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HOW DO FIXED-EXCHANGE-RATES REGIMES WORK: THE EVIDENCE FROM THE GOLD STANDARD, BRETTON WOODS AND THE EMS

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ABSTRACT

This paper defines two competing hypotheses on the working of fixed exchange rates. The "symmetry" hypothesis states that every country is concerned with the good functioning of the system, and cannot afford to deviate from world averages. Every country is just left to follow the "rules of the game," that is to avoid sterilizing balance of payments flows. The world price level is pegged down either by an external numeraire like gold, or by cooperation among central banks, in a fiat currency system. The competing hypothesis states that fixed-exchange-rates regimes are inherently asymmetric: they are characterized by a "center country" which provides the nominal anchor for the others, either by managing the gold parity in a centralized fashion, or by arbitrarily setting some other nominal anchor. I discuss the empirical evidence to discriminate between the two hypotheses, by studying the institutional features and the data on three experiences of fixed rates: the International Gold Standard, the Bretton Woods regime, and the European Monetary System.

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1. Introduction

Few countries freely float their currencies: the International Financial Statistics Supplement on Exchange Rates (1985) lists only 12 out of 147 members of the IMF as "independently floating". While this list includes large countries like the United States, Japan and the United Kingdom, as many as 34 countries, for example, peg their currencies to the US dollar. Even so, in the current open-economy macroeconomics literature most theoretical and empirical papers deal with aspects of flexible-exchange-rates regimes.

There exist two competing hypotheses on the working of fixed exchange rates. The "symmetry" hypothesis states that every country is concerned with the good functioning of the system, and cannot afford to deviate from world averages. Every country is just left to follow the "rules of the game," that is to avoid sterilizing balance of payments flows. This hypothesis is masterfully described by McCloskey and Zecher [1976].

If every country is just concerned with accomodating reserve flows in order to maintain its exchange-rate parities, however, the international monetary system as a whole suffers from an indeterminacy: there is no system-wide nominal anchor. According to the proponents of the symmetry hypothesis, this nominal anchor is provided by an external numeraire like gold, or is agreed upon by member countries through a process of international cooperation. Hence Helpman's [1981] labeling of this regime as a "cooperative peg".

The competing hypothesis states that fixed-exchange-rates regimes

Under the Bretton Woods system, the IMF Articles of Agreement[3] stipulated that each member country declare its par value in terms of gold.[4] The dollar price of gold was 35$ an ounce, and it was never changed, until the Smithsonian conference of December 1971. The main difference between the gold standard and the Bretton Woods system is that in the former regime monetary authorities--at least in those countries on a full gold standard (Britain, Germany and the US)[5]--were required by law to exchange domestic banknotes with gold coins at the par value (plus or minus transactions costs), whereas after World War II central banks used gold in transactions among themselves, and intervened in the private bullion market at their own discretion. Since the private sector had no rights of official conversion of national currencies into gold,[6] gold was much less of a direct constraint on national monetary policies than in the gold standard era.[7]

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3 See Tew [1977] for an analysis of the IMF Articles of Agreement.

4 Countries could also declare their exchange rates "in terms of the US dollar of the weight and fineness in effect on July 1, 1944," that is, the gold parity could be defined in terms of the US dollar. Even with this method, however, the ultimate numeraire is gold.

5 In France the conversion of banknotes into coins was at the authorities' discretion.

6 Tew [1977] page 120.

7 The constraint operated through the influence on speculators' confidence exercised by deviations between the official and free-market prices of gold.

With gold as an external numeraire, the gold standard and the Bretton Woods system provide, in different degrees, an official nominal anchor for all member countries. In the EMS, by contrast, this official nominal anchor is altogether absent. Each EMS currency, and each currency in the European Community, has a central rate determined in terms of the European Currency Unit (ECU), a basket unit of account that comprises a specified quantity of every currency in the European Community. The ratio of any two ECU central rates is used to obtain bilateral central rates, which are the target rates for monetary authorities. Given that the ECU is just a weighted average of the member countries' currencies, if n is the number of currencies in the ECU, there are only n-1 bilateral exchange rates to be pegged: for this reason a nominal anchor is absent from the rules governing the EMS.[8]

2.2 Bands

In the gold standard regime, individual currencies' gold parities, and the costs of shipping gold internationally, jointly implied bilateral bands within which exchange rates could fluctuate without requiring any action by monetary authorities. Whenever bilateral

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[8] Since some currencies like the pound and the drachma are not part of the EMS exchange-rate arrangements, the missing external numeraire is in practice provided by these currencies.

2.3 Adjustment and Financing

During the gold standard central banks were compelled to take corrective actions by a combination of two mechanisms: the convertibility of banknotes into gold coins, which encouraged arbitrage by the private sector whenever exchange rates exceeded bilateral fluctuation limits, and the coverage of banknotes by gold, which forced central banks to maintain a certain ratio of gold reserves to circulating banknotes, thus reacting to fluctuations of their gold reserve.[12] Changes in the discount rate and open market operations (Bloomfield [1959]) were the standard corrective actions. Various central banks also resorted to the so called "manipulation of gold points" which I discuss below in section 3.

No central-bank financing arrangement was part of the institutional setup of the gold standard. However, a number of instances are recorded when central banks granted bilateral credit to each other. Ford [1962] notes that the Bank of France discounted Sterling bills to ease the

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12 Few countries specified a constant ratio of circulation to reserves. As Eichengreen [1985] notes, England, among others, was on a fiduciary system, requiring full backing of note issue after a certain limit (the fiduciary issue) was reached. In Germany the Bank Act required that note circulation could not exceed a limit above three times the value of gold reserves, and if it did, the Reichsbank had to pay a 5 percent tax on the excess circulation. See US National Monetary Commission [1911].

strain on London in the Autumn of 1906, 1907, 1909, 1910. Kindleberger [1984] describes the cooperation between European central banks in the crisis of 1890, when the Bank of England asked the Russian State Bank not to draw on its deposits in London, obtained from the State Bank a 800,000 sterling gold loan, and from the Bank of France a loan of 3,000,000 sterling in gold.[13]

The Bretton Woods system and the EMS, by contrast, are characterized by a complex structure of loans available to finance balance-of-payments needs. These financial resources support the foreign exchange market intervention required to keep currencies within their fluctuation bands. Neither the IMF Articles of Agreement, nor the rules governing the EMS, spell out the actions that central banks have to take when exchange rates reach bilateral fluctuation margins. In both systems the modality of adjustment to external disequilibria is only specified through the rules governing the financing of central banks' external imbalances, though there are some concessions to the principle of symmetry (in the Bretton Woods regime through the clauses on 'scarce' currencies, see Argy [1981], in the EMS with the divergence indicator, and the Very Short Financing Facility, described below).

Under the Bretton Woods regime member countries could draw on various tranches of their IMF "quota". These tranches are characterized by different degrees of "conditionality", that imposes progressively

[13] See also Bloomfield [1959].

tighter constraints on monetary and fiscal policies: resources are made available to the borrowers subject to their meeting certain prespecified performance criteria.[14]

The EMS rules for balance-of-payments financing appear to be designed to avoid crises: the central banks of the currencies reaching bilateral intervention margins are supposed to grant each other automatic credit (not subject to authorization) in unlimited amounts under the Very Short Term Financing Facility.[15] The Very Short Term Financing Facility can also be used to support foreign exchange market intervention within the marginal fluctuation bands, subject to the authorization of the central bank whose currency is being drawn. The Short Term Monetary Support, another form a financial assistance available to EMS central banks experiencing temporary balance-of-payments difficulties, is instead governed by a "quota" system similar to that used by the IMF.

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[14] In the 1960s even the lowest conditionality resources, however, were not obtainable quickly enough to be usable to fend-off balance-of-payments crises.

[15] See Alesina and Grilli [1987] for an illustration of the effectiveness of these arrangements in avoiding speculative attacks. Credit lines for marginal intervention mature 75 days after the end of the month following the one in which the intervention has taken place.

2.4 Is Asymmetry Induced by the Institutions?

The very brief survey of institutional features of the three fixed-exchange-rates regimes suggests two observations. First, the basic structure of international monetary systems has not changed dramatically in the last century. In particular, despite the efforts of policymakers to improve upon the IMF Articles of Agreement, the features of the Bretton Woods system and the EMS are noticeably similar. Both systems are characterized by essentially a lack of an external nominal anchor (given the minor role played by gold during the Bretton Woods regime), and by elaborate structures of balance of payments financing arrangements, which stand in contrast to the absence of any explicit rules for central banks to follow when bilateral fluctuations margins are reached. The added complications of the EMS, regarding the divergence indicator, have proved impractical.[16] In the gold standard, instead, adjustment rules were provided by the market mechanism, and by each country's coverage system.

The second observation suggested by my survey is that the rules of the gold standard, Bretton Woods and the EMS do not seem per se to induce an asymmetric working of international adjustment. Except in the case of Bretton Woods--where the bilateral fluctuation bands of the dollar are narrower than those of the other currencies--none of the basic institutional features of the three fixed-exchange-rate regimes

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16 See Giavazzi and Giovannini [forthcoming] for a discussion.

devices were used by the Bank of France and the Reichsbank (Bloomfield [1959]).

The use of regulatory controls as emergency measures is common also in the Bretton Woods and EMS years. Article VI of the IMF Articles of Agreement even allows the Fund to request countries with balance of payments problems to impose capital controls for a limited time, in order to prevent the use of Fund resources. In response to capital account deficits, the Kennedy Administration proposed an investment tax credit in 1961, and passed the Interest Equalization Tax in 1963--a tax on US residents' purchases of foreign securities--followed by the Foreign Credit Restraint Program and the Foreign Direct Investment Program--aimed at limiting foreign investments by commercial banks, other financial institutions, and industrial companies. French and Italian authorities tightened various measures to prevent capital outflows after the Summer of 1968 and the Fall of 1969.

The practice of using capital controls as a fine-tuning device to stem speculative flows has survived in the EMS. Countries like France and Italy, which until recently have prohibited the non-firm private sector to trade on financial assets with the rest of the world, have used restrictions on international trade credits to slow down or speed up the response of short term capital flows.[19]

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[19] In Giavazzi and Giovannini [forthcoming] we show that the tightening and release of controls on international trade credits by France and Italy can be explained by the occurence of balance of payments difficulties, and is used very frequently by central banks. We also

Giavazzi and Giovannini [1986] argue that in the EMS countries like France and Italy crucially rely on capital controls, witness the large divergences between domestic and offshore interest rates on franc and lira assets. They see asymmetries of capital controls as just a reflection of the central role played by the Bundesbank, and capital controls as instrumental for countries other than Germany to maintain their exchange rate targets in the EMS, without having to surrender completely their monetary sovereignty. This observation raises two related questions. Are all fixed-exchange-rates regimes characterized by asymmetries in the degree to which capital controls are used? Is the presence of these asymmetries an indication of the existence of a central country?

A broad overview of the usage of capital controls suggests a positive answer to the first question. There is ample qualitative evidence and opinion (see, for example, Bloomfield [1959], Ford [1962], Scammell [1965]) that the Bank of England tended to use administrative devices less frequently than its counterparts in the continent. It is well known that the convertibility of banknotes into gold was not guaranteed by law in France, but was left to the central bank's discretion. The much less frequent changes of the discount rate by the Bank of France, relative to the Bank of England and the Reichsbank, tends to imply the effectiveness of the threat of inconvertibility,

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model the effects of controls on trade credits on the differentials between onshore and offshore rates.

which was accompanied by numerous changes of the gold points. In Germany international shipments of gold were apparently discouraged by moral suasion. As Bloomfield [1959] reported, Reichsbank officials questioned at the United States National Monetary Commission denied that the central bank discouraged commercial banks to obtain gold for export when the gold export point was reached, but admitted that at certain times German banks refrained from shipping gold when it was profitable to do so. This phenomenon is independently confirmed by Birch [1887], in his presidential address to the London Institute of Bankers:

> "I was raising the question, only a few days since, with some of the leading bankers in Berlin, whether the Bank of Germany would give large amounts of gold in exchange for its notes, and they explained to me that, if gold was required to use as currency, they had no difficulty in getting what they wanted, but that they were too Patriotic to think of going to the bank for gold with a view to making a profit on the export." (Birch [1887, p. 510])

The evidence on asymmetric use of capital controls during the Bretton Woods years is, to some extent, less clearcut. While in the second postwar period as a whole the United States have regulated international capital flows less than their European counterparts, episodes like the Interest Equalization Tax were clearly motivated by the concern of the external influence on domestic monetary management.

The imposition of capital controls was not only resorted to by deficit countries. In the months preceding the revaluation of the Deutsche mark of March 1961, the Bundesbank struggled with capital inflows by imposing a series of discriminatory measures meant to discourage foreign residents' purchases of German assets.[20] These measures included higher reserve requirements on foreign owned deposits at German commercial banks, the prohibition to pay interest on foreign-owned sight and time deposits, and the prohibition to sell money-market paper to nonresidents.

In summary, both the evidence on the gold standard and the EMS suggest that countries other than England (during the gold standard) and Germany (in the EMS) imposed regulations in order avoid compliance to the "rules of the game": in an asymmetric system the rules of the game consist in accomodating fully the center-country's monetary policies.[21] Hence these regulations might have been suggesetd by a desire of maintaining some degree of monetary sovereignty. The evidence on the Bretton Woods seems to indicate that capital controls were resorted to more often outside of the US, although even the US experimented with them in a number of cases.

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[20] Yaeger [1966].

[21] This point is shown explicitly in the next section.

4. Symmetric and Asymmetric Fixed Exchange Rates Regimes: A Definition

The alternative hypotheses about the working of fixed exchange rates can be illustrated using the canonical model of the gold standard.[22] This model concentrates on the external influences on domestic monetary policy, and on domestic aggregate variables. It relies on the assumption that monetary policy is powerless in affecting real variables, so that real and nominal variables are determined independently. This assumption, which is probably not accurate in practice, is not essential for the conclusions I will draw here, but is quite helpful to sharpen the distinction between the alternative hypotheses on the working of the international monetary system.

There are two countries, a domestic and a foreign country--whose variables are identified by an asterisk. The rate of inflation in each country is determined by the rate of money growth and a velocity shock, that is independent of monetary factors:

$$p = m + v \qquad p^* = m^* + v^* \tag{1}$$

where m is the rate of growth of money, and p the rate of inflation. v represents the rate of growth of velocity. The law of one price holds

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[22] See Dornbusch and Giovannini [1988], for example. Here I adopt the version of the model used by Barsky _et al._ [1988], who analyzed the international implications of the creation of the Federal Reserve System.

in the goods market.[23] Hence the rates of inflation at home and abroad are the same in equilibrium. Real rates of return on domestic and foreign securities are equalized except for a variable, x, representing international portfolio shifts. x is independent of monetary policies:[24]

$$p = p^{*} \tag{2}$$

$$r^{*} = r + x \tag{3}$$

The balance sheets of the two central banks imply:

$$m = d - f \qquad\qquad m^{*} = d^{*} - f^{*} \tag{4}$$

In a fiat currency system, d could be interpreted as the change in domestic credit relative to the initial stock of nominal money. f is the outflow of foreign exchange reserves, also measured in terms of the initial stock of money. Under the gold standard, d and f are the rate of growth of the fiduciary issue and the outflow of gold, respectively.

Since there are only two countries in the model, one country's gold

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23 See Calomiris and Hubbard [1987] for a careful evaluation of the law of one price in goods and assets markets during the gold standard.

24 It can be shown that in this model a variable real exchange rate, not affected by monetary policy, is equivalent to x. Hence x can be intepreted as a general idiosyncratic shock in goods and assets markets.

or reserve outflows are the other country's inflows. Assuming that the two countries are of equal size, we have:

$$f = - f^{*} \tag{5}$$

Equations (1) to (5) imply the following expressions for the world rate of inflation, and the flow of international reserves:

$$p = 0.5[(d + d^{*}) + (v + v^{*})] \tag{6}$$

$$f = 0.5[(d - d^{*}) + (v - v^{*})] \tag{7}$$

As equations (6) and (7) show, the world rate of inflation is a weighted average of the domestic and foreign rates of growth of domestic credit (adjusted for velocity shocks), while reserve flows are determined by the deviations of the domestic and foreign monetary policies, and money demand shocks. Nominal interest rates are determined by the Fisher equation:

$$i = r + p, \qquad i^{*} = r^{*} + p^{*} \tag{8}$$

I define the symmetric fixed-exchange-rateange-rate regime as follows. Under a symmetric fixed-exchange-rates regime each central bank attempts to control a domestic target and a foreign target, represented by the nominal interest rate, and the rate of change of foreign exchange reserves: the two target variables have the same weights and desired values in central banks' objectives. I borrow the assumption that central bankers' objectives can be described by a domestic target and a foreign target from Giovannini [1986], Eichengreen [1987], Giavazzi and Giovannini [forthcoming], and Barsky <u>et al.</u> [1988]. The specification of the domestic target in terms of the nominal rate of interest is due to Barro [1988], and Barsky <u>et al.</u> [1988]. In a symmetric system, the objective (loss) functions are:

$$W = (i - \bar{i})^2 + bf^2 \tag{9}$$

$$W^* = (i^* - \bar{i})^2 + bf^{*2} \tag{10}$$

In a commodity-based system like the gold standard, the similarity of the two objective functions would arise from the common rules on the convertibility of banknotes into gold coins, and on the similarity of the rules about specie coverage of banknote circulation. In a fiat system like the EMS, the similarity of the two objective functions would arise as a result of systematic international consultations among member countries, whose objective is to define common guidelines for monetary policy.

When central banks maximize (9) and (10) world interest rates and reserve flows are as follows:

$$i = \bar{i} - 0.5x \qquad i^* = \bar{i} + 0.5x \tag{11}$$

$$f = (0.5/b)x \tag{12}$$

International disturbances are equally shared by the two countries, and international reserve flows are inversely proportional to the importance of the external target in the two countries' objectives.

By contrast, I define the asymmetric system as follows: the center country targets the domestic interest rate, while the other country minimizes the fluctuations of international reserves. Hence countries objective functions differ:

$$W = (i - \bar{i})^2 \tag{9'}$$

$$W^* = f^{*2} \tag{10'}$$

The reaction functions implied by (9') and (10') are:

$$d = 2(\bar{i} - r) - d^* - (v+v^*) \tag{13}$$

$$d^* = d + (v-v^*) \tag{14}$$

Equations (13) and (14) show that the center country accomodates world money demand shocks, but--given the real rate of interest and money demand--it offsets any changes of domestic credit policy in the periphery. The country at the periphery accomodates the center country's policy, and offsets differences in money demand shocks, which tend to give rise to international reserve flows. The equilibrium interest rates and reserve flows are:

$$i = \bar{i} \qquad i^{*} = \bar{i} + x \tag{15}$$

$$f = 0 \tag{16}$$

Equations (15) and (16) reveal most clearly the fundamental difference between symmetric and asymmetric fixed-exchange-rates systemstes systems: in an asymmetric system countries at the periphery give up control of their domestic target to achieve stability of foreign reserve flows. In equilibrium all international portfolio shifts are fully reflected in changes in the interest rates at the periphery, but do not change the interest rate in the center country.

The illustration of the symmetric and asymmetric regimes adopted in this section--based on postulated asymmetries in the objectives of central bankers--was preferred to an alternative specification, based on the hypothesis that the center-country is a "Stackelberg leader". That model relies on the assumption that changes in monetary policies by countries other than the leader cannot elicit the leader's reaction. By contrast, the model I use has in my opinion the virtue of being based on a symmetric game structure, but is silent on what gives rise to the asymmetries in the objective functions. The asymmetries could be generated by four different phenomena, which I briefly review below. They include Mundell's [1968] "proper division of the burden of international adjustment", the presence of a "reserve currency" country, liquidity constraints affecting differently surplus and deficit countries, and the issue of "imported reputation".

Robert Mundell [1968] demonstrates that the adjustment to country-specific disturbances should be divided in inverse proportion to the sizes of the countries involved. In our problem, the adjustment to relative interest-rate shocks is carried out by the small country: the interest rate in the large country is unaffected. This result can be illustrated considering a world made up by two equally-sized regions: one occupied by a single large country (the "domestic country"), and the other by a large number of small countries (denoted by an asterisk, *), indexed by $j=1,\dots,N$.[25] In this world, the rate of inflation is:[26]

$$p^*_j = p = 0.5[\ (d_j+(1/N)\Sigma d^*_j) + (v+(1/N)\Sigma v^*_j)\ ] \qquad (17)$$

Each small country's domestic credit policy has a negligible effect on its own rate of inflation. By contrast, the small countries' reserve flows are:

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25 This subdivision of the world economy, suggested to me by David Backus, facilitates the comparison with the symmetric case reported above.

26 From goods markets equilibrium, $d-f+v=d^*_i-f^*_i+v^*_i$, for all i's. Summing this conditions over all i's, and using the condition that world reserve flows are zero, one can solve for f. To compute the world rate of inflation, substitute the expression for f into (4) and (1).

$$f_j^* = d_j^* + v_j^* - 0.5[\ (d+(1/N)\Sigma d_j^*) + (v+(1/N)\Sigma v_j^*)\ ] \qquad (18)$$

In equilibrium, deviations of the two target variables from their desired values are inversely related to the relative effectiveness of the instrument: hence the small countries end up nearly pegging their foreign exchange reserves, while the task of pegging the world interest rate is left to the center country: this corresponds to the the asymmetric regime postulated above.

A similar result would obtain if one of the two countries issues a "reserve" currency: this case is discussed by Swoboda [1978] and Genberg and Swoboda [1982]. An increase in high-powered money by the reserve-currency country has a larger effect on world inflation than the same increase from a non-reserve-currency country. The foreign exchange reserves of the other country increase by a multiple of the original monetary expansion, equal to the money multiplier of the reserve currency. Hence the non-reserve-currency central bank would be relatively ineffective at targeting the rate of interest, and, as above, would end up targeting foreign exchange reserves.

A third reason for the endogenous establishment of an asymmetric regime is the presence of constraints on the size of balance-of-payments deficits, justified, for example, by liquidity constraints. With identical objective functions, the equilibrium reserve outflow from the domestic country is given by equation (12). If the domestic country faces systematically positive realizations of x, i.e. it is a "deficit country", and if the costs of financing reserve outflows are large, the domestic country would find it advantageous to forego interest rate stability by accomodating fully the monetary policy of the center country.

Finally, asymmetric exchange rate regimes could arise in the "imported credibility" models of Giavazzi and Giovannini [1987] and Giavazzi and Pagano [1988]. These authors show that, when exchange-rate targets are fully credible, inflation-prone central banks might find it advantageous to accomodate fully to a central bank which has an "inflation fighter" reputation.[27]

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[27] As Giavazzi and Giovannini [forthcoming] stress, however, these models do not provide a justification as to why the center-country would prefer such an arrangement over, for example, a flexible exchange rate regime.

5. Empirical Evidence

In this section I discuss the empirical evidence on the hypothesis that the three fixed-exchange-rates regimes worked asymmetrically. I first review the evidence on the timing of discount rate changes during the gold standard. Then I study the behavior of interest rates in correspondence of parity realignments, both during the Bretton Woods and the EMS. And finally I derive and test some stochastic implications of the model of section 4.

5.1 The Timing of Discount-Rate Changes During the Gold Standard

During the gold standard, changes in the bank rate were considered the main policy instruments used by central banks to affect their gold reserves and international capital flows. Bloomfield [1959] and Eichengreen [1987] argue that British rate changes immediately followed by changes changes in the continent are evidence suggestive of the central role of the Bank of England in the gold standard. To verify this hypothesis, I have looked at the data published by the US National Monetary Commission [1910], reporting dates and amounts of discount rate changes for Britain, France and Germany in the period from January 1989 to December 1907.

First, I have computed the number of occurrences when a change in the British discount rate was followed (within 1 week) by a change in the discount rate in France or Germany. During that period, the Bank of England changed the discount rate 104 times, increasing it 59 times, and decreasing it 45 times. The Reichsbank followed the increases in the British discount rate 11 times, and followed the rate decreases 14 times. There are also 14 cases when the Reichsbank discount rate changes preceded those of the Bank of England.[28] France, by contrast, followed changes of the bank rate much less frequently (a reflection of the less intensive use of discount rate policy by the Bank of France). Only three British rate changes were followed by France within a week (2 negative and 1 positive), while France's discount rate adjustments were also followed by the Bank of England in three occasions (2 negative changes 1 positive). In the case of France, there are also three instance of discount rate changes occurring the same day.[29]

Table 2 contains statistical tests of the timing of discount rate changes, using 992 weekly observations in the period mentioned above. I estimate a vector autoregression including 8 lags of the British, French and German rates, and test the joint significance of the coefficients of each set of lagged rates in each regression. The table shows no evidence of temporal precedence in the changes in the British bank rate. Instead, lagged values of the German discount rate are significantly

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[28] 7 times upwards, 7 downwards.

[29] January 10 and January 24, 1989.

correlated with the Bank rate and the French discount rate.[30] In summary, there is very little evidence in support of the hypothesis that Bank rate changes preceded changes in discount rates in the continent. As I argue in Giovannini [1986], at least in the monthly data, there is a strong contemporaneous correlation between the British and the German rate.[31] This correlation, however, is almost entirely due to the common seasonal component in discount rate policies, and therefore cannot be interpreted as supporting the hypothesis of the leadership of the Bank of England.[32]

How should we interpret these results? The temporal pattern of discount-rate changes being tested in this section is consistent with a leader-follower structure, where the center country's central bank always moves first, independently of the other central banks' actions, and taking their reactions into account. The empirical evidence

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[30] This evidence contrasts with the findings of Eichengreen [1987]. He estimated monthly bivariate VARs which included the British discount rate and the German and French rate, respectively. He found that lagged values of the British rate were significantly correlated with both the French and the German rates. I was unable to reproduce these results, by reconstructing Eichengreen's sample. While my coefficient estimates are virtually identical to his, I found in the monthly data that lagged values of the British rate were not significantly correlated with the German rate, while lagged values of the French rate were significant in the Bank Rate regression.

[31] Since the French rate changes only few times in this period, I left it out of my analysis.

[32] See Andreades [1909], Keynes [1930] and Ford [1962] for a description of the "autumnal drains" that prompted these reactions by central bankers.

presented here rejects this hypothesis.[33] This evidence, however, has no conclusive implications for the asymmetric model of the gold standard in section 4.[34]

5.2 The Asymmetric Behavior of Interest Rates

A rather general implication of the model in section 4 regards the behavior of interest rates. While in a symmetric regime international portfolio shifts are reflected in both countries' interest rates, in an asymmetric regime the center country's rate is unaffected, and international portfolio disturbances perturb only the other countries' rates.[35]

This result suggests a simple test of the asymmetry hypothesis,

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33 Evidence on the timing structure of discount rates during the EMS is provided by Roubini [1988]. Using quarterly data, he finds that lagged values of the German discount rate are correlated with Italian, Belgian and Danish rates, which he inteprets as evidence of German leadership. Genberg Saidi and Swoboda [1982] test the temporal precedence of US monetary policies during the Bretton Woods years: their evidence does not consistently support the hypothesis that US monetary policy changes preceded those in the rest of the world.

34 The limited use of Granger causality tests is argued in detail by Cooley and Leroy [1985].

35 Giavazzi and Giovannini [1987] show that the asymmetric behavior of interest rates is also an implication of models where prices are sticky.

based on the observation of countries' interest rates in correspondence of observable international portfolio shifts. The most natural choice of episodes of shifts between countries' assets is the periods preceding devaluations. Both under the Bretton Woods regime and in the EMS there have been several realignments of central parities, which have been prompted by countries' inability to withstand balance-of-payments difficulties, and have been anticipated--though to different degrees--by financial markets. In this section I analyze the behavior of interest rates around the Bretton Woods realignments of March 1961 (Deutsche mark revalued), November 1967 (devaluation of sterling), August 1969 (French franc devalued), and October 1969 (Deutsche mark revalued).

Figures 1, 2 and 3 report monthly observations of the 1-month eurodollar deposit rates, and of the differential between the eurodollar rate and a domestic money market rate in the US, during an interval of two years around the realignments of 1961, 1967 and 1969.[36] Figures 4, 5, 6 and 7 report weekly data (taken on Fridays) on the US Treasury Bills rate and the forward premium. The sources are the Wall Street Journal for the US interest rate, and the Economist for the forward premium. The forward premium is calculated using the bilateral rates of sterling: it is the ratio of the 1-month forward rate (expressed in units of the currency for 1 dollar) and the spot exchange rate, less 1 (the result is multiplied by 1200 to express the implied interest rate

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[36] These data are obtained from International Financial Statistics.

differential in percent per annum).

Figures 1 and 4 illustrate the behavior of dollar interest rates and the DM/dollar forward premium in correspondence of the revaluation of the mark on March 6, 1961. Figure 4 shows that the volatility of the interest rate differential implied by the forward market much exceeds the volatility of the US Treasury bills rate. On January 13 the foreign exchange market implies a negative DM-dollar differential of about 1 percent. That differential decreases to -6 percent and -2.5 percent the weeks following the realignment. These large fluctuations of the interest rate differential implied by the forward rate are accompanied by a much smaller increase of the eurodollar rate (shown in figure 1), which reached 4.14 percent in December 1960, but fell to about 3.5 percent the February before the revaluation of the DM.

Figures 2 and 5 report US rates and forward premia around the devaluation of sterling on November 20, 1967. Figure 2 shows a large peak in the Eurodollar interest rate and the offshore-domestic differential for the dollar in the month of November--suggesting that the sterling crisis had some repercussion on the dollar (evidence against the asymmetry hypothesis). Figure 5 shows wide swings in the forward discount on sterling, especially after the date of the devaluation, and a slight increase in the US TBill rate in the weeks preceding the devaluation.

Finally, figures 3, 6 and 7 illustrate the data for the August 11, 1969 devaluation of the franc, and the October 24 revaluation of the DM.

As figure 3 shows, 1969 is a year of high and volatile Eurodollar interest rates. Figure 6 presents the data for the French devaluation. It shows that the forward market implied a very high differential between French and US interest rates at the end of June, without any large swings in the US Tbills rate. The TBill rate, however, falls from 7.4 to 6.05 percent in the week preceding the devaluation. Figure 7 contrasts the relative stability of the US Tbills rate with a sharp increase of the dollar-DM interest rate differential implied by the forward premium, which reached 13 percent on September 19.

Figures 8 and 9 report domestic and offshore interest rates for the lira, the French franc and the Deutsche mark, in the weeks preceding and immediately following the EMS realignment of April 7, 1986, when both the lira and the French franc were devalued relative to the Deutsche mark. This episode was first studied by Giavazzi and Giovannini [1987]. The large swings of the offshore interest rates on the franc and the lira occur despite of a strikingly stable pattern of the domestic and offshore DM rates.

In summary, the behavior of interest rates in correspondence to devaluations strongly suggests the presence of asymmetry in the two EMS episodes. The sharp movements of dollar rates in correspondence of the sterling devaluation in 1967 are in contrast to the hypothesis that the US was the center country during the Bretton Woods years. The Bretton Woods data, however, should be interpreted with caution, since this analysis cannot identify and control for portfolio shifts that did not involve dollar assets: the maintained assumption is that the observed international interest rate differentials reflect incipient portfolio reallocations between dollar assets and the assets denominated in the depreciating or appreciating currency.

5.3 Exploring the Stochastic Implications of the Asymmetric Model of Fixed Exchange Rates

Following the analysis of section 4, I assume that central banks minimize the following objective functions:

$$W_t = - E_t \, [(y_{1t+j} - \bar{y}_{1t+j})^2 + b(y_{2t+j} - \bar{y}_{2t+j})^2] \tag{19}$$

$$W_t^* = - E_t \, [(y_{1t+j}^* - \bar{y}_{1t+j}^*)^2 + b(y_{2t+j}^* - \bar{y}_{2t+j}^*)^2] \tag{19'}$$

Where y_1 and y_2 are the home and external target variables, in both countries (foreign-country variables denoted by a *). This maximization is performed subject to equations describing the dynamics of the target variables:

$$Y_t = A(L)Y_{t-1} + B(L)Y_{t-1}^* + C(L)Z_t \tag{20}$$

$$Y_t^* = A^*(L)Y_{t-1} + B^*(L)Y_{t-1}^* + C^*(L)Z_t \tag{21}$$

Where A(L), B(L) and C(L), and the corresponding starred variables are polynomials in the lag operator. Y and Y^* are the vectors of targets for the domestic and the foreign country, and Z is a vector which includes exogenous variables, stochastic disturbances, and the instruments available to the two central bankers.

The first-order condition for the domestic central bank is

$$E_t(y_{1t} - \bar{y}_{1t}) = -bE_t(y_{2t} - \bar{y}_{2t}) \tag{22}$$

A similar condition holds for the foreign central bank.

Equation (22) implies that, if b equals zero, deviations of the domestic target variable from its desired value should be uncorrelated with information at time t, and in particular with past realizations of the external target variable. Under the alternative hypothesis, lagged realizations of the external target variable--presumably correlated with the right-hand side of equation (22)--are correlated with the term on left-hand side. Intuitively, in the center country the deviations of the domestic target from its desired value are white-noise errors.[37]

In order to derive testable implications, I need identifying assumptions about the unobservable term $\bar{y}_{1t}$. It is plausible to assume that it is uncorrelated with lagged values of the external target, thus allowing the domestic and the external targets to be more clearly isolated. In this case, when a country's monetary authority targets a

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[37] See Sargent and Wallace [1976] for derivations of similar tests in the context of linear-quadratic control models.

domestic variable exclusively, lagged values of the external target should be uncorrelated with the domestic target. These tests are apparently similar to those performed by Pippenger [1984] and Dutton [1984], who analyzed central bank policies under the gold standard. As I stress in Giovannini [1986], however, the interpretation of my test is dramatically different. While I concentrate on the reduced-form properties of the data, implied by the alternative structures of the international monetary system, Pippenger and Dutton intend to estimate parameters of central banks' reaction functions. These specifications, however, are not linked to an underlying optimization problem of central banks: hence the tests of the significance of individual parameters proposed by these authors are difficult to interpret.

Tables 3, 4 and 5 report the results of some exploratory tests of the asymmetry hypothesis. Table 3 contains the results for the gold standard data (monthly). I assume that the domestic target variable for each central bank is an index of coverage of the central bank's liabilities: the proportion of the gold reserve to total deposit liabilities in the Banking Department of the Bank of England, the proportion of cash to total demand liabilities in the Reichsbank,[38] and the ratio of the gold reserve to circulation in the Bank of France. In addition, I assume that the desired value of the target variable is

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[38] Which equals the ratio of the sum of coin and Imperial treasury notes, divided by the sum of notes in circulation and other demand liabilities.

constant (plausibly determined by national regulations on coverage, and banking practice). For all three countries, I test whether lagged values of net imports of gold are significantly correlated with the target variable (in first difference), beyond a set of seasonal dummies.[39] The table shows that the null hypothesis of no correlation is rejected at the 5 percent level in the case of Germany and France (the marginal significance level, the probability that the test statistic exceeds the reported value when the null hypothesis is true, is actually less than 1 percent in the case of Germany), but it is not rejected for England.

Table 4 contains the results for the Bretton Woods data (quarterly). The domestic target variable is assumed to be the domestic money-market interest rate, while the foreign target variable is the change in foreign exchange reserves relative to high-powered money.[40] As before, I include seasonal dummies in the regression.
I find that past balance of payments flows are highly significantly correlated with the domestic money market rate in the United States and in the United Kingdom. This correlation is insignificant in France and

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[39] Since the theory does not predict that the disturbances should be i.i.d. under the null hypothesis, the test statistics are computed using the White [1980] correction for heteroskedasticity.

[40] All the data is from International Financial Statistics. Valuation effects on foreign exchange reserves are subtracted by subtracting the "other items" line from net foreign reserves at the central bank.

West Germany.

Table 5 contains the results for the EMS data. The specification of the regression equations is identical to that for the Bretton Woods data. The hypothesis that lagged values of foreign reserve flows are orthogonal to the domestic target (nominal interest rate) is rejected at the 1 percent level in the case of France of Italy, but not in the case of West Germany. In summary, the test results agree with the "center country" hypothesis in the case of the gold standard and the EMS, but not in the case of Bretton Woods.

6. Concluding Observations

The data seems to support the hypothesis of asymmetry, at least in the case of the gold standard and the EMS. Although the institutional setup in both regimes is clearly not inducing asymmetry, there are striking similarities in the use of capital controls. Furthermore, the evidence on interest rate behavior and the statistical tests both support the asymmetric model.

In the case of Bretton Woods, the statistical model rejects the asymmetry hypothesis, and the evidence on interest rates is--at least in some cases--not as clearcut as in the case of the EMS.

In this paper I have followed the strategy of trying to uncover evidence of asymmetry without exploiting the implications of specific models of asymmetric international monetary systems, like those mentioned in section 4. None of the factors giving rise to asymmetries described above, in my opinion, can alone fully explain all three historical experiences studied in this paper. I do believe, though, that further empirical work should help to identify which of the alternative models of an asymmetric international monetary system best fit the individual historical experiences.

Table 1:

Bilateral Fluctuation Bands

Currency	(x-rate)	Parity	Lower Limit	Upper Limit
			Gold Standard	
Sterling	($/pound)	4.866	4.827	4.890
Franc	(FF/$)	5.183	5.148	5.215
Mark	(DM/$)	4.198	4.168	4.218
			Bretton Woods	
Sterling	($/pound)	2.8	2.772	2.828
Franc	(FF/$)	4.937	4.887	4.986
Mark	(DM/$)	4.2	4.158	4.242
			European Monetary System	
Franc	(FF/DM)	2.310	2.258	2.362

Sources. Gold Standard: Morgenstern [1959]. Sterling points are computed for gold trade from Britain to the US (in 1879). Franc and mark points are computed for trade from Paris and Berlin (respectively) to New York (in 1901). Bretton Woods: International Financial Statistics. Data refers to the year 1960. EMS: European Economy. Data refers to March 1979.

Table 2:

The Timing of Discount Rates During the Gold Standard

		Dependent Variables: GB	GER	FRA
R^2		0.434	0.956	0.982
DW		2.000	2.000	2.001
F-tests:	GB	0.000	0.432	0.780
	GER	0.000	0.000	0.038
	FRA	0.117	0.574	0.000

Sample: Weekly from January 1890 to December 1907. The entries denoted by F-test are the marginal significance levels of the null hypothesis that the coefficients of the lagged discount rates of the country of the corresponding row are not significant in the regressions with dependent variable the country of the corresponding colunmn.

Table 3:

Test Results: Gold Standard

	Country:		
	Britain	Germany	France
Sample	1889:12 1907:12	1892:12 1907:12	1900:10 1907:12
R^2	0.480	0.915	0.515
F-tests:	0.271	0.004	0.029

The entries denoted by F-test are the marginal significance levels of the null hypothesis that the coefficients of the lagged net imports of gold are not significant. The statistic is computed using the White [1980] correction of the variance-covariance matrix of disturbances.

Table 4:

Test Results: Bretton Woods

	Country:			
	US	UK	Germany	France
Sample	62:2 71:4	64:2 71:4	62:2 71:4	62:2 71:4
R^2	0.516	0.594	0.185	0.163
F-tests:	0.000	0.000	0.518	0.400

The entries denoted by F-test are the marginal significance levels of the null hypothesis that the coefficients of the lagged ratio of reserves flow relative to high powered money are not significant. The statistic is computed using the White [1980] correction of the variance-covariance matrix of disturbances.

Table 5:

Test Results: EMS

	Country:		
	Germany	France	Italy
Sample	80:3 88:1	80:3 88:1	80:3 87:4
R^2	0.079	0.345	0.350
F-tests:	0.690	0.009	0.003

The entries denoted by F-test are the marginal significance levels of the null hypothesis that the coefficients of the lagged ratio of reserves flow relative to high powered money are not significant. The statistic is computed using the White [1980] correction of the variance-covariance matrix of disturbances.

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Fig. 1: Dollar Interest Rates Around the 1961 Realignment

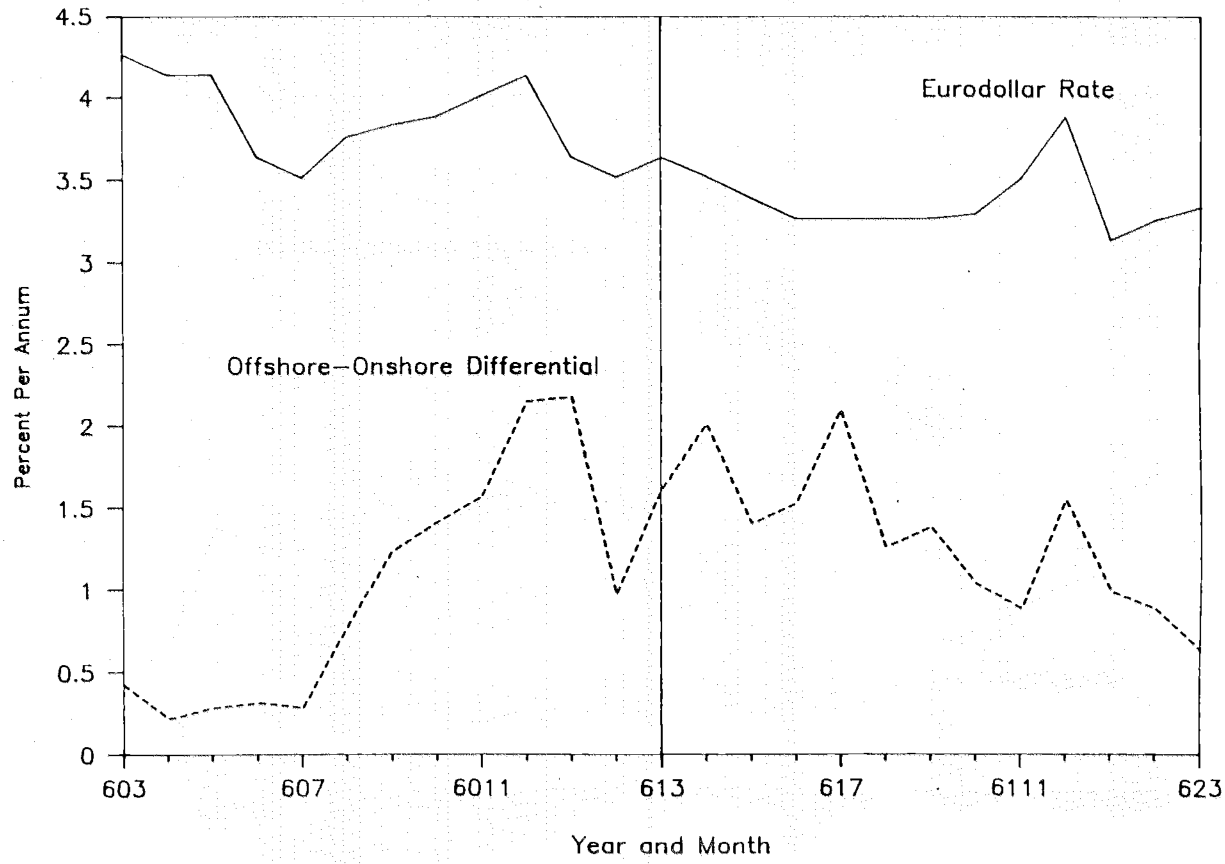

Fig. 2: Dollar Interest Rates Around the 1967 Realignment

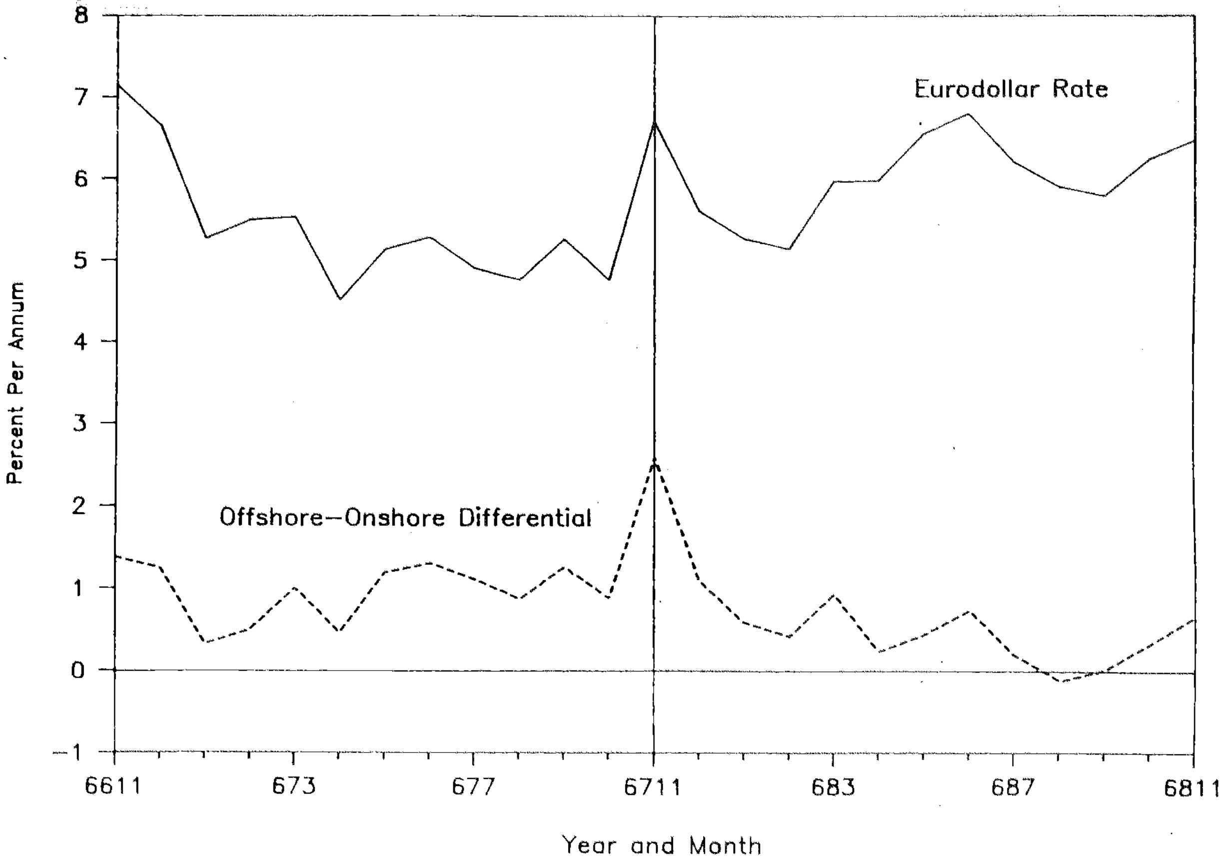

Fig. 3: Dollar Interest Rates Around the 1969 Realignments

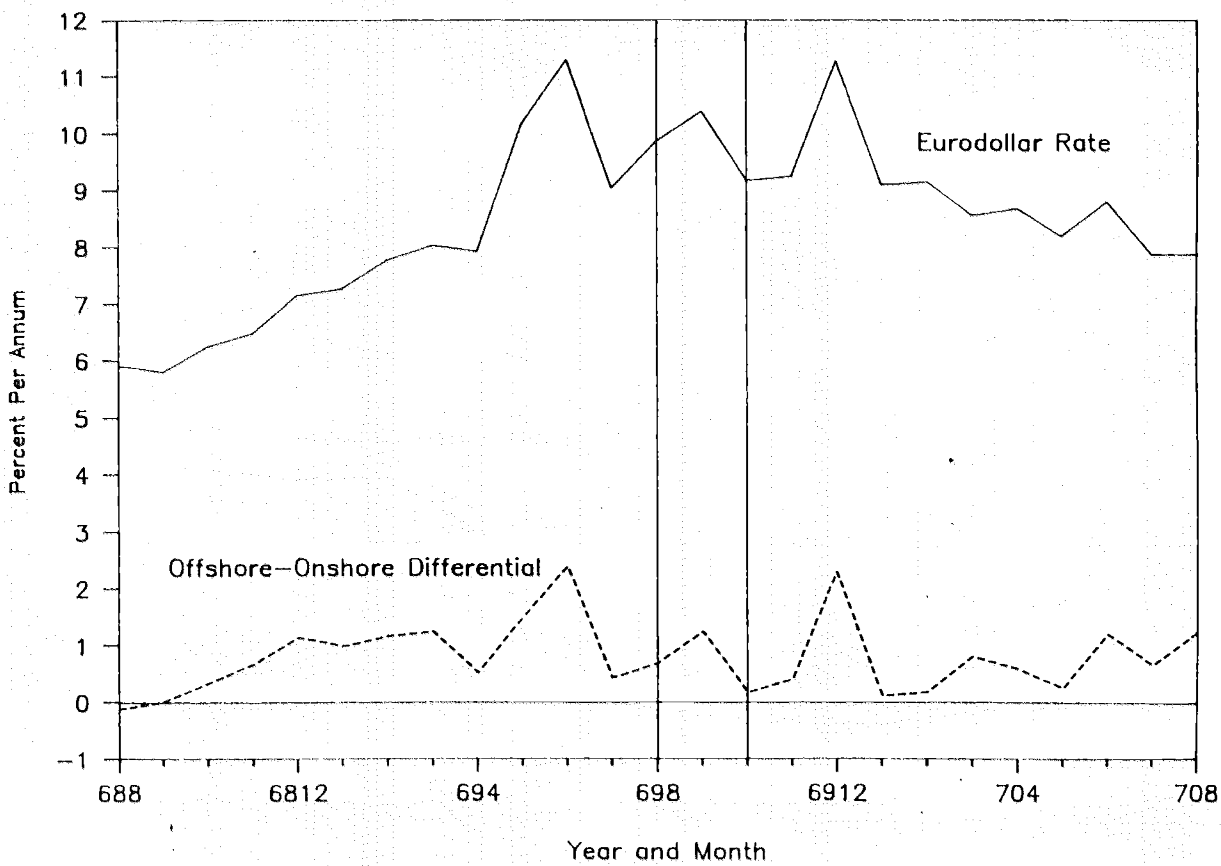

Fig. 4: Forward Premia Around the 1961 Realignment

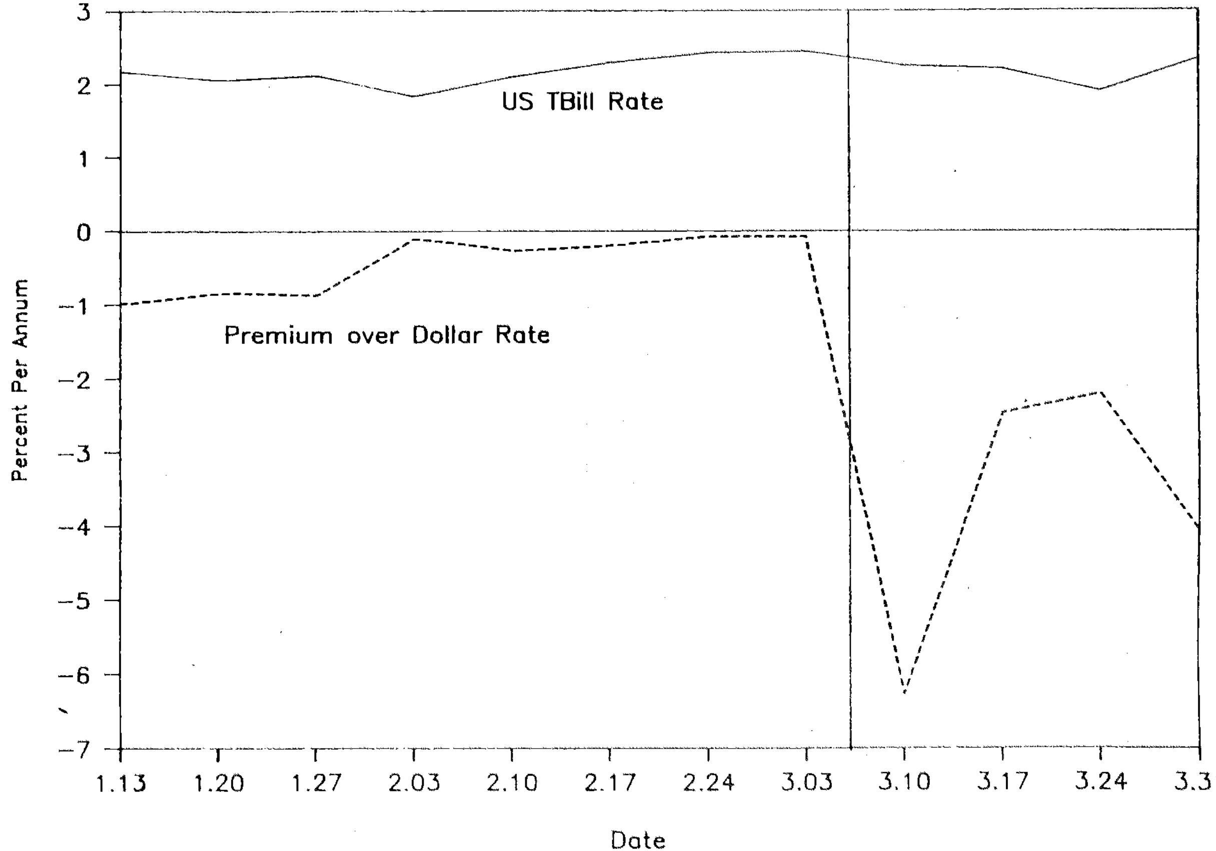

Fig. 5: Forward Premia Around the 1967 Realignment

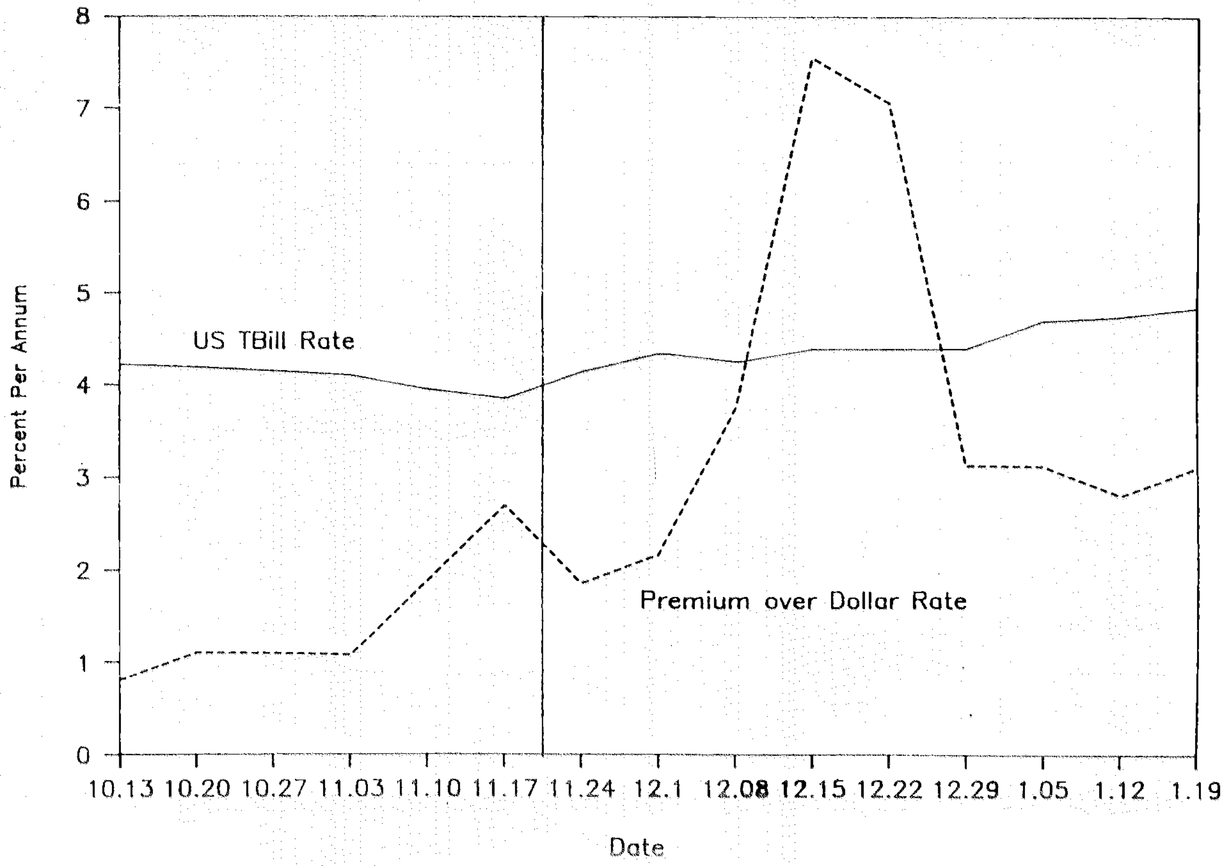

Fig. 6: Forward Premia Around the August 1969 Realignment

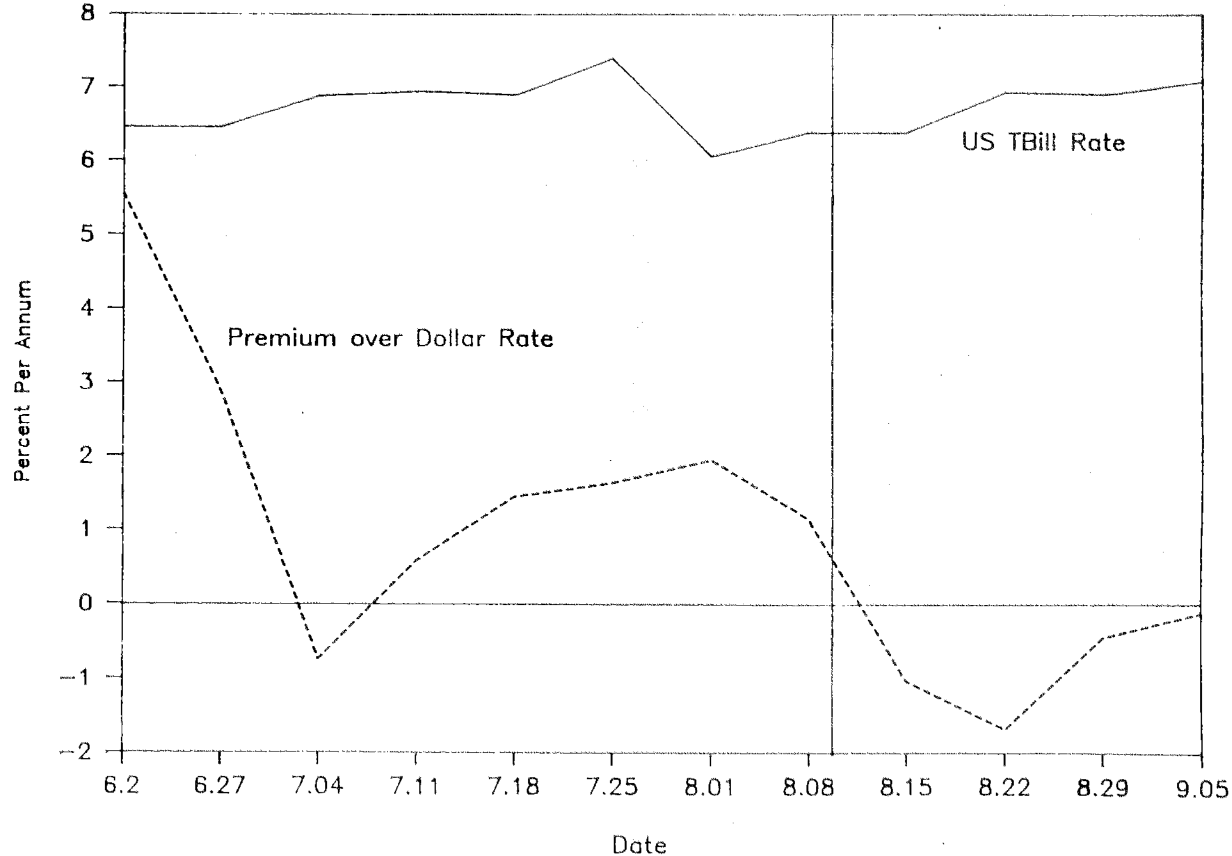

Fig. 7: Forward Premia Around the October 1969 Realignment

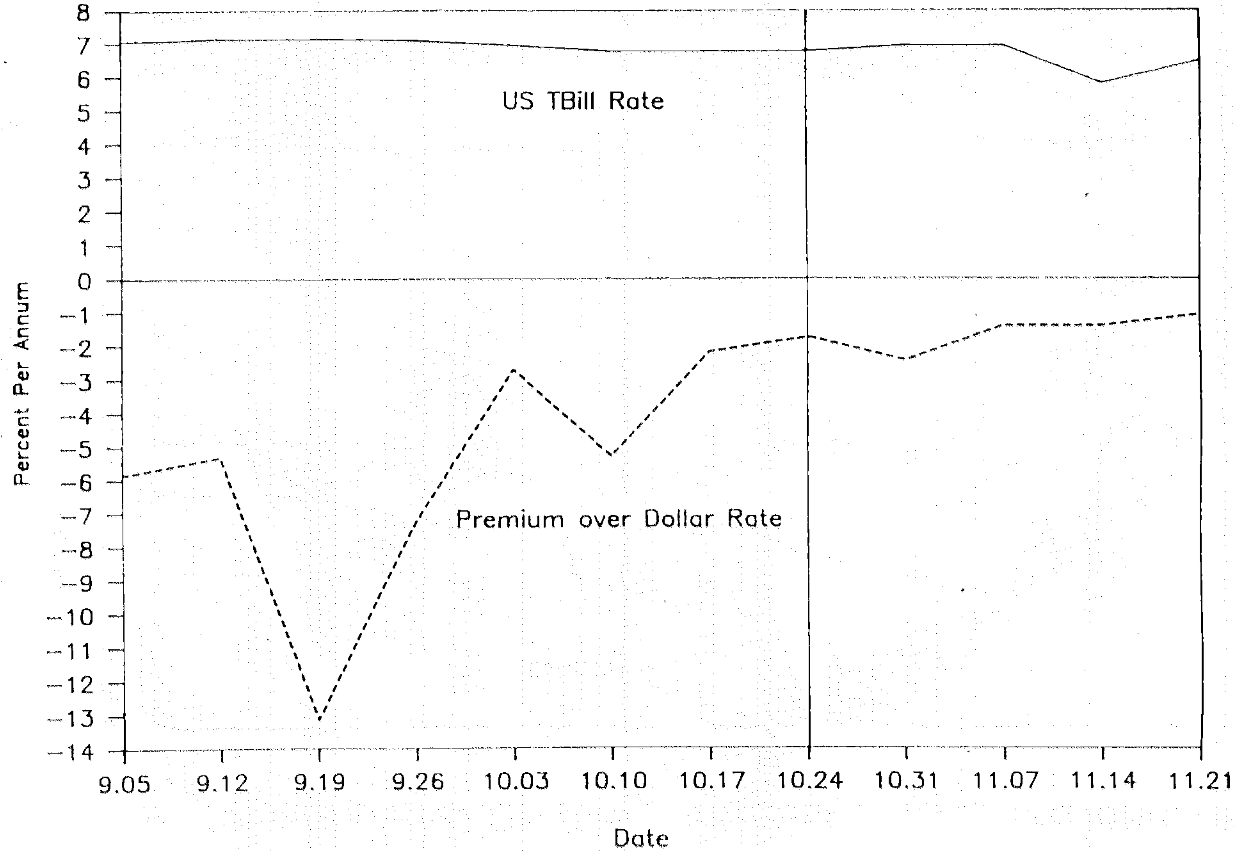

Fig. 8: Onshore and Offshore Interest Rates: lira and DM

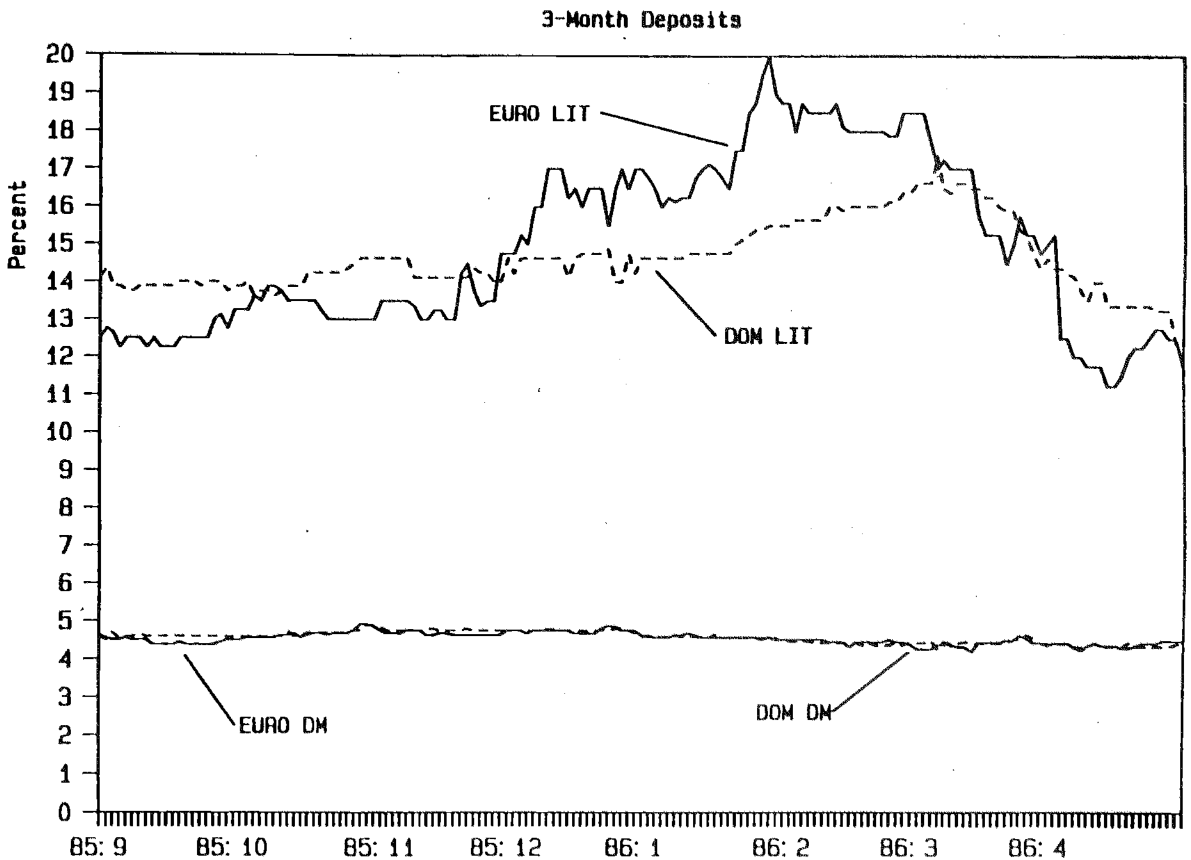

Fig. 9: Onshore and Offshore Interest Rates: franc and DM