ERMII anchoring on the way to EMU: more notional than real effects ?

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Abstract:

The switch to EMU meant both the death of the ERM-I and the birth of a new system. The so-called ERM-II is intended to provide an institutional framework for organising the links between the Euro and the currencies of the European Union members which do not take part of EMU from 1st January 1999 on.

A lot remains to be known however about the precise features that such a mechanism has until now recovered. Besides the Danish and the Greek adhesions to the ERM-II, the number and the name of other participating countries is still an open issue, notably as regards Sweden and the UK, and more generally, in the perspective of EU enlargement, regarding pre-accession countries. In particular, with respect to the latter issue, it seems important to evaluate whether this exchange rate mechanism can be related to a genuine management of the exchange rate or whether it should be considered as an empty shell (except from an institutional viewpoint). Indeed, the opportunity of a shadow anchoring strategy (to the ERMII) for the pre-accession economies would partly depend on the stabilising properties (if any) of such a mechanism

In order to infer on this issue, we assess the empirical evidence on ERMII and rely on daily spot rates to evaluate whether the market has held precise views about potential parities of the *Ins* and *Outs* currencies from January 1997 to December 2000. We thus have to disentangle two sub-periods during which different interdependent factors could have influenced market expectations.

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According to the results, the behaviour of the future *Ins* currencies can hardly be reconciled with the view that the ERM-II has been perceived by the market participants as a binding exchange rate mechanism. Things have been clarified somewhat since the mid-1999, given the monetary policy design in the future *Ins* countries. All in all, whether the ERM II proves to be more than a shadow exchange rate regime remains for the time being an open question.

Keywords: monetary union, exchange rate dynamics, transition, equilibrium value

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1.- Introduction

With the creation of EMU, it seems that the exchange rate question in Europe has shifted from the core to the periphery and, nowadays, the emphasis has to be put on the foreign exchange relationships between the *Ins* and the *Outs*. The set-up of EMU meant in this respect both the death of the European Exchange Rate Mechanism (ERM-I) and the birth of a new system. The so-called ERM-II is intended to provide an institutional framework for organising the links between the Euro and the currencies of the European Union members which do not take part of EMU from 1st January 1999 on. Countries involved in the EU-enlargement process are also concerned by the ERMII in so far as they have to define a specific exchange rate strategy in the perspective of their future adhesion to the monetary union.

A lot remains to be known however about the precise features that such a mechanism has until now recovered. To focus only on European Union countries, anad even if the Danish and the Greek authorities have decided to let their currencies participate in the ERM-II[1], the number and the name of other participating countries is still an open issue, notably as regards Sweden and the UK. Furthermore, and as reaffirmed in the Amsterdam Treaty (June 1997), the requirements for being eligible to enter the Euroland do not concern only the stabilisation relative to the Euro, the new anchor currency of the ERM-II which replaced the German Mark. With respect to the exchange rate criterion, the emphasis may also be put on the convergence of the candidate's inflation rate to the EMU standard since direct inflation

[1] Short assessments are reported on the legal aspects of this adhesion and the setting-up of ERM-II by the European Central Bank [1998]. See also Kenen [1996] and Wyplosz [1996] for a thorough examination of the issues raised by EMU.

targeting may contribute to exchange rate pegging through the manipulation of the domestic interest rates[2].

All in all, such a vague schedule suggests a variety of alternatives regarding the behaviour of the currencies of the (current and next) *future Ins* countries. How could the latter be anchored to the Euro within this mechanism and what would this imply for their exchange rate paths before and after their entering into the ERM-II, especially if the countries concerned were worried about qualifying for EMU?

More generally, in the perspective of EU enlargement, it seems important to evaluate whether this exchange rate mechanism can be related to a genuine management of the exchange rate or whether it should be considered as an empty shell (except from an institutional viewpoint). Indeed, the opportunity of a shadow anchoring strategy (to the ERMII) for the pre-accession economies would partly depend on the stabilising properties (if any) of such a mechanism (see Le Cacheux [1997] and Wyplosz [1996]).

The answering to these questions depends on whether the new ERM may be regarded as a truly effective mechanism regarding exchange rate stability. It also involves considering in this perspective not only the policies that the monetary authorities would undertake to this objective but also the expectations that the market may formulate on its achievement and on the possibly retained parities.

[2] It has been reluctantly agreed at the Verona meeting in April 1996 that membership in ERM-II would be *voluntary* only. This was a concession made to the British position, according to which exchange rate stability could be achieved only by adopting consistent inflation targets (Kenen, 1996). See also the divergent proposals of Persson & Tabellini [1996], Gros [1996], and Spaventa [1997].

This study attempts to make an empirical assessment concerning the form that these expectations could take (and have taken) before and after the creation of EMU. Section **2** gives an overview of the European exchange rate issue covered by this study with a special focus on the May 1998 decision and its likely impact on the exchange rate dynamics during the final months of the transition to EMU and thereafter. The institutional features of the ERM-II are also briefly specified. The econometric method used to extract the exchange rate market expectations from the observed paths of the spot rate of the concerned currencies against the Euro is developed in section **3**. Results are discussed in section **4**, and section **5** concludes.

2.- From ERM-I to ERM-II: a mere reincarnation?

Contrary to what had been predicted or feared[3], there were neither speculative attacks launched against the *Ins* currencies during the last months of the transition phase, nor huge tensions on the European exchange rates, even after the final parity grid adjustment for the Irish currency[4]. The definite success of this kind of exchange rate fixing process relies heavily on what the market thinks about the potential parities which could be retained as the eventual anchors. While this issue has mattered during the final months of the transition to EMU, exchange rate developments in the periphery of the Euro zone are likely to be cast in the same framework as for the *Ins*. At least two reasons provide a rationale for this parallel.

[3] On the rationale of the possible speculative pressures and its links to the institutional framework adopted for the switch to the *Euro*, see De Grauwe [1998] and Obstfeld [1997].
[4] On the economic grounds for the stabilising properties of this convergence process and of the announcement of the central parities, see Begg *et al.* [1997], and De Grauwe et *al.* [1999]. Alberola *et al.* [1999] offer a broader view on the exchange rate misalignments on the eve of the switch to EMU.

(1) First, an *Out* currency has to participate in the ERM-II to allow for the qualification of the issuing country for EMU. Therefore, one question concerns the parity level (*vis-à-vis* the *Euro*) at which the potential currency candidate would like to enter into this new structure. Setting the bilateral central rates to their new *Euro* parities[5] for the former members of the ERM-I (the Danish Krone and the Greek Drachma) is only one part of the answer. The other pertains to whether the market found this choice relevant or not, which might have led it to revise its expectation.

(2) Second, if a *future In* succeeds in qualifying for EMU, to what extent could the conversion rate for its currency against the *Euro* differ from the prevailing parity within the ERM-II? Given the record of the Drachma, realignments are still allowed within the new structure. One may ask how they might affect the behaviour of the current exchange rates (prior to and following their implementation), and how the monetary authorities would accommodate or prevent them (through interventions[6]).

These issues would be however of limited relevance if the ERM-II schedule were not a truly binding mechanism, but an empty shell. Indeed, a wide spectrum of exchange rate strategies would be consistent with the legal framework built at Amsterdam. In particular, the new ERM should provide a relevant benchmark for assessing the fulfilment of the exchange rate criterion to qualify for the EMU (Greece at the time being) while it does not prevent *Opting Outs*[7] from being part of it.

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[5] It had been partly so as the indeterminacy of the Euro rates in terms of the *In* or *Out* currencies prevented from knowing the central rates in the ERM-II with certainty before the switch to EMU. Market rates in ECUs at the launch date of the Euro have also played a role (De Grauwe, 1998).

[6] According to the statutes of the ERM-II, the latter are automatically triggered at the margins, but may be stopped if they impede the pursuit of the Central Banks' primary objectives.

[7] Like Sweden, United Kingdom and to a lesser extent Denmark which "*have decided that membership in the Common Market does not require giving up monetary independence*" (Wyplosz, 1996).

The operational features share a lot in common with those of the defunct ERM-I, except for the bilateral status implied by the Euro. Wide fluctuation margins, while limiting the impact of large competitive depreciations[8], cannot be seen as a strong commitment towards exchange rate discipline. Some countries (like Denmark) may decide to join the system with a narrower than officially allowed currency band and/or to make strong monetary policy statements in order to convince the market of their willingness to meet the EMU standards for an imminent adhesion.

Thus, given the range of alternatives, it is useful to assess the extent to which a *genuine* management of the exchange rate (or any constraint upon it) could have actually resulted from membership to this system and, thus, whether "the rules of the game" laid down at Amsterdam have been, until now, more notional than real. This critical analysis will not be restricted to the pioneering ERM-II members however. This system might have also influenced the path followed by other *Outs* currencies in so far as it could represent an attractive shadow anchoring mechanism[9]. Moreover, this allows one to test whether the impact of the switch to the EMU on monetary cohabitation in Europe has been contingent upon a new ERM.

In the following we analyse these issues by evaluating whether the market has held precise views about potential parities of the *Ins* and *Outs* currencies from January 1997 to December 2000. We thus have to disentangle two sub-periods during which different interdependent factors could have influenced market expectations.

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[8] Reminiscent of the huge 1992-93 crises, they aimed at removing irrelevant speculative pressures.

[9] In the following of the study, Outs countries do not include pre-accession countries (unknown at the time where the ERMII was created). But the shadow anchoring strategy would be a relevant one also for the latter – at different stages of the enlargment process.

On the one hand, the revealing of the qualified countries for EMU in May 1998 could have acted as a trigger event since then the convergence process of the bilateral rates of the *Ins* currencies towards their announced conversion ratios might have contrasted with the *Outs'* dynamics which could have been already governed by the expectations regarding future adhesion to the ERM-II. Furthermore, this coexistence could have also played a role by itself as the convergence process of the *In*s could have affected the behaviour of the *Out*s, given the determination issue of the external value of the Euro at the date of the changeover.

On the other hand, from January 1st 1999 on, the setting-up of the ERM-II could have exerted a twofold influence on the *Outs* exchange rates depending on their official anchoring to the European currency within such an arrangement.

3.- Extracting market expectations from the spot exchange rate dynamics

Our main working hypothesis is that the dynamics of the bilateral exchange rates of the concerned (*Outs*) currencies *vis-à-vis* the Euro can be modelled as a specific diffusion process. Let thus assume that the exchange rate is subject to the following stochastic differential equation:

$$\begin{cases} dS(t) = \beta[\alpha - S(t)]dt + \sigma dW(t) \\ S(t_0) = S_0 \end{cases} \qquad (1)$$

S(t) refers to the number of domestic currency units for one Euro at date *t* (with starting value S_0). *W(t)* is the standard Wiener process. α is the stationary value to which the spot rate is expected to converge in the long run. While positive, β is the *mean-reversion* parameter. The

latter measures the intensity with which S(t) is attracted by α. Put differently, β is the speed of convergence towards *the implicit (or shadow) parity* α. □ amounts to the instantaneous volatility of the spot rate.

The solution for the current exchange rate can be derived from (1). For any $t > t_0$, we obtain the expression of an Ornstein-Uhlenbeck process:

$$S(t) = S_0 e^{-\beta(t-t_0)} + \alpha\left[1 - e^{-\beta(t-t_0)}\right] + \sigma\left(\int_{t_0}^{t} e^{-\beta(t-\tau)} dW(\tau)\right) \qquad (2)$$

Both econometric and theoretical rationales may be provided to support this analytical framework.

From an economic point of view, the Ornstein-Uhlenbeck process assumption may provide a relevant and flexible theoretical basis for the exchange-rate path under a target-zone regime or in a managed float system (Froot & Obstfeld, 1991). In this type of model, fundamentals are subject to a mean-reversion drift which transmits itself to the exchange rate. Such a dampening force may result directly from central bank interventions at the limits and/or within the band. For example, Lindberg & Söderlind [1994] cast their analysis of the Swedish Krona's behaviour in an extended target zone model. The mean-reversion property may be also an indirect consequence of the implementation of some stabilising policy based on instruments like interest rates to ensure the convergence of inflation and/or output to their desired targets.

To some extent, this kind of exchange rate regime may not have been so different either from the operating of the ERM-I since the widening of the fluctuation margins in August

1993, or from the regime which the other non-participating currencies were subject to. Moreover, we want to investigate further on the features of the ERM-II about which little is yet known. Facing this problem, a cautious attitude leads us to adopt a rather flexible specification for the exchange rate process which could account for the singularities of each currency[10].

Accordingly, nothing is imposed concerning the presence and the level of the implicit parity value in the course of the estimation. The attraction point is undetermined whenever β is not significant from zero. If the mean-reverting component vanishes, the exchange rate follows a random walk as expected under a pure float regime with efficient markets.

From an econometric point of view, we are left with the difficulty of specifying an appropriate structure for the exchange rate dynamics. Pitfalls encountered by numerous approaches, which used, or even abused, unit-root tests to detect mean-reversion, suggest evaluating the former through the differential equation assumed to describe the exchange rate path (Ball & Roma, 1992, 1994).

In this respect, a very general specification for the exchange rate motion could have taken into account the peculiarities of the European target zones: reflection at both edges of the band, the risk of parity realignments, and conditional heteroskedasticity (induced in principle by the convergence process towards EMU). However, no consensus has yet emerged about the relevant way of incorporating the aforementioned features of the

[10] Moreover, it is obvious from equation (2) that the features of each Out currency rate against the Euro are inferred through the observation of the path followed by the corresponding bilateral rate, no matter what external developments could have been. But there are good reasons to consider both versions of the ERM as "hub and spokes" systems (according to the European Commission's terminology), and so to focus on bilateral monetary links (especially for the ERM-II).

exchange rate dynamics[11]. Furthermore, substantial bias is likely to be introduced in the estimates given the absence of an analytical solution for such a rich, though highly questionable, specification and, as such, requires deriving a discrete-time expression for estimation purposes.

More generally, looking at the stabilising properties of the ERM and the equilibrium parities perceived by market participants (in the prospect of a membership to the Euroland) seems a quite specific approach by focusing on the spot exchange rates dynamics only. Indeed, several studies concentrated on forward exchange rates (De Grauwe *et al.*, 1997), interest rates differentials (De Grauwe, 1996) or derivative products[12] (Söderlind, 2000) to extract market expectations about future exchange rate developments. Others tried to find a "fundamental" equilibrium exchange rate, even if it seems fanciful given the theoretical debate and the unconvincing evidence (Flood & Rose, 1995).

Without denying the interest of such approaches, and because the comparison of their relative merits goes far beyond the scope of this study, we wish rather to propose an operational procedure aiming, among other things, at providing a crude indicator of the bilateral conversion rate which would be consistent with the perceived "long-run" market equilibrium.

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[11] Ball & Roma [1994] observe the limits from the official parity grid[11], notwithstanding the institutional features (Honohan, 1993), and the recent findings (Chen, 1995, Labhard & Wyplosz, 1996). The endogeneity of the realignment probability and width (Bertola & Svensson, 1992), their time-varying nature (Pentecôte & Sénégas, 1997), the revaluation/devaluation asymmetry (Bertola & Caballero, 1993), and the underlying jump process (Perraudin, 1990) are still under debate. Finally, the growing family of ARCH-type processes illustrates the difficulty to find the ideal model.

[12] The latter method often assumes that the underlying spot (exchange or interest) rate follows the explosive path of a geometric Brownian motion. Such a behaviour is at odds with both the convergence process towards the EMU and the institutional design of the new ERM.

The next step thus consists of implementing a maximum likelihood estimation directly on equation (2) (see appendix **1**). The only requirement is regularly spaced exchange rate quotations over the sample period. Given closed-market days, the original daily quotes are interpolated to generate a "continuous" data set. Estimation of the discrete version of process (2) is done in an iterative way in order to account for the time-variability of the parameters. Two procedure are involved: the first one is the usual recursive scheme by which one quote is added step by step; the other is based on a sixth-month window of observations[13] which moves over the whole sample period. The latter method dampens the memory effect of the former which could blur, to a significant extent, the time behaviour of the implicit parities.

We focus the potential candidates for future entry into the EMU and thus for possible (if not already current in the period considered) ERM-II members. Among these four *future Ins*, two took part of the ERM-I (the Danish Krone, DKK, and the Greek Drachma, GRD), one left it (the British Pound, GBP) while the last currency has never belonged to it (the Swedish Krona, SEK). For comparison purposes, we consider two *Ins*: the Irish Pound (IEP) and the Finnish Markka (FIM). Two *Out*s are also studied, although with very different statuses: the Dollar (USD) plays a major role together with the Euro (EUR) in the stability of international monetary system; the Norwegian Krone (NOK), while not a member state of the European Union, may be influenced by the policies of its Scandinavian neighbours (Gerlach [1997]).

Daily bilateral spot exchange rate data (from the Pacific Exchange Rate Service Retrieval Interface of the British Columbia University) run from January 2nd, 1997 to December 30th, 2000. Since bilateral quotations against the Ecu were rather indicative until January 1st, 1999,

[13] The window width influences the size and significance of the mean reversion and volatility parameters, but it has a limited impact, if any, on the long term attraction value of the exchange rate.

Euro rates are obtained from the cross-product of German Mark market rates in terms of the considered currency with the irrevocable conversion rate of the German currency in terms of Euro. Thus, the exchange rate *dynamics* should not be altered by this change in currency denomination[14]. Although they cannot be considered as true spot rates like those observed since 1999, we think that this choice preserves consistency of the estimates throughout the whole sample and their comparability over selected sub-samples.

4.- Monetary cohabitation on the way to EMU

First of all, the estimates over the whole sample period should be compared with those obtained for sub-periods, especially before and after the implementation of the Euro. One may then ask whether official commitments to specific regimes have had any influence on private market expectations which may have led to distinct exchange rate dynamics. It is possible to know to what extent the switch to EMU, and the corresponding change in the ERM configuration, has modified the behaviour of spot rates, given the attitude of the countries concerned towards the Euroland.

Next, if noticeable changes were observed in the behaviour of the bilateral current exchange rates under study, it may be helpful to examine whether and how the former have been taken into account by the market. We thus analyse how the new stance of monetary cohabitation has been progressively learned by private investors, given official announcements.

[14] For example, the Danish Krone market rate against the Euro is given by $(DKK/DEM)_t x (DEM/EUR)^*$ at day *t*. Thus, until the EMU, the evolution of the Euro exchange rate of a currency mimics its observed path against the

4.1. Exchange rate regimes shifts and spot rate dynamics: was there ERM-II effect?

Results from estimation of process (**2**) are reported for all bilateral rates against the Euro in table **A1** (appendix **2**). No close relationship appears between exchange rate dynamics and the regime which is officially maintained by the monetary authorities.

Under the ERM-I, the stochastic process followed by the Finnish Markka resembled to those associated with the British Pound and the US Dollar against the Euro. The strength of the mean-reversion component is significant and similar for these three rates. Thus, an officious and discretionary leaning-against-the-wind strategy seems to produce the same effects as those implied by a pre-announced commitment to a specific rule. Moreover, the convergence speed is not significant in the Drachma case, while it is the highest for the Danish Krone, suggesting that multilateral exchange rate agreements may be subjected to national practices.

Because the magnitude of instantaneous volatility seems to depend on the level of the underlying exchange rate, the first column of table **A1** shows *normalised* volatility coefficients for all Euro rates and over the different sample periods ($\hat{\sigma}/\hat{\alpha}$ in table **A1**). The currencies can be split into two groups: FIM, IEP, DKK, and GRD are characterised by a low level of normalised volatility, *i.e.* less than 6%, while GBP, NOK, SEK, and USD show greater variability. However, it remains unclear whether this threshold would help to distinguish between the various foreign exchange systems. This trigger value seems also to change over

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German Mark. Since January 1999, its dynamics has to be analysed for itself.

time, since a general decrease in normalised volatility estimates can be observed from table **A1**.

The first line of table **2** below reports, for each currency, the percentage of deviation of the estimated shadow parity (*Shadow1* over January 1997-December 1998, and *Shadow2* over January 1999-December 2000) from the corresponding official level (*Parity*), except for the US Dollar for which deviations are measured on the basis of a one-to-one conversion rate. The identity constraint between the two former parities is tested and t-statistics are reported in italic below the estimates. In the case of the Drachma, the second sub-period is split according to the date of its ultimate parity adjustment (January 17th, 2000).

Table 2: Comparisons of the estimated shadow values with the official parity

Currency	Shadow1/Parity	Shadow2/Parity	Shadow2/Parity*
FIM	0,03% *0,05*	-	
IEP	-1,28% *-0,62*	-	
DKK	-0,45% *-2,47*	-1,10% *-53,34*	
GRD	-7,90% *-1,69*	-5,74% *-5,72*	-2,33% *-2,23*
USD*	12,00% *9,33*	-6,81% *-1,40*	

N.B.: The 5% critical value for the tests is ±1,96 given the degrees of freedom at hand.

The results indicate that the underlying long-run (market) equilibrium parities may differ noticeably from the announced official central rates, especially under very flexible regimes like the wide target zone for the Drachma and the apparent floating system for the Dollar before EMU. The behaviour of the Greek Drachma and Irish Pound share common features since their implicit parities have initially diverged noticeably from their central rates before undergoing a moderate under-valuation following their last "technical" realignment.

Table **3** (below) shows the extent to which the setting of the new European Exchange Rate Mechanism with the Euro as anchor might have modified the main parameters describing the behaviour of future-*Ins'* and *Outs'* currencies spot rates. For each of them, the first line of figures reveals the relative change in every parameter estimates, while the second is the associated test statistic under the null of identical mean-values in the two sub-periods.

Table 3: Relative change in parameters following the switch from ERM-I to ERM-II

Currency	Shadow value	Convergence speed	Volatility
DKK	**-0,66%**	**480%**	**-32%**
	-5,10	6,59	-5,85
GRD	1%	136%	**-20%**
	0,33	1,11	-2,25
GBP	**-9%**	-33%	-2%
	-5,37	-0,97	-0,59
SEK	-6%	**392%**	**-23%**
	-0,80	2,07	-5,80
NOK	-5%	**553%**	**-34%**
	-0,58	2,51	-5,97
USD	**-17%**	**-65%**	5%
	-5,28	-2,26	1,35

N.B.: Assuming again Normality distribution, the same critical values as above apply.

The statistically significant decrease in instantaneous volatility is often associated with a significant positive stimulus in the convergence process, while variations in shadow parities reveal the weakness of the Euro against almost all other currencies. But the magnitudes of such variations differ considerably among the exchange rates.

As a possible candidate for EMU and a member of the ERM-II, the DKK/EUR spot rate has seen its volatility reduced by a third and its mean-reverting force strengthened around five times. This is in accordance with the renewed announcement of the Danish authorities to peg firmly her currency to the Euro (through the official adoption of a narrow fluctuation band).

This commitment has also been accompanied by a significant appreciation of the Danish Krone as suggested by the movement in the shadow long-run value reported above.

But these movements can hardly be related to the membership of the Danish currency to the new ERM. As illustrated in table **3**, two *Out* currencies, namely the Swedish and Norwegian Krona, exhibit the same pattern. This supports the idea that foreign exchange stabilisation may result either from an active (and credible) policy of exchange rate targeting (as in Denmark) or an equivalent strategy directly based on the inflation rate (as in Sweden). Results also suggest that there still remain close regional monetary relationships between the Nordic countries. Norwegian Krona's dynamics strictly follows its Swedish counterpart. It is therefore difficult to conclude that the observed changes in the Danish currency path derive from the enforcement of the new ERM rather than from the protracted links to its Scandinavian partners.

Concerning the Greek participation in the ERM-II as a prerequisite for joining the Euroland, it seems to have only significantly dampened the variability of the GRD/EUR spot rate (by a fifth compared with its previous level). Although substantial, the corresponding increase in the convergence speed estimate is not statistically significant. This evidence may receive two conflicting interpretations. It may be argued that private market participants have already incorporated the new monetary stance in Europe into their expectations in order to determine the spot market rate such that the dynamics of the former was left unchanged. Alternatively, one may conclude that the last European monetary reforms have had a limited impact on the former current rate. Further examination is thus needed.

The results also confirm how hesitant the first steps of the Euro were on the international scene. Its behaviour against the Dollar is marked by a five percent increase in volatility

(while not statistically significant), a (significant) lower mean-reverting force (reduced by two thirds) toward a (near significant 20 percent) depreciated shadow value. It looks as if the stabilisation of European currencies against the Euro has been at the expense of greater variability between the Euro and the Dollar. This could reflect the relative "benign neglect" attitude on the behalf of the authorities in both sides of the Atlantic Sea because of the distinct priority level assigned to price stability and the lack of synchronisation in their business cycles.

4.2. *Market learning about official statements and commitments*

We will now make use of the iterative estimation procedures in order to capture some of the features of the interaction -suggested *infra*- between the market participants and the monetary authorities in the determination of the *Outs* exchange rate dynamics.

For this purpose, the 6-month gliding estimates of the various parameters of interest are presented on the figures **1** to **8** (Appendix **3**). The implicit parity derived from the spot rate behaviour is plotted against the official central rate for each currency against the Euro in the upper part. The associated 95-percent confidence interval shows whether the discrepancy between the two reference values is significant. The estimated speed of the convergence implied by the OU motion is illustrated in the middle part. As stressed earlier, mean-reversion requires a significant and strictly positive value of β: the higher the latter, the stronger the attraction force on the current rate. To complete the picture, variations in the estimated instantaneous volatility of each spot rate, measured by its standard deviation over the sample window, are reported on the bottom part.

4.2.1. Expectations before joining a pre-announced exchange rate regime

Three questions may be addressed here. Does the announced participation to a given exchange rate system produce the same transitional dynamics for each currency concerned? Does the shift to a specific regime mean a particular type of transitional dynamics of the current exchange rate? In both cases, does the market take the official statements into account, and how is it reflected in the spot rate?

Adhesions to the old and the new ERM can firstly be assessed. Both the experiences of the Greek Drachma and the Danish Krone should be instructive since they behaved differently towards the monetary unification process. Greece decided to join the ERM-I on March 14th, 1998, just a few months before adhering to the ERM-II, whereas Denmark is a long-standing member of the European system.

During the last weeks preceding the Greek entry into the ERM-I, a dramatic acceleration occurred in the convergence speed (multiplied ten times) of the GRD/EUR spot rate toward a shadow (medium-run) value with respect to which the chosen central parity (in May 1998)[15] was clearly undervalued; meanwhile it became more volatile (figure **1**). However, no similar shift in either parameter is apparent before its entry into the ERM-II. The underlying parity stays far away from its official value; it also shows much greater instability and is estimated with less precision in the second half of 1998. By contrast, the Danish decision to join the ERM-II is not preceded by any significant change in the convergence speed of the DKK/EUR rate, although its shadow value seems to move gradually closer toward the official target such that both coincide by the end of 1998 (figure **2**).

The former two currencies share the common feature of a big downward jump in their instantaneous volatility by the end of July 1998. Given the 6-month window of observations used for estimation, such a breakdown in the volatility path suggests that the announcement in May 1998 did partly remove the uncertainty about the future conversion rates at the time of the changeover to the single currency. Furthermore, this seems to have contributed to the stabilisation of the DKK/EUR rate around this central parity without requiring sustained official interventions to strengthen the mean-reversion effect. This may be interpreted as

evidence of the credibility attached by the market to EU central bankers' decision a few months ago.

However, a similar reduction can be noticed in the estimated volatility of the two *Ins* currencies at the same time (see fig. **3** and **4** for the Irish and Finnish cases respectively). As with the above *Outs*, their variability is about half of their former level. The influence of official announcements on the spot rate volatility seems thus to depend more on what is believed by the market than on the alleged institutional changes in the exchange rate system.

Things take a different course as far as the other two parameters are concerned. The convergence speed tends to accelerate during the ultimate phase of transition to the EMU, although sooner and stronger in the Irish case than in the Finnish one. The shadow parities of the *Ins* remain remarkably stable and close to their announced conversion rates after the resolution taken by the European Commission. Before that, a substantial part of the uncertainty about the underlying equilibrium exchange rate already vanished together with a gradual decrease in the spot rate volatility.

It is however doubtful that the official statement in May 1998 succeeded in putting an end to the strong linkages between *Ins* and *Outs*, whatever the regime under which they were placed or expected to be put. On the one side, the Irish Pound (fig. **3**) and the Pound Sterling (fig. **7**) show similar volatility trajectories, with convergence speeds of comparable magnitudes (although rarely significant) and shadow equilibrium values close to their corresponding (official or officious) central rates during the months preceding the launch of the Euro. On the other side, similar evidence is found among the Nordic currencies (FIM,

[15] This dynamics has also to be associated with a sharp jump in the spot exchange rate.

DKK, NOK and SEK, see fig. **4**, **2**, **5**, and **6** resp.). Their estimated instantaneous volatility doubled from September to December 1998. This shift was accompanied by a significant mean-reversion effect on the DKK and FIM spot rates (somewhat stronger on the latter) which seems to have contributed to smooth the path of the shadow parity. The Norwegian and Swedish spot rates show a rather different behaviour: the estimation algorithm often diverged in the absence of an attraction force. This result may reflect the reactions of the monetary authorities with respect to their own official commitments.

A final parallel may be drawn between the Greek (fig. **1**) and the Irish records (fig. **3**) regarding their common experience with an ultimate realignment before joining EMU. The volatility of the two currencies lowered gradually more than a year before their irrevocable peg to the Euro, meaning also that it started to diminish before the official decision was taken. The most striking feature lies in the linear trend followed by the estimated shadow GRD/EUR parity since the mid-1999, so that it induces an almost perfect match between the final estimated shadow parity and the conversion rate of the Greek currency within EMU. This tendency is unaffected by the so-called "technical" realignment on January 17th, 2000, which is clearly at odds with the discontinuous path of the Irish Pound.

All in all, it is hard to conclude that the spot exchange rate smooth dynamics observed before the introduction of the Euro has been induced by some "honeymoon effect" of official commitments on private market expectations.

4.2.2. Expectations following new official commitments

The entry of the Hellenic currency into the ERM-I is associated with a small increase in the variability of the parameters which seems to dampen only slowly in the early months of 1999 (fig. **1**). It looks as if the market tries to identify the strategy which was actually followed by the authorities at the time of their anchoring to the European system. The discrepancy between the market exchange rate and the implicit parity value on the one hand, and the official central rate within the ERM-II on the other hand (fig. **1**) suggests that the game between these two "players" did not end as the setting-up of the new arrangement took place.

The stable path of the Danish Krone under the new mechanism contrasts with that undecided of the Drachma (fig. **2**). The substantial and prolonged acceleration in the convergence speed confirms the official wish to engage in a closer peg to the Euro within the ERM-II than under the ERM-I. But such an exchange rate stabilisation is not exclusive to the EMU candidates. The Norwegian and Swedish currencies (fig. **5** and **6)** follow their Danish neighbour (fig. **2**), even though to a lesser extent in terms of convergence speed and instantaneous volatility.

If we now consider the two last *Outs* currencies, the GBP and USD (fig. **8**) behaviours reflect more a floating exchange rate than a managed one. Given the low significance of the mean reversion parameter, it remains to be known whether the monetary authorities did intervene on the foreign exchange market at all[16]. The official statements of the central banks suggest a negative answer. In addition, should the attraction points be significant, these long-term projections by the market would not be fundamentally opposed to the daily behaviour of the spot rates. However, the pattern of these implicit values is often more

uneven (and scattered with sharp breaks) than those of the market rates, raising the possibility of no well-defined underlying dynamics for these currencies even over a given sub-period.

Two arguments may be put forward to explain the previous and diverse empirical findings. First, it may be argued that the convergence process of the *Ins* bilateral spot rates towards the announced conversion ratios (from May to December 1998) has put the weight of its own adjustment on the peripheral currencies. To some degree, a trade-off might have prevailed between the stability of the former and the variability of the underlying dynamics of the *Out*s currencies. As mentioned earlier, the legal constraints on the external value of the *Euro* at the time of the switch to EMU could have had an impact on the behaviour of the *Opting-Outs* currencies (but part of the ECU basket) in order to prevent any instability on the *Ins'* side.

Second and more importantly, the shift in the monetary strategies that the *Out*s countries could have implemented after the May 2nd, 1998 announcement could have influenced the path of the related foreign exchange rates. In order to qualify for EMU, the latter could have decided, for a while, not to adopt an explicit exchange rate target (in the form of a strict anchoring towards the Euroland) so that this new deal could have been foreseen by the market. As it stands, the Amsterdam requirements restrain the member countries from using the budgetary weapon and, in this perspective, some exchange rate flexibility may be welcome to preserve a room of manoeuvre. The English and Swedish records suggest moreover that inflation targeting can make a credible alternative to an exchange rate peg as a

[16] This is also suggested by the dubious evidence on the Swedish Krona (Gerlach, 1997).

monetary strategy[17]. In this respect, the contrasting empirical evidence obtained for the latter currencies on the one hand, and the Danish Krone on the other hand has certainly something to do with the various options in the monetary policy framework which have been pursued in these economies, and which are partly reflected in countries' attitudes with respect to ERM-II membership[18].

5.- Conclusion

According to the empirical results from this study, the behaviour of the future *Ins* currencies can hardly be reconciled with the view that the ERM-II has been perceived by the market participants as an enforcing exchange rate framework (even from the 1st of January 1999 on). The instability of the coefficients in the underlying dynamics we have examined could signal their transitory nature and suggests that the market was uncertain about the future status of the *Outs* currencies during the first months after the implementation of the ERM-II. Things have been clarified somewhat since the mid-1999. Monetary policy design in the future *Ins* countries could partly explain these developments. Furthermore this mixed empirical evidence militates in favour of a regularly renewed assessment of the parameters of the dynamics involved. All in all, whether the ERM II proves to be more than a shadow exchange rate regime remains for the time being an open question.

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[17] Insightful analyses of the exit out of the ERM-I strategy followed by the English monetary authorities can be found in Villa [1995] and Cobham [1997].

[18] Figures **9** and **10** (not reported here) also reveal that the spot rate lies close to its corresponding moving shadow value as the former converges to the retained conversion rate against the Euro for four of the eight currencies (IEP, FIM, GRD). Instead, the current market rates of the remaining *Out* currencies show much greater variability and diverge more often from their recursively estimated parities than the *Ins* or future *Ins*. The

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Appendix 1: Maximum likelihood estimation of an Ornstein-Uhlenbeck process

Consider equation (2) at two different dates, s and t, such that $t = s + h$ with h>0. As it stands, the underlying discretization scheme requires equidistant dates of observation. From the properties of the Wiener process, it ensues that:

$$S(t) - e^{-\beta \cdot h} S(t-h) - \alpha\left(1 - e^{-\beta h}\right) \sim N\left(0, \sigma\left(\frac{1 - e^{-2\beta h}}{2\beta}\right)^{0.5}\right) \qquad (3)$$

For a given realisation $S(n)$ of the process, $n \in N$, the corresponding innovation is:

$$u(n) \equiv S(n) - e^{-\beta h} S(n-h) - \alpha\left(1 - e^{-\beta h}\right) \qquad (5)$$

such that:

$$u(n) \sim N\left(0, \sigma\left(\frac{1 - e^{-2\beta h}}{2\beta}\right)^{0.5}\right) \qquad (6)$$

Thus, the log-likelihood function may be expressed as follows:

$$l = \sum_{n=2}^{N} l(n) = -\frac{N-1}{2}\ln(2\pi) - \frac{N-1}{2}\ln\left(\sigma^2\left(\frac{1 - e^{-2\beta h}}{2\beta}\right)\right) - \frac{1}{2\sigma^2\left(\frac{1 - e^{-2\beta h}}{2\beta}\right)}\sum_{n=2}^{N} u^2(n) \qquad (7)$$

MV estimators of the parameters of interest are obtained through the minimization of the former function. Before the implementation of the optimisation algorithm, data were interpolated by a cubic spline with a discretisation step equal to $h = \frac{1}{365}$.

Appendix 2: Estimation results

Table A1: Results from Maximum Likelihood

Exchange rate	Sample period	Parameters	Estimates	Std. err.	t-stat.	p-val.	Dg. Free.	Log-like.
FIM/EUR	*97/01/01-98/12/31*	a	5,827	2,494	2,34	0,020	739	2148
		b	5,947	0,030	200,32	0,000		
4,3%		σ	0,258	0,018	14,33	0,000		
IEP/EUR	*97/01/01-98/12/31*	a	1,643	1,235	1,33	0,184	739	3459
		b	0,777	0,016	47,84	0,000		
5,6%		σ	0,044	0,002	20,48	0,000		
GRD/EUR	*97/01/01-00/12/31*	a	1,307	0,612	2,14	0,033	1481	-2079
		b	332,033	8,280	40,10	0,000		
5,7%		σ	18,804	1,407	13,36	0,000		
	97/01/01-98/12/31	a	1,247	1,068	1,17	0,243	739	-1113
		b	328,783	16,704	19,68	0,000		
6,3%		σ	20,766	2,457	8,45	0,000		
	99/01/04-00/12/31	a	2,944	1,885	1,56	0,119	737	-944
		b	332,823	3,548	93,81	0,000		
5,0%		σ	16,626	0,834	19,94	0,000		
DKK/EUR	*97/01/01-00/12/31*	a	10,932	2,970	3,68	0,000	1481	4715
		b	7,470	0,009	820,86	0,000		
2,6%		σ	0,196	0,010	19,36	0,000		
	97/01/01-98/12/31	a	12,173	3,751	3,24	0,001	739	2234
		b	7,494	0,014	550,51	0,000		
3,1%		σ	0,231	0,016	14,06	0,000		
	99/01/04-00/12/31	a	70,597	11,963	5,90	0,000	737	2574
		b	7,445	0,002	4784,30	0,000		
2,1%		σ	0,157	0,007	21,12	0,000		

Nota Bene: *Std. Err.* measures the sample standard error associated with the corresponding estimate.
p-val. stands for the marginal probability value of rejecting the nul hypothesis of no significance.
Dg. Free. represents the degrees of freedom.
Log-like. shows the maximum of the (log-)likehood function.

Table A1 (continued):

Exchange rate	Sample period	Parameters	Estimates	Std. err.	t-stat.	p-val.	Dg. Free.	Log-like.
GBP/EUR	*97/01/01-00/12/31*	a	1,757	0,741	2,37	0,018	1481	6562
		b	0,643	0,017	36,96	0,000		
8,7%		σ	0,056	0,001	39,35	0,000		
	97/01/01-98/12/31	a	5,055	1,968	2,57	0,010	739	3277
		b	0,680	0,008	87,53	0,000		
8,3%		σ	0,056	0,002	28,51	0,000		
	99/01/04-00/12/31	a	3,401	1,391	2,45	0,015	737	3282
		b	0,621	0,013	46,31	0,000		
8,9%		σ	0,055	0,002	26,77	0,000		
SEK/EUR	*97/01/01-00/12/31*	a	2,498	1,796	1,39	0,165	1481	2953
		b	8,730	0,134	65,13	0,000		
7,3%		σ	0,634	0,021	30,46	0,000		
	97/01/01-98/12/31	a	1,305	2,783	0,47	0,639	739	1393
		b	9,127	0,977	9,35	0,000		
7,8%		σ	0,708	0,033	21,74	0,000		
	99/01/04-00/12/31	a	6,424	2,103	3,05	0,002	737	1586
		b	8,570	0,060	142,84	0,000		
6,4%		σ	0,547	0,022	25,09	0,000		
NOK/EUR	*97/01/01-00/12/31*	a	2,586	1,928	1,34	0,180	1481	3018
		b	8,250	0,126	65,47	0,000		
7,4%		σ	0,607	0,032	18,90	0,000		
	97/01/01-98/12/31	a	1,315	2,907	0,45	0,651	739	1388
		b	8,581	0,997	8,60	0,000		
8,3%		σ	0,713	0,052	13,72	0,000		
	99/01/04-00/12/31	a	8,585	2,883	2,98	0,003	737	1695
		b	8,170	0,036	229,93	0,000		
5,8%		σ	0,473	0,023	20,71	0,000		
USD/EUR	*97/01/01-00/12/31*	a	0,901	0,632	1,43	0,154	1481	5684
		b	0,975	0,085	11,42	0,000		
10,3%		σ	0,100	0,003	38,14	0,000		
	97/01/01-98/12/31	a	5,545	2,070	2,68	0,008	739	2867
		b	1,120	0,013	87,06	0,000		
8,7%		σ	0,098	0,004	25,88	0,000		
	99/01/04-00/12/31	a	1,959	0,866	2,26	0,024	737	2818
		b	0,932	0,049	19,13	0,000		
11,0%		σ	0,103	0,004	28,09	0,000		

Figure1

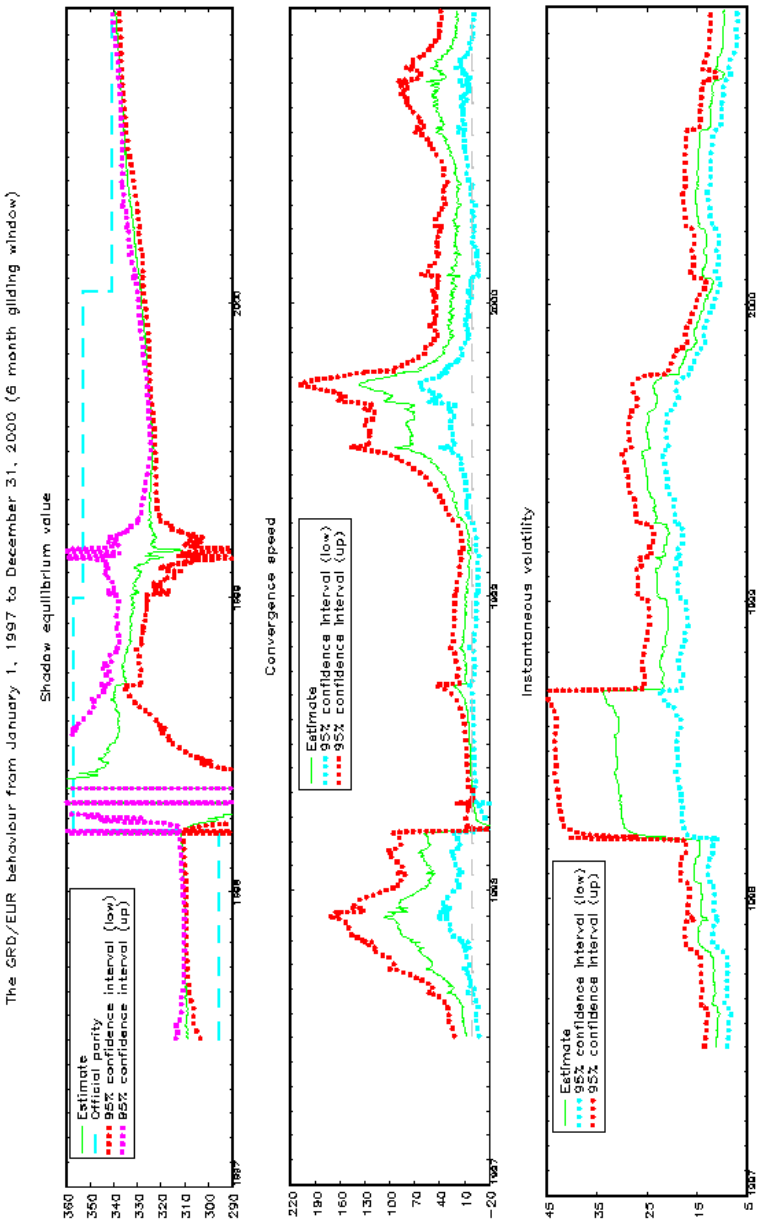

The GRD/EUR behaviour from January 1, 1997 to December 31, 2000 (6 month gliding window)
Shadow equilibrium value
Estimate
Official parity
95% confidence interval (low)
95% confidence interval (up)
Convergence speed
Estimate
95% confidence interval (low)
95% confidence interval (up)
Instantaneous volatility
Estimate
95% confidence interval (low)
95% confidence interval (up)

Figure 2

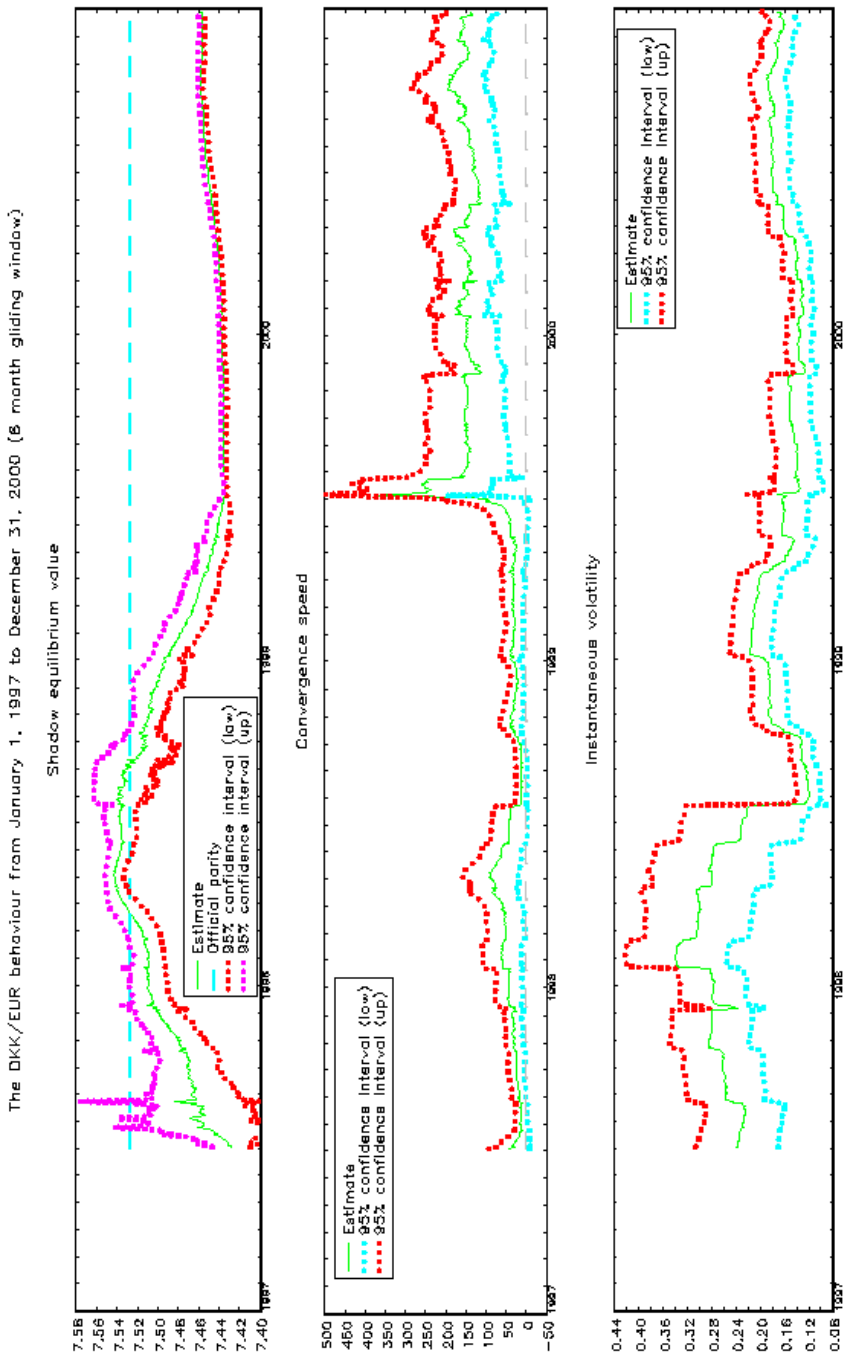

The DKK/EUR behaviour from January 1, 1997 to December 31, 2000 (6 month gliding window)
Shadow equilibrium value
Estimate
Official parity
95% confidence interval (low)
95% confidence interval (up)
Convergence speed
Estimate
95% confidence interval (low)
95% confidence interval (up)
Instantaneous volatility
Estimate
95% confidence interval (low)
95% confidence interval (up)

Figure 3

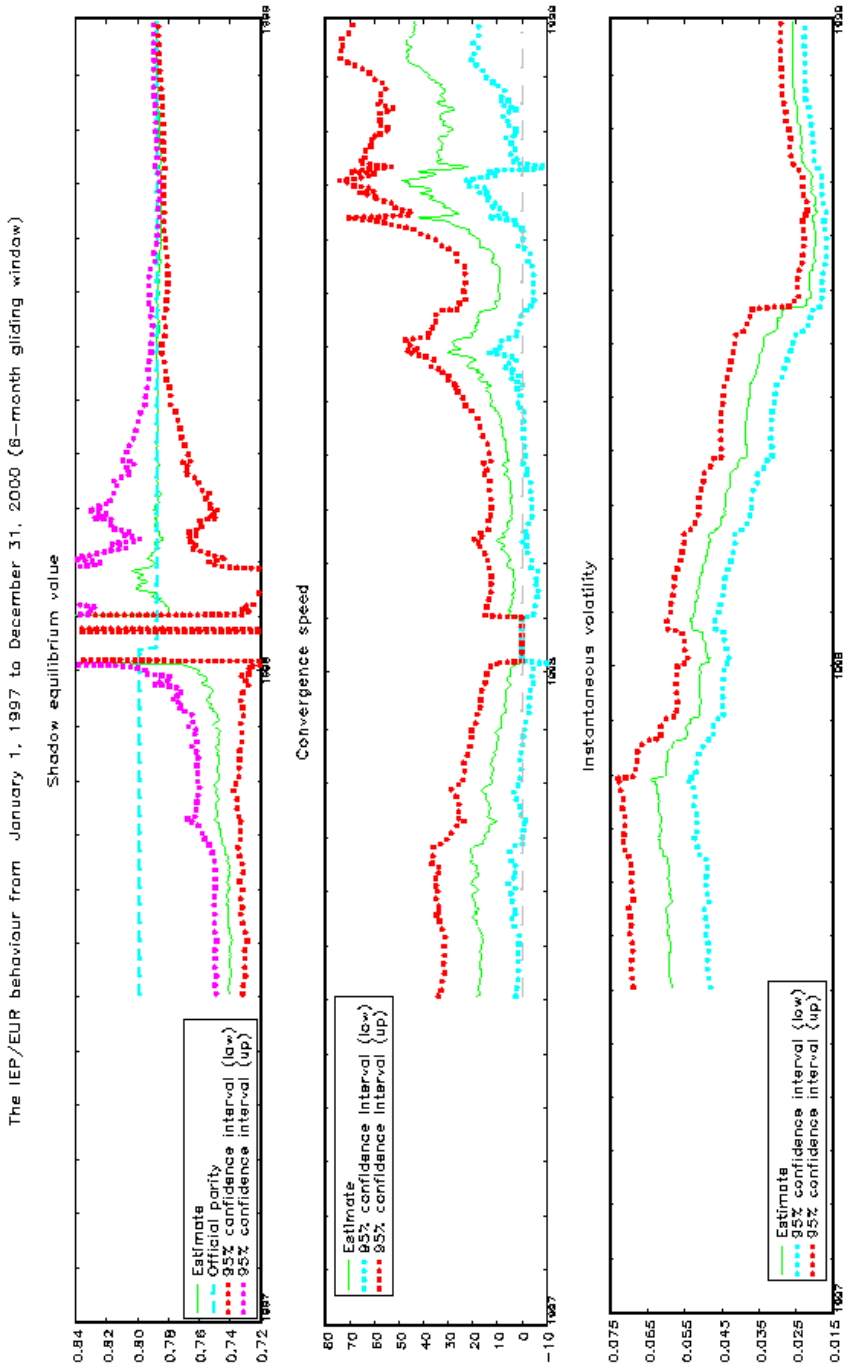

The IEP/EUR behaviour from January 1, 1997 to December 31, 2000 (6-month gliding window)
Shadow equilibrium value
Estimate
Official parity
95% confidence interval (low)
95% confidence interval (up)
0.84
0.82
0.80
0.78
0.76
0.74
0.72
1997
1998
Convergence speed
Estimate
95% confidence interval (low)
95% confidence interval (up)
80
70
60
50
40
30
20
10
0
-10
1997
1998
Instantaneous volatility
Estimate
95% confidence interval (low)
95% confidence interval (up)
0.075
0.065
0.055
0.045
0.035
0.025
0.015
1997
1998

Figure 4

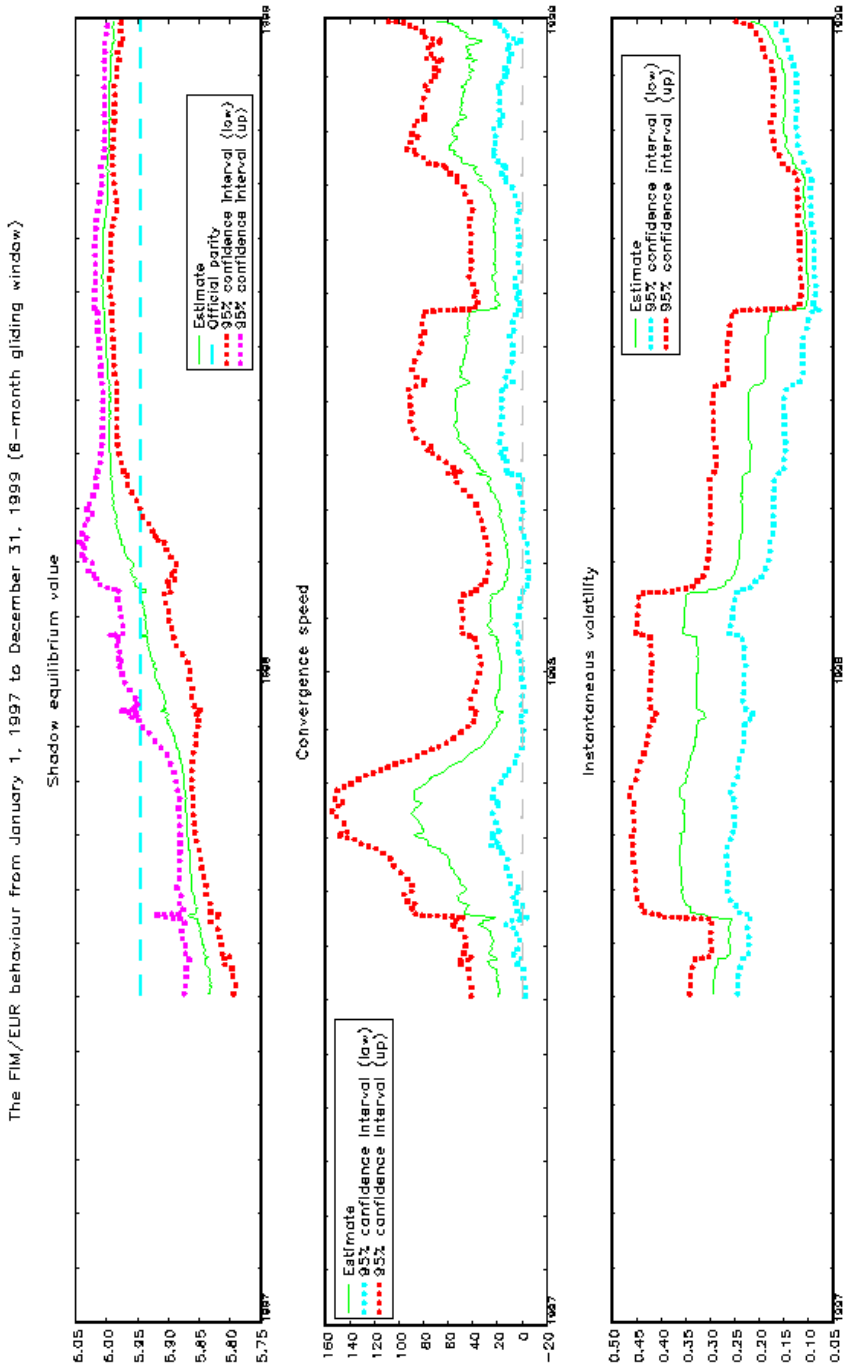

The FIM/EUR behaviour from January 1, 1997 to December 31, 1999 (6-month gliding window)
Shadow equilibrium value
Estimate
Official parity
95% confidence interval (low)
95% confidence interval (up)
6.05
6.00
5.95
5.90
5.85
5.80
5.75
Convergence speed
Estimate
95% confidence interval (low)
95% confidence interval (up)
160
140
120
100
80
60
40
20
0
-20
Instantaneous volatility
Estimate
95% confidence interval (low)
95% confidence interval (up)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05

Figure 5

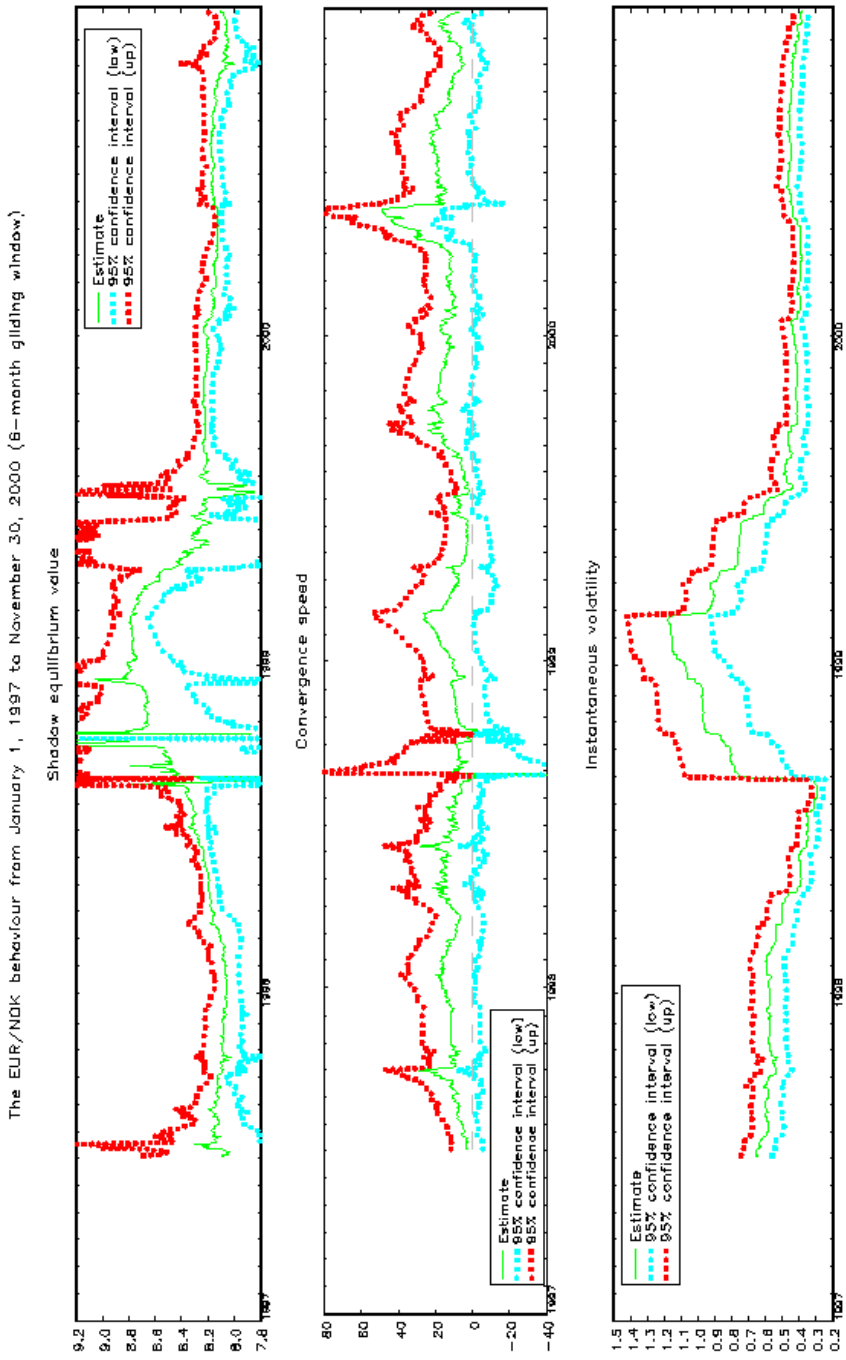

The EUR/NOK behaviour from January 1, 1997 to November 30, 2000 (6-month gliding window)
Shadow equilibrium value
Estimate
95% confidence interval (low)
95% confidence interval (up)
Convergence speed
Instantaneous volatility

Figure 6

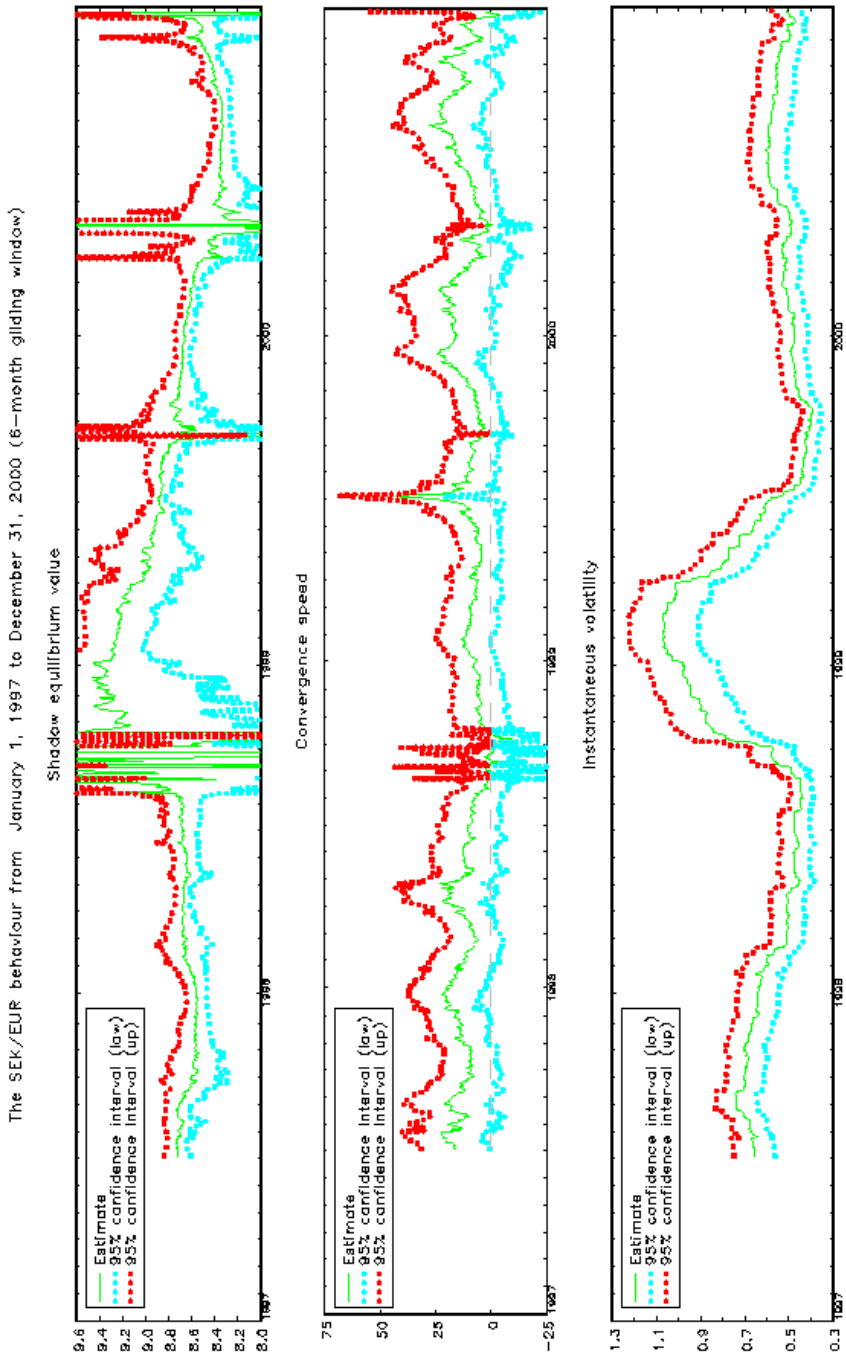

The SEK/EUR behaviour from January 1, 1997 to December 31, 2000 (6-month gliding window)
Shadow equilibrium value
Convergence speed
Instantaneous volatility
Estimate
95% confidence interval (low)
95% confidence interval (up)

Figure 7

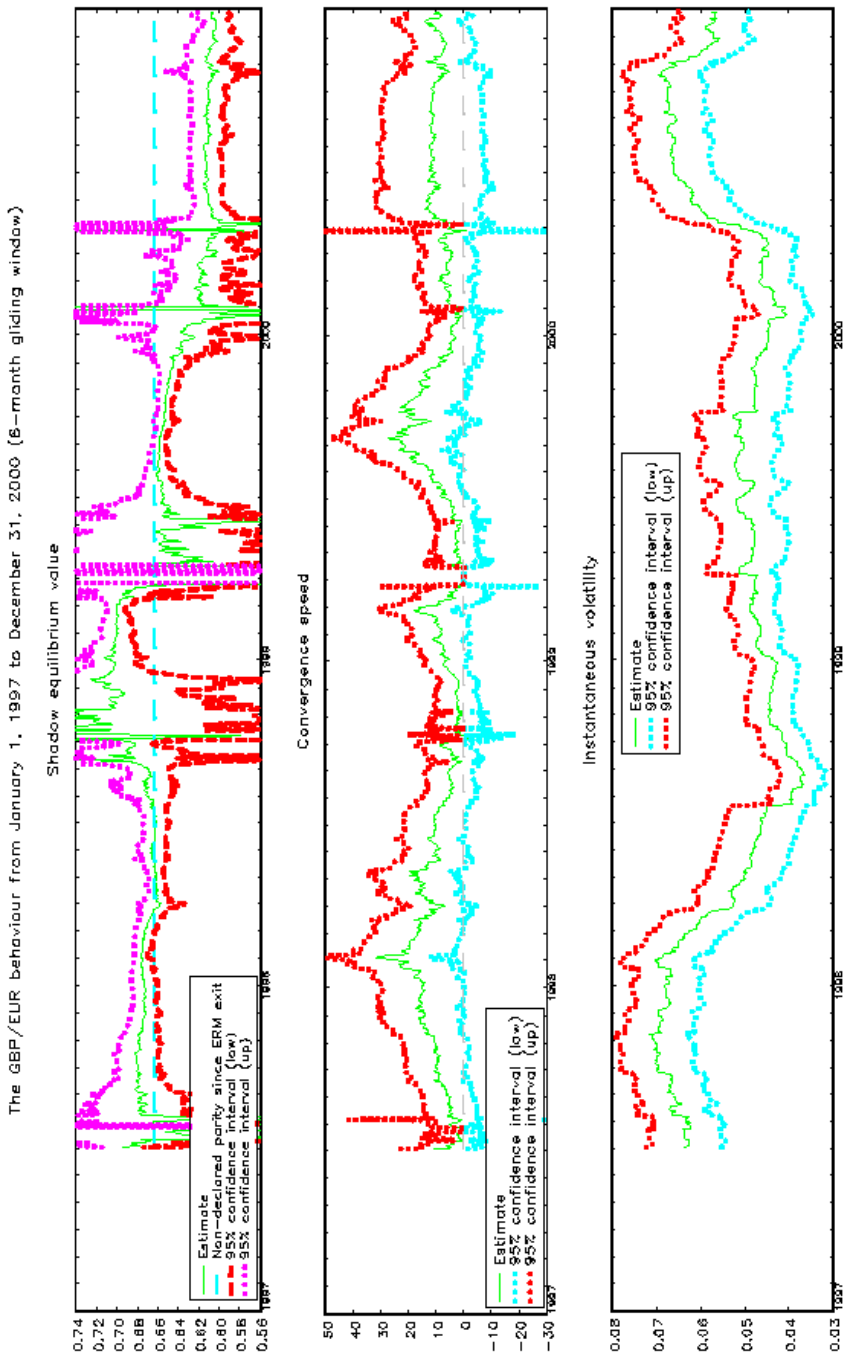
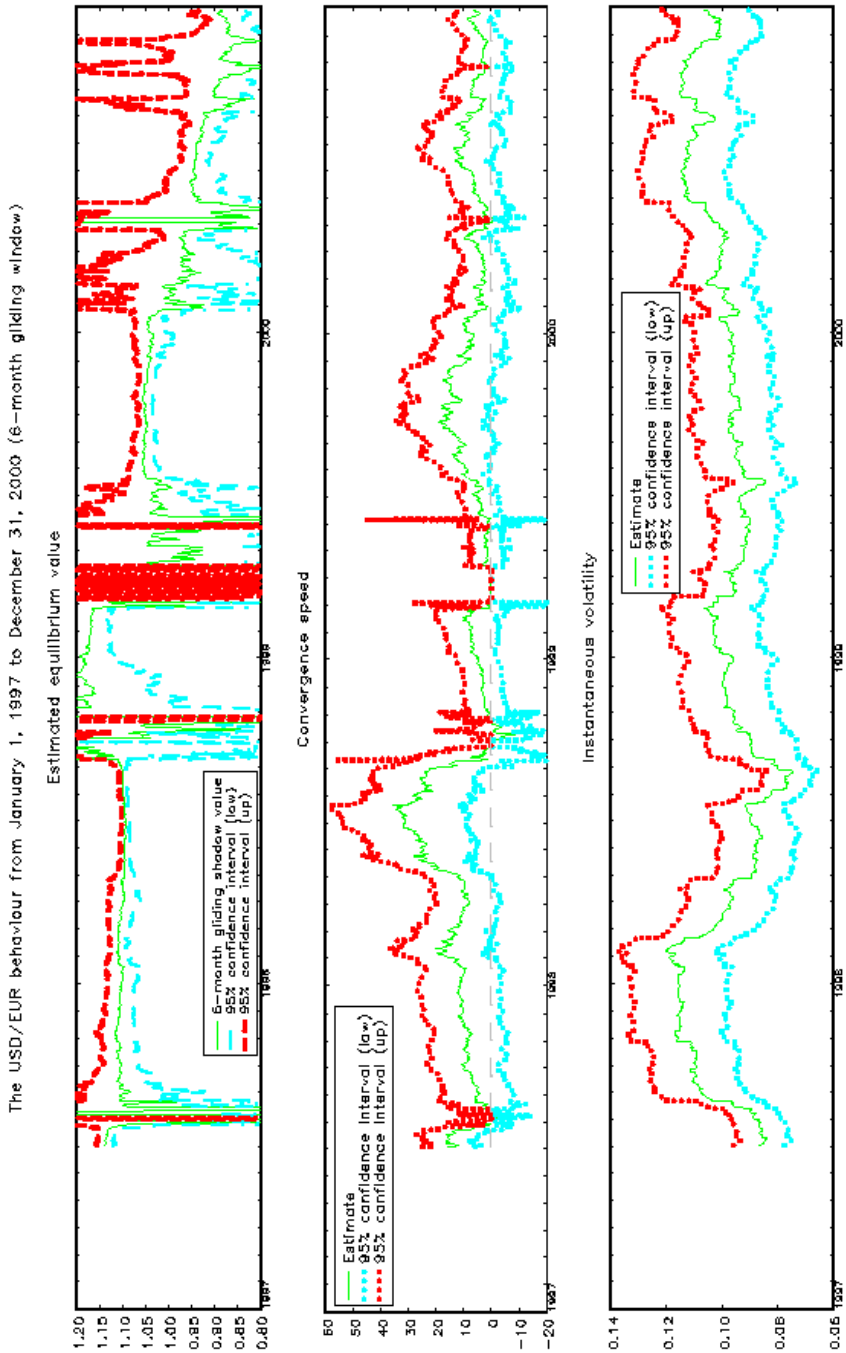

The GBP/EUR behaviour from January 1, 1997 to December 31, 2000 (6-month gliding window)
Shadow equilibrium value
Estimate
Non-declared parity since ERM exit
95% confidence interval (low)
95% confidence interval (up)
Convergence speed
Estimate
95% confidence interval (low)
95% confidence interval (up)
Instantaneous volatility
Estimate
95% confidence interval (low)
95% confidence interval (up)

Figure 8


The USD/EUR behaviour from January 1, 1997 to December 31, 2000 (6-month gliding window)
Estimated equilibrium value
6-month gliding shadow value
95% confidence interval (low)
95% confidence interval (up)
Convergence speed
Estimate
95% confidence interval (low)
95% confidence interval (up)
Instantaneous volatility
Estimate
95% confidence interval (low)
95% confidence interval (up)