Between Realignments and Intervention: the Belgian Franc in the European Monetary System

Kees G. Koedijk
University of Limburg

Phillip A. Stork
Erasmus University Rotterdam

Casper G. de Vries
Erasmus University Rotterdam

Follow this and additional works at: http://docs.lib.purdue.edu/ciberwp

http://docs.lib.purdue.edu/ciberwp/78

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact epubs@purdue.edu for additional information.
BETWEEN REALIGNMENTS AND INTERVENTION: 
THE BELGIAN FRANC IN THE EUROPEAN MONETARY SYSTEM

Kees G. Koedijk 
*University of Limburg*

Phillip A. Stork 
Casper G. de Vries * 
*Erasmus University Rotterdam*

94-001

* Casper deVries was a CIBER Visiting Professor at Purdue University in the Spring, 1994
Between Realignments and Intervention:
The Belgian Franc in the European Monetary System*

Kees G. Koedijk, Rijksuniversiteit Limburg
Philip A. Stork, Tinbergen Instituut Rotterdam
Casper G. de Vries, Tinbergen Instituut Rotterdam

July 1993

Abstract

We analyse the functioning of the Belgian franc in the European Monetary System between 1979 and 1991. A discrete time target zone model which captures the features displayed by the continuous time models is combined with intervention data provided by the Belgian central bank. Simple prediction formulas are derived to calculate one-week-ahead conditional probabilities on a realignment of the Belgian franc relative to the Deutsche mark. The devaluation probabilities are matched with the intervention data. We find support for the notion that Belgian intervention policy was a policy of leaning against the wind.

Mailing Address

Tinbergen Instituut
Oostmaaslaan 950
3063 DM Rotterdam
The Netherlands
Tel.: (31)-10-4088945
Fax: (31)-10-4527347

* The second author was supported by grant 450-229-006 of the Dutch Research Foundation (NWO) while the third author benefited from grant IUAP26 of the Belgian government. We are grateful to the Belgian central bank for providing us with weekly intervention data. We benefited from comments and suggestions on an earlier version of this paper by Roel Beetsma, Mark de Broeck, Paul de Grauwe, Frank de Jong, Neil Shephard and Peter Vlaar.
1. INTRODUCTION

During the formative years of the European Monetary System (EMS), Belgium followed more or less similar monetary and exchange rate policies as France and had, like France, to devalue its currency repeatedly. First gradually and since mid 1990 more drastically, Belgium changed its monetary policy. Currently, Belgium pegs its currency more strongly to the D-mark than is required by prevailing EMS rules. It seems that the functioning of the EMS has had a clear effect on Belgian monetary policies and the Belgian franc. In this paper we analyse the behaviour of the Belgian franc from the beginning of the EMS until the affirmation of the new policy in 1990.

To analyse the behaviour of the Belgian franc we develop a discrete time target zone model for a partially credible band, in which official intervention as a tool to keep the franc within the band, is made explicit. The motivation for this setup is as follows. The analysis of a target zone has recently gained momentum through the elegant solution for the exchange rate behavior developed by Krugman (1991), showing that the exchange rate approaches the band in a S-shaped manner. The analysis, however, is cast in the framework of a continuous time regulated Brownian motion, and is therefore not particularly amenable to empirical analysis (see e.g. Flood et al., 1991). Several factors contribute to this: (i) interventions do not appear to be infinitesimal at the boundaries, but rather are discrete and intra-marginal in nature (Dominguez and Kenen, 1992); (ii) exchange-rate innovations tend to be non-normal fat tailed distributed (see Koedijk et al., 1990) and exhibit clusters of volatility (see Baillie and McMahon, 1989, ch.4), (iii) and estimation of the continuous time model is rather involved. A discrete time model such as developed in Koedijk et al. (1993) is better able to capture the distributional properties and straightforward to estimate.

Apart from the discrete time aspect, the other important feature of our analysis is the explicit modelling of official intervention. In Krugman's target zone model, the exchange rate is kept within the band through regulation of the fundamentals. Assuming that
excessive money supply is the driving force behind the pressure on the currency, official
tervention can then be used to counter the slide of the currency. In this paper we
explicitly take account of this policy tool. The fortunate availability of discrete data on
Belgium official intervention enables us to conduct an empirical evaluation.

From the Belgian central bank we have available an indicator data set showing in which
weeks the bank undertook official EMS interventions. The effect of interventions is
studied in two ways. We distinguish a level and a volatility effect. It is often maintained
that official intervention should not be directed at changing the current exchange rate,
which given the (near) martingale nature is infeasible, but should be targeted at lowering
the exchange rate volatility. Studies in the past, such as the large scale project by the US
Federal Reserve on sterilized intervention indeed convey that interventions have almost no
level effect. Much less attention has been paid towards the possibility of calming down
markets. The model we develop nicely allows for distinguishing between the two effects.

The plan of this paper is as follows. In section 2 we introduce the discrete time target
zone model and incorporate the central bank intervention into the specification. In section
3 we estimate the model, test for the S-effect and the various intervention effects. We
also try to infer the degree of credibility of the franc in section 4. This is done by
calculating one-step-ahead realignment probabilities. To further evaluate the functioning
of the Belgian franc, we match realignment probabilities with official intervention data in
section 5. Conclusions are offered in section 6.

2. THEORY

The reduced form free float model in discrete time has the following canonical structure

\[ s_t = f_t + \lambda E_t[s_{t+1}], \quad 0 < \lambda < 1, \]

where \( s \) denotes the logarithm of the spot exchange rate and \( f \) denotes the fundamentals.
If \( f_t \) follows a martingale, then the no-bubble solution to \( s_t \) is well-known to be linear in \( f_t \):

\[
(2) \quad s_t(f_t) = \sum_{i=0}^{\infty} \lambda^i E_t [f_{t+i}] = f_t / (1 - \lambda).
\]

Now suppose \( s_t \) is kept within a band through regulation of \( f_t \) at symmetric boundaries \(-\tilde{f}\) and \( \tilde{f} \), i.e. \( f_{t+1} = f_t + \epsilon_{t+1} \) if \( f_t + \epsilon_{t+1} \in [-\tilde{f}, \tilde{f}] \), while \( f_{t+1} \) is kept at the boundary which would otherwise be exceeded. If the distribution of \( \epsilon_t \) is unimodal, such as is the case for e.g. the normal and student-t distributions, then \( s_t(f_t) \) becomes a convex-concave function about the central parity \( q \). To see this, first consider the effect of a one-sided bound on \( f_t \), say a fundamentals floor \(-\tilde{f}\). Thus \( f_{t+1} \) slopes downward along the 45°-line as \( f_t + \epsilon_{t+1} \) is falling, until the floor is reached and \( f_{t+1} \) is kept constant at \(-\tilde{f}\). Hence \( f_{t+1} \) is a convex function in \( f_t + \epsilon_{t+1} \). Let \( k(.) \) be any convex function, and let \( g(\epsilon) \) be the density of \( \epsilon \). For any pair \( f_1, f_2 \in \mathbb{R} \) the following basic inequality holds:

\[
(3) \quad \alpha k(f_1 + \epsilon)g(\epsilon) + (1-\alpha)k(f_2 + \epsilon)g(\epsilon) \geq k(\alpha f_1 + (1-\alpha)f_2 + \epsilon)g(\epsilon), \quad 0 < \alpha < 1
\]

Because (3) holds for any \( \epsilon \), integration with respect to \( \epsilon \) preserves the weak inequality. Hence \( E[k(f_t + \epsilon)] \) is convex in \( f_t \). Repeated application of this result and the fact that the class of convex functions is closed under addition, shows that \( \sum \lambda^i E_t [f_{t+i}] \) is a convex function of \( f_t \) in case of a price floor. Similar reasoning can be used to show that \( s(f) \) is concave near an upper boundary. Several authors, see e.g. Flood et al. (1991) and Pesaran and Samiei (1992), have investigated the S-shaped relation between \( s \) and \( f \). The difficulty in this approach is that we lack a reliable model of the fundamentals, cf. Meese and Rogoff (1983). Here we take an indirect route, by noting that \( s_t \) and \( s_{t+1} \) are also

---

1 For the purpose of presentation in this part of the paper the central parity \( q \) is set at \( q=0 \).

2 A full fledged proof for the case of two-sided regulation through a band using Leibniz' rule and exploiting unimodality is available in Koedijk et al. (1993).
linked through a S-shaped function. Nevertheless, we have information about a subset of the fundamentals, i.e. the official intervention data, and this is made explicit. Assuming that official intervention $I$ enters linearly, like in the monetary model, we split the vector of fundamentals: $f = f' + \rho I$. We can then rewrite eq (1) as follows

$$ E_t[s_{t+1}] = \frac{1}{\lambda} s_t - \frac{1}{\lambda} r_t - \frac{\rho}{\lambda} I_{t+1} $$

(4)$$ = a(s_t) - \frac{\rho}{\lambda} I_{t+1} $$

say, where $a(s)$ is convexoconcave in $s$. Given rational expectations and the nature of $I$, we arrive at

$$ s_{t+1} = a(s_t) - \frac{\rho}{\lambda} I_{t+1} - \Phi_{t+1} $$

(5)$$ s_{t+1} = a(s_t) - \frac{\rho}{\lambda} I_{t+1} - \Phi_{t+1} $$

where the innovation $\Phi_{t+1}$ is orthogonal to the information set.

The nonlinear function $a(s)$ can be approximated by a Taylor expansion around the central parity $q$, after which the coefficients of the expansion are estimated by standard regression techniques, see Cramer (1969, Ch.5). Interestingly, Rose and Svensson (1991) and Svensson (1993) use similar specifications, except for the explicit modelling of the intervention. A first order expansion of $a(s)$ in eq. (5) renders:

$$ s_{t+1} = q_t + \beta(s_t-q_t) - \frac{\rho}{\lambda} I_{t+1} + \Psi_{t+1} $$

(6)$$ s_{t+1} = q_t + \beta(s_t-q_t) - \frac{\rho}{\lambda} I_{t+1} + \Psi_{t+1} $$

where $\Psi_{t+1}$ comprises the remainder of the expansion plus the orthogonal innovation

---

3 Recalling that $s(f')$ is convexoconcave and using the implicit function theorem, it can be shown that $s-f'$ is convexoconcave in $s$.

4 In case of the free float and fully credible target zone solution this would also be the second order expansion, due to the convexoconcavity of $a(s)$ around $q$. 

5
\( \Phi_{t+1} \). Equation (6) can be rewritten in a format that is estimated more easily. The intervention data consist of a 0/1 variable, with value 1 for the weeks in which the central bank intervened and 0 for the other weeks. To enable an effective comparison between intervention weeks and non-intervention weeks, we replace the term \( \frac{-p}{\lambda} f_{t+1} \) by

\[ \alpha_1 I_{t+1} + \alpha_2 (1 - I_{t+1}) \]

Moreover, let \( \beta = 1 - \delta \) and rewrite eq. (6) as follows.

(7) \[ s_{t+1} - s_t = \alpha_1 I_{t+1} + \alpha_2 (1 - I_{t+1}) - \delta (s_t - q_t) + \Psi_{t+1} \]

If \( \delta = 0 \) cannot be rejected we conclude that the exchange rate band has no influence on the exchange rate. If on the other hand, \( \delta > 0 \) significantly, there is mean reversion of the exchange rate and we conclude that the band is effective. The next step is to specify the error term \( \Psi_{t+1} \). In the case of a fully credible band the conditional innovation \( \Phi_{t+1} \), given \( s_t \), follows a two-sided truncated distribution, e.g. Pesaran and Samiei (1992). In case of the Svensson partially credible band the conditional distribution of \( \Phi_{t+1} \) becomes a mixture of two distributions, one of which is truncated. In reality the EMS exchange rates do exit the band and this has to be modelled. Our approach will be to (directly) make some distributional assumptions for \( \Psi \) which do justice to the established empirical regularities, but at the risk of violating the moment restrictions implied by eq. (5).

There are two prominent empirical regularities: (i) exchange rate innovations are non-normal, fat-tailed; and (ii) exhibit clusters of volatility. Both regularities are present in freely floating dollar rates and the regulated EMS rates, see Baillie and McMahon (1989, ch. 4) and Koedijk et al. (1990). The GARCH (1,1) process with Student-t innovations is used to exhibit both regularities. In addition, we want to allow for a volatility effect of intervention because it is often stated that official intervention should not be used for trying to influence the exchange rate level, but rather should be directed at tempering the fluctuations. We obtain the following specification:
\[ \Psi_{t+1} = x_{t+1} \left[ h_{t+1} \left( \frac{\nu - 2}{\nu} \right) \right]^{1/2}, \]

\[ h_{t+1} = \omega_1 I_t + \omega_2 (1 - I_t) + \gamma \Psi_t^2 + \gamma h_t \]

and where the \( x_t \) are i.i.d. Student-t with \( \nu \) degrees of freedom distributed variables. Here \( \omega_1 \) measures the tempering effect of intervention on volatility.

3. Empirical Results

3.1 Data Description

Weekly quotations of exchange rates are taken from Datastream, covering the period from 2 April 1979, up to and including 15 July 1991. All quotations are middle rates, the average of bid and offer rates. Germany is taken as the benchmark country and the exchange rate is expressed as the number of D-marks per unit of Belgian francs (British notation). Table 1 reports the key characteristics of the dataset.

<table>
<thead>
<tr>
<th>No. obs</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>St. Dev.</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>643</td>
<td>-6.47</td>
<td>3.18</td>
<td>-0.014</td>
<td>0.572</td>
<td>-2.37</td>
<td>29.2</td>
</tr>
</tbody>
</table>

The mean return is negative due to the repeated devaluations of the Belgian franc against the D-mark, but is small in absolute value. The distribution is skewed to the left and has a high level of kurtosis, which confirms the heavy tailed behavior found in many studies on daily and weekly exchange rates, e.g. Boothe and Glassman (1987), Koedijk et al. (1990) and Hols and de Vries (1991).

Belgium was one of the founding members of the EMS as it joined both the EMS and the ERM as early as March 1979. Since then the Belgian franc devalued seven times. The
realignments dates and magnitudes are given in Table 2:

Table 2. Realignment Dates and Magnitudes

<table>
<thead>
<tr>
<th></th>
<th>24/09/79</th>
<th>05/10/81</th>
<th>22/02/82</th>
<th>14/06/82</th>
<th>23/03/83</th>
<th>07/04/86</th>
<th>12/01/87</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.0 %</td>
<td>-5.5 %</td>
<td>-8.5 %</td>
<td>-4.25 %</td>
<td>-4.0 %</td>
<td>-2.0 %</td>
<td>-1.0 %</td>
<td></td>
</tr>
</tbody>
</table>

Both the frequency and the size of the realignments are reduced over time, indicating the increased convergence of the EMS economies.

3.2 Parameter Estimation

Next, the model of eq. (7)-(9) is estimated by maximum likelihood. Parameter estimates and 95% (simulated) confidence intervals between brackets are reported in Table 3:

Table 3. Parameter Estimates

<table>
<thead>
<tr>
<th>$\alpha_1$</th>
<th>$\alpha_2$</th>
<th>$\delta$</th>
<th>$\omega_0$</th>
<th>$\omega_1$</th>
<th>$\gamma$</th>
<th>$\delta$</th>
<th>$\nu$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.23 E-3</td>
<td>-0.18 E-3</td>
<td>0.085</td>
<td>0.53 E-6</td>
<td>1.69 E-6</td>
<td>0.24</td>
<td>0.77</td>
<td>4.27</td>
</tr>
<tr>
<td>(-1.50 E-3,</td>
<td>(-6.67 E-3,</td>
<td>(0.083,</td>
<td>(0.14 E-6,</td>
<td>(0.58 E-6,</td>
<td>(0.12,</td>
<td>(0.65,</td>
<td>(3.02,</td>
</tr>
<tr>
<td>-0.99 E-3)</td>
<td>0.30 E-3)</td>
<td>0.087</td>
<td>1.70 E-6</td>
<td>4.52 E-6</td>
<td>0.38</td>
<td>0.85</td>
<td>6.00</td>
</tr>
</tbody>
</table>

A prominent feature of the results reported in Table 3 is the fact that the sum of the parameters of the GARCH (1,1) process ($\gamma_1$) exceed 1, possibly implying infinite unconditional variance. Hence the standard t-test confidence interval may not be applicable. Therefore we determined the significance of the parameter estimates by means of confidence intervals generated through Monte Carlo simulations, see Appendix A. The confidence intervals show that only the estimate for $\alpha_2$ is not significantly different from zero. Several of the confidence intervals are slightly skewed to the right, but the estimated parameter value is usually in the middle of the interval$^5$.

$^5$ This is also testified by the figures in Appendix A.
The significance of the mean-reversion effect is determined by the δ estimate. The standard unit root test is again impaired by the IGARCH nature of the model. Hence, we again turned to simulations in order to test against the presence of a unit root. Restricting δ = 0, the model (7)-(9) together with the point estimates from Table 3 were used to generate the needed replications (see Appendix A for a description of the Monte Carlo procedure). The 95% (simulated) confidence interval for δ, when δ = 0, reads (-0.0055, 0.011), and clearly does not include the original δ-estimate value of 0.085. We therefore conclude that there is strong empirical support for mean-reversion of the Belgian franc-Deutsch mark exchange rate, as predicted by the target zone model.

The specification of eq. (7) also enables us to determine whether and how the change in the exchange rate was affected by government intervention. The fact that α₁ is more negative than parameter α₂ means, that on average in the intervention weeks the exchange rate decreased more than in weeks without intervention. The significance of the difference between α₁ and α₂ is determined through Monte Carlo simulations. We replicated the model as if α₁ = α₂ = α (-0.81 E-3). The value of α is determined by reestimating the model under the above restriction. The 95% confidence intervals of α₁ and α₂ then become (-1.09 E-3, -0.55 E-3) and (-1.29 E-3, -0.36 E-3) and don't include the estimated values of α₁ and α₂. We therefore conclude that the difference is significant. This finding suggests that a policy of leaning against the wind was used by the Belgian monetary authorities. ⁶

The estimates of ω₁ and ω₂ in eq. (9) indicate that on average the conditional variance was relatively low during the intervention weeks. To determine the significance of the difference between ω₁ and ω₂, we again resorted to replicating the model with ω₁ = ω₂ = 0.71 E-6 and reestimated the model. The 95% confidence intervals of ω₁ and ω₂ are (0.39; 1.32) and (0.12; 1.95) which shows the difference is not significant at the 5% level. Hence, contrary to the results for the exchange rate change (α₁ < α₂), we find no

---

⁶ For a recent review article on intervention, see Almekinders and Eyffinger (1993).
significant difference between intervention weeks and non-intervention weeks with regard to exchange rate variability.

4. Realignments and Rumours

The uses of the model are its potential to foresee upcoming realignments earlier than the general public, and the role of official intervention in deferring realignments. This section focusses on forecasting potential, while the next section looks into the other issue. Suppose that a realignment takes place whenever the fundamental and hence the exchange rate moves outside the band. From eqs. (7) - (9) the one step ahead probability on this event can be calculated. In practice we only observe the band on the exchange rate, \([b,u]\) say, where \(b\) and \(u\) denote the lower and upper boundaries on the exchange rate. Also, the interventions are not public information. Hence they can not be used for forecasting realignments. Therefore, in eq. (7) the term \(\alpha_1 I_t + \alpha_2 (1 - I_{t+1})\) is replaced by the constant \(\alpha\) and in eq. (9) the term \(\omega, I_t + \omega_2 (1 - I_t)\) is replaced by the constant \(\omega\). The probability of a realignment and \(t+1\) given information up to and \(\epsilon\) including \(t\) is: 1 - \(P\{b < s_{t+1} < u\}\). From the adjusted equations (7) - (9) we find:

\[
\begin{align*}
P \{ b < s_{t+1} < u \} &= \mathcal{P} \left[ \frac{b - \alpha - (1-\delta)s_{t,\delta}q}{[h_{t+1}(v-2)/v]^{1/2}} < x_{t+1} < \frac{u - \alpha - (1-\delta)s_{t,\delta}q}{[h_{t+1}(v-2)/v]^{1/2}} \right] \\
\end{align*}
\]

and where

\[
h_{t+1} = \omega + \gamma(s_{t,\delta} - (1-\delta)s_{t,\delta}q - \alpha)^2 + \delta h_t.
\]

After reestimating the model for \(\alpha_1 = \alpha_2 = \alpha (= -0.81 \ E-3, \) see above) and \(\omega_1 = \omega_2 = \omega (=0.71 \ E-6, \) see above), the parameter estimates of the GARCH with mean-reversion model of table 3 are employed to calculate the one-step-ahead realignment probabilities for the Belgian franc versus the D-mark. These probabilities are recorded in figure 1, which consists of two parts with an identical format. The horizontal axis measures time in
weeks. The vertical axis measures one-step-ahead devaluation and revaluation probabilities in percentage points. The upper half of the figure contains the revaluation probabilities and the lower half contains the devaluation probabilities. The dashed bars with dates printed alongside in a vertical format indicate the date the Belgian franc devalued against the D-mark. The other bars denote the one-step-ahead revaluation probabilities (upper half of figure 1) and devaluation probabilities (lower half of figure 1).

The general impression that emerges from figure 1 is that realignment probabilities are most prominent between 1979 and 1987. After the devaluation in January 1987 realignment probabilities decrease substantially. This supports the notion that in recent years the Belgian franc has gained credibility. A second aspect which immediately strikes the eye is that according to figure 1, there were a few short periods during which there were moderately high revaluation probabilities of the Belgian franc against the D-mark around 1981/1982 and 1983. These short episodes of relatively high revaluation probability are caused by the position of the franc in the top of the band immediately after a devaluation. In line with expectations however, the devaluation probabilities do in general exhibit more pronounced and more frequent periods of strain versus the D-mark. A more detailed assessment of figure 1 is achieved by comparing the signals given by the realignment probabilities to the abstracts of the Financial Times around the realignment dates.

The first thing to notice is that prior to five of the seven devaluations the one-step-ahead devaluation probabilities are quite high. Only for the devaluations of 22-03-1982 and 12-01-1987 did the probabilities lack to provide early warning signs of more than twenty percent. The periods of increased tension often precede realignments and seem to come in surging waves during which the probabilities jump up and down. In most cases, as soon as the currency devalues, the devaluation probabilities decrease immediately. This indicates that the devaluation sufficed to take away the tension between the Belgian franc and the D-mark and that the exchange rate returned to a stable situation. The devaluation

---

7 See for instance Ungerer et al. (1990).

8 Complete transcripts are available from the second author upon request.
of 22-02-1982 apparently is different as it is succeeded by increasing instead of decreasing devaluation probabilities. That this was not an ordinary devaluation is also testified by the newspapers and broadcasts around that time. This remarkable realignment is discussed in extenso below.

In our discussion we focus on the four largest devaluations of the Belgian franc relative to the D-mark, which are the devaluations of respectively 05-10-81, 22-02-82, 14-06-82 and 21-03-83.

The first realignment we focus on is the realignment of 05-10-81. The end of 1980 and especially early 1981 were turbulent times for the EMS. In the spring of 1981 devaluation probabilities suddenly jumped up as can be seen from figure 1. This pressure was also felt by other EMS currencies and on 23-03-1981 the Italian Lira was devalued with six percent against the D-mark. The increasing strains in the EMS were reported by "Het Financieel Dagblad", which on March 24 stated (translation is ours): "Although in foreign exchange markets this action of the Italian government had been expected for some time, the timing was a surprise. Also, a combined action had been expected as the strong D-mark has made more victims recently". In spite of the increasing pressure to devalue, the Belgian Central Bank stuck to its proclaimed no-devaluation rule. Belgian newspapers in April 1981, i.e. one week after the devaluation of the Italian Lira, did expect the Belgian franc to devalue in less than a week's time and there was a large public discussion on the pro's and contra's of a devaluation. At the time the central bank seemed determined not to be influenced and managed to postpone the devaluation until October 1981 through interventions and high interest rates. In October the Belgian central bank had to give in and the Deutsche mark was revalued with 5.5 percent. Abstracts on 03-10-1981 show that a general realignment of EMS parities was foreseen: "The sources describe a realignment in the EMS, probably involving a higher revaluation of the D-mark, as well as a devaluation of the French franc as already overdue".
The second realignment we focus on is the devaluation of 22-02-82. As can be seen from figure 1 this devaluation was not convincingly predicted by our one-step-ahead probabilities. This realignment was reported in the Financial Times of 22-02-1982 as a complete surprise: "EMS members unite against Belgium’s 12% realignment proposal; other EMS members were taken aback by the ambitious scale of the Belgian proposal and by the fact that it had appeared to encourage Denmark to lodge a request for a 7% devaluation of the Krone. The Danish move was considered opportunistic .... and not justified by any undue strains on the currency within the EMS". Devaluations of the Belgian franc were strongly opposed by the central bank on the grounds that it would trigger a new round of wage and price indexing. The German revaluation at the end of 1981 seemed to take away some of the tension and vested the belief with the public that the central bank’s view was dominant. With the government imposed devaluation of February 1982, the government sought to provide a shock signal to break the inflation spiral. The government’s view proved to be right, no indexation followed. But the devaluation also signalled the end of the no-devaluation rule. This change in monetary policy triggered a period of prolonged uncertainty in the exchange market; which explains why the devaluation probabilities remained high until the second realignment of 1982, on the 14th of June.

The third realignment we focus on is the realignment of 21-03-1983. The realignment probabilities clearly show that the realignment was long forecasted by our model. The fact that this realignment of 4 percent was anticipated in the market is corroborated by the Financial Times. This newspaper reports on 21-03-83: "This was the most widely anticipated of all seven EMS realignments".

After 1987 devaluation probabilities seem to fade out with relatively small outbursts every now and then. This reflects to a large extent the increased credibility of the EMS and the

---

9 For an extensive description of the economic conditions preceding this realignment, see De Grauwe (1992), pp. 43.
Belgian franc in particular.

5. Intervention Policy and Devaluation Probabilities

In this section we analyse the intervention policy of the Belgian central bank. In particular, we focus on the relationship between official intervention and realignment probabilities.

Belgian official intervention and its relation to the Belgian franc is illustrated in Figures 2 and 3. Figure 2 shows a histogram of the position of the Belgian franc. The 4.5% fluctuation band is divided in 10 equally sized subbands. The horizontal axis measures the position in the band, that is the subband number. Number 1 represents the subband covering the area from -2.25% up to -1.80% and number 10 is the subband between 1.80% and 2.25%. The vertical axis measures the number of exchange rate realizations within each subband. By far the largest number of observations fall in the first five subbands, that is the lower half of the fluctuation band. Especially the second subband, which ranges from -1.80% to -1.35% contains many observations.

In order to test the hypothesis that the central bank uses interventions as a tool to lean against the wind we computed the relative intervention frequency for each of the ten subbands. For each subband the percentage of weeks during which there were interventions is recorded and plotted in the histogram of Figure 3. The horizontal axis measures the position in the band, like in Figure 2. The vertical axis measures in percentage points the intervention frequency relative to the number of realizations in the subband.
Figure 2

Figure 3

Figure 3 shows that the relative intervention frequency is high when the Belgian franc is close to its lower fluctuation margin and that the relative intervention frequency decreases
when the franc moves up, away from the lower margin. If the franc moves up further and closer to the upper fluctuation margin, then the relative intervention frequency increases again, as is testified by the tall bar for subband nine. In short, it seems that the central bank intensified its intervention activities as the Belgian franc got closer to its fluctuation margins. At the lower end this is to counter devaluation pressure, at the upper end this is to increase the reserves lost during an attack (and sometimes in order to support a weak currency).

In the previous section we considered the effects of intervention on the level and the volatility of the exchange rate through the values of the intercept parameters $d_i$ and $\omega_i$, treating $I_t$ as exogenous. Here we investigate the mutual dependency between $I_t$ and the strength of the Belgian franc. Specifically we investigate the correlation between $I_t$ and $P_t$, i.e. the interventions and the devaluation probabilities, through the following regression.

$$I_t = C + \beta P_t,$$

where $I_t$ is the intervention in week $t$ (0 or 1), $C$ is a constant and $P_t$ is the probability that next week the Belgian franc devalues against the D-mark given in eq. (10). We follow Ungerer (1990) and split the testing period in three separate subperiods:

02/04/1979 - 21/03/1983 (I); 28/03/1983 - 07/09/1987 (II); 16/09/1987 - 22/07/1991 (III). The parameter estimates for the three subperiods are reported in table 4:
Table 4 Relation between interventions and devaluation probabilities

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.39</td>
<td>0.44</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>(3.17)</td>
<td>(4.11)</td>
<td>(3.68)</td>
</tr>
<tr>
<td>(\beta)</td>
<td>0.031</td>
<td>0.0035</td>
<td>0.091</td>
</tr>
<tr>
<td></td>
<td>(3.69)</td>
<td>(0.52)</td>
<td>(1.90)</td>
</tr>
</tbody>
</table>

The three columns represent the three subperiods. The first row contains the estimates for the constant \(C\) and the second contains the estimates for the parameter \(\beta\). The t-values of the parameter estimates are given between brackets. A positive value of \(\beta\) implies that a higher value of the devaluation probability corresponds with a higher probability that the central bank intervened that week. The results show that the relation between the devaluation probability and relative intervention frequency was significant only in the first period. For the second period the estimate for \(\beta\) is insignificant and there is no apparent relation between interventions and devaluation probabilities. In the third period the evidence for the existence of such a relation reappears, although the estimate for \(\beta\) is significant at the 10% level only.

The results in table 4 are in line with the general evolution of intervention policies within the EMS as described by Ungerer (1990) and by Mastropasqua et. al. (1988). In the first period of the EMS, most of the interventions were obligatory and near the margins, as envisaged by the EMS Agreement. This is confirmed by the highly significant estimate for \(\beta\). In the years to follow, intra-marginal interventions replaced obligatory marginal interventions. During a relatively short time (1983-1986), intra-marginal interventions...
became the rule rather than the exception. It appears that the Basle-Nyborg agreement of September 1987 strongly affected the set-up and functioning of the EMS. One of the intentions of the agreement was to make a fuller and more flexible use of the exchange rate bands in order to deter speculation and avoid intra-marginal intervention over longer periods. Indeed, immediately after September 1987 the franc moved closer to its lower fluctuation margin and remained there without interruptions until June 1990. The second goal of the Basle-Nyborg agreement was to avoid too much intra-marginal interventions, and this seems to have been accomplished at least partially. The \( \beta \) estimate seems to confirm that after September 1987 the relative intervention frequency again was correlated with the devaluation probability. This implies that there were relatively more interventions near the margins than intra-marginally.

6. Conclusion

The aim of this paper was to investigate the behaviour of the Belgium franc within the EMS. To evaluate the effects of the presence of a band and the accompanying official interventions, we developed a discrete time target zone model. This model was then estimated and evaluated in terms of its power to predict upcoming realignments. The effect of the band was uncovered through the significance of the mean reversion parameter. Official intervention and exchange rate innovations are negatively correlated, and this seems to point to a leaning against the wind policy. But we found little evidence for a policy directed towards reducing volatility through official interventions. When compared with statements from the financial press the model seems to anticipate upcoming upheaval in the currency market early on, except at the time of the drastic change in monetary policy in 1982. Official intervention has been used in response to devaluation pressures primarily in the first stage of the EMS. The improved conduct of monetary policy, i.e. keeping in line with the German monetary policy, both relieved the franc from its frequent devaluation pressure and lessened the necessity of official intervention, resulting in increased credibility of the Belgian franc in the European Monetary System.
6. References


APPENDIX A1.

This appendix briefly describes the simulation procedure that was implemented to obtain the confidence intervals. The point estimates of Table 3 together with eqs. (7)-(9) were used to generate 1000 replications, each consisting of 643 observations. Each replication was used to reestimate the model, and the parameter estimates were saved. After arranging the parameter estimates from low to high, the 25th and 97.5th highest estimates were used as the boundaries of the 95% confidence intervals. For reference, we here report the confidence intervals that are obtained under the usual assumption of normality - i.e. the parameter estimate $\pm 1.96 \times \text{s.e.}$ - and note that these do not appreciably differ from the simulated intervals reported in the main text.

Table 1A. Confidence intervals under assumption of normality

<table>
<thead>
<tr>
<th>$\alpha_1$</th>
<th>$\alpha_2$</th>
<th>$\delta$</th>
<th>$\omega_1$</th>
<th>$\omega_2$</th>
<th>$\gamma$</th>
<th>$\delta$</th>
<th>$\varphi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.23 E-3</td>
<td>-0.18 E-3</td>
<td>0.085</td>
<td>0.53 E-6</td>
<td>1.69 E-6</td>
<td>0.24</td>
<td>0.77</td>
<td>4.27</td>
</tr>
<tr>
<td>(-1.67 E-3,</td>
<td>(-0.68 E-3,</td>
<td>(0.055,</td>
<td>(-0.14 E-6,</td>
<td>(0.05 E-6,</td>
<td>(0.09,</td>
<td>(0.65,</td>
<td>(2.81,</td>
</tr>
<tr>
<td>-0.79 E-3)</td>
<td>0.32 E-3)</td>
<td>0.116</td>
<td>1.19 E-6</td>
<td>3.33 E-6</td>
<td>0.40</td>
<td>0.90</td>
<td>5.73</td>
</tr>
</tbody>
</table>

Also reported in this appendix are the empirical distributions of the parameter estimates for the simulated data, see the figures on the following page. It is evident that most estimates have relatively small variability, reflected in small confidence intervals.
Appendix A
APPENDIX, NOT FOR PUBLICATION

In this appendix from Koedijk et al. (1993) the main lemma needed to derive the S-shaped behaviour of s if f is kept within a band is obtained.

It is shown that $E[k(f+\epsilon)|f]$ is convexoconcave about 0, if $k(.)$ is convexoconcave about 0 and $\epsilon$ has a unimodal distribution $G(\epsilon)$:

$$E[k(f+\epsilon)|f] = e(f) =$$

$$\int_{-\infty}^{-f-f} k(-f)g(\epsilon)d\epsilon + \int_{-f-f}^{f-f} k(f+\epsilon)g(\epsilon)d\epsilon + \int_{f-f}^{\infty} k(f)g(\epsilon)d\epsilon$$

By Leibniz' rule we find

$$\frac{de(f)}{df} = \int_{-f-f}^{f-f} \frac{dk(f+\epsilon)}{df} g(\epsilon)d\epsilon > 0,$$

and using the unimodality we also get that

$$\frac{d^2e(f)}{df^2} = \int_{-f-f}^{f-f} \frac{dk(f+\epsilon)}{df} g(\epsilon)d\epsilon + \int_{-f-f}^{f-f} \frac{d^2k(f+\epsilon)}{df^2} g(\epsilon)d\epsilon$$

$$+ \frac{dk(-f)}{df} g(-f-f) < 0 \text{ as } f > 0$$

Together the signs of these derivatives imply the desired convexoconcavity.
DISCUSSION PAPERS TINBERGEN INSTITUTE

International and Development Economics

TI 93-1  Dynamics of Distribution and Growth in a Small Open Economy with Heterogeneous Agents, Casper van Ewijk, University of Amsterdam.

TI 93-2  Trade Liberalisation with Imperfect Competition in Goods and Labour Markets, John Driffill, University of Southampton, United Kingdom, and Frederick van der Ploeg, University of Amsterdam.

TI 93-7  The Real Interest Rate as an Optimum Currency Area Indicator in Search of an Optimum Criterion, Henk Jager and Bertholt Leeflang, University of Amsterdam.

TI 93-20  Does Inequality Cause Inflation? The Political Economy of Inflation, Taxation and Government Debt, Roel M.W.J. Beetsma, CentER, Tilburg University and Frederick van der Ploeg, University of Amsterdam and CEPR.

TI 93-24  Growth, Deficits and R&D in the Global Economy, Frederick van der Ploeg and Paul J.G. Tang, University of Amsterdam.


TI 93-88  Sector-Specific Capital, 'Bang-Bang' Investment and the Filippov Solution, Charles van Marrewijk, Erasmus University Rotterdam, Jos Verbeek, University of Amsterdam and World Bank.

TI 93-123  Sustainable growth and renewable resources in the global economy, Frederick van der Ploeg, University of Amsterdam, Jenny Lighart, Erasmus University Rotterdam.

TI 93-128  Capital Controls on the Official Market of a Dual Exchange Rate Regime: the Belgian Experience Post-mortem, P. Reding, University of Namur, J.-M. Viaene, Erasmus University Rotterdam.

TI 93-129  Trading Networks and Endogenous Trade Regimes in Applied General Equilibrium Modelling, Chris Elbers, Free University Amsterdam.

TI 93-140  The Solution to the Tullock Rent-Seeking Game when \( R > 2 \): Mixed-Strategy Equilibria and Mean Dissipation Rates, Michael R. Baye, The Pennsylvania State University, Dan Kovenock, Purdue University, Casper G. de Vries, Erasmus University Rotterdam.


TI 93-146  An EMS Target Zone Model in Discrete Time, Kees G. Koedijk, University of Limburg, Philip A. Stork, Casper G. de Vries, Erasmus University Rotterdam.

TI 93-155  Producer Services, Comparative Advantage, and International Trade Patterns, Charles van Marrewijk, Joachim Subora, Albert de Vaal, Jean-Marie Viaene, Erasmus University Rotterdam.
TI 93-167  
*Excess Volatility of Stock Prices and Capital Income Taxation*, E.W.M.T. Westerhout, 
Ministry of Economic Affairs, The Hague.

TI 93-192  
*Between Realignments and Intervention*, Kees G. Koedijk, University of Limburg, Philip 
A. Stork, Casper G. de Vries, Erasmus University Rotterdam.
No. 93-101  Gordon M. Phillips, Robert J. Weiner  

No. 93-102  Stephen R. Goldberg, Frank L. Heflin  
"The Association Between the Level of International Diversification and Risk"

No. 93-103  John A. Carlson  
"Risk Aversion, Foreign Exchange Speculation and Gambler's Ruin"

No. 93-104  John A. Carlson, Assim M. Husain, Jeffrey A. Zimmerman  
"Penalties and Exclusion in the Rescheduling and Forgiveness of International Loans"

No. 93-105  Kent D. Miller  

No. 93-106  Stephen R. Goldberg and Joseph H. Godwin  
"Foreign Currency Translation Under Two Cases-Integrated and Isolated Economies"

No. 93-107  Kent D. Miller  
"A Comparison of Managers' Uncertainty Perceptions and Country Risk Indices"

No. 93-108  Jon D. Haveman  
"The Effect of Trade Induced Displacement on Unemployment and Wages"

No. 93-109  Jon D. Haveman  
"Some Welfare Effects of Dynamic Customs Union Formation"

No. 93-110  John A. Carlson, Insook Kim  
"Central Banks' Expected Profits From Intervention

If you would like to request copies of specific papers, please contact the Center for International Business Education and Research, Purdue University, Krannert School of Management, West Lafayette, IN 47907.  
(Phone: 317/494-4463 or FAX: 317/494-9658)
<table>
<thead>
<tr>
<th>No. 94-001</th>
<th>Casper G. De Vries, Phillip A. Stork, Kees G. Koedijk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;Between Realignments and Intervention: The Belgian Franc in the European Monetary System&quot;</td>
</tr>
<tr>
<td>No. 94-002</td>
<td>Casper G. de Vries, K. U. Leuven</td>
</tr>
<tr>
<td></td>
<td>&quot;Stylized Facts of Nominal Exchange Rate Returns&quot;</td>
</tr>
<tr>
<td>No. 94-003</td>
<td>Kent D. Miller</td>
</tr>
<tr>
<td></td>
<td>&quot;Operational Flexibility Responses to Environmental Uncertainties&quot;</td>
</tr>
<tr>
<td>No. 94-004</td>
<td>Kent D. Miller</td>
</tr>
<tr>
<td></td>
<td>&quot;Economic Exposure and Integrated Risk Management&quot;</td>
</tr>
<tr>
<td>No. 94-005</td>
<td>Kent D. Miller</td>
</tr>
<tr>
<td></td>
<td>&quot;Diversification Responses to Environmental Uncertainties&quot;</td>
</tr>
<tr>
<td>No. 94-006</td>
<td>John M. Hannon, Ing-Chung Huang, Bih-Shiaw Jaw</td>
</tr>
<tr>
<td></td>
<td>&quot;International Human Resource Strategy and Its Determinants: The Case of Multinationals and Their Subsidiaries in Taiwan&quot;</td>
</tr>
<tr>
<td>No. 94-007</td>
<td>John M. Hannon, Ing-Chung Huang, Bih-Shiaw Jaw</td>
</tr>
<tr>
<td></td>
<td>&quot;International Human Resource Strategy and Control: The Case of Multinationals and Their Subsidiaries&quot;</td>
</tr>
<tr>
<td>No. 94-008</td>
<td>John M. Hannon, Yoko Sano</td>
</tr>
<tr>
<td>No. 94-009</td>
<td>John A. Carlson, Insook Kim</td>
</tr>
<tr>
<td></td>
<td>&quot;Leaning Against the Wind: Do Central Banks Necessarily Lose?&quot;</td>
</tr>
<tr>
<td>No. 94-010</td>
<td>John A. Carlson, David W. Schodt</td>
</tr>
<tr>
<td></td>
<td>&quot;Beyond the Lecture: Case Teaching and the Learning of Economic Theory&quot;</td>
</tr>
<tr>
<td>No. 94-011</td>
<td>Alok R. Chaturvedi, Hamant K. Jain, Derek L. Nazareth</td>
</tr>
<tr>
<td></td>
<td>&quot;Key Information Systems Management Issues in Developing Countries: Differences in the Indian and US Contexts&quot;</td>
</tr>
</tbody>
</table>

If you would like to request copies of specific papers, please contact the Center for International Business Education and Research, Purdue University, Krannert School of Management, West Lafayette, IN 47907. (Phone: 317/494-4463 or FAX: 317/494-9658)