GNP deflator is taken from *Economic Report of the President*, February 1991, p. 290. GNP deflators for Germany and Japan come from the data set used in Michael Bordo's chapter in this volume--which I refer to henceforth as the Bordo data. (I am grateful to Michael Bordo for making these data available.) Labor productivity growth rates are from Maddison (1987, p. 684); capital productivity growth rates from the same source (p. 656).

Table 2: Covered interest differentials relative to the U.S. are defined by $d_t = 100 \times \{(1 + i_t^{US})^4 - [(F_t/E_t)(1 + i_t^*)]^4\}$. Here, interest rates are expressed at quarterly rates and are end-of-month three-month treasury bill rates. Forward exchange rates are 90-day end-of-month rates, expressed in U.S. cents per foreign currency unit. Spot exchange rates are end-of-month rates, expressed in cents per foreign currency unit. Data have a monthly frequency and are taken from the RATS OECD data base. (As noted in the text, the October 1967 dollar-sterling forward rate has been changed to 277.62 U.S. cents per pound.)

Table 3: All regressions in this table are based on the Bordo data. Price levels are GNP deflators (GDP deflator for France, NNP deflator for the U.K.). Output is real GNP (real GDP for France, real NNP for the U.K.). Money stocks are M1 (France, Japan), M2 (Germany, U.S.), M3 (Italy, U.K.). Data frequency is annual.

Figure 1: International reserves are quarterly data on gold plus foreign exchange holdings, in billions of deutschemarks, measured at end of quarter. Data to December 1951 come from *Statistiches Handbuch der Bank Deutscher Länder, 1948-54* (SH), table VII-2.

Figures up to March 1952 originally were reported in U.S. dollars but were converted to deutschemarks at the rate of 4.2 marks per dollar. Figures from March 1952 are from *Monthly Report of the Bank Deutscher Länder* and *Monthly Report of the Deutsche Bundesbank* (MRDB), January and July issues. Money stock is M1, measured quarterly at end of quarter. Data come from IMF, *International Financial Statistics* (IFS), line 50 until July 1955 issue, line 24 thereafter. Data after March 1957 are series 34 from the IFS tape.

Figures 2 through 6: Real exchange rate index for country i is calculated as $(X_i \div \Pi_j X_j^{1/12}) \times 100$, where j runs over Australia, Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the U.K., and the U.S., and X_i is series 13 (price level of GDP) from the Penn World Table (Mark 5). (See Summers and Heston 1991.) Nominal exchange rate index for country i is calculated as $\Pi_j E_j^{1/12} \div E_i$ and multiplied by an arbitrary scaling factor, where E_i is series 17 (the domestic-currency price of the U.S. dollar) from the Penn World Table.

Figure 7: Monthly data on German 60-to-90-day treasury bill interest rates come from SH, table IV-1b (1949-1953), and from MRDB thereafter (July issue, odd years). Rates are those prevailing on the date nearest the end of the month. Monthly data on 90-day U.S. treasury bill rates are an unweighted average of tender rates on new bills issued within the period, and come from IFS.

Figure 8: Monthly data on U.K. 91-day treasury-bill interest rates are weighted averages from IFS. U.S. treasury-bill rate data are the same as those in figure 7.

Figure 9: Monthly data on 24-month German government bond interest rates come from SH, table IV-1b (1953-1954), and from MRDB thereafter (July issue, odd years). Rates are

those prevailing on the date nearest the end of the month. Monthly data on U.S. three-year government bond rates are period averages from IFS.

Figure 10: Monthly data on U.K. 20-year government bond interest rates are averages of daily quotations from IFS. Monthly data on U.S. 20-year government bond rates are period averages from IFS.

Figures 11 and 12: Data are the differentials d_t, constructed as described in equation (8) on the basis of the data underlying the regressions in table 2 (see table 2 data description above).

References

Aliber, Robert Z. 1973. The interest rate parity theorem: A reinterpretation. *Journal of Political Economy* 81 (November/December): 1451-1459.

_____. 1978. The integration of national financial markets: A review of theory and findings. *Weltwirtschaftliches Archiv* 114 (no. 3): 448-479.

Alogoskoufis, George S., and Ron Smith. 1991. The Phillips curve, the persistence of inflation, and the Lucas critique: Evidence from exchange-rate regimes. *American Economic Review* 81 (December): 1254-1275.

Artus, Jacques R. 1975. The 1967 devaluation of the pound sterling. *International Monetary Fund Staff Papers* 22 (November): 595-640.

Balassa, Bela. 1964. The purchasing power parity doctrine: A reappraisal. *Journal of Political Economy* 72 (December): 584-596.

Barsky, Robert B. 1987. The Fisher hypothesis and the forecastability and persistence of inflation. *Journal of Monetary Economics* 19 (January): 3-24.

Bewley, Truman. 1983. A difficulty with the optimum quantity of money. *Econometrica* 51 (September): 1485-1504.

Bordo, Michael D. 1984. The gold standard: The traditional approach. In *A retrospective on the classical gold standard, 1821-1913*, ed. Michael D. Bordo and Anna J. Schwartz, 23-113. Chicago: University of Chicago Press (for the NBER).

Bordo, Michael D., and Finn E. Kydland. 1990. The gold standard as a rule. National Bureau of Economic Research Working Paper no. 3367 (May).

Cagan, Phillip. 1975. Changes in the recession behavior of wholesale prices in the 1920s and post-World War II. *Explorations in economic research* 2 (Winter): 54-104.

Cairncross, A. K. 1953. *Home and foreign investment 1870-1913*. Cambridge, U.K.: Cambridge University Press.

Cooper, Richard N. 1968. The balance of payments. In *Britain's economic prospects*, ed. Richard E. Caves, 147-197. Washington, D.C.: The Brookings Institution.

_____. 1971. *Currency devaluation in developing countries*. Essays in International Finance no. 86. Princeton, NJ: International Finance Section, Department of Economics, Princeton University.

Darby, Michael R.; James R. Lothian; Arthur E. Gandolfi; Anna J. Schwartz; and Alan C. Stockman. 1983. *The international transmission of inflation*. Chicago: University of Chicago Press (for the NBER).

Dieterlen, Pierre, and Huguette Durand. 1973. Monetary policy in France. In *Monetary policy in twelve industrial countries*, ed. Karel Holbik, 117-160. Boston: Federal Reserve Bank of Boston.

Dooley, Michael P., and Peter Isard. 1980. Capital controls, political risk, and deviations from interest-rate parity. *Journal of Political Economy* 88 (April): 370-384.

Dornbusch, Rudiger. 1976. Expectations and exchange rate dynamics. *Journal of Political Economy* 84 (December): 1161-1176.

Eichengreen, Barry. 1989. The gold standard since Alec Ford. National Bureau of Economic Research Working Paper no. 3122 (September).

Edwards, Sebastian. 1989. *Real exchange rates, devaluation, and adjustment*. Cambridge, MA: The MIT Press.

Ferrari, Alberto. 1973. Monetary policy in Italy. In *Monetary policy in twelve industrial countries*, ed. Karel Holbik, 214-245. Boston: Federal Reserve Bank of Boston.

Foley, Duncan K., and Martin F. Hellwig. 1975. Asset management with trading uncertainty. *Review of Economic Studies* 42 (July): 327-346.

Giovannini, Alberto. 1989. How do fixed-exchange-rate regimes work? Evidence from the gold standard, Bretton Woods, and the EMS. In *Blueprints for exchange rate management*, ed. Marcus Miller, Barry Eichengreen, and Richard Portes, 13-41. New York: Academic Press.

Gold Commission. 1982. *Report to the Congress of the Commission on the Role of Gold in the Domestic and International Monetary Systems*. Washington, D.C.: Government Printing Office.

Goodhart, Charles A. E. 1973. Monetary policy in the United Kingdom. In *Monetary policy in twelve industrial countries*, ed. Karel Holbik, 465-524. Boston: Federal Reserve Bank of Boston.

Gordon, Robert J. 1983. A century of evidence on wage and price stickiness in the United States, the United Kingdom, and Japan. In *Macroeconomics, prices, and quantities: Essays in memory of Arthur M. Okun*, ed. James Tobin, 85-121. Washington, D.C.: The Brookings Institution.

Grilli, Vittorio. 1990. Managing exchange rate crises: Evidence from the 1890s. *Journal of International Money and Finance* 9 (September): 258-275.

Haberler, Gottfried. 1970. Contribution to panel discussion. In *The international adjustment mechanism*. Conference Series no. 2. Boston: Federal Reserve Bank of Boston.

Hall, Robert E., and John B. Taylor. 1991. *Macroeconomics*. Third edition. New York: W.W. Norton & Company.

Harrod, Roy F. 1952. *The pound sterling*. Essays in International Finance no. 13. Princeton, NJ: International Finance Section, Department of Economics, Princeton University.

Hayashi, Fumio. 1989. Japan's saving rate: New data and reflections. National Bureau of Economic Research Working Paper no. 3205 (December).

Helpman, Elhanan. 1981. An exploration in the theory of exchange-rate regimes. *Journal of Political Economy* 89 (October): 865-890.

Herring, Richard J., and Richard C. Marston. 1977. *National monetary policies and international financial markets*. Amsterdam: North-Holland.

Hirsch, Fred. 1969. *Money international*. Harmondsworth, U.K.: Penguin Books.

Horsefield, J. Keith, ed. 1969. *The International Monetary Fund 1945-1965: Twenty years of international monetary cooperation*. 3 vols. Washington, D.C.: International Monetary Fund.

Hume, David. 1985. On the balance of trade. In *The gold standard in theory and history*, ed. Barry Eichengreen, 39-48. New York and London: Methuen.

Johnson, Harry G. 1970. The case for flexible exchange rates, 1969. In *Approaches to greater flexibility of exchange rates*, ed. George N. Halm, 91-111. Princeton, NJ: Princeton University Press.

Keynes, John Maynard. 1971. *A treatise on money: The applied theory of money. The collected writings of John Maynard Keynes*, vol. 6. London: Macmillan (for the Royal Economic Society).

Kindleberger, Charles P. 1965. *Balance-of-payments deficits and the international market for liquidity*. Essays in International Finance no. 46. Princeton, NJ: International Finance Section, Department of Economics, Princeton University.

_____. 1973. *The world in depression, 1929-1939*. Berkeley and Los Angeles: University of California Press.

Kriz, Miroslav A. 1952. *The price of gold.* Essays in International Finance no. 15. Princeton, NJ: International Finance Section, Department of Economics, Princeton University.

Laffer, Arthur B. 1977. Exchange rates, the terms of trade, and the trade balance. In *The effects of exchange rate adjustments*, ed. Peter B. Clark et al., 32-44. Washington, D.C.: U.S. Government Printing Office (for the Department of the Treasury).

Laney, Leroy O., and Thomas D. Willett. 1982. The international liquidity explosion and worldwide inflation: Evidence from sterilization coefficient estimates. *Journal of International Money and Finance* 1 (August): 141-152.

Machlup, Fritz, and Burton G. Malkiel, eds. 1964. *International monetary arrangements: The problem of choice. Report on the deliberations of an international study group of 32 economists.* Princeton, NJ: International Finance Section, Department of Economics, Princeton University.

Maddison, Angus. 1987. Growth and slowdown in advanced capitalist economies. *Journal of Economic Literature* 25 (June): 649-698.

Meade, James E. 1951. *The balance of payments.* London: Oxford University Press.

Meese, Richard A. 1984. Is the sticky price assumption reasonable for exchange-rate models? *Journal of International Money and Finance* 3 (August): 131-139.

Metzler, Lloyd A. 1948. The theory of international trade. In *A survey of contemporary economics*, ed. Howard S. Ellis, 210-254. Philadelphia: Blakiston (for the American Economic Association).

Michaely, Michael. 1971. *The responsiveness of demand policies to balance of payments: Postwar patterns.* New York: Columbia University Press (for the NBER).

Miles, Marc A. 1979. The effects of devaluation on the trade balance and the balance of payments: Some new results. *Journal of Political Economy* 87 (June): 600-620.

Modigliani, Franco, and Giorgio La Malfa. 1967. Inflation, balance of payments deficit and their cure through monetary policy: The Italian example. *Banca Nazionale del Lavoro Quarterly Review*, no. 80 (March): 3-47.

Mundell, Robert A. 1961. The international disequilibrium system. *Kyklos* 14: 154-172

_____. 1962. The appropriate use of monetary and fiscal policy for internal and external balance. *International Monetary Fund Staff Papers* 9 (March): 70-79.

Mussa, Michael. 1977. A dynamic theory of foreign exchange. In *Studies in modern economic analysis*, ed. Michael J. Artis and A. Robert Nobay. Oxford: Basil Blackwell.

Obstfeld, Maurice. 1980a. Imperfect asset substitutability and monetary policy under fixed exchange rates. *Journal of International Economics* 10 (May): 177-200.

_____. 1980b. Sterilization and offsetting capital movements: Evidence from West Germany, 1960-1970. National Bureau of Economic Research Working Paper no. 494 (June).

_____. 1986. Speculative attack and the external constraint in a maximizing model of the balance of payments. *Canadian Journal of Economics* 19 (February): 1-22.

Officer, Lawrence H. 1985. Integration in the American foreign-exchange market, 1791-1900. *Journal of Economic History* 45 (September): 557-585.

_____. 1986. The efficiency of the dollar-sterling gold standard, 1890-1908. *Journal of Political Economy* 94 (October): 1038-1073.

Persson, Torsten. 1984. Real transfers in fixed exchange rate systems and the international adjustment mechanism. *Journal of Monetary Economics* 13 (May): 349-369.

Romer, Christina D. 1991. Remeasuring business cycles. Mimeo. Department of Economics, University of California, Berkeley.

Rotemberg, Julio J. 1982. Sticky prices in the United States. *Journal of Political Economy* 90 (December): 1187-1211.

Sachs, Jeffrey D. 1980. The changing cyclical behavior of wages and prices: 1890-1976. *American Economic Review* 70 (March): 78-90.

Salant, Michael. 1977. Devaluations improve the balance of payments even if not the trade balance. In *The effects of exchange rate adjustments*, ed. Peter B. Clark et al., 97-114. Washington, D.C.: U.S. Government Printing Office (for the Department of the Treasury).

Schultze, Charles L. 1981. Some macro foundations for micro theory. *Brookings Papers on Economic Activity* 2: 521-576.

Solomon, Robert. 1982. *The international monetary system, 1945-1981*. New York: Harper and Row.

Spiller, Pablo T., and Robert O. Wood. 1988. Arbitrage during the dollar-sterling gold standard, 1899-1908: An econometric approach. *Journal of Political Economy* 96 (August): 882-892.

Summers, Robert, and Alan Heston. 1991. The Penn World Table (Mark V): An expanded set of international comparisons, 1950-1988. *Quarterly Journal of Economics* 106 (May): 327-368.

Swoboda, Alexander K., and Hans Genberg. 1982. Gold and the dollar: Asymmetries in world money stock determination, 1959-1971. In *The international monetary system under flexible exchange rates: Global, regional, and national*, ed. Richard N. Cooper et al., 235-257. Cambridge, MA: Ballinger.

Taylor, John B. 1987. Improvements in macroeconomic stability: The role of wages and prices. In *The American business cycle: Continuity and change*, ed. Robert J. Gordon, 639-659. Chicago: University of Chicago Press (for the NBER).

Triffin, Robert. 1957. *Europe and the money muddle: From bilateralism to near-convertibility, 1947-1956.* New Haven: Yale University Press.

_____. 1960. *Gold and the dollar crisis: The future of convertibility.* New Haven: Yale University Press.

U.S. Bureau of the Budget, Review Committee for Balance of Payments Statistics. 1965. *The balance of payments statistics of the United States: A review and appraisal.* Washington, D.C.: Government Printing Office.

Viner, Jacob. 1937. *Studies in the theory of international trade.* New York: Harper & Brothers.

Williamson, John. 1983. *The open economy and the world economy.* New York: Basic Books.

_____. 1991. *The economic opening of Eastern Europe.* Policy Analyses in International Economics no. 31 (May). Washington, D.C.: Institute for International Economics.

Wilson, Harold. 1971. *The Labour government 1964-1970: A personal record.* London: Weidenfeld and Nicolson and Michael Joseph.

Yeager, Leland B. 1976. *International monetary relations: Theory, history, and policy.* Second edition. New York: Harper and Row.

Endnotes

1. IMF Articles of Agreement, Article I(v), reproduced in Horsefield (1969, vol. 3, pp. 185-214).

2. Yeager (1976, p. 385) places the total of Marshall Plan aid through the end of 1951 at nearly $11.5 billion. "At its peak," he writes, "the aid program was providing most recipient countries with additional goods and services worth only 3 or 4 percent of their own total production." These are very large numbers by the standard of common welfare-cost calculations.

3. Although only the vaguest limits were placed on a member's use of its *own* gold and foreign-exchange reserves to finance capital outflows.

4. Most countries did not simultaneously institute *internal* (or resident) convertibility, that is, the freedom for residents to convert domestic money into foreign exchange for current-account purposes. West Germany, already facing problematic reserve inflows, formally established convertibility on capital as well as current account for residents and nonresidents. It is noteworthy that recent moves toward convertibility in the former Soviet bloc have emphasized internal convertibility (see Williamson 1991). Absent trade restrictions, either form of convertibility can play the vital role of "importing" world relative prices for tradable goods. If the domestic currency is not internally convertible, however, domestic residents may have no legal way of getting their hands on foreign currency.

5. IMF, Articles of Agreement, Article IV, Section 5(a). (Italics added.)

6. Pegging an exchange rate may or may not correspond to using reserves as a buffer, depending on the source of disturbance, the degree of price flexibility in the economy, and the goals of the authorities. Under conditions of capital immobility and rigid money wages, a temporary downward shift in foreign demand will cause a fall in output and a flow reserve loss (a trade deficit) when the exchange rate is pegged. The reserve loss makes some contribution to smoothing demand: obviously consumption and investment are higher than they would be if the exchange rate remained fixed but imports were lower. Policymakers, however, might prefer to allow currency depreciation, a choice that would raise foreign demand and smooth the volume of output (and employment) at the cost of a loss in the terms of trade. The tradeoffs are complex, and involve the scope and efficiency of domestic insurance markets, the strains that unemployment compensation puts on the public finances, etc.

7. The old Department of Commerce definition of the U.S. balance-of-payments deficit was motivated by the need for a broad view of the national liquidity position. Accordingly, U.S. statistics, in those days, did not consider short-term private capital inflows or U.S. government foreign borrowing to be balance-of-payments credits, on the grounds that such lending could quickly be reversed. Aside from other well-known difficulties with this accounting convention and its rationale, it probably understated the strength of the U.S. liquidity position. The Bernstein committee's subsequent definition of the balance of payments, which is now standard, is the change in U.S. foreign-exchange reserves less the increase in official foreign claims on the U.S.--the official settlements balance (U.S. Bureau of the Budget, Review Committee for Balance of Payments Statistics 1965). Despite its virtues, the Bernstein committee definition also may mislead. For example, when a foreign central bank acquires a dollar deposit in New York, the U.S. balance of payments falls by $1. But when the central bank deposits the same $1 in a London Eurobank, which then deposits the dollar in New York, the U,.S. balance of payments does not fall. Yet the two scenarios basically have identical implications for U.S. liquidity.

Standard balance-of-payments statistics also do not report forward foreign exchange commitments, which are equivalent to sterilized sales of foreign exchange and can represent massive claims against cash reserves. Hirsch (1969, p. 229) states that "In Britain in 1964-6, the authorities' forward commitments may have exceeded the gross reserves even as shored up by I.M.F. and central banking credits."

8. This formulation implies that there is no *canonical* standard of optimal current-account balance. The optimal investment rate is unique, but the "optimal" saving rate is very much a function of the income distribution, both within and across generations. And income distribution, in turn, reflects political institutions and historical factors. The statement in the text takes income distribution--that is the weights in the national social welfare function--as given.

9. It is hard not to feel uneasy about simply imposing a monetary "transactions technology" on an economy where a need to use money does not arise endogenously. Highly relevant problems that I have assumed away in this section, such as informational problems, obviously motivate the use of monies. Asserting that money is needed amounts to admitting that to some degree these problems exist. Unfortunately, and despite some recent advances, models of endogenous money use still are too rudimentary to address many issues in macroeconomics.

10. See Obstfeld (1986) for a more detailed analysis.

11. For a similar model see Swoboda and Genberg (1982).

12. All the conclusions derived below would still follow in the nonstationary version of this model, provided the real exchange rate's path remained independent of purely monetary factors.

13. Bretton Woods rules obliged the United States to redeem foreign official dollar holdings for gold at a price of $35 per ounce.

14. Notice that changes in reserves might be relevant, even with capital mobility, if all available taxes were distortionary. Open-market operations alter the currency composition of the government's portfolio, and this change alters the government's incentives to levy unexpected inflation taxes.

15. In this vein, Kindleberger (1965) argued that U.S. payments deficits resulting from liquidity imbalances in foreign money markets were not an indication of dollar weakness. Notice that the change described in the text does affect Europe's fiscal position. The stock increase in real money demand yields seigniorage revenue; by pegging the exchange rate, the government spends this revenue to acquire interest-bearing foreign assets. Were the European currency allowed to appreciate instead, the seigniorage revenue would be returned to the public in the form of a negative inflation tax payment.

16. For this calculation I hold π constant and assume that America does not sterilize gold losses. The first assumption would follow if gold conversion did not alter America's money growth rate.

17. And as long as the official price of gold, P^g, is not raised. In the present setting, however, there is no reason to raise this price.

18. This result recalls Ricardo's argument, paraphrased by Harrod (1952, pp. 2-3.), that "to re-establish and maintain a gold standard, it was not desirable to collect a large gold reserve. The prime method of maintaining the gold value of sterling was to limit the quantity of sterling issued."

19. Eichengreen (1989, p. 30) and Giovannini (1989, p. 17).

20. Officer (1986) concentrates on the 1890-1908 period, reaching similar results. Officer's findings contradict some influential earlier studies, but the arguments behind them are convincing. Spiller and Wood (1988) use a different approach to arrive at conclusions similar to Officer's. The chapter by Alberto Giovannini in this volume presents further evidence supporting the efficiency of gold-standard capital markets.

21. See Hume (1985).

22. Hume mentions as another equilibrating mechanism the variation of exchange rates within their gold points.

23. See, for example, appendix C of Bordo (1984).

24. For extensive references, see Bordo (1984), Eichengreen (1989), and, from an earlier era of scholarship, Viner (1937).

25. For a case in which borrowing from private markets played a key role in allowing a currency to remain on gold, see Grilli's (1990) study of the 1894-1896 U.S. exchange-rate crisis.

26. Triffin (1960, p. 31) writes: "Current discussions of reserve requirements stress primarily the role of reserves in the cushioning of balance of payments deficits.... Such a concept would have been largely alien to nineteenth century writers, and did not indeed play any prominent role in either academic or policy analyses of the problem until the second world war..... They were concerned exclusively and directly with the avoidance of excessive currency issues...."

27. Metzler (1948, p. 220).

28. Michaely (1971, p. 32).

29. Yeager (1976, pp.476-477).

30. Goodhart (1973, p. 513).

31. The Labour government was not deterred, however, from adopting expansionary fiscal measures in 1967 (Artus 1975, p. 626).

32. See also Haberler (1970).

33. Other tools of policy were available, of course. These included changes in the pace of external liberalization (particularly before 1958), import restrictions, export subsidies, capital controls, forward exchange intervention, direct credit controls, influence over government-owned enterprises (including banks), industrial or "structural" policies, price controls, incomes policies, and all kinds of moral suasion. Trade policies were frowned on by the GATT and invited retaliation; other policies had little capacity to bring about the permanent relative-price changes often needed for a return to balance.

34. An exception was President Pompidou's decision to devalue the franc in August 1969 "during a period of relative calm...." (Yeager 1976, p. 483.) The devaluation followed President de Gaulle's attempt to prop up the franc through restrictive macro policies and controls (November 1968), de Gaulle's resignation (April 1969), and intense speculative outflows in favor of the deutschemark (April-May 1969). See also Solomon (1982, chapter IX).

35. For a theoretical study of the long-run dynamics implied by sterilization in a model with imperfect international asset substitution, see Obstfeld (1980a).

36. See Michaely (1971), Laney and Willett (1982), and Darby et al. (1983) for surveys. Sterilization was widespread, and not confined to surplus countries.

37. See, for example, Herring and Marston (1977) and Obstfeld (1980b). Studies in Darby et al. (1983) examine the question of monetary autonomy for Germany as well as other industrial countries, reaching a broadly similar conclusion.

38. A further asymmetry was the dollar's central role in the definition of par values. The need for a dollar devaluation relative to foreign currencies was not a contingency that the Articles of Agreement had clearly foreseen. In the December 1971 Smithsonian agreement the dollar finally was devalued.

39. The absence of a global liquidity shortage does not imply, of course, that *individual* countries will never face liquidity problems.

40. Yeager (1976, p. 445). This figure does not include dependencies.

41. Swoboda and Genberg (1982) present evidence that U.S. deficits were incompletely sterilized. Giovannini (1989) finds that past U.S. deficits are correlated with the U.S. money-market interest rate. However, Michaely (1971, p. 62) classifies the U.S. (along with Germany

and Sweden) as countries in which "monetary policy does not appear to have been generally, or even mostly, responsive to the balance of payments...."

42. For detailed accounts see Hirsch (1969, chapter 10), Solomon (1982, chapters VII and XII), Yeager (1976, pp. 425-428), and Gold Commission (1982).

43. Kriz (1952, p. 3).

44. I do not disaggregate the public and private sectors of the economy.

45. Viner (1937, p. 315) paraphrases Ricardo's observation that "non-transportable 'home commodities' ... would be higher in price in countries where the effectiveness of labor in export industries and therefore also the wages of labor were comparatively high ...." Ricardo's account analyzes the "Balassa effect" from the perspective of the factor markets and the economy's supply side.

46. Given inflation, an important determinant of national saving is the nominal interest rate determined by monetary policy. If capital mobility is perfect and the exchange-rate peg credible, capital inflows will automatically keep the nominal interest rate at the world level. But if there is scope for sterilization, the authorities may be able to slow domestic inflation for a while by pushing up the nominal interest rate and with it, saving.

47. See Yeager (1976, pp. 521-535).

48. The twelve countries are Australia, Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom, and the United States.

49. In 1988, the most recent year for which data are available, the level was 80.7.

50. Solomon (1982, p. 111).

51. For more general discussion and empirical analysis of devaluation in particular, see Cooper (1971) and Edwards (1989). These authors focus on developing countries, but many of their findings are relevant to the present discussion.

52. Harrod's (1952) gloomy assessment of the 1949 devaluation was largely based on its terms-of-trade effects; in addition, he was an elasticity pessimist as far as Britain was concerned. In Harrod's view the British government should have blocked and rescheduled the sterling balances after the war; this move, he believed, would have allowed the country to achieve convertibility in 1947, to avoid the crisis of 1949, and, more generally, to restore international confidence in the value of sterling. He was not a believer in modern "trigger-strategy" reputation mechanisms; as he put it (p. 13), "Memories are short, and business is conducted mainly by reference to present advantage."

53. On the latter problems, see Wilson (1971, p. 258). In November 1967, the Chancellor of the Exchequer, James Callaghan, resigned over the government's failure to maintain the value of the sterling balances. (Callaghan had supported devaluation, and felt honor-bound to make a gesture of penance. He nonetheless became Home Secretary, and served as Prime Minister in the late 1970s.) To persuade foreign countries to continue holding sterling reserves, Britain subsequently negotiated a conditional guarantee against future depreciation of the pound. As the main reserve currency issuer, the U.S. naturally faced a problem similar to Britain's, but on a larger scale, in deciding whether to devalue the dollar.

54. If devaluation is from a position of unemployment, there is no need in theory for an inflation of domestic prices to follow, even if contractionary policies are not adopted (see appendix A). The rise import prices will cause a one-time price-level jump, however. Dieterlen and Durand (1973, p. 142) assert that "It was the increase in the volume of domestic credit that was responsible for [post-1958 French] inflation." British inflation after 1967 was due to several factors, including real-wage resistance, an eventual policy reversal, and increasing inflation abroad.

55. See Ferrari (1973) and Yeager (1976, p. 538). For an analytical account of the crisis, see Modigliani and La Malfa (1967).

56. See tables 8 and 11 in the statistical appendix to Triffin (1957).

57. Contemporary observers attributed much of the differential to the risks posed by Britain's large stock of short-term sterling liabilities to official and private holders (the so-called sterling balances). See, for example, Cooper (1968, p. 187). Cooper (p. 184) places the average magnitude of the balances at £3,500 million over 1945-1966. This figure is just over 10 percent of Britain's 1966 nominal GDP.

58. For other applications to the Bretton Woods period, see Aliber (1978) and Dooley and Isard (1980). An alternative measure (and a superior one for some purposes) would be based on a comparison of interest rates on similar assets denominated in the *same* currency but issued in different countries. Unfortunately, appropriate data do not extend as far back as the early 1960s.

59. A more thorough analysis would also attempt to correct for transaction costs.

As noted in Appendix 2, the relevant interest and exchange rates are taken from the OECD data base distributed with RATS. There is a puzzle in the data, however. The RATS data, as well as the OECD's *Main economic indicators: Historical statistics, 1964-1983*, report the end-October 1967 ninety-day forward rate as 241.30 U.S. cents per pound. (On November 18 the British government changed the parity from $2.80 to $2.40 per pound.) In an earlier publication, *Main economic indicators: Historical statistics, 1960-1979*, however, the OECD reports the end-October 1967 ninety-day forward rate as 277.62 cents per pound. Perhaps surprisingly, it is the latter number, not the updated one, that is more nearly correct. According to Yeager (1976, p. 460):

> Before devaluation, the pound had not gone to a large forward discount. Aware of how important the forward rate was as an indicator of expectations and as an incentive to outward arbitrage, the Bank of England had been intervening since 1964. The discount on three-months-forward sterling remained smaller than 1 percent per annum from early 1967 until the end of October and reached only 1.73 percent on the eve of devaluation.... Devaluation, when it came, left the authorities with massive commitments to buy pounds at a rate well above the new spot price.

Prime Minister Wilson's recollections (Wilson 1971, p. 460) confirm the absence of a crisis atmosphere in October:

> The financial pages of the press had not been expressed in crisis terms until the very last week. *The Economist*, usually quick to catch the changing mood of markets, had not devoted any leading article to describe anything in the nature of a gathering crisis--as opposed to unease--until its issue of 11th November. Even this was in the business section at the back and was in part expressed in terms of prospects for the next six months.

One presumes that *The Economist* would have remarked upon a double-digit forward discount on sterling had one existed! In the regression analysis, the October 1967 forward rate reported in the RATS OECD data base therefore is changed to 277.62¢ per pound, the value originally reported by the OECD.

60. Box-Ljung Q-statistics were also calculated as a portmanteau test against serial correlation of unknown form. Only for the U.K., over the complete sample, did the Q-test provide evidence of serial correlation at the 10 percent level or below. (The result was $Q(33) = 57.08$, with a significance level of 0.006.)

61. See Hall and Taylor (1991) for a discussion of evidence.

62. The methodologies of Cagan, Sachs, and Schultze all rely in part on a precise dating of prewar business cycles. This dating has been questioned by Romer (1991).

63. To take a simple example, let the log price level follow the stochastic process $p_t = \beta p_{t-1} + k_t$, where β is an adjustment coefficient that would be zero under perfect price flexibility and k_t is an unobservable exogenous driving process. Suppose that the "fundamentals," k_t, follow the process $k_t = \varphi k_{t-1} + \eta_t$, where φ measures the persistence in fundamentals. Then the price level can be described by either of the observationally equivalent representations:

(i) $$p_t = \beta p_{t-1} + \sum_{i=0}^{\infty} \varphi^i \eta_{t-i},$$

(ii) $$p_t = \varphi p_{t-1} + \sum_{i=0}^{\infty} \beta^i \eta_{t-i}.$$

On the basis of the time-series of prices alone, one will never be able to distinguish the role of β from that of φ: equation (ii) looks like the price equation we would get if prices had persistence φ and fundamentals persistence β. Alternatively, notice that either (i) or (ii) implies the AR(2) representation for the price level, $p_t = (\beta + \varphi)p_{t-1} - \beta\varphi p_{t-2} + \eta_t$. Neither β nor φ is individually identifiable.

64. Meese (1984) discusses tests of price stickiness based on contemporaneous correlations.