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Abstract

This paper attempts to identify implicit exchange rate regimes for the Yen/Dollar exchange rate. To that end, we apply a sequential procedure that considers both the dynamics of exchange rates and central bank interventions to data covering the period from 1971 to 2003. Our results would suggest that implicit bands existed in two subperiods: April-December 1980 and March-December 1987, the latter coinciding with the Louvre Accord. Furthermore, the study of the credibility of such implicit bands indicates the high degree of confidence attributed by economic agents to the evolution of the the Yen/Dollar exchange rate within the detected implicit band rate, thus lending further support to the relevance of such implicit bands.

JEL classification: F31; F33

Keywords: Exchange rate regimes; Implicit fluctuation bands, exchange rates.

1. Introduction

The *de facto* exchange rate policy adopted by monetary authorities has tended to differ from the announced *de iure* exchange rate regime, which is why IMF classifications are not always a good guide to the true exchange rate intentions of said authorities.

New literature seeks to achieve two linked objectives, namely, to detect divergences between *de iure* and *de facto* regimes and to assess the consequences of these differences on the relevance of exchange rates for macroeconomic performance¹. Recognition of the divergences opens up a number of key questions regarding the analysis and recommendations of international economic organizations as well as for academic work: which is the correct classification and which variables and methods should be considered for this purpose?

Reinhart and Rogoff (2004) presented recently a comprehensive classification of the exchange rate regimes of 153 countries over the last half-century. Their research suggests the importance of *de facto* bands in the international economy. Other approaches focus on the variation of central bank reserves and acknowledge the relevance of intervention in detecting implicit pegs and bands (see, for instance, Poirson, 2001).

The main objective of this paper is to use a sequential procedure that considers both the dynamics of exchange rates and central bank interventions to detect implicit bands for the Yen/Dollar exchange rate.

The Yen/Dollar rate has traditionally been considered a paradigmatic example of a flexible exchange rate (see e.g. Cooper, 1999). Notwithstanding the customary consideration of the Yen/Dollar exchange rate as free-floating, a number of studies have examined the behaviour of the US Federal Reserve (Fed) and the Japanese monetary authorities in exchange rate markets and the efficacy of said intervention in driving the rate².

This paper is organized as follows. To place the study in its proper context, Section 2 presents a brief history of exchange rate regimes. In Section 3 we use a proposal by Reinhart and Rogoff (2004) to detect implicit bands and analyses its sensitivity. In addition, we apply two tests to interventions and to exchange rate data to assess both the intention and the efficacy of foreign exchange market interventions. Section 4 examines the credibility of the implicit bands suggested in Section 3. Finally, Section 5 provides some concluding remarks.

2. Exchange rate regimes

The relationship between a country's exchange rate regime and its macroeconomic performance has been discussed extensively ever since the collapse of

¹ See Coudert and Dubert (2004) for a survey of studies on implicit exchange rate regimes. Reinhart and Rogoff (2004) examine the relevance of the exchange rate regime classifications for empirical macroeconomics.

² For example, Ito and Yabu (2004) and Frenkel et al. (2004) estimate the Japanese monetary authorities' reaction function.

the Bretton Woods system. After the prolonged period of fixed exchange rates which characterized the system, many anticipated a generalization of more flexible regimes in the belief that these were better equipped to protect the economy from real and monetary shocks. Instead, however, in several countries the monetary authorities pegged the external value of their currencies to the Dollar, the Yen, Sterling or to a basket of currencies³, believing that greater exchange rate flexibility led to excessive fluctuations. Such volatility was considered to originate economic instability, negatively impacting on productive investment, international trade and growth.

During the 1980s monetary authorities adopted their exchange rate regimes with the clear intention of seeking a sound stabilization instrument to protect against real and monetary shocks. In particular, they expected that fixing the exchange rate would prevent excessive monetary growth, thus conferring greater discipline on public spending (Levy-Yeyati and Sturzenegger, 2001). The widespread monetary instability experienced during the period called for disinflation and budget consolidation policies and it was no surprise that monetary considerations attracted most attention.

The choice of which hard currency to use to fix the external value of the nation's currency was motivated by other considerations also, among them the desire for greater credibility, given that for many countries the only way to acquire credibility was by pegging their rate to a hard currency of sufficient reputation. One of the main arguments in support of the European Monetary System (EMS) was that it facilitated the necessary process of disinflation, raising the costs of inflation by obliging members to engage in good practices. The aim was to impose discipline on macroeconomic policies to ensure that fiscal deficits would not be compounded by monetary expansion. On such issues Germany emerged almost naturally as the anchor for exchange rate and inflation expectations. Indeed, the EMS might even be viewed as an institutional arrangement that enabled its members to 'borrow' the Bundesbank's reputation by pegging their exchange rates to the Deutsche Mark. Weaker currencies achieved greater credibility thanks to the reputation effects within the Exchange Rate Mechanism (ERM). In other words, European Union member states with histories of high inflation used the EMS as a way of *importing* the Bundesbank's anti-inflationary credibility.

The economic impact of exchange rate systems came in for more extensive treatment in the wake of the crises in Mexico and in Asia. Both hard pegs, such as Argentina's currency board, and soft pegs, such as the ERM, proved problematic during the 1990s, given the speculative attacks they attracted on numerous occasions. The ensuing devaluation, following successful assaults on the currencies of many developing countries, increased the debt burden of domestic foreign-currency borrowers, producing bankruptcies and financial crises.

The series of crises in the 1990s led many to once again question the appropriateness of pegged exchange rates. More flexible systems were now considered more adequate than their fixed counterparts as a means of protection against speculative pressures. This change in perspective stemmed from the growing importance of movements of private capital between countries, a circumstance which had a profound impact on the international financial system. The crises experienced during these years centred on the evolution of the capital account, in contrast to the previous decades,

³ Yoshino *et al.* (2004) note that a basket-peg with trade weights will generally not be the optimum choice for a small, open economy.

when more traditional causes –high fiscal deficits and the ensuing monetization, distortions in goods and services markets, as well as production market factors, among others- were paramount (Summers, 2000).

The main lesson appears to be that, in the current context of financial deregulation and growing liberalization of international capital flows, it is no longer possible to fix external value to a hard currency (or to a basket of currencies). On the contrary, a pegged exchange rate system is now expected to increase output volatility, as well as the negative impacts of real and financial shocks, by raising expectations of windfall profits through speculation against the value of the exchange rate remaining unchanged. The most common result anticipated is the devaluation of the currency as a consequence of speculative attacks, confirming the view that the liberalization of capital movements and the associated increase in foreign-denominated debt of firms and public administrations lead to financial crisis and bankruptcy.

Traditional arguments in favour of pegged exchange rates -lower inflation and volatility, lower interest rates and exchange risks- have lost importance. Instead, monetary authorities now look for greater protection against external shocks and, in particular, seek credibility in international markets. Moreover, in underlining the possibility of external speculation and how this might be prevented, intermediate regimes have become more attractive to speculators in times of crisis, while conventional peg regimes attract speculative attacks which undermine their credibility (and foreign currency reserves). Indeed, many authors have emphasized that fixed exchange rates were present in all the major financial crises of the 1990s (Summers, 2000). It would seem, then, that governments today are moving towards more flexible exchange rate regimes.

Some researchers, beginning with Bean (1992), even before the successive ERM crises of 1992-93, and Eichengreen (1994), shortly after, have argued that, in a context of financial deregulation and the removal of restrictions on capital movements, intermediate regimes are unsustainable in the long run because they are fragile when under speculative attacks⁴. Hence some authors advocate that the only possible choice is between a hard (and irrevocable) peg - dollarisation or a monetary union - and a pure float. This “vanishing middle regime” hypothesis, as it was dubbed by Frankel (1999)⁵, implies that, given growing capital mobility, the only viable long-run solutions lie at the corners (Eichengreen, 1994, 2000; Fischer, 2001).

A monetary union of the type entered into by the 12 countries of the European Union with the creation of the euro is not an alternative open to the vast majority of countries. Since dollarisation does not seem sufficiently appealing to many, the obvious alternative would be a free-floating regime. However, many countries experience what

⁴ This point of view is tied to the argument of the impossible trinity, as it has been called (see, e.g., Fischer, 2001), which stresses the notion that no economy may at the same time have complete freedom of capital movements, a fixed exchange rate and a monetary policy directed exclusively towards national objectives. A country may choose at most two of these goals, but never all three, given that an irreconcilable conflict will appear sooner or later.

⁵ Frankel (1999) did not agree with the idea. An explanation by a proponent of the “bipolar perspective” can be found in Fischer (2001). For a more recent view opposing the “theory of the excluded middle”, see Reinhart and Reinhart (2003), who argue that said hypothesis is a fallacy “contrary to theory and evidence”. As we will see later, the majority of countries have some form of *de facto* intermediate exchange regime.

Calvo and Reinhart (2002) and Reinhart (2000) have called the “fear of floating”, namely, they do not really allow their exchange rates to move freely, regardless of the *de iure* exchange rate system reported by the authorities to the IMF.

This fear of floating appears to stem from the excessive exposure to exchange rate risk caused by the high indebtedness of public and private agents in foreign-denominated titles⁶. Unfavourable expectations regarding the future evolution of the exchange rate are usually accompanied by destabilizing changes in the commitment of foreign “investors” towards a country, resulting in capital outflows and, worse still, producing contagious effects elsewhere. For this reason, such countries do not allow their exchange rates to move freely but rather usually rely on interest rate handling and recourse to foreign-currency reserves to keep exchange rate movements within certain limits, which they somehow consider more adequate.

The choice of exchange rate regime every country has to make has also centred empirical discussion on the appropriate estimation of the economic costs and benefits of the different systems. A difficulty that often arises concerns the wide range of possibilities, since there are more than two extremes (in contrast to the approach taken in the numerous studies which naturally employed the official IMF classification). Rather, countries use a range of regimes, such as currency boards, narrow bands, moving or crawling bands and managed floats.

To all these should be added another difficulty which has come to light more recently: many countries do not declare the true system used. The exchange rate policy followed *de facto* by numerous countries has been found to be vastly different to what, *de iure*, was officially notified to the IMF by the economic authorities.

One of the consequences of this divergence between “deeds” and “words” (Levy-Yeyati and Sturzeneger, 2000; 2001) has been to call into question the results of various empirical studies based on the IMF classification. For this reason, before proceeding any further with an evaluation of the different exchange rate regimes, a classification of the *de facto* systems is needed to replace the *de iure* systems used until recently by researchers in the field of International Economics.

One of the aims of this paper is to identify implicit band or peg regimes. Specifically, we examine the possible existence of fluctuation bands, “agreed” by the monetary authorities in order to intervene in the Yen/Dollar market during the period 1971-2003. In this regard, Fischer (2001), for example, has pointed to the possibility that a commitment to maintain a desired exchange rate target zone between the US Dollar, the Euro (the Deutsche Mark previously) and the Yen may have existed, albeit informally and loosely.

Beginning with the seminal work by Krugman (1991), many papers have addressed the dynamics of exchange rates in target zones (for a review, see Kempa and Nelles, 1999). The main result of the target zone model is that, with perfect credibility, the zone exerts a stabilizing (or so-called “honeymoon”) effect, reducing exchange rate sensitivity to a given change in economic fundamentals. However, in a target zone with credibility problems, expectations concerning future interventions tend to destabilize the

⁶ Non-resident “investors” usually lend in their own currency. Therefore, residents are indebted in foreign currencies and are exposed to every modification undergone by exchange rates.

exchange rate, making it less stable than the underlying fundamentals (Bertola and Caballero, 1992). Credibility seems to be a crucial factor in explaining the success of a target zone.

Credibility can be defined as the degree of confidence attributed by economic agents to announcements by policymakers. In the context of an exchange rate target zone like the EMS, credibility refers to agents' perceptions with respect to commitments to maintain the exchange rate around a central parity⁷. The possibility of a change in the central rate might be anticipated by economic agents, triggering expectations of future modifications in the exchange rate that could become a destabilizing factor within the system.

3. Implicit bands

3.1. Detection of implicit bands

Reinhart and Rogoff (2004) proposed a "natural" classification of exchange rate regimes, as opposed to the "artificial" one followed by the IMF. In their extensive research they collected monthly data on the exchange rates of 153 countries from 1946 to 2001, highlighting the existence of dual, multiple, or even parallel (legally or otherwise) rates. In the event of the absence of a dual market to adequately classify the *de facto* regimes, their approach based the search for peg or band regimes on the proportional variation of the absolute value of the exchange rate, as well as on the probability that it would remain within a given fluctuation band ($\pm 1\%$, $\pm 2\%$ or $\pm 5\%$) over a rolling 2 or 5-year period. Reinhart and Rogoff (2004), somewhat surprisingly, focus on the evolution of exchange rates, without taking into account variations in official foreign currency reserves.

They accept the existence of a *de facto* pegged system if, during at least four consecutive months, no variation is seen in the exchange rate. They then calculate the probability that the monthly variation remained within $\pm 1\%$ over a rolling 5-year period. If the probability is at least 80%, the regime is labelled a *de facto* peg or crawling peg during said years. If the exchange rate does not show drift, it is classified as a fixed parity. If a positive drift is observed, it is identified as a crawling peg while if the rate undergoes periods of both appreciation and depreciation it is deemed to be a moving peg.

In the case of pre-announced and *de facto* bands, Reinhart and Rogoff (2004) follow a similar two-step process also, although here the limit for the monthly variation is $\pm 2\%$ as opposed to $\pm 1\%$. If a band was announced by the authorities and a dual or parallel market did not exist, the authors accept the existence of bands, except where it was found previously to be a *de facto* peg. They also verify whether the *de jure* (announced) and the *de facto* bands coincide, since the former tend to be considerably wider. The authors then calculate the probability that the monthly exchange rate variation remains within a $\pm 2\%$ band over a rolling 5-year period. If the probability is 80% or above, the system is labelled a *de facto* narrow band, narrow crawling or moving band for the

⁷ A target zone needs to rely on some degree of policy cooperation among its members. The failure to cooperate may easily transform market pressure into an exchange rate crisis. The literature on the ERM experience seems to confirm the importance of policy disagreements as a determinant of speculative pressure and realignments (Edin and Vredin, 1993; De Grauwe, 2000). A case in point occurred following German unification, which led to high interest rates at a time when other EMS countries were in the midst of a recession (Fischer, 2001).

period during which it remains continuously above 80%. Where the limits to the announced fluctuation are wide, they also test $\pm 5\%$ bands.

Among the most interesting results obtained by Reinhart and Rogoff (2004), pegs are found to account for 33% of observations during the period 1970-2001, while crawling pegs or narrow crawling bands account for over 26% of the sample.

We have applied this same procedure to the Yen/Dollar exchange rate. Figure 1 gives the results obtained by calculating the monthly proportion of the 24 previous months during which the percentage monthly variation in the exchange rate is less than $\pm 1\%$. The proportion is close to 80% in the early phases of the sample period (i.e. the final Bretton Woods years and just after the system was abandoned).

[Figure 1, here]

The same procedure is followed in Figure 2, although here a fluctuation band of $\pm 2\%$ is considered. Taking again a threshold of 80%, the procedure more clearly suggests the existence of bands in 1971 and 1972, as well as during the period from the second quarter of 1974 to the first quarter of 1978. Our results coincide with those obtained by Reinhart and Rogoff (2004).

[Figure 2, here]

One of the weaknesses of the approach taken by Reinhart and Rogoff (2004) is that the results are not filtered by their statistical significance. For this reason we perform a test in which the null hypothesis is that the probability of the exchange rate variation remaining within a ± 1 or $\pm 2\%$ fluctuation band during a rolling period of two years will be less than or equal to the above-mentioned threshold of 0.8.

Formally, we test if the population proportion is less than or equal to a given frequency, p_0 , and we can thus establish whether bands are absent, as follows:

$$\begin{aligned} H_0 : p &\leq p_0 \\ H_1 : p &> p_0 \end{aligned}, \text{ where } p_0 \text{ is the determined probability.}$$

The acceptance region of the null hypothesis is: $\hat{p} \leq \varepsilon$, where \hat{p} is the estimated sample proportion and $\varepsilon = p_0 + z_{1-\alpha} \frac{\sqrt{p_0 q_0}}{\sqrt{n}}$, where $z_{1-\alpha}$ is the critical value of the standard normal distribution at a confidence level of $1 - \alpha$, q_0 is $1 - p_0$, $\frac{\sqrt{p_0 q_0}}{\sqrt{n}}$ is the population deviation and n the sample size.

The results of this test do not allow us to reject the null hypothesis of absence of bands over the entire sample period, when a $\pm 1\%$ width is considered, although Reingart and Rogoff suggest they are present following the end of the Bretton Woods system. Using $\pm 2\%$, the null hypothesis is rejected only in the second quarters of 1974 and 1976, which would suggest that bands are present. Thus, a considerably shorter

period is detected by a strict application of the procedure used by the aforementioned authors.

3.2. A variant of the Reinhart and Rogoff approach

An alternative approach to detect implicit pegs or bands involves direct testing to see whether the average of the proportional absolute monthly variations for each rolling 24-month period is significantly less than $\pm 1\%$ or $\pm 2\%$. To test if the population mean (of the monthly variations during 24-month periods) is less than or equal to a given mean μ_0 ($\pm 1\%$ or $\pm 2\%$) the following expression may be used:

$$\begin{aligned} H_0 : \mu &\leq \mu_0 \\ H_1 : \mu &> \mu_0 \end{aligned}, \text{ where } \mu_0 \text{ is the given mean.}$$

The acceptance region of the null hypothesis is $\bar{x} \leq \varepsilon$, where \bar{x} is the sample mean of the Yen/Dollar exchange rate and $\varepsilon = \mu + z_{1-\alpha} \frac{\sigma}{\sqrt{n}}$, where $z_{1-\alpha}$ is the critical value of the standard normal distribution at a confidence level of $1-\alpha$, σ is the serial population deviation and n is the sample size. At a 5% confidence level we choose a critical value of 1.65.

The results of the application of this statistical procedure, which avoids the need to count the periods previously, as Reinhart and Rogoff do, are given in Figures 3 and 4.

[Figure 3, here]

Figure 3 shows the results when $\pm 1\%$ fluctuation bands are considered. The average value (24 months rolling) of absolute proportional variations of the exchange rate of each month with respect to the previous month is given in blue, while the critical region appears in red. Thus, when the red series is above the blue one the null hypothesis cannot be rejected, which would suggest the presence of fluctuation bands. This occurs around the Bretton Woods period but extends until the end of 1977. Likewise, between 1983 and 1985 there is also evidence of fluctuation bands. Between 1995 and 1997 the results indicate that the regime was in the band neighbourhood.

[Figure 4, here]

As can be seen in Figure 4, the average of the monthly variations generally lies below the critical region when a $\pm 2\%$ fluctuation band is used, suggesting (given the rolling quality of the 24-month test) that in practical terms there were monthly limits of $\pm 2\%$ during the entire period. Combining this result with that observed with the $\pm 1\%$ bands, we can be confident that fluctuation bands between $\pm 1\%$ and $\pm 2\%$ existed throughout the sample period, except during the three subperiods detected with the $\pm 1\%$ test, when the bands were narrower.

3.3. Interventions

In this section we incorporate interventions into the search for bands in the Yen/Dollar exchange rate. In the previous section different periods of *de facto* bands or pegs were identified from different approaches based on exchange rate data, which

suggests that the results obtained using the Reinhart and Rogoff approach are not robust. Most of the literature that classifies exchange rate regimes also uses exchange rate data or a combination of foreign reserve and exchange rate data. Such analysis either has not taken into account central bank interventions or has used an imperfect proxy for these to detect periods with exchange rate regimes other than a free floating regime⁸. An ideal method should, however, consider interventions in foreign markets to screen both for the intentions of central banks and their efficacy with regard to peg or band regimes⁹.

In spite of its relevance, the availability of intervention data limits its consideration. Here we use Federal Reserve intervention data from 1 January 1980 to 31 December 2003, and data from the Japanese Ministry of Finance between 13 May 1991 and 31 March 2001.

Two approaches are followed in order to ascertain the relevance of interventions. Firstly, the Pesaran and Timmermann (1992) test is used as a directional prediction test of change. Secondly, Fisher's exact test of independence is applied. In the two tests the sign of central bank intervention and the exchange rate trend are related, particularly when lagged interventions (to measure efficacy) and leads (to detect the monetary authorities' intention to maintain bands or pegs) are considered relative to the exchange rate trend. In the first case one would expect the *ex ante* intervention consisting of the purchase of Yens to be followed by an appreciation of the Yen. In the second case the *ex post* intervention is considered once the trend has been observed, assuming that the intervention is of the *leaning against the wind* type: a depreciation of the Yen should normally be followed by Yen purchases¹⁰.

Both tests are applied to daily exchange rate and intervention data and calculated for monthly periods (i. e., the frequencies needed to construct both statistics are obtained for each month of the sample period)¹¹. The sign of the exchange rate trend is measured by the difference between the current value s_t and the previous value s_{t-k} , where $k=1,5,10,20,30,40,60$.

3.3.1. Pesaran-Timmermann test

The Pesaran and Timmermann (DA, 1992) test is a directional prediction test of changes under the null hypothesis that the actual and predicted values are independent. In the case of *ex post* interventions, the actual values are the exchange rate trends and the predicted values are the signs of the interventions. The contrary is true when *ex ante* interventions are considered.

⁸ Neely (2000) shows that interventions and reserve changes may be loosely related. Therefore, the use of reserves instead of interventions may lead to inadequate classifications.

⁹ We study the incidence of interventions at the exchange rate level. For a survey of the literature analyzing the effect of interventions on the volatility of exchange rates, see Domínguez (1993, 2003).

¹⁰ We adopt these approaches because standard time-series techniques may not be appropriate when dealing with the study of interventions and the associated behaviour of exchange rates. Exchange rates are highly volatile and interventions are usually sporadic (Fatum and Hutchison, 2003). In contrast, Frenkel et al. (2004) estimate a reaction function for sterilised interventions by the Japanese monetary authorities and find major interventions after 1995 in reaction to the previous exchange rate trend.

¹¹ To calculate these frequencies we only consider the number of days during a given month in which the monetary authority intervened.

The distribution of the DA statistic is $N(0,1)$, which has the following structure:

$$DA = [\text{var}(SR) - \text{var}(SRI)]^{-0.5}(SR - SRI), \quad \text{where} \quad SR = H^{-1} \sum_{h=1}^H I_i[y_h \cdot \hat{y}_h > 0] \quad \text{and}$$

$$SRI = p_1 \hat{p}_1 + (1 - p_1)(1 - \hat{p}_1), \quad SRI \text{ being the success ratio in the case of independence}$$
between **actual** and predicted values under the null hypothesis. The other elements are: $p_1 = H^{-1} \sum_{h=1}^H I_i[y_h > 0]$, $\hat{p}_1 = H^{-1} \sum_{h=1}^H I_i[\hat{y}_h > 0]$, $\text{var}(SR) = H^{-1}[SRI(1 - SRI)]$ and $\text{var}(SRI) = H^{-2} [H(2\hat{p}_1 - 1)^2 p_1(1 - p_1) + (2p_1 - 1)^2 \hat{p}_1(1 - \hat{p}_1) + 4p_1\hat{p}_1(1 - p_1)(1 - \hat{p}_1)]$.

[Table 1, here]

The results for the interventions by the Federal Reserve are reported in Table 1. The results in Panel A suggest that the Fed showed willingness to maintain the exchange rate only in specific supperiods. In particular, the Pesaran-Timmermann test indicates the years 1980 (coinciding with explicit commitments by the US and Japanese economic authorities) and 1987 (when the Louvre Accord was signed to stabilize exchange rates) for most of the values of k . In the rest of the sample period the null hypothesis of independence is not rejected.

These conclusions can be confirmed in Panel B, where the efficacy of the interventions is analysed. For several months in 1980, as well as August 1987, the interventions appear to have been effective¹².

Analysis of Japanese interventions was restricted by the availability of data (from March 1991 only). Although quite weak in April and August 1992, which might signal dependence, in general the results do not seem to reject the hypothesis of independence¹³.

3.3.2. Fisher's exact test

Fisher's exact test of independence (for 2x2 tables) is used when the members of two independent groups can fall into one of two mutually-exclusive categories. In our case, each day in a given month can fall into one of two categorical variables: the sign of the exchange rate trend and the sign of the intervention. The former may give two levels (appreciation or depreciation of the Yen) while the latter indicates the purchase or sale of Yens.

This test computes the probability, given the observed marginal frequencies, of obtaining the frequencies observed and any more extreme configuration (i.e. with a

¹² Based on an event study methodology, Fatum and Hutchison (2003) analyse the Deutsch Mark/Dollar exchange rate and find evidence that intervention affects the rate in the short term. Taylor (2004) also obtains evidence supporting the view that interventions increase the probability of stability (only when the exchange rate is misaligned) in a Markov-switching model.

¹³ Schwartz (2000) argues that a strong Yen has not weakened as a result of interventions and sterilization of Dollar purchasing. However, Pinto de Andrade and Divino (2004) attribute a major role to exchange rates in accounting for cyclical patterns of the interest rate. In this sense, the Bank of Japan appears to have attempted to stabilize the exchange rate via interest rates.

lower probability of occurrence in the same direction or in both directions). We present the results obtained when the alternative hypothesis to independence is the correct prediction; for instance, in the case of *ex post* intervention, when a sale of yens follows an appreciation of the currency (assuming interventions are *leaning against the wind*).

[Table 2, here]

As can be seen in Table 2, the lowest probabilities of non-rejection of the null hypothesis are observed in various months of 1980 and 1987. These results are very similar to those obtained in the previous subsection. Hence 1980 and 1987 seem clearly to be the years in which the exceptions to a free-floating regime emerge. Again, the results for Japanese interventions are less informative and the independence hypothesis could not be rejected for the whole sample period.

4. Credibility

In this section we study the degree of credibility for the implicit band regimes suggested by the analysis in the previous section. Specifically, we obtain signs of the presence of a target zone in 1987, coinciding with the Louvre Accord among the leading industrial nations. This commitment involved the coordination of macroeconomic policies in order to stabilize exchange rates.

Furthermore, our analysis indicates the presence of bands for the Yen/Dollar exchange rate in 1980. In 1979, as inflationary pressures at the wholesale level built up drastically and the current account was pushed deep into deficit, the Yen caved heavily on offer and depreciated sharply on the exchange market. On 2 March the Bank of Japan announced that the Fed, the German Bundesbank and the Swiss National Bank would cooperate to prevent the Yen from declining excessively. By mid-April, with United States' interest rates falling, the Yen began to recover along with other major currencies [see, e. g., OECD (1980, 1981) and Pardee (1980, 1981)]. The Fed interventions suggest the presence of a crawling band.

In the study of the period covering 30 April to 31 December 1980, implicit central parity is estimated by a least squares regression in which only a trend and a constant are included. The estimated central parity is shown in Figure 5. A band of $\pm 6\%$ is considered to include all observations falling within it during the aforementioned period¹⁴. From the analysis carried out in the previous section and from OECD reports, we assume a constant depreciation of the Yen/Dollar exchange rate within bands. Figures 5 and 6 illustrate the evolution of the Yen/Dollar exchange rate, adding the central parities and the band for the two periods studied.

[Figures 5 and 6, here]

Credibility is analysed using three indicators: the Svensson simple test, the drift adjustment method and an inverse measure of the probability of realignment. Svensson (1991) provides a simple test to study the credibility of a target zone exchange rate regime with fluctuation bands. We calculated a 100% confidence interval for the

¹⁴ This band has been chosen as an exploratory proposal and hence the results must be interpreted in relative terms (i.e. through comparison of the different subperiods in the period studied, in this case 1980).

expected rate of realignment of the Yen/Dollar exchange rate using the three-month interbank rate. Taking into account the uncovered interest parity hypothesis, the expected rate of realignment is bounded according to:

$$i_t - i_t^* - (\bar{x}_t - x_t) / \tau \leq E_t[\Delta c_{t+\tau}] / \tau \leq i_t - i_t^* - (\underline{x}_t - x_t) / \tau \quad (1)$$

where x_t is the deviation of the log exchange rate s_t from the log central parity c_t , \underline{x}_t and \bar{x}_t are the lower and upper bounds of the exchange rate bands, τ is the maturity (valued at 3/12 for a 3-month maturity), i_t^* is the interest rate differential and $E[\cdot]$ is the expectation operator.

The results of this test for 1980 and 1987 are shown in Figures 7 and 8 respectively. As can be seen in both cases, the hypothesis of a realignment expectation equalling zero cannot be rejected. Nonetheless, in 1980 the expected rate of revaluation grows as of the early part of the period, reaching its highest values around June. This behaviour was likely related to trader caution due to the upcoming parliamentary election on 22 June, particularly given that the sudden death of Prime Minister Ohira had added further uncertainty to the campaign. The lowest values of the expectation of revaluation occur in August, most likely due to the outbreak of hostilities between Iran and Iraq [see, e. g., (Pardee, 1980, 1981) and (OECD, 1980,1981)]. Furthermore, in the case of 1987 this measure could reflect both the existence of revaluation expectations at the end of March, before the supposed change in central parity from 153.5 to 146 Yen/Dollar, and expectations of devaluation at the end of July.

[Figures 7 and 8, here]

The second indicator to gauge credibility is the drift adjustment method. This method, originally proposed by Bertola and Svensson (1993), computes an econometric estimate of the expectations of economic agents regarding the realignment. These realignment expectations constitute an inverse measure of credibility. The procedure involves estimating the expected rate of variation of the exchange rate within the band in the absence of realignment, and then computing the expected rate of realignment g_t^τ . Once g_t^τ has been estimated, the corresponding 90% confidence intervals can be calculated.

In this paper we have estimated the expected rate of depreciation within the bands using a linear regression model where the exchange rate and the domestic and foreign interest rates are taken as explanatory variables:

$$\frac{x_{t+\tau} - x_t}{\tau} = \sum_j \alpha_j d_j + \beta_1 x_t + \beta_2 i_t^* + \beta_3 i_t + \varepsilon_{t+\tau} \quad (2)$$

where $x_{t+\tau}$ and x_t are the exchange rate (log) deviation from the central parity at times $t+\tau$ and t , respectively. In the case of the 1987 bands, the variables d_j denote the dummies for the subperiods defined by the realignment on 7 April suggested by Esaka (2000).

Figures 9 and 10 show the expected rate of realignment and the 90% confidence intervals for the periods in 1980 and 1987, respectively. For 1980, expectations of

reevaluation are confirmed as increasing in May and June, as well as in December, following the announcement early that month by the Ministry of Finance that it would increase the quotas available to Japanese and foreign banks for swapping Dollar borrowing into Yen. This announcement gave more scope for capital inflows and improved market sentiment for the Yen. For their part, the expected rates of realignment greater than zero are obtained in August. For 1987, the method enables us to reject the hypothesis of null expectations of a realignment during the more critical stages of the period studied. Thus, it clearly reflects both the expectations of revaluation in March, May-June and August-September, and the expectations of devaluation in July and October. These results are very similar to those obtained by Esaka (2000, p. 123).

[Figures 9 and 10, here]

Lastly, the probability of non-realignment is obtained using a logit estimation. Here we have introduced the exchange rate, the distance to central parity and the interest rate differential as the explanatory variables. The selection of these variables stems from our interest in estimating credibility with high frequency data.

Assuming there is no credibility when $y_t=0$ and that when $y_t=1$ there is credibility, we use the drift-adjustment method to design the logit model. As explained above, the method estimates the 90% confidence interval. If both limits of the interval were simultaneously greater than, or less than, zero, the agents would have expected realignments with 90% confidence and $y_t = 0$, otherwise $y_t = 1$.

[Figures 11 to 16, here]

The probabilities estimated from the exchange rate, distance to central parity and the interest rate differential are illustrated in Figures 11, 12, and 13 for the 1980 period, and Figures 14, 15, and 16 for the 1987 period. As can be seen in Figure 11, when the exchange rate is used as the explanatory variable in estimating the probability of non-realignment, May 1980 could be classified as a low-credibility month. When distance to central parity is used (Figure 12) credibility is reduced in August and at the beginning of December 1980. Figure 13 indicates an increase in credibility from August until December, with some marginal credibility losses in October and December.

Figure 14 shows that, when the exchange rate is used, the probability of non-realignment would have been lower at the end of February and in March 1987, as well as at the end of July and the early days of August of that year. Figure 15, constructed using the distance of the exchange rate to the central parity, would suggest that the probability of realignment is higher during May and in the latter part of July. The use of the interest rate differential confirms the lower credibility in March, as can be seen in Figure 16, as well as suggesting marginal credibility losses in July.

5. Concluding remarks

In this paper we have attempted to identify implicit exchange rate regimes for the Yen/Dollar. This particular rate was chosen because it is generally viewed as being the most flexible of all the exchange rates in the world economy and hence confirmation

of the existence of such regimes has major empirical implications, given the widespread comparative use made of the rate.

To that end, we apply different statistical approaches proposed in the literature to data covering the period 1971-2003. Our results indicate that implicit regimes other than a free-floating one appear to exist. An approach based on the use of exchange rate data to find *de facto* bands suggests such regimes are present, but shows sensitivity to small variations in the methods used. A more realistic method considers central bank interventions in the exchange markets in order to study the intention (and efficacy) in maintaining the bands within certain limits.

Two statistical tests using exchange rate data only were applied to complement the results obtained from the Reinhart and Rogoff approach. These tests analysed the empirical relationship between the exchange rate and interventions and found that standard time-series techniques may not be ideally suited to the study of interventions and of exchange rate behaviour. A test of independence and a directional prediction test considerably restrict the implicit band regimes for the Yen/Dollar exchange rate. In the case of the Fed, the intention and efficacy of interventions are suggested for two subperiods: April-December 1980 and March-December 1987, the latter coinciding with the Louvre Accord.

To the extent that the market learns about the intentions behind central bank stabilizing interventions, an announcing hypothesis can also be considered. A study of the credibility of implicit bands is therefore undertaken for both subperiods mentioned above and several critical events are detected for the Yen/Dollar exchange. For the episode of implicit bands detected in 1980, all the indicators reflect a lack of credibility in June, August and December, while for the period identified around the Louvre Accord in 1987 there is evidence of credibility losses in May and June. For the remaining subperiods, the credibility indicators suggest a high degree of confidence by agents as regards the rate's evolution within the implicit bands. This, in turn, could be taken as further evidence supporting the existence of such implicit bands compromising the behaviour of the Fed and the Bank of Japan in exchange rate markets.

This paper has demonstrated the potential usefulness of a sequential procedure to detect implicit bands, taking into account both the dynamics of the exchange rate and the interventions of central banks. In our opinion, the results provided suggest that further consideration of this procedure for other exchange rates could prove a fruitful exercise.

From the empirical point of view, central banks should be more transparent when communicating their interventions in foreign exchange markets, even providing researchers with the actual data involved in these operations. Where this is not possible, extensive literature exists to suggest alternative, more realistic measures of interventions than the naïve change in foreign reserves [see, e. g., Quirk (1977), Dornbusch (1980), Gärner (1987) and Hodgman and Resek (1987)].

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Figure 1

Proportion of monthly variations. Bands of $\pm 1\%$

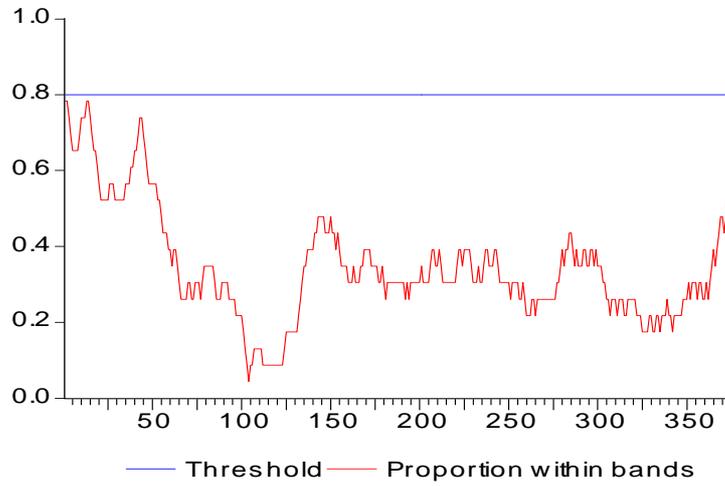


Figure 2

Proportion of monthly variations. Bands of $\pm 2\%$

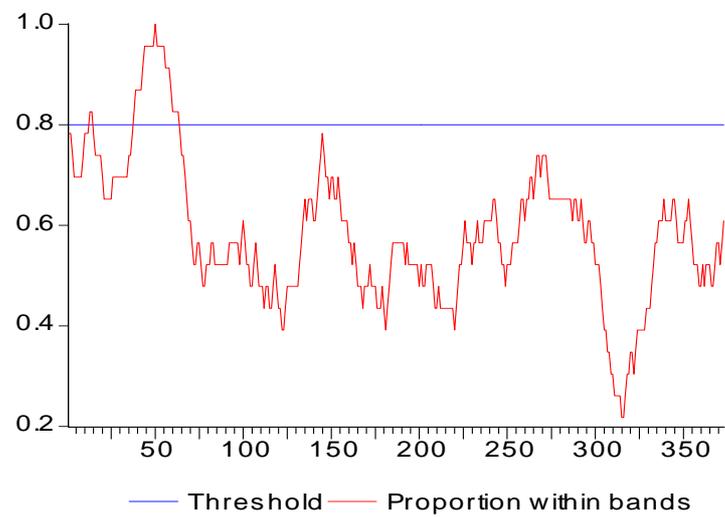


Figure 3

Test of the average monthly variations. Bands of $\pm 1\%$

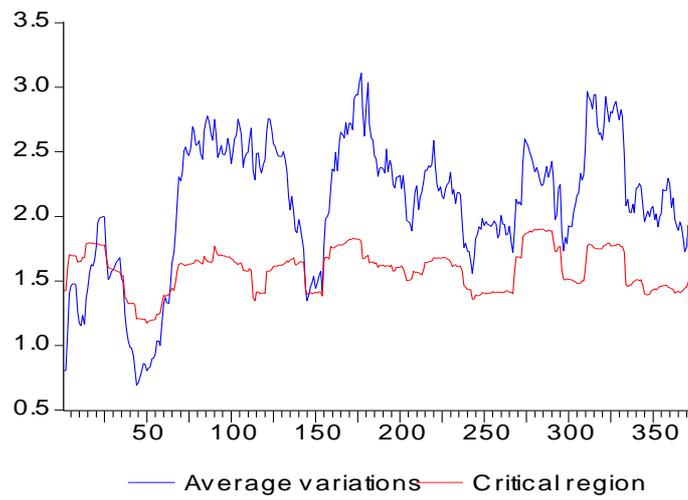


Figure 4

Test of the average monthly variations. Bands of $\pm 2\%$

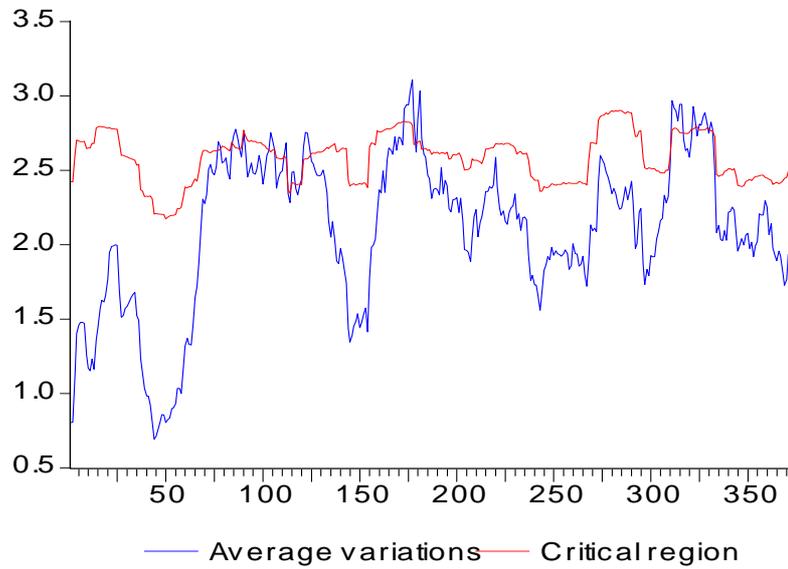


Figure 5

**Yen/Dollar exchange rate, implicit central parity and bands
(30 April 1980 to 31 December 1980)**

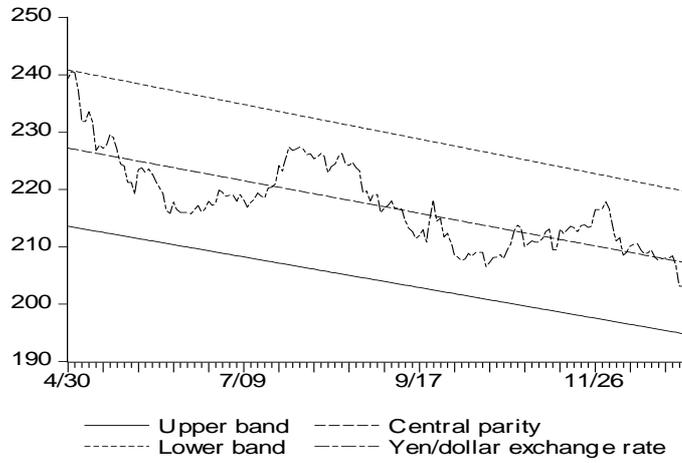


Figure 6

**Yen/Dollar exchange rate, implicit central parity and bands
(23 February 1987 to 18 October 1987)**

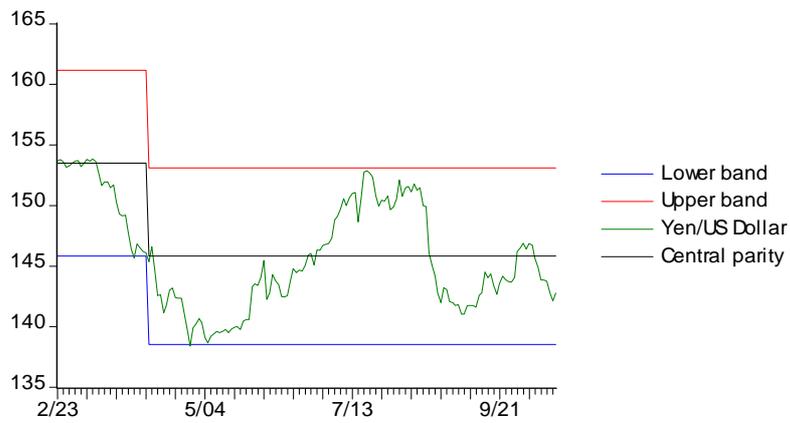


Figure 7

**Svensson's test. 100% confidence interval
(30 April 1980 to 31 December 1980)**

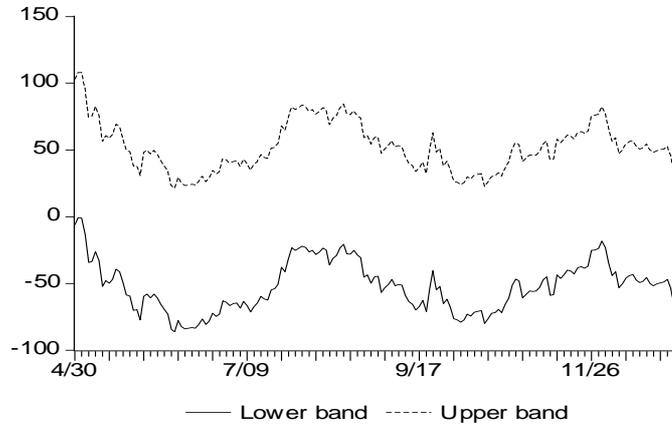


Figure 8

**Svensson's test. 100% confidence interval
(23 February 1987 to 18 October 1987)**

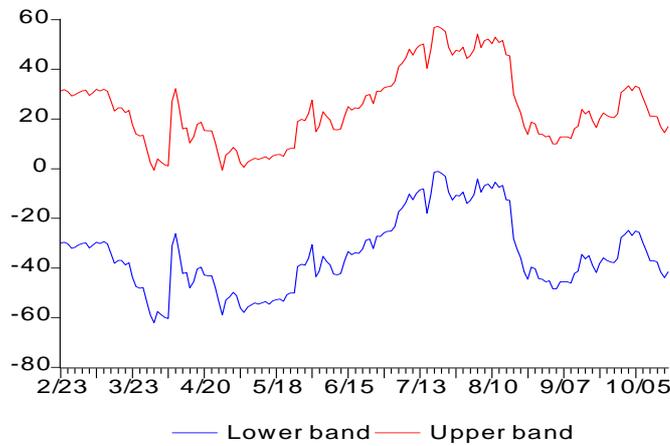


Figure 9

**Drift adjustment method. 90% confidence interval
(30 April 1980 to 31 December 1980)**

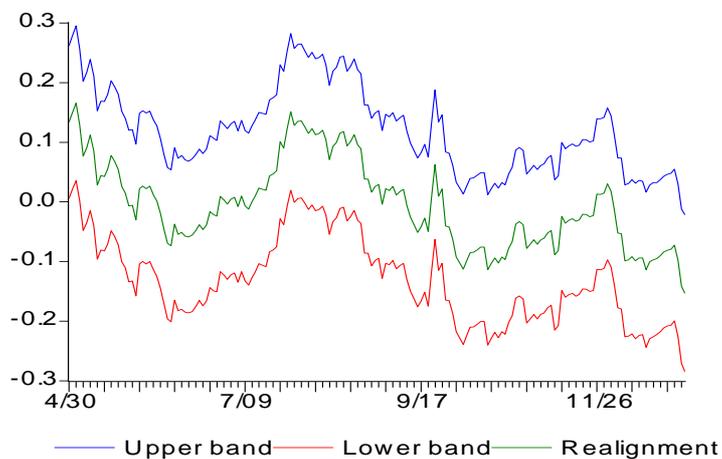


Figure 10

**Drift adjustment method. 90% confidence interval
(23 February 1987 to 18 October 1987)**

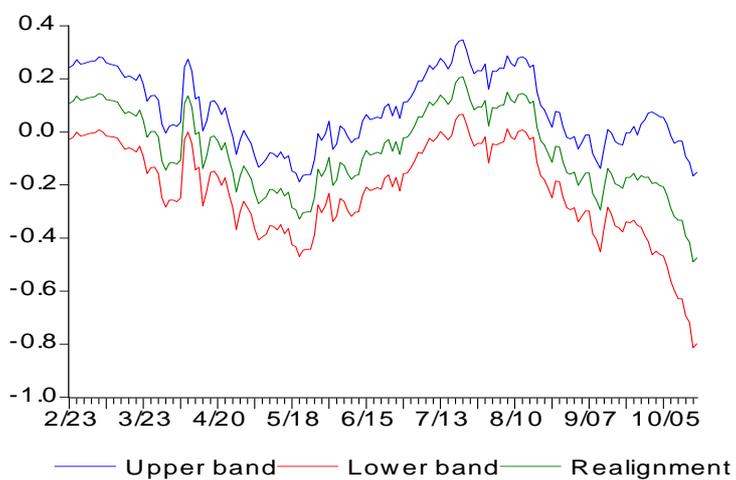


Figure 11

**Probability of non-realignment. Exchange rate variable
(30 April 1980 to 31 December 1980)**

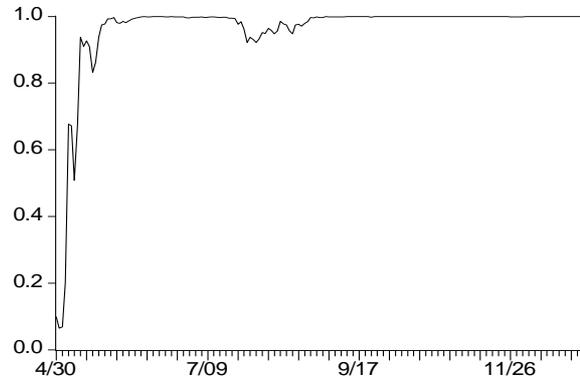


Figure 12

**Probability of non-realignment. Central parity variable
(30 April 1980 to 31 December 1980)**

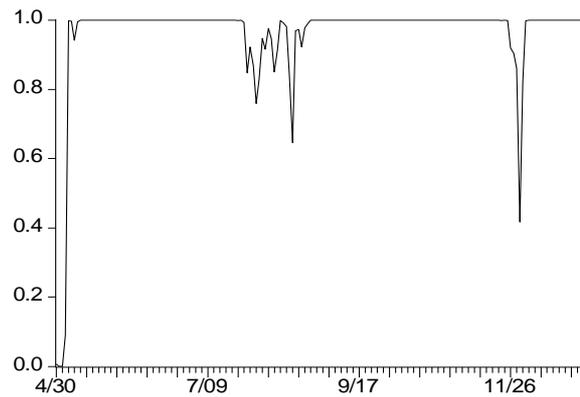


Figure 13

**Probability of non-realignment. Interest rate differential
(30 April 1980 to 31 December 1980)**

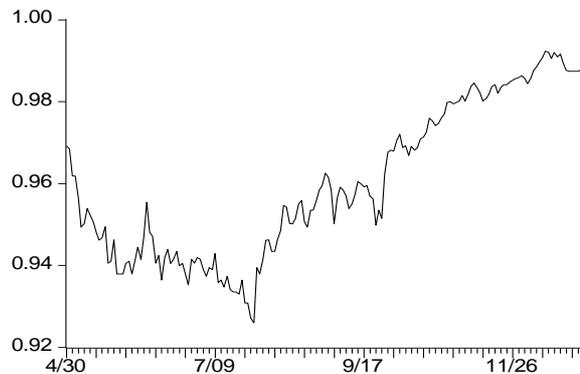


Figure 14

**Probability of non-realignment. Exchange rate variable
(23 February 1987 to 18 October 1987)**

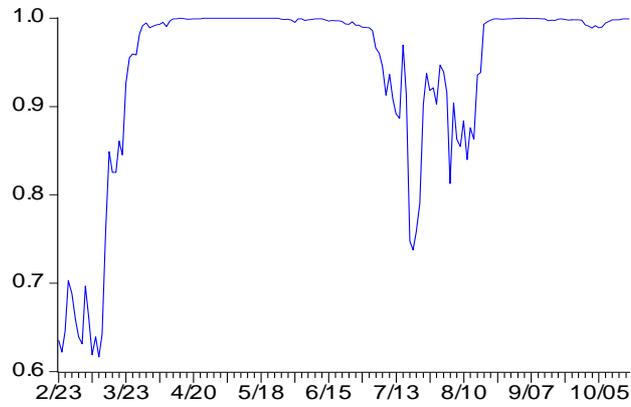


Figure 15

**Probability of non-realignment. Central parity variable
(23 February 1987 to 18 October 1987)**

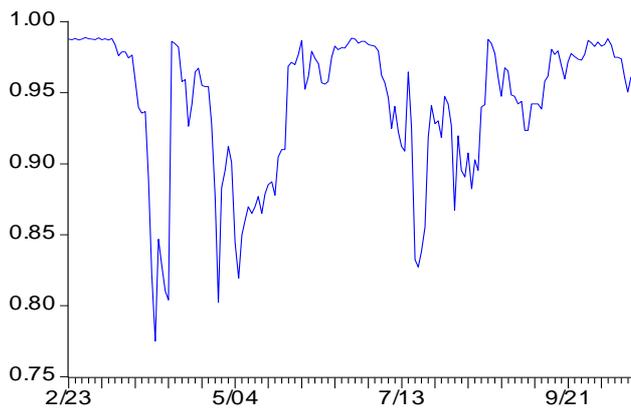


Figure 16

**Probability of non-realignment. Interest rate differential
(23 February 1987 to 18 October 1987)**

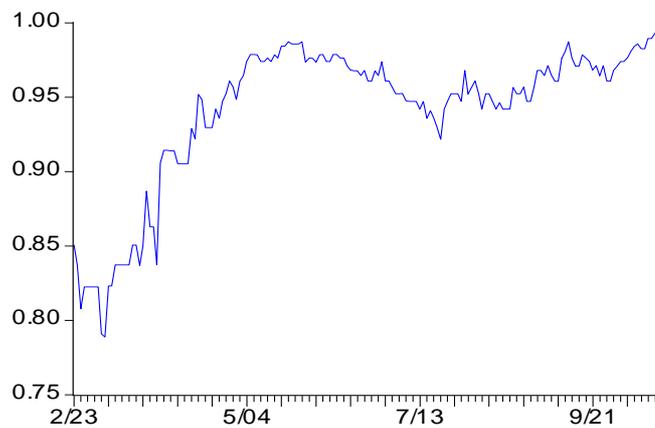


Table 1
Pesaran-Timmermann Test

Months	k-values (days)						
	1	5	10	20	30	40	60
Panel A: ex-post							
1980-Jan	1.35	0.89	-0.78	1.41	0.45		
1980-Mar					2.00	2.00	2.00
1980-Apr	3.03	2.27	1.73	1.13	1.48	1.48	1.48
1980-May	1.59						
1980-Jul	1.11	0.50	-0.13	1.01	1.75	2.52	2.52
1980-Aug	0.88	0.76	0.76	1.78	4.01	4.01	4.01
1980-Nov	2.44	1.89	3.62	-0.33	1.89	1.09	1.01
1980-Dec	-0.80				0.60	2.11	2.11
1981-Jan	1.20	2.25	-1.52	0.95			
1982-Oct	0.71	0.71	0.71	0.71	0.71	0.71	0.71
1987-Mar	1.98	3.02	3.02	3.02	3.02	3.02	3.02
1987-Aug	2.14	2.86	2.14	2.86	2.86	2.86	2.86
1988-Sep	0.71	0.71		0.71	0.71	0.71	0.71
1989-Apr	0.71	0.71		0.71	0.71	0.71	0.71
1989-May	1.50						
1989-Jun					2.00	2.00	2.00
1989-Jul	1.00						1.00
1990-Mar		1.41	1.41	1.41	1.41	1.41	1.41
Panel B: ex-ante							
1980-Jan	0.78	-1.81	0.45				
1980-Mar						2.00	2.00
1980-Apr	-0.43	-1.54					
1980-May	-1.26	1.59				-0.60	
1980-Jul	-1.26	1.75	1.75	2.52	1.75	-0.19	
1980-Aug	1.14	-0.54	-0.29				
1980-Nov	-0.63	0.92	1.09	-0.33			
1980-Dec	0.60	-0.40					-0.40
1981-Jan	-1.20	0.92	1.34	0.51			
1982-Oct		0.71	0.71		0.71	0.71	0.71
1987-Mar	0.66						0.43
1987-Aug	0.48	-0.65	2.09	2.86	2.86	2.09	
1988-Sep	0.71	0.71		0.71	0.71	0.71	0.71
1989-May	0.85	0.47	0.37	0.47	0.75	0.66	0.47
1989-Jun					2.00		

Note: the results for periods with Student-t close to 0.00 are omitted.

Table 2
Fisher Exact Test

Months	k-values (days)						
	1	5	10	20	30	40	60
Panel A: ex-post							
1980-Jan	0.36		0.92		0.64		
1980-Feb							0.75
1980-Mar			0.15				
1980-Apr	0.01	0.06		0.21		0.25	
1980-May	0.23				0.25		
1980-Jul	0.36	0.59		0.50	0.16	0.05	
1980-Aug	0.60	0.67	0.66	0.21	0.06	0.06	0.53
1980-Nov	0.16	0.25	0.08		0.25	0.50	
1980-Dec	0.99				0.77	0.22	
1981-Jan	0.30		0.98				
1982-Oct							
1987-Mar	0.25		0.12		0.12	0.12	
1987-Aug	0.11		0.11		0.03	0.03	0.03
1988-Sep							
1989-Apr							
1989-May							
1989-Jun							
1989-Jul							
1990-Mar							
Panel B: ex-ante							
1980-Jan	0.50		0.64				
1980-Feb		0.75	0.75			0.75	
1980-Mar							
1980-Apr	0.85						
1980-May	0.93	0.24				0.92	0.77
1980-Jul	0.93	0.42	0.16	0.05	0.16	0.83	
1980-Aug	0.47	0.99					
1980-Nov		0.58	0.50				
1980-Dec	0.78	0.99					0.99
1981-Jan	0.96	0.40	0.29	0.81			
1982-Oct							
1987-Mar	0.75						0.87
1987-Aug	0.63		0.14		0.81	0.14	
1988-Sep							
1989-May	0.59	0.83	0.89	0.83	0.67	0.72	0.82
1989-Jun							
Note: P-value given in brackets. The results for periods with probability of non-rejection of null hypothesis are close to unity							