University of California Berkeley

CENTER FOR INTERNATIONAL AND DEVELOPMENT ECONOMICS RESEARCH
Working Paper No. C94-040

The Stability of the Gold Standard and the Evolution of the International Monetary System

Tamim Bayoumi
International Monetary Fund

and

Barry Eichengreen
University of California, Berkeley

October 1994

Department of Economics

CIDER

iber

CENTER FOR INTERNATIONAL AND DEVELOPMENT ECONOMICS RESEARCH

CIDER

The Center for International and Development Economics Research is funded by the Ford Foundation. It is a research unit of the Institute of International Studies which works closely with the Department of Economics and the Institute of Business and Economic Research. CIDER is devoted to promoting research on international economic and development issues among Berkeley faculty and students, and to stimulating collaborative interactions between them and scholars from other developed and developing countries.

INSTITUTE OF BUSINESS AND ECONOMIC RESEARCH

Richard Sutch, Director

The Institute of Business and Economic Research is an organized research unit of the University of California at Berkeley. It exists to promote research in business and economics by University faculty. These working papers are issued to disseminate research results to other scholars.

Individual copies of this paper are available through IBER, 156 Barrows Hall, University of California, Berkeley, CA 94720. Phone (510) 642-1922, fax (510) 642-5018.

UNIVERSITY OF CALIFORNIA AT BERKELEY

Department of Economics

Berkeley, California 94720-1922

CENTER FOR INTERNATIONAL AND DEVELOPMENT ECONOMICS RESEARCH
Working Paper No. C94-040

The Stability of the Gold Standard and the Evolution of the International Monetary System

Tamim Bayoumi
International Monetary Fund

and

Barry Eichengreen
University of California, Berkeley

October 1994

Key words: exchange rates, gold standard, international monetary system
JEL Classification: N0, F0

Abstract

This paper examines some popular explanations for the smooth operation of the classical gold standard. We find that the rapid adjustment of economies to underlying disturbances played an important role in stabilizing output and employment under the gold standard system, but no evidence that this success also reflected relatively small underlying disturbances. Finally, the paper also suggests an explanation for the evolution of the international monetary system based on growing nominal inertia over time.

This paper is forthcoming in Tamim Bayoumi, Barry Eichengreen, and Mark Taylor (eds.), *Modern Perspectives on the Classical Gold Standard*. It does not necessarily represent the views of the International Monetary Fund.

I. Introduction

Despite the attention lavished on it by generations of scholars, the question of why the classical gold standard operated so smoothly for so long remains stubbornly unresolved. Under the gold standard, the exchange rates of the major industrial countries were firmly pegged within narrow bands ("the gold points") in an environment free of significant restrictions on international flows of financial capital. This is precisely the sort of international monetary arrangement that recent experience suggests should be fragile, precarious and difficult to maintain. The breakdown of the Bretton Woods System following the liberalization of international capital markets in the 1960s and the collapse of the narrow-band European Monetary System on the heels of the removal of Europe's residual capital controls in the 1980s illustrate the point. How the gold standard managed to avoid the same fate constitutes an analytical mystery and an important policy question.

The literature on this subject can be separated into two strands concerned with the policy regime and with the structure of markets, respectively. The former focuses on the stabilizing nature of the policy rules followed by central banks and governments during the gold standard years. Eichengreen (1992), for example, focuses on credibility and cooperation as the dual pillars of the policy regime. At the core of the system -- in Britain, France and Germany -- there was no doubt, barring the most exceptional circumstances, that whatever steps were needed would be taken to defend the central bank's gold reserves and the exchange rate peg.[1] Lending credibility to this policy was the fact that the connections between policy and employment remained incompletely understood. So long as there was no properly articulated theory of the relationship between policy and the economy, observers could reasonably disagree about whether the level of interest rates was aggravating unemployment; their disagreement neutralized pressures that might have been applied to modify policy. Public spending ratios were low, budgets balanced. Governments "generally abided by a balanced budget objective, which could be regarded, in effect, as representing the required fiscal constraint on national policies" (Goodhart, 1992). Those who suffered most from unemployment were in no position to make their objections felt. The right to vote was generally limited to men of property. Labor parties representing working men were in their formative years. The working man at risk of unemployment when the central bank raised interest rates had little opportunity to voice his objections, much less to expel from office the government and central bankers responsible for the policy.

For all these reasons a negative disturbance to a country's balance of payments did not weaken the exchange rate to the point where painfully large interest rate increases had to be undertaken. Instead, any weakness was quickly offset by capital inflows prompted by the expectation that the authorities would do what was required to stabilize it. This fact limited the distress caused by those necessary steps.

The other stabilizing element of the policy regime was international cooperation among central banks and governments. Cooperation was episodic,

---

1 Experience was very different in Latin America and other parts of the "periphery," as emphasized by Ford (1962), de Cecco (1984) and others.

but it occurred precisely when the system's anchor currencies came under attack. Central banks discounted bills on behalf of the affected country or lent gold to its monetary authority. The most famous such instance was the 1890 Baring Crisis, when the Bank of England was faced with the insolvency of a major British bank, Baring Brothers, which had extended bad loans to the Government of Argentina. The Bank of England borrowed £3 million of gold from the Bank of France and obtained a pledge of £1.5 million of gold coin from Russia. With their help, the crisis was surmounted.[2]

Bordo and Kydland (1994) attribute the credibility of policymakers' commitment to defend their gold standard parities to the contingent nature of the policy rule. In this view, the monetary authorities adhered faithfully to the fixed price of gold except during major disturbances. In the event of a serious disturbance such as a war, however, specie payments could be suspended in order to facilitate the issue of paper money and debt. This relieved the authorities of the need to assume an insupportable -- and hence incredible -- commitment to defend their fixed parities. But because there was no question about the temporary, emergency nature of the suspension, it did not undermine confidence in the authorities' commitment to maintain the gold parity in normal times. This contingent rule thus

---

2 Cooperation was repeated subsequently. In 1895 a consortium of European banks, with the encouragement of their governments, defended the U.S. gold standard. In 1898 the Reichsbank and German commercial banks obtained assistance from the Bank of England and the Bank of France. In 1906 and 1907 the Bank of England, confronted by another financial crisis, again obtained support from the Bank of France and from the Reichsbank. The Russian State Bank shipped gold to Berlin to replenish the Reichsbank's reserves. In 1909 and 1910 the Bank of France again discounted English bills, making gold available to London. Smaller European countries such as Belgium, Norway and Sweden also borrowed reserves from foreign central banks and governments.

supported a time-consistent and credible monetary regime.

Using a similar approach, Eichengreen (1994a) explains the viability of temporary suspensions in terms of models of exchange rate escape clauses, in which it is argued that exceptional circumstances can be invoked to justify a temporary suspension of the exchange rate peg without undermining the credibility of the authorities' commitment to defend it in normal times only if those exceptional circumstances are independently verifiable and clearly not of the authorities' own making.[3] Given the nature of the policy regime described above, these preconditions were better satisfied under the classical gold standard than subsequently. Over time, the conduct of policy became increasingly politicized and the viability of the escape clause declined. Temporary suspensions threatened to raise questions about the dedication of governments to the defense of their gold standard parities and to erode the credibility of their commitment to their maintenance. Invocation of the escape clause became rare, and the classical gold standard increasingly came to resemble a fixed exchange rate system.

Questions nonetheless remain about whether the policy regime can explain the stability of the gold standard system.[4] Some authors have looked instead to the nature of the underlying economic environment, and to the structure of commodity and factor markets in particular. The maintenance of the gold standard could be attributable simply to a

---

[3] On the concept of escape clauses and for applications to exchange rates, see Canzoneri (1985), Obstfeld (1992), Flood and Isard (1989) and de Kock and Grilli (1989).

[4] For instance, there is Bloomfield's (1959) seminal article emphasizing central banks' violations of the rules of the gold standard game.

favorable environment (relatively small and infrequent macroeconomic disturbances) or to the flexibility of markets (relatively fast adjustment of prices and quantities to those disturbances which occurred). This strand of literature has been lent new impetus by recent developments in time-series econometrics. A number of investigators (Keating and Nye 1991, Bayoumi and Eichengreen 1992, Bordo 1993) have applied a technique developed by Blanchard and Quah (1989) to extract aggregate-supply and aggregate demand disturbances and speeds of adjustment to shocks from time series on output and prices. These studies generally find that shocks were not smaller and less prevalent under the gold standard than subsequently but that the adjustment of prices and quantities was faster, as if market flexibility allowed disturbances to be more easily accommodated at low cost during the gold standard years.

The framework employed in these studies is the familiar aggregate-supply-aggregate demand model of Figure 1.[5] It predicts that an aggregate demand disturbance like that depicted in panel (b) will raise output temporarily but prices permanently, while an aggregate supply disturbance like that of panel (c) will raise output and reduce prices in both the short and long runs. The empirical methodology, as described in the appendix, does not impose these price responses. While the price level generally responds as predicted when the model is estimated with data for the Bretton Woods System and the post-Bretton Woods float, the same is not true for the classical gold standard years. Rather, investigators find a

---

[5] Blanchard and Quah themselves formulated the model in terms of output and unemployment rather than output and prices. Keating and Nye estimate both variants of the model.

tendency for prices to rise in response to permanent shocks, as if aggregate demand curves sloped up. This raises obvious questions about the applicability of the aggregate-supply-aggregate-demand framework to gold standard experience.

In addition, Neumann (1993) has questioned whether the slopes of the aggregate supply and aggregate demand schedules associated with the variances of the estimated disturbances shift with changes in the exchange rate regime as predicted by the model. Fixed exchange rates like those of the gold standard should be associated with a relatively flat aggregate demand schedule, since domestic prices cannot diverge radically from prices in the rest of the world and the money supply should adjust endogenously to shocks. However, Neumann's numerical calculations, based on Bordo's econometric estimates, imply that aggregate demand curves were steeper under Bretton Woods than under floating and only slightly flatter in the gold standard years.

With this debate as background, we reassess the evidence on the incidence of macroeconomic disturbances and the speed of adjustment under the classical gold standard. Our innovation is to introduce linkages between domestic and foreign prices, further opening up the aggregate-supply-aggregate-demand framework to transactions with the rest of the world. This extension proves sufficient to resolve several of the paradoxes described above. We still find that shocks were no smaller or less frequent under the gold standard than the post-war period, but that the adjustment of prices and quantities was faster. Now, however, we find that on average demand curves slope down over the short and intermediate runs before international arbitrage restores prices to the levels that prevailed prior to the shock. The exceptions are countries like Australia, for which gold discoveries were a major source of disturbances and one with unique implications for the association between supply shocks and the price level.

Finally, we analyze shifts across international monetary regimes in the slopes of the aggregate demand and aggregate supply schedules. We find that these slopes did in fact shift over time in directions consistent with the predictions of standard models. Aggregate demand curves were flatter under the quasi-fixed exchange rates of the gold standard than the pegged but adjustable rates of Bretton Woods and flatter under Bretton Woods than the post-Bretton Woods float. Even the interwar period, which encompassed a succession of different exchange rate regimes, is consistent with this taxonomy. Moreover, short-run aggregate supply curves were steeper under earlier international monetary regimes than later ones, consistent with the notion that nominal inertia increased over time. We show that the steady increase in the slope of the short-run aggregate supply curve provided an incentive for policymakers to adopt monetary regimes featuring progressively greater exchange rate flexibility. This analysis thus provides a unified explanation for the historical evolution of the international monetary system.

II. An Analysis of the Classical Gold Standard

For the gold standard period 1880-1913 we gathered data for seven countries for which it was possible to obtain consistent estimates of national income in both real and nominal terms: the United States, Great

Britain, Germany, Italy, Sweden, Australia and Denmark.[6] Growth and inflation were calculated as the first difference of the logarithm of real GDP and the implicit GDP deflator, respectively. In each case, we included two lagged values in our bivariate VARs so as to preserve the symmetry of specification across countries. The Schwartz Bayesian information criterion generally indicated an optimal lag length of one or two. Chow tests provided little evidence of significant structural shifts across subperiods within the gold standard years.

Table 1 summarizes the variability of the estimated aggregate supply and aggregate demand shocks for different countries and periods.[7] We construct the international aggregate by first estimating the vector autoregressions on individual country data and then aggregating the results using GDP weights.[8] SD is the standard deviation of this aggregate series, whereas SD* denotes the GDP-weighted standard deviation of individual country series around the aggregate.

Both demand and supply shocks are larger for Australia than for any other country. There is reason to think that the Australian case is different from that of the other economies in the sample, as we explain below. Both shocks are relatively small in the Great Britain, the country at the center of the gold standard system.

The data on the size of aggregate disturbances (SD) indicates a

---

[6] Aside for Australia, for which our data come from Butlin (1984), and the United States, for which they are drawn from Romer (1989), the source of these time series is Mitchell (1976).

[7] Using the decomposition suggested in Bayoumi (1991).

[8] Results using a decomposition from aggregate data are similar (Bayoumi and Eichengreen, 1993).

decline over time in the size of demand shocks and an increase in the size of supply shocks after 1890. The dispersion across countries of supply and demand disturbances (SD*) is relatively stable, except for a decrease in the dispersion of demand shocks after 1902. The fall in the size and dispersion of aggregate demand disturbances in our time plausibly reflects the solidification of the gold standard system, while increase in the size of aggregate supply disturbances after 1890 may be associated with the increasing disruptiveness of financial crises in the U.S.

We use the impulse response functions associated with these regressions to plot the aggregate demand and short-run aggregate supply curves in price-output space. For the aggregate demand curve this is the path traced out by prices and output in response to a supply shock. For the aggregate supply curve it is the line segment marked off by the initial equilibrium on one end and the level of output and prices in the first period following a demand shock on the other end. This is the impact effect of a shift in aggregate demand, which traces out a movement up or down the short-run supply curve. The remainder of the adjustment to a demand shock can be thought of as a movement along the new demand curve, with prices rises and demand falling. The simulated supply and demand schedules are shown in the top half of Figure 2. The left-hand panel shows the schedules themselves, the right-hand panel includes their stylized counterparts. These are derived from estimates using aggregate data for the sum of our seven countries, constructed using 1900 GDP weights. Two features are noteworthy. First, the short-run aggregate supply schedule is quite steep, as if much of the adjustment of prices and quantities to shocks was completed within a year. Second, the aggregate demand curve is upward sloping, confirming the paradoxical finding of previous authors.

Various explanations have been advanced for this counterintuitive result. Keating and Nye invoke the Tobin effect, which suggests that demand shocks that cause inflation could induce agents to substitute for capital for money, raising the capital/labor ratio and increasing output permanently. Why this effect should have operated more powerfully in the gold standard period, however, is not clear. (Indeed, the fact that inflation was less likely to be persistent under the gold standard than the fiat money regimes that followed should have weakened the operation of the Tobin effect, other things equal.) They mention the possibility that negative demand shocks could have led to a permanent deterioration in levels of human and physical capital, as in recent hysteresis models, although again it is not clear why hysteresis effects should have operated more powerfully before 1913. They suggest that there may have existed multiple equilibria in late-19th century economies, with demand shocks permanently shifting them from one equilibrium to another. Insofar as subsequent reductions in transactions costs facilitated the efforts of agents to coordinate on the superior equilibrium, technological progress could have worked to eliminate the multiplicity problem. Finally, there is the possibility that econometric techniques are incapable of distinguishing highly persistent temporary disturbances from permanent ones when applied to relatively short time series.

Our explanation rests on the importance of arbitrage in international commodity and factor markets during the gold standard years and on the tendency for the money supply to adjust endogenously to permanent shocks. Recall that the aggregate demand curve is traced out by subjecting the system to a permanent (aggregate supply) shock. In a closed economy this would tend to raise output and lower prices as in Panel (c) of Figure 1, tracing out a negatively-sloped demand curve. Under the fixed rates of the gold standard, however, commodity-market arbitrage should have prevented domestic and foreign prices from diverging substantially. If goods produced at home and abroad were imperfect substitutes in consumption, some relative price movement was still possible; in the limiting case of perfect substitutability, arbitrage would drive domestic prices back to the level of foreign prices, in the long run if it takes time to work, instantaneously if no unexploited arbitrage profits are assumed to exist (as in McCloskey and Zecher, 1984). The money supply will adjust through the balance of payments to render the now permanently higher level of output an asset as well as a commodity market equilibrium.

This suggests that the relevant way of measuring the aggregate demand curve is in output/relative price space, where the domestic price level is measured relative to the foreign price level. We re-estimated the same bivariate VARs using domestic output and this relative price variable. The price level is measured relative to the aggregate price level (a GDP weighted aggregate of individual-country price levels). Australia was excluded from the aggregate for reasons we describe momentarily.

The lower panel of Figure 2 shows the results from this decomposition. The aggregate demand curve now slopes down in the short-run, after which domestic prices recover to world levels. In fact, domestic prices more than recover to world levels. An interpretation of this last finding is that many of the positive supply shocks experienced by these industrial economies took the form of declines in the prices of imported primary products, which raised the relative price of manufactured goods in the long run. That the countries (aside from Australia) for which prices do not rise in the long run are Denmark and Italy, the two economies in our sample specializing most heavily in the production of agricultural products, supports this interpretation.

One country for which these adjustments fail to remove the anomaly is Australia, where the aggregate demand curve when plotted in output/relative price space continues to display a pronounced positive slope. Australia was more dependent on gold production than any other country in our sample, which may account for the positive price response to aggregate supply shocks. Positive supply shocks which take the form of gold discoveries and increased gold production would have tended to raise prices even in the short run (by raising the amount of gold and hence the amount of money in the economy). From this point of view the persistence of a positive price response to supply shocks is no paradox.

III. Comparisons of the Gold Standard with Other Regimes

A noteworthy feature of the impulse response functions for the classical gold standard years is the combination of a strikingly flat aggregate demand curve with a steep aggregate supply schedule. In this section we contrast these slopes with comparable estimates for subsequent international monetary regimes and advance an explanation for the observed shifts.

We followed the same procedure for the interwar period as for the classical gold standard, using real GDP and relative price data to estimate bivariate VARs for the U.S., Great Britain, Italy, Sweden and Australia for the years 1919-1938.[9] Again, Australia yielded anomalous results, with prices rising in both the short and long runs in response to a positive supply shock. Insofar as money supplies were gold based for much of this period, we are inclined toward the same explanation as before. For the postwar period, we followed previous work in estimating VARs using output and the domestic price level for each of the G7 countries, splitting the sample around the time of the breakdown of the Bretton Woods System of pegged exchange rates. The two subperiods were 1955-70 and 1973-88 (with an additional two annual observations to allow for lags). Data were collected from the OECD National Accounts.[10] We used 1970 GDP weights to construct the international aggregate from the individual country results.[11]

This comparative analysis lends little support to the hypothesis that disturbances were smaller under the classical gold standard than subsequent international monetary regimes. Admittedly, the standard deviation of demand shocks to the gold standard aggregate is only about half as large as that to its interwar counterpart, consistent with the view that the gold standard imposed discipline on national economic policymakers. The difference in the ratio of the standard deviations of supply shocks is even

---

[9] Breaks in wartime and during the postwar hyperinflation prevented us from constructing comparable estimates for Denmark and Germany, respectively.

[10] For additional discussion of the data and results for the post-World War II period, see Bayoumi and Eichengreen (1994).

[11] The aggregate supply and aggregate demand schedules traced out by the impulse-response functions generally accorded with the predictions of the standard model. One exception was France in the post-1972 period, for which neither response had converged toward a new long-run equilibrium level even after 20 years. We therefore exclude France from the post-1972 aggregate plotted below.

larger, about one third as large during the gold standard period as between the wars. The largest shocks are those for the United States, the country whose industrial production declined most dramatically and which suffered the most severe financial crises in the 1930s. Further analysis of the interwar results also suggests a predominance of demand shocks in the 1920s and of supply shocks in the 1930s (Bayoumi and Eichengreen, 1993), consistent with qualitative accounts of the period. Far and away the largest increase in the magnitude of supply shocks occurs in the United States, reflecting the exceptional severity there of the financial crisis and its negative supply-side repercussions.

The picture is very different when extended to the post-World War II years. The average supply shock was over twice as large under the classical gold standard as under Bretton Woods and the post-Bretton Woods float. Demand shocks, meanwhile, also appear to have been about twice as large under the classical gold standard. Similarly, the dispersion of supply and demand shocks across countries (SD*) was larger than under either Bretton Woods or the post-Bretton Woods float. There is little support here, in other words, for the notion that the smooth operation of the gold standard, compared to modern international monetary arrangements, reflected the accommodating nature of the underlying environment.

Figure 3 juxtaposes the impulse-response functions for all four periods, together with the stylized supply and demand schedules. There is a clear tendency for short-run aggregate supply curves to become flatter over time and for aggregate demand curves grow steeper. This flattening of supply curves suggests a declining short-run responsiveness of prices to demand shocks, and hence a growing tendency for demand shocks to displace output from long-run equilibrium levels. At the same time, the speed of adjustment along the curves slows over time. This is consistent with evidence presented by some previous investigators (e.g. Cagan 1975, Sachs, 1980) of a tendency for nominal variables to grow increasingly inertial.[12] The steepening of the demand curve has an obvious interpretation. Under fixed exchange rates domestic prices could not diverge significantly from prices in the rest of the world; as explained above, this meant that supply shocks resulted in a large ratio of output to price responses. By this explanation, the aggregate demand curve should have been flatter under the gold standard, when the exchange rates of the countries in our sample were essentially fixed, than under the Bretton Woods System, when they were pegged but could be adjusted periodically, and flatter under Bretton Woods than under the post-1972 float, when the link between domestic and foreign prices was further relaxed.

How the interwar period fits into this hierarchy is not clear. The countries in our sample were all back on the gold standard in the second half of the 1920s. Some of them, including the United States and Sweden, return to gold even earlier, while others such as the U.K. and Australia behaved as if they had, managing their price levels to shadow those of the gold standard countries even before resuming convertibility. With the breakdown of the gold standard in the 1930s, few countries allowed their exchange rates to float freely. The U.S. repegged the dollar to gold, Australia joined the sterling area, and France maintained a fixed rate until 1936. While exchange rates were more flexible than under the

---

12 For further discussion of the literature surrounding this point, see Eichengreen (1994b).

classical gold standard, it is not clear how to categorize the interwar period relative to the gold standard years. The short-run aggregate demand curve for this period is clearly flatter than that for Bretton Woods, as if countries attempted to maintain a high degree of exchange rate fixity in the short run, while the long-run aggregate demand curve is nearly as steep as that for Bretton Woods, reflecting the fact that Bretton Woods was in fact characterized by some exchange rate variability over long intervals.[13]

The flattening of the short-run aggregate supply curve and the steepening of the aggregate demand curve may be connected. As the short-run aggregate supply curve becomes flatter, changes in aggregate demand have larger effects on real output in the short-run. As a result, governments have an incentive to adjust policy in a manner more responsive to deviations in real output and less responsive to changes in prices, producing a steeper aggregate demand curve.

These ideas can be illustrated with a small macroecomic model made up of a welfare function, an aggregate demand curve, an aggregate supply curve, and a monetary reaction function.

$W = - var(y) - \alpha var(p)$	Welfare Function
$y + \beta p = \Psi m$	Aggregate Demand
$y = \delta p + (1+\beta)\epsilon_t$	Aggregate Supply
$m = \phi/\Psi p$	Monetary Reaction

[13] These results dissolve the paradox offered by Neumann (1993), since we generate the slopes of the relevant schedules directly on the basis of impulse response functions, rather than inferring them from the variance of output and prices and some auxiliary assumptions.

W is welfare, y is output, p is the price level, m is the money supply (which is a proxy for all macroeconomic demand policies), ϵ_t is a random aggregate supply disturbance, and α, β, Ψ, and ϕ are coefficients. All variables are measured as deviations from desired levels, and all coefficients (except possibly ϕ) are positive.

The welfare function says that the government aims to minimize a weighted average of the variance of real output and prices. The aggregate demand function, which can be shifted by changes in macroeconomic policy, incorporates the standard negative relationship between prices and output in the money market, while the aggregate supply curve shows the positive short-run relationship between prices and output in the goods market. Finally, the monetary response function shows the degree to which macroeconomic policy responds to fluctuations in prices.

Consider the response to an aggregate supply shock, ϵ_t. In the absence of a monetary response (i.e. if $\phi=0$) this disturbance would raise output by $\beta\epsilon_t$ and lower prices by ϵ_t. The government chooses the monetary response to such a disturbance, in other words the value of ϕ. From the aggregate supply curve it follows that a monetary rule will raise prices by $\phi\epsilon_t$ and output by $\phi\delta\epsilon_t$. Hence, output changes by $(\beta+\phi\delta)\epsilon_t$, prices by $(\phi-1)\epsilon_t$.

Given the welfare function, the optimal ϕ is that which minimizes:

$$((\beta+\phi\delta)^2 + \alpha(1-\phi)^2)\sigma_\epsilon^2.$$

This value, ϕ^*, is:

$$\phi^* = (\alpha-\delta\beta)/(\alpha+\delta^2).$$

ϕ^* depends upon the slope of the aggregate supply curve. If the supply curve is vertical (δ=0), so that policy affects prices but not output, the optimal ϕ is 1, the value that eliminates the fluctuations in prices. For very large values of δ (i.e. a very flat aggregate supply curve) so that policy only affects output, the optimal ϕ is $-\beta/\delta$, the value at which fluctuations in output are minimized. Intermediate values of δ produce responses which take account of both effects.

The slope of the observed aggregate demand curve is the ratio of the responses of output and prices,

$$(1-\phi)/(\alpha-\phi\delta).$$

It is easy to show that the slope of the aggregate demand curve under optimal government policy is horizontal when the aggregate supply curve is vertical and becomes steeper as the aggregate supply curve becomes flatter. This result obtains even though the welfare function and determinants of aggregate demand remain unchanged. The steepening of the aggregate demand curve is purely a function of the change in the optimal response of policy to disturbances produced by the flattening of the aggregate supply curve.

Clearly, this is a simple model lacking dynamics and taking no account of the fact that private sector responses may themselves change in response to government policy. Still, at a basic level its provides an intuitive explanation for the development of the international monetary system over time.[14] During the gold standard years, this argument runs, prices were relatively flexible, dampening the impact on output of

---

[14] We intend this story to apply only to the industrial countries whose experience is analyzed above.

disturbances even in the short run. With a steep short-run aggregate supply curve preventing output from being significantly displaced from long-run equilibrium levels, economic policy could be keyed to the maintenance of price stability. This was achieved through the operation of a fixed exchange rate regime in which the price level was linked to the rest of the world and largely insulated from domestic disturbances.

With the passage of time, economies came to display growing price inertia, magnifying the impact on output of macroeconomic disturbances. Consequently, policy was increasingly directed toward cushioning the impact of disturbances on output. This required more freedom for governments to pursue policies that might alter the price level; greater exchange rate flexibility was a necessary concomitant of this change in priorities. This trend is evident in the international monetary system's evolution from the relatively rigid exchange rates of the classical gold standard to the pegged but adjustable rates of the Bretton Woods System to the increasingly adjustable rates of the post-Bretton Woods float. Our analysis suggests that this evolution was a logical consequence of the growth of nominal rigidities which reduced the capacity of industrial economies to absorb macroeconomic disturbances without experiencing deviations of output and employment from normal levels in the short run.

IV. Conclusion

In this paper we have examined some popular explanations for the smooth operation of the classical gold standard. Along with the credibility of the policy rules followed by central banks and governments, such explanations focus on potentially stabilizing features of the underlying economic environment, such as the magnitude of disturbances to the participating economies and the latter's capacity to accommodate supply and demand shocks without suffering costly output and employment fluctuations. Our analysis confirms the findings of previous studies which have rejected explanations for the success of the gold standard based on an absence of destabilizing shocks. Rather, we find that the rapid adjustment of economies to such disturbances played an important role in stabilizing output and employment under the gold standard system.

Our methodological innovation is to introduce into the vector autoregression framework used to analyze these questions arbitrage conditions linking domestic and foreign prices. This extension dispatches several perplexing findings that have emerged from earlier studies. Most notably, it eliminates the paradox of an upward sloping aggregate demand curve in the short and intermediate runs. Rather, it suggests that the aggregate demand curve was extremely flat in the gold standard years, consistent with the predictions of standard models of fixed exchange rate regimes, and that it grew progressively steeper with the evolution of the international monetary system toward greater exchange rate flexibility.

Finally, the simple aggregate-supply-aggregate-demand framework of the paper suggests an explanation for the evolution of the international monetary system. Insofar as we find the short-run aggregate supply curve becoming progressively flatter, implying growing nominal inertia over time, this suggests that governments have had an incentive to opt for regimes permitting greater exchange rate flexibility, since the growth of output fluctuations gives them reason to sacrifice a modicum of price and exchange rate stability in return for freedom to use policy to stabilize output.

Thus, the trend toward greater exchange rate flexibility following the gold standard years is a logical response of the change in policy priorities that is itself a consequence of changes in economic structure.

Appendix

The point of departure for our econometric analysis is the aggregate-supply-aggregate-demand diagram appearing above as Figure 1. We estimate this model using a procedure proposed by Blanchard and Quah (1989) for distinguishing temporary from permanent shocks to a pair of time-series variables. Consider a system where the true model can be represented by an infinite moving average representation of a (vector) of variables, X_t, and an equal number of shocks, ϵ_t. Using the lag operator L, this can be written as:

$$\begin{aligned} X_t &= A_0\epsilon_t + A_1\epsilon_{t-1} + A_2\epsilon_{t-2} + A_3\epsilon_{t-3} \ldots. \\ &= \sum_{i=0}^{\infty} L^i A_i \epsilon_t \end{aligned} \tag{3.1}$$

where the matrices A_i represent the impulse response functions of the shocks to the elements of X.

Let X_t be made up of change in output and the change in prices, and let ϵ_t be demand and supply shocks. Then the model becomes:

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} \epsilon_{dt} \\ \epsilon_{st} \end{bmatrix} \tag{3.2}$$

where y_t and p_t represent the logarithm of output and prices, ϵ_{dt} and ϵ_{st} are independent supply and demand shocks, and a_{11i} represents element a_{11} in the matrix A_i.

The framework implies that while supply shocks have permanent effects on the level of output, demand shocks only have temporary effects. (Both have permanent effects upon the level of prices.) Since output is written in first difference form, this implies that the cumulative effect of demand shocks on the change in output (Δy_t) must be zero. This implies the restriction:

$$\sum_{i=0}^{\infty} a_{11i} = 0. \qquad (3.3)$$

The model defined by equations (A.2) and (A.3) can be estimated using a vector autoregression. Each element of X_t can be regressed on lagged values of all the elements of X. Using B to represent these estimated coefficients, the estimating equation becomes,

$$\begin{aligned} X_t &= B_1 X_{t-1} + B_2 X_{t-2} + \ldots + B_n X_{t-n} + e_t \\ &= (I-B(L))^{-1} e_t \\ &= (I + B(L) + B(L)^2 + \ldots) e_t \\ &= e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + \ldots \end{aligned} \qquad (3.4)$$

where e_t represents the residuals from the equations in the vector autoregression. In the case being considered, e_t is comprised of the residuals of a regression of lagged values of Δy_t and Δp_t on current values of each in turn; these residuals are labeled e_{yt} and e_{pt}, respectively.

To convert (A.4) into the model defined by (A.2) and (A.3), the residuals from the VAR, e_t, must be transformed into demand and supply shocks, ϵ_t. Writing $e_t = C\epsilon_t$, four restrictions are required to define the four elements of the matrix C in the two-by-two case considered. Two are simple normalizations, which define the variance of the shocks ϵ_{dt} and ϵ_{st}. A third comes from assuming that demand and supply shocks are orthogonal.

The final restriction, which uniquely defines the matrix C, is that demand shocks have only temporary effects on output. This implies equation (A.3). In terms of the VAR:

$$\sum_{i=0}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = \begin{bmatrix} 0 & . \\ . & . \end{bmatrix} \quad (3.5)$$

This allows C to be uniquely defined and the demand and supply shocks to identified. Note from equation (A.4) that the long run impact of the shocks on output and prices is equal to $(I-B(1))^{-1}$. The restriction that the long-run effect of demand shocks on output is zero implies a simple linear restriction on the coefficients of this matrix.

This is where our analysis, based on Blanchard and Quah (1989), differs from other VAR models. The usual decomposition assumes that the variables in the VAR can be ordered such that all the effects which could be attributed to (say) either a_t or b_t are attributed to whichever comes first in the ordering, which is achieved by a Choleski decomposition.

Interpreting shocks with a permanent impact on output as supply disturbances and shocks with only a temporary impact on output as demand disturbances is controversial. Doing so requires adopting the battery of restrictions incorporated into the aggregate-supply-aggregate-demand model. One can think of frameworks other than the standard aggregate-supply-aggregate-demand model in which that association might break down. Moreover, it is conceivable that temporary supply shocks (for example, an oil price increase that is reversed subsequently) or permanent demand shocks (for, example, a permanent increase in government spending which affects real interest rates and related variables) dominate our data. But here a critical feature of our methodology comes into play. While restriction (A.5) affects the response of output to the two shocks, it says nothing about their impact on prices. The aggregate-supply-aggregate-demand model implies that demand shocks should raise prices while supply shocks should lower them. However, these responses are not imposed on the estimation, and hence can be used as an over-identifying restriction to see how well the responses corresponds to those expected from the underlying model.

The Blanchard-Quah procedure has also come in for more general criticism. Lippi and Reichlin (1993), in a comment on the Blanchard-Quah paper, point out that the procedure includes the assumption that the error terms in the model are fundamental, and that nonfundamental representations can give different results. As noted by Blanchard and Quah (1993) in their reply,however, this is a very general issue which is not specific to VAR representations, but covers virtually all dynamic analysis. Hence, while acknowledging that the assumption that the errors are fundamental is important to our procedure, we would note that this is a very general assumption in applied time-series work. On a different tack, Faust and Leeper (1994) discuss the identifying restrictions required for long-run restrictions to provide reliable results, involving the relationship between the long-run behavior and finite horizon data, aggregation across disturbances, and aggregation over time. These issues are clearly important, however, as in the case of Lippi and Reichlin, it remains unclear to us that these problems are peculiar to the structural VAR methodology. Overall, while we agree that it is important to understand the underlying assumptions required to implement a technique, these papers do not convince us that the identifying assumptions required by the Blanchard-Quah approach are significantly different from those used most other applied work.

References

Bayoumi, Tamim (1991) "A Note on the Decomposition of Vector Autoregressions," unpublished manuscript, International Monetary Fund.

Bayoumi, Tamim and Barry Eichengreen (1993), "Economic Performance Under Alternative Exchange Rate Regimes: Some Historical Evidence," forthcoming in Francesco Papadia, Franco Saccamoni and Peter Kenen (eds), The Future of the International Monetary System, Cambridge: Cambridge University Press.

Bayoumi, Tamim and Barry Eichengreen (1994), "Macroeconomic Adjustment Under Bretton Woods and the Post-Bretton Woods Float: An Impulse-Response Analysis," Economic Journal (forthcoming).

Blanchard, Olivier and Danny Quah (1989), "The Dynamic Effects of Aggregate Demand and Aggregate Supply Disturbances," American Economic Review 79, pp.655-673.

Bloomfield, Arthur I. (1959), Monetary Policy Under the International Gold Standard, New York: Federal Reserve Bank of New York.

Bordo, Michael (1993), "The Gold Standard, Bretton Woods and Other Monetary Regimes: A Historical Appraisal," Federal Reserve Bank of St. Louis Review 75:2, pp.123-191.

Bordo, Michael and Finn Kydland (1994), "The Gold Standard as a Contingent Rule," this volume.

Butlin, N.G. (1984), "Select Comparative Economic Statistics 1900-1940," Source Papers in Economic History No. 4, Department of Economic History, RSSS, Australian National University.

Cagan, Philip (1975), "Changes in the Recession Behavior of Wholesale Prices in the 1920s and Post-World War II," Explorations in Economic Research 2, pp.54-104.

Canzoneri, Matthew (1985), "Monetary Policy Games and the Role of Private Information," American Economic Review 75, pp.1056-1070.

de Cecco, Marcello (1984), The International Gold Standard: Money and Empire, London: Francis Pinter (2nd edition).

de Kock, Gabriel and Vittorio Grilli (1989), "Endogenous Exchange Rate Regime Switches," NBER Working Paper No. 3066.

Eichengreen, Barry (1992), Golden Fetters: The Gold Standard and the Great Depression, 1919-1939, New York: Oxford University Press.

Eichengreen, Barry (1994a), "Central Bank Cooperation and Exchange Rate Commitments: The Classical and Interwar Gold Standards Compared," Financial History Review (forthcoming).

Eichengreen, Barry (1994b), "Deja Vu All Over Again: Lessons from the Gold Standard for European Monetary Unification," this volume.

Flood, Robert and Peter Isard (1991), "Monetary Policy Strategies," Staff Papers 36, pp.612-632.

Ford, Alec G. (1962), The Gold Standard: Britain and Argentina, Oxford: Clarendon.

Goodhart, Charles (1992), "Economic and Monetary Union (EMU) in Europe: A UK Perspective," in Ernst Baltensperger and Hans-Werner Sinn (eds), Exchange-Rate Regimes and Currency Unions, New York: St. Martin's Press, pp.183-199.

Keating, John W. and John V. Nye (1991), "Permanent and Transitory Shocks in Real Output: Estimates from Nineteenth Century and Postwar Economies," Working Paper No. 160, Department of Economics, Washington University in St. Louis.

McCloskey, Donald N. and J. Richard Zecher (1984), "The Success of Purchasing-Power Parity: Historical Evidence and its Implications for Macroeconomics," in Michael D. Bordo and Anna Schwartz (eds), A Retrospective on the Classical Gold Standard, Chicago: University of Chicago Press, pp.121-150.

Mitchell, B.R. (1976), European Historical Statistics, London: Macmillan.

Neumann, Manfred J.M. (1993), "Commentary on the Gold Standard, Bretton Woods and Other Monetary Regimes: A Historical Appraisal," Federal Reserve Bank of St. Louis Review 75:2, pp.192-199.

Obstfeld, Maurice (1991), "Destabilizing Effects of Exchange Rate Escape Clauses," NBER Working Paper No. 3606.

Romer, Christina (1989), "The Prewar Business Cycle Reconsidered: New Estimates of Gross National Product, 1869-1908," Journal of Political Economy 97, pp.1-37.

Sachs, Jeffrey (1980), "The Changing Cyclical Behavior of Wages and Prices, 1890-1976," American Economic Review 70, pp.78-90.

Table 1. Standard Deviations of Disturbances During the Gold Standard

	1880-1913	1880-1890	1881-1901	1902-1913
	--------------------	Demand	--------------------	
Aggregate SD	.019	.026	.019	.010
SD*	.019	.021	.021	.015
United States	.032	.041	.033	.018
Great Britain	.016	.019	.019	.010
Germany	.027	.030	.030	.020
Italy	.032	.032	.032	.031
Australia	.043	.046	.043	.041
Sweden	.029	.038	.026	.024
Denmark	.019	.022	.043	.013
	--------------------	Supply	--------------------	
Aggregate SD	.014	.009	.014	.017
SD*	.022	.021	.026	.019
United States	.027	.024	.030	.030
Great Britain	.024	.018	.029	.024
Germany	.028	.033	.030	.024
Italy	.033	.033	.037	.026
Australia	.047	.032	.062	.044
Sweden	.033	.025	.035	.031
Denmark	.029	.032	.026	.030

Notes. Estimates are from VARs using the price level.

Table 2. Underlying Disturbances Across Exchange Rate Regimes

	Gold Standard 1880-1913	Interwar Period 1919-1938		Bretton Woods 1955-1970	Post-Bretton Woods 1973-1988
		Demand			
Aggregate SD	.018	.032	Aggregate SD	.008	.011
SD*	.014	.020	SD*	.012	.013
United States	.024	.050	United States	.016	.018
Great Britain	.019	.049	Japan	.016	.016
Germany	.023	...	Germany	.018	.015
Italy	.029	.059	France	.019	.011
Australia	.042	.046	United Kingdom	.010	.021
Sweden	.023	.055	Italy	.008	.028
Denmark	.022	...	Canada	.025	.021
		Supply			
Aggregate SD	.016	.046	Aggregate SD	.006	.007
SD*	.020	.016	SD*	.009	.013
United States	.027	.065	United States	.009	.013
Great Britain	.023	.049	Japan	.018	.016
Germany	.028	...	Germany	.012	.010
Italy	.034	.045	France	.011	.011
Australia	.046	.053	United Kingdom	.011	.030
Sweden	.036	.061	Italy	.013	.021
Denmark	.026	...	Canada	.005	.021

Notes. Estimates are from preferred models. As a result, the results for the Gold Standard are not the same as in Table 1.

Table 2. Underlying Disturbances Across Exchange Rate Regimes

	Gold Standard 1880-1913	Interwar Period 1919-1938		Bretton Woods 1955-1970	Post-Bretton Woods 1973-1988
Demand					
Aggregate SD	.018	.032	Aggregate SD	.008	.011
SD*	.014	.020	SD*	.012	.013
United States	.024	.050	United States	.016	.018
Great Britain	.019	.049	Japan	.016	.016
Germany	.023	...	Germany	.018	.015
Italy	.029	.059	France	.019	.011
Australia	.042	.046	United Kingdom	.010	.021
Sweden	.023	.055	Italy	.008	.028
Denmark	.022	...	Canada	.025	.021
Supply					
Aggregate SD	.016	.046	Aggregate SD	.006	.007
SD*	.020	.016	SD*	.009	.013
United States	.027	.065	United States	.009	.013
Great Britain	.023	.049	Japan	.018	.016
Germany	.028	...	Germany	.012	.010
Italy	.034	.045	France	.011	.011
Australia	.046	.053	United Kingdom	.011	.030
Sweden	.036	.061	Italy	.013	.021
Denmark	.026	...	Canada	.005	.021

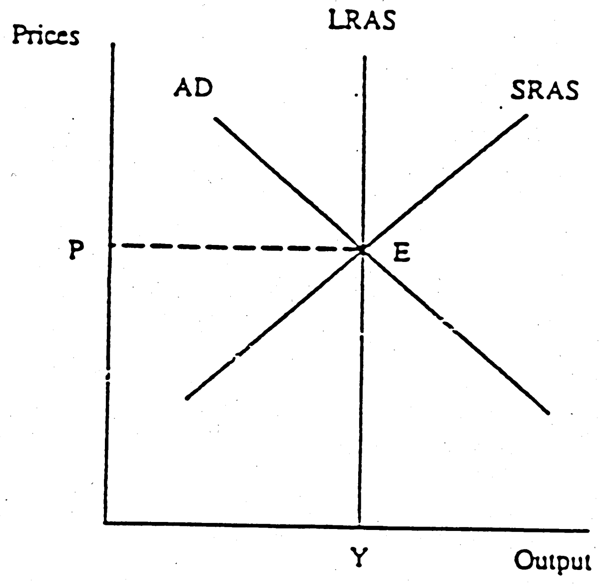
Notes. Estimates are from preferred models. As a result, the results for the Gold Standard are not the same as in Table 1.

03/31/94 - R:\DOC\EO\TB\MISC\UND-DIS.TB2

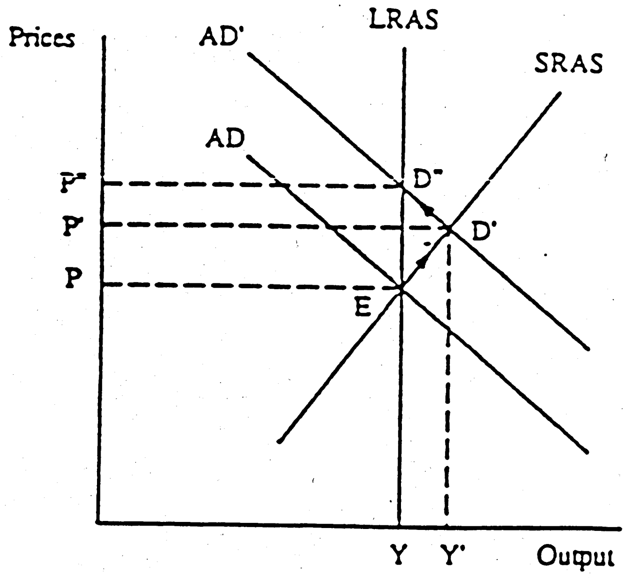
Figure 1

The Aggregate Demand and Supply Model

(a) The Model



(b) A Demand Shock



(c) A Supply Shock

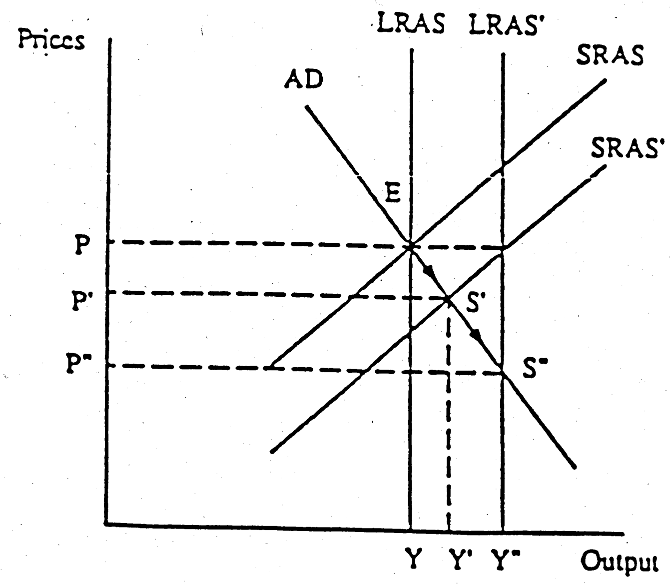


Figure 2
Alternative Estimates of Gold Standard Model

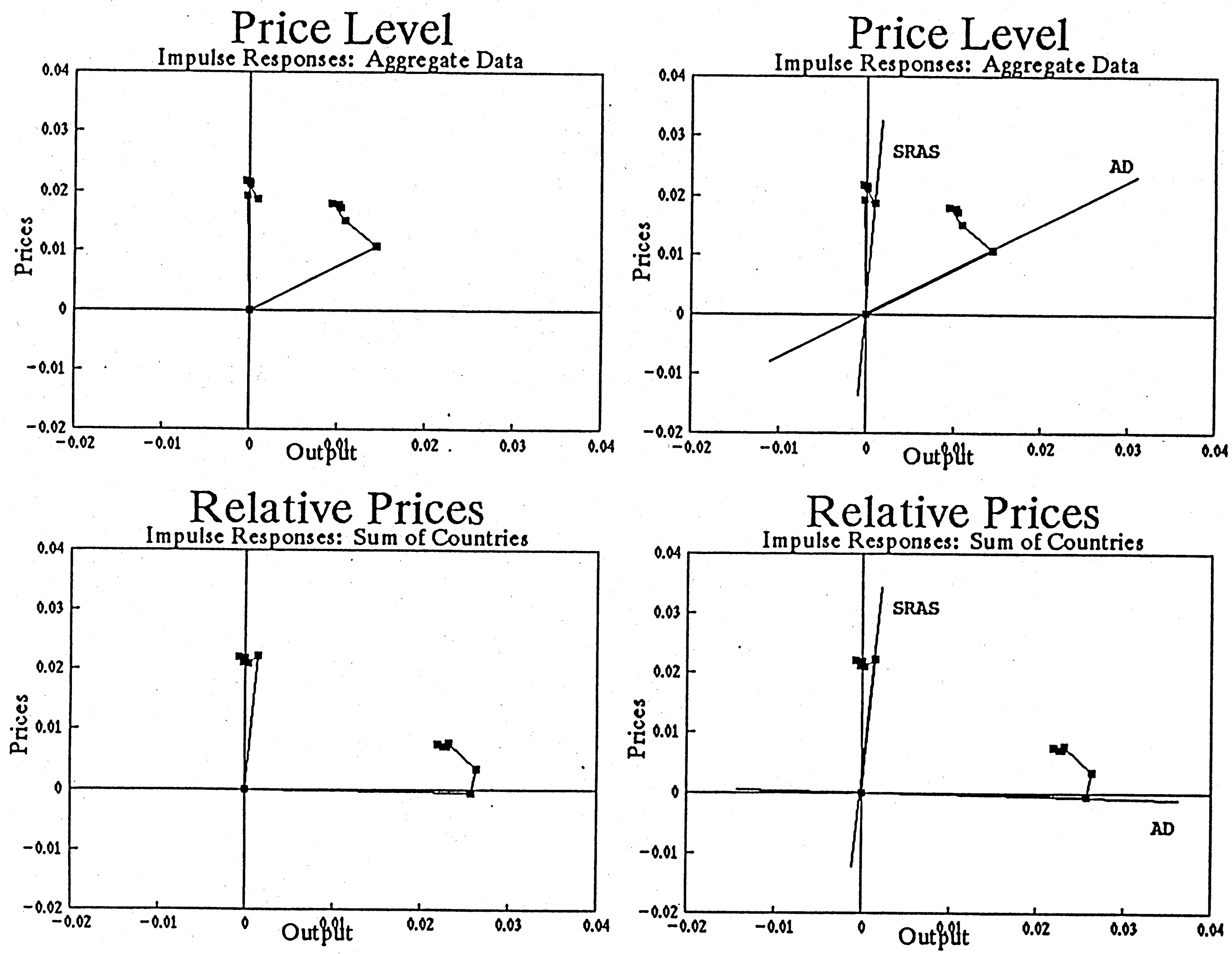
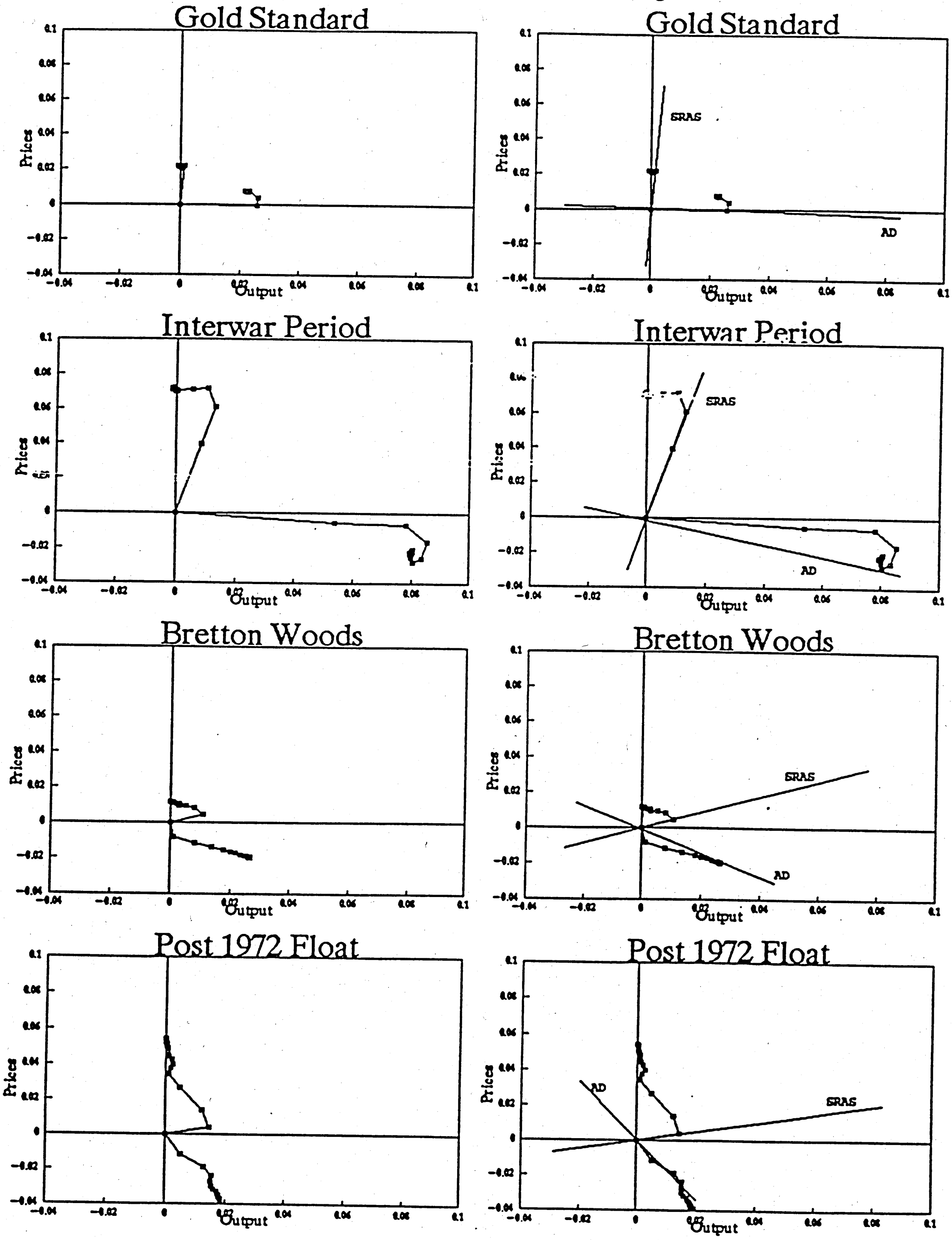


Figure 3
ADAS Estimates Across Different Regimes



CIDER
Center for International and Development Economics Research
INSTITUTE OF INTERNATIONAL STUDIES

University of California, Berkeley
Center for International and Development Economics Research
Working Paper Series

The Center for International and Development Economics Research at the University of California, Berkeley is funded by the Ford Foundation. It is a research unit of the Institute of International Studies which works closely with the Department of Economics and the Institute of Business and Economic Research (IBER). All requests for papers in this series should be directed to IBER, 156 Barrows Hall, University of California at Berkeley, Berkeley CA 94720-1922, (510) 642-1922, email bagdon@haas.berkeley.edu.

C92-003 "Arbitration in International Trade." Alessandra Casella. December 1992.

C92-004 "The Political Economy of Fiscal Policy After EMU." Barry Eichengreen. December 1992.

C92-005 "Financial and Currency Integration in the European Monetary System: The Statistical Record." Jeff Frankel, Steve Phillips, and Menzie Chinn. December 1992.

C93-006 "Macroeconomic Adjustment under Bretton Woods and the Post-Bretton-Woods Float: An Impulse-Response Analysis." Tamim Bayoumi and Barry Eichengreen. January 1993.

C93-007 "Is Japan Creating a Yen Bloc in East Asia and the Pacific?" Jeffrey A. Frankel. January 1993.

C93-008 "Foreign Exchange Policy, Monetary Policy and Capital Market Liberalization in Korea." Jeffrey A. Frankel. January 1993.

C93-009 "Patterns in Exchange Rate Forecasts for 25 Currencies." Menzie Chinn and Jeffrey Frankel. January 1993.

C93-010 "A Marshall Plan for the East: Options for 1993." Barry Eichengreen. February 1993.

C93-011 "Model Trending Real Exchange Rates." Maurice Obstfeld. February 1993.

C93-012 "Trade as Engine of Political Change: A Parable." Alessandra Casella. February 1993.

C93-013 "Three Comments on Exchange Rate Stabilization and European Monetary Union." Jeffrey Frankel. March 1993.

C93-014 "Are Industrial-Country Consumption Risks Globally Diversified?" Maurice Obstfeld. March 1993.

C93-015 "Rational Fools and Cooperation in a Poor Hydraulic Economy." Pranab Bardhan. May 1993.

C93-016 "Risk-Taking, Global Diversification, and Growth." Maurice Obstfeld. July 1993.

C93-017 "Disparity in Wages but not in Returns to Capital between Rich and Poor Countries." Pranab Bardhan. July 1993.

C93-018 "Prerequisites for International Monetary Stability." Barry Eichengreen. July 1993.

C93-019 "Thinking about Migration: Notes on European Migration Pressures at the Dawn of the Next Millennium." Barry Eichengreen. July 1993.

C93-020 "The Political Economy of Fiscal Restrictions: Implications for Europe from the United States." Barry Eichengreen and Tamim Bayoumi. September 1993.

C93-021 "International Monetary Arrangements for the 21st Century." Barry Eichengreen. September 1993.

C93-022 "The Crisis in the EMS and the Transition to EMU: An Interim Assessment." Barry Eichengreen. September 1993.

C93-023 "Financial Links around the Pacific Rim: 1982-1992." Menzie David Chinn and Jeffrey A. Frankel. October 1993.

C93-024 "Sterilization of Money Inflows: Difficult (Calvo) or Easy (Reisen)?" Jeffrey A. Frankel. October 1993.

C93-025 "Is There a Currency Bloc in the Pacific?" Jeffrey A. Frankel and Shang-Jin Wei. October 1993.

C93-026 "Emerging Currency Blocs." Jeffrey A. Frankel and Shang-Jin Wei. October 1993.

C93-027 "The Implications of New Growth Theory for Trade and Development: An Overview." Pranab Bardhan. October 1993.

C93-028 "The Reconstruction of the International Economy, 1945-1960." Barry Eichengreen. November 1993.

C93-029 "International Economics and Domestic Politics: Notes on the 1920s." Barry Eichengreen and Beth Simmons. November 1993.

C93-030 "One Money or Many? On Analyzing the Prospects for Monetary Unification in Various Parts of the World." Tamim Bayoumi and Barry Eichengreen. November 1993.

C93-031 "Recent Changes in the Financial Systems of Asian and Pacific Countries." Jeffrey A. Frankel. December 1993.

C94-032 "Deja Vu All Over Again: Lessons from the Gold Standard for European Monetary Unification." Barry Eichengreen. January 1994.

C94-033 "The Internationalization of Equity Markets: Introduction." Jeffrey A. Frankel. April 1994.

C94-034 "Trading Blocs: The Natural, the Unnatural, and the Super-Natural." Jeffrey Frankel, Ernesto Stein and Shang-jin Wei. April 1994.

C94-035 "A Two-Country Analysis of International Targeting of Nominal GNP." Jeffrey A. Frankel and Norbert Funke. April 1994.

C94-036 "Monetary Regime Choices for a Semi-Open Country." Jeffrey A. Frankel. April 1994.

C94-037 "International Capital Mobility in the 1990s." Maurice Obstfeld. May 1994.

C94-038 "The Contributions of Endogenous Growth Theory to the Analysis of Development Problems: An Assessment." Pranab Bardhan. July 1994.

C94-039 "Political Stabilization Cycles in High Inflation Economies." Ernesto Stein and Jorge Streb. August 1994.

C94-040 "The Stability of the Gold Standard and the Evolution of the International Monetary System." Tamim Bayoumi and Barry Eichengreen. October 1994.

C94-041 "History and Reform of the International Monetary System." Barry Eichengreen. October 1994.

C94-042 "The Geography of the Gold Standard." Barry Eichengreen and Marc Flandreau. October 1994.

C94-043 "The Bretton Woods System: Paradise Lost?" Barry Eichengreen. October 1994.