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Measuring Exchange Market Pressure for the Belgian Franc 1975-1994 : A Principal Components Analysis

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Abstract

The Girton-Roper model of exchange market pressure suffers from two major drawbacks. First, the measure of pressure is model-specific. Second, the model neglects the role interest rate changes can play in the alleviation of exchange market pressure. We propose a new general index of exchange market pressure, consisting of a linear combination of the rate of depreciation, the proportional loss of international reserves and the change in the interest rate differential with the rest of the world. We apply the technique of principal components to find the appropriate weight on each variable in this overall measure.

The results for Belgium vis-à-vis Germany over the period from 1975 to 1994 show that, apart from the 1993 ERM-crisis, exchange market tensions have been reduced significantly over the last few years, esp. since the Belgian monetary authorities switched from a soft-currency to a hard-currency policy.

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1. Introduction

In this paper we investigate to what extent there has been downward pressure on the Belgian franc during the last two decades. Over this period, Belgium participated uninterruptedly in European arrangements to limit exchange rate variability, viz. the Snake and the ERM. The starting point of the analysis is the view that exchange rate changes constitute a partial measure of foreign exchange market tensions. One should also take into account other instruments the monetary authorities can use to defend a fixed rate, such as exchange market intervention and increases in interest rates.

We therefore concentrate on the broader concept of "exchange market pressure" (henceforth emp). Various measures of emp are examined in section 2. It appears that there is no unique measure, because each (exchange rate) model leads to its own measure. In section 3 we discuss ad-hoc measures and propose conducting a principal components analysis in order to construct an overall emp-measure. Section 4 contains the outcome of such an exercise to the Belgian franc (relative to the German mark) over the period 1975-1994. In section 5 we comment on this measure. The final section concludes.

2. Defining and measuring exchange market pressure

The concept of exchange market pressure was introduced by Girton & Roper (1977, henceforth GR). They define emp as "the volume of intervention necessary to achieve any desired exchange rate target" (p. 537). GR's emp-measure is simply the sum of the observed rate of depreciation of the domestic currency ($\Delta e = \Delta E/E_{t-1}$ where E is the bilateral exchange rate, measured as the domestic currency price of one unit of foreign currency) and the observed loss of international reserves (R), proportional to the inherited monetary base (H) ($-\Delta r = -\Delta R/H_{t-1}$)[1]:

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[1] Actually, Girton & Roper's original measure is the opposite of emp_{GR}, indicating pressure on the domestic currency to appreciate (and on international reserves to grow).

(1) $emp_{GR} = \Delta e - \Delta r$

The underlying model, developed by GR, is a combination of the monetary approaches to the balance of payments and to the exchange rate. GR thus derive a monetary model that is valid for all exchange rate regimes. It starts from the equilibrium conditions in the domestic and foreign base money markets in first differences:

(2) $\Delta h = \Delta r + \Delta d = \Delta p + b.\Delta y + a.\Delta i$

(2') $\Delta h^* = \Delta r^* + \Delta d^* = \Delta p^* + b^*.\Delta y^* + a^*.\Delta i^*$

where h, p and y are the logs of base money, the price level and real income, i is the interest rate level, Δr is defined as above and Δd is the proportional change in the domestic component (D) of the monetary base (i.e. $\Delta d = \Delta D/H_{t-1}$). Parameters a and b are the semi-elasticity of base money demand w.r.t. the interest rate and the elasticity w.r.t. real income respectively ($a<0$, $b>0$). Asterisks refer to foreign variables and parameters.

The model is closed by assuming continuous PPP (Hacche & Townend, 1981):

(3) $\Delta e = \Delta p - \Delta p^*$

so that one obtains:

(4) $\Delta e - \Delta r + \Delta r^* = \Delta d - \Delta d^* - b.\Delta y + b^*.\Delta y^* - a.di$

where di represents the change in the interest rate differential with the foreign economy (i.e. $di = \Delta i - \Delta i^*$) and domestic and foreign semi-interest elasticities are assumed to be equal ($a = a^*$).

Furthermore, GR assume that the "centre" or foreign country (the U.S. in their case-study) carries out full sterilization of reserve flows, thus forcing most or all of the adjustment burden on the "small" country (Canada). Because of this asymmetry, Δr^* can be considered as exogenous. Therefore, Δr^* is moved to the right-hand side of equation (4), so that the model yields GR's measure of emp:

(5) $emp_{GR} = \Delta e - \Delta r = \Delta d - \Delta h^* - b.\Delta y + b^*.\Delta y^* - a.di$

where Δh^*, the percentage change in the foreign money base, is the sum of Δr^* and Δd^*.

As noted above, the GR-model is valid for all exchange rate regimes. If there is no intervention, as in the case of a perfect float, $\Delta r = 0$, and the emp-measure reduces to the rate of depreciation. If the exchange rate is perfectly fixed ($\Delta e = 0$), emp is measured by the proportional loss of international reserves. In the more general cases of intervention without a perfectly fixed exchange rate or managed floating, the emp-measure is given by $\Delta e - \Delta r$.

Recently, Weymark (1995) has shown that emp-measures are necessarily (exchange rate) model-dependent and that the GR-measure is merely a special case of a more general emp-measure. Weymark also introduces a new, general definition: emp is "the exchange rate change that would have been required to remove excess demand [for a currency in international markets] in the absence of exchange market intervention, given the expectations generated by the exchange rate policy actually implemented" (p. 278). In other words, it measures "the exchange rate change that would have occurred if the policy authority had *unexpectedly* refrained from intervening in the exchange market" (p. 280, emphasis in original).

Her measure (emp_W) is derived from a simple model of a small open economy with exchange market intervention and rational expectations. It consists of the same variables as the GR-measure, but the coefficient on intervention is no longer restricted to be negative unity. Emp should be measured as a *weighted* sum of both variables, with the weights depending on the exchange rate model one has in mind.

(6) $emp_W = \Delta e + w.\Delta r$ $\quad (w<0)$[2]

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[2] In Weymark's model, the weight w equals $-[c_1+c_2]^{-1}$, where c_1 is the coefficient on the exchange rate in the domestic price equation (PPP is not imposed) and c_2 is the absolute value of the semi-elasticity of money demand w.r.t. the interest rate.

Weymark's contribution leaves us with the unsatisfying conclusion that one cannot be certain about the weights in the emp-measure, because all measures are by necessity model-dependent and exchange rate models have performed poorly so far (see e.g. Meese & Rogoff, 1983; Flood & Rose, 1993).

Another drawback of both the GR and Weymark measures is that they neglect other instruments the monetary authorities can use to contain exchange market pressures, such as capital controls and interest rate changes. Del Giovane (1994) provides a detailed account of the use of exchange rate, international reserves and interest rate changes in the ERM countries over the period from 1987 to 1993.

3. Ad-hoc emp-measures

As a solution to the first problem, one could leave the theoretical measures aside and construct an emp-measure with the weights on the various components derived in an ad-hoc fashion.

This is the approach of Eichengreen, Rose & Wyplosz (1994, 1995; henceforth ERW), who note that the GR-measure adds two variables with significantly different volatilities. Therefore, emp_{GR} is likely to be dominated by the component with the largest volatility. This leads ERW to the adoption of an ad-hoc "index of speculative pressure", in which all variables are (i) transformed in order to have equal conditional volatilities and (ii) added or substracted according to ERW's a priori's[3].

ERW deal with the second criticism by considering a set of three instruments instead of two, as in the measures of GR and Weymark. With Germany as the reference country, their emp-

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[3] ERW's preference of conditional over unconditional volatilities is not motivated but probably stems from the fact that they pool data over several countries as well as over various exchange rate regimes.

measure includes the rate of change of the bilateral exchange rate vis-à-vis the D-mark, the proportional change in reserves relative to Germany (as in equation 4) as well as the percentage change in the short-term interest rate differential with Germany.

In the next section we conduct a principal components analysis to derive an ad-hoc emp-measure consisting of three variables. This technique essentially finds uncorrelated linear combinations between a set of correlated (standardised) variables. The first linear combination or principal component explains the largest proportion of variance in the set of original variables.

When these variables are considered as partial measures of one concept, the first component is interpreted as an overall index, summarising the information contained in the original variables[4]. The technique therefore seems ideally suited to the problem at hand: we would like to summarise three partial emp-indicators into a single composite measure.

The similarity between this approach and the one adopted by ERW is that both cope with different volatilities/variances of the measure's components. Principal components achieves this by standardising all series prior to the analysis, ERW by applying volatility-smoothing weights.

We prefer the use of principal components analysis to ERW's approach because the former offers two additional advantages. Firstly, ERW set the weights of the transformed variables to unity or minus unity. With principal components analysis, the weights are data-determined, explaining the largest portion of system variance possible. Secondly, while ERW set the sign with which these transformed variables enter the index accor-

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[4] See Gorsuch (1983, p. 350-355) on the operationalization of constructs with the help of principal components or factor analysis.

ding to their a priori beliefs, principal components analysis delivers signed weights. It can then be verified whether these do or do not contradict our a priori's.

4. A principal components based emp-measure for Belgium: 1975-1994

Most of the data entering the Belgian emp-measure were taken from the IMF's International Financial Statistics on CD-Rom (see Data Appendix for details). The data are quarterly; the sample runs from 1975:1 to 1994:4 and is determined by data availability.

The depreciation rate series (Δe) is the percentage change of the end-of-period exchange rate of the Belgian franc vis-à-vis the D-mark[5]. First differences of the money market rate differential with Germany enter the index as $\Delta(i-i^*)$.

We use data on the change in the stock of international reserves of the Belgian monetary authorities as a proxy of exchange market intervention in defence of the exchange rate. This series is transactions-based, so there is no need to adjust it for valuation changes.

However, the series is modified to take into account the effect of government foreign borrowing. It is well known that the Belgian Treasury used to hand over its foreign currency receipts from foreign borrowing to the Belgian National Bank in exchange for BF base money. As an increase of international reserves arising from such operations does not reflect a strong position of the Belgian franc, we substract foreign borrowing from the published changes in reserves series (cf. Moore & O'Connell, 1992).

If other monetary authorities intervene to influence their

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[5] The dual exchange rate system was abolished in March 1990. We use the commercial rate, which is the rate targeted by the monetary authorities.

currency's rate vis-à-vis the Belgian franc, neglecting their activities would cause us to underestimate exchange market pressure in both directions. Two "solutions" to this problem have been offered in the literature.

One follows the GR-assumption that the home country is so unimportant that the rest of the world does not care to intervene in support of its currency and therefore neglects third country interventions.

The other is adopted by ERW. In their work on DM rates of several currencies, they calculate all countries' reserve changes relative to Germany's reserve change, arguing that ERM regulations make interventions at the margin compulsory and that Germany is the ERM's strong currency country[6]. However, ERW rightly point out that this is a very imperfect way of picking up other countries' interventions, because assigning all German intervention to the currency under examination is probably unwarranted. Furthermore, the effect of other countries' interventions is neglected still.

For lack of data, we use a unilateral measure of Belgian reserves changes (proportional to the inherited Belgian narrow money stock[7]): Δr.

Table 1 shows the results of conducting a principal components analysis of the three partial emp-measures[8]. The matrix of correlation coefficients reveals that one of the three coefficients is insignificantly different from zero. Bartlett's test is significant, rejecting the null that the

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[6] It is a bit odd, though, to give the same treatment to the non-ERM countries in ERW's sample, such as Canada and Australia.

[7] We use the money supply as a proxy for the money base, see Data Appendix.

[8] We use the FACTOR procedure in SPSS 5.0, which automatically standardises the variables.

matrix is the identity matrix (see e.g. Gorsuch, 1983, p. 149-150). Thus, a principal components analysis should make sense.

The first two principal components explain 76 percent of the total system variance; the proportion accounted for by the first component is 46 percent. The factor matrix shows each (standardised) variable as a linear combination of the principal components. The weights can be interpreted as correlations between the variables and the components. All variables have a highly significant loading on the first component.

Table 1: Principal components output

Correlation matrix

	Δe	Δr	Δ(i-i*)
Δe	1.00000		
Δr	-.21540**	1.00000	
Δ(i-i*)	.11894	-.23985**	1.00000

Bartlett's test of sphericity

χ^2 = 8.62760**

Component	Eigenvalue	Pct of Var	Cum Pct
1	1.38707	46.2	46.2
2	.88200	29.4	75.6
3	.73094	24.4	100.0

Factor matrix

	Component 1	Component 2	Component 3
Δe	.62154***	.70996***	.33114*
Δr	-.75357***	.05062	.65541***
Δ(i-i*)	.65794***	-.61270***	.43786**

Factor score coefficient matrix

	Component 1	Component 2	Component 3
Δe	.44809	.80494	.45304
Δr	-.54329	.05739	.89667
Δ(i-i*)	.47434	-.69467	.59904

Notes:
***, ** and * denote significance at the 1, 5 and 10 percent level respectively. Factor matrix: critical values are obtained using the third method described in Child (1970, p. 45-46 and his Appendix C), which takes into account the number of variables in the analysis as well as the number of the principal component, so that these values decrease with the variance of the component (two-tailed test).

The inverse of this matrix, the factor score coefficient matrix, tells us how to express each component as a linear

composite of the (standardised) variables[9]. The signs of the weights on the first are all in line with our a priori beliefs about how the partial measures should enter the overall emp-measure: both the exchange rate and interest rate variables contribute positively to the general index, while reserves accumulation influences it negatively.

For all these reasons, we think we can safely regard the first component as a general emp-measure[10]. The Belgian emp-measure thus becomes:

(7) $emp_{PC} = 0.44809\ \Delta e_{st} - 0.54329\ \Delta r_{st} + 0.47434\ \Delta(i - i^*)_{st}$

where the subsript "st" denotes a standardised variable. The emp_{PC}-index itself is also a standardised variable, with mean zero and standard deviation 1.

5. Comments on the Belgian emp-measure

The Belgian monetary authorities have always shown a strong preference for fixed exchange rates. After the breakdown of the Bretton Woods system Belgium participated fully and uninterruptedly in the European exchange rate arrangements set up to mitigate intra-European exchange rate variability, viz. the Snake Agreement (1972-78) and the European Monetary System (since 1979)[11].

According to Belgian policy makers, a small open economy like Belgium, whose international trade is highly dependent on the

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9 Alternatively, one could derive these weights as the entries in the factor matrix divided by the appropriate eigenvalue (Harman, 1976, p. 366).

10 According to the second component, the rate of depreciation of the domestic currency is negatively related to changes in the Belgian-German interest rate differential (and reserves changes are relatively unimportant, see factor matrix). This relationship might reflect the sensitivity of capital flows to interest rate changes: increasing interest rate differentails induce a capital inflow, leading to an appreciation.

11 See Table 3 in Appendix for the ERM history of the Belgian franc.

neighbouring European countries, has a lot to gain from exchange rate stability with these partners. This concern motivated the commitment to link the BF to the "strongest ERM currency", made public on June 16th, 1990. It also explains the determination and efforts of the Belgian government to belong to the core countries of the European Economic and Monetary Union (EMU).

The question arises, however, to what extent the fixed rate policy option has yielded low exchange market pressure. Figure 1, which shows the Belgian emp-measure in eq. (7), reveals that exchange market pressure has on certain occasions been quite high over the period 1975-1994. This holds especially for the beginning of the 1980s. Since then, emp has been reduced significantly, with the important exception of the 1993 EMS-crisis.

The same insight can be derived from table 2. Following Gros & Thygesen's (1992, p. 67-69) analysis of the working of the EMS we divide the entire sample period into five subperiods[12].

Table 2: Subperiods, average emp and crisis quarters

Period		Average emp	Proportion of crisis quarters
75:1-78:4	Snake period	-0.0805	2/16=0.125
79:1-83:1	'Turbulent start' of the ERM	0.5501	6/17=0.353
83:2-87:1	'Calmer intermediate phase'	-0.0406	3/16=0.188
87:2-90:2	'ERM without realignments'	-0.3209	1/13=0.077
90:3-94:4	Formal BF-DM link	-0.1626	1/18=0.056
75:1-94:4			13/80=0.163

Note: The terms in quotation marks are taken from Gros and Thygesen's (1992) ERM chronology.

[12] We added the (later part of the) Snake period to Gros & Thygesen's chronology. We also split the post 1987:1 period in two parts, with the break in June 1990 (official announcement of the BF-DM link).

The table reports average values of emp for each subperiod, together with the proportion of crisis quarters. We define a crisis quarter as one in which the measure of emp *positively* exceeds the average for the whole sample period by at least one standard deviation[13]. This enables us to identify 13 crisis quarters out of a total of 80 quarters.

The table confirms that the highest average level of emp and proportion of crisis quarters are situated in the 79:1-83:1 period. This was a turbulent period for the EMS as a whole. More specifically, the Belgian economy saw a significant worsening of the current account balance, a steady increase in the government deficit and a sharp increase in the unemployment rate (see OECD, 1988).

These imbalances arose in the wake of the first oil crisis. The deterioration of the terms of trade brought about a real impoverishment of the Belgian economy. Initially, in the Snake period, these disequilibria led to moderate exchange market pressure. The rigid wage formation process (automatic wage indexation) and the relatively generous social security system, however, soon seriously aggravated the problems of the Belgian economy. Accordingly, during the second subperiod, the adherence to a fixed exchange rate policy caused severe exchange market pressure, including a 8.5% devaluation of the BF in February 1982 (See Table 3 in Appendix).

The next ERM subperiod, 83:2-87:1 is regarded by Gros & Thygesen as a "calmer intermediate phase". On average, Belgian emp also proved much lower than before. This can be explained

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[13] The choice of one standard deviation around the mean is of course rather arbitrary. Setting the significance level at the more conventional 5 percent level (two standard errors), would reduce the number of crisis quarters over the whole period to a mere 3.
Recall that the emp_{PC}-measure is a standardised variable, so that the first (second) criterion identifies all points above the 1 (2) gridline in figure 1 as crisis quarters.

by the positive effects on the current account balance of the 1982 devaluation, together with a number of fiscal policy measures in 1984 and 1986 to correct the government budget deficit. As a consequence, from 1985 onwards, primary budget surpluses were realised. Further, with respect to wage formation, the government imposed a real wage freeze from 1982 until 1986. In the meantime, it had also introduced a so-called competitiveness norm that enabled it to interfere in the wage formation process.

Notwithstanding the marked decrease in emp relative to the previous period, confidence in the Belgian franc was still weak. Both the average emp-value and the relative occurrence of crises are higher than in the Snake period.

The ERM-phase "without realignments" covers the quarters from 87:2 to 90:2. Shortly after and as a reaction to the January 1987 realignment, the Basle-Nyborg agreement was concluded, aiming at closer coordination between monetary authorities in order to increase their ability to counter ERM tensions. ERM parities remained unchanged for almost 6 years (see Table 3 in Appendix)[14]. However, we set the end of this subperiod in 1990:2, in order to examine the effects of the official BF-DM link announced in June 1990.

This period is marked by a very low average emp-value and proportion of crisis quarters. It coincides with strong economic growth in Belgium, among other things in anticipation of the European 1992 project. This led to a substantial decrease of the (officially registered) unemployment rate from 11 % in 1987 to 7.2 % in 1990. Inflation remained very moderate.

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[14] In January 1990, when Italy joined the narrow ERM band, the lira was effectively devalued by 3.6774 percent, by keeping the upper intervention limit unchanged and raising the lower limit.

In these circumstances, the National Bank of Belgium switched from a soft currency to a hard currency policy. From mid-1987, the movements of its official interest rates mirrored those of Germany and the Netherlands (Weber, 1991). In contrast, new measures in the field of public finance were adopted hesitantly, leading to a mere stabilization of the government deficit. This is explained by a loosening of the fiscal retrenchment policy and by high interest payments (almost 10 % of GDP) on public debt (exceeding the level of GDP from 1983 onwards).

Exploiting the fact that inflation was so low, the government implemented a radicalization of its exchange rate policy in June 1990, by declaring its determination to link the Belgian franc more tightly to the "EMS anchor currency". In practice, this meant that the government committed itself not to change the central rate vis-à-vis the German mark any more and to stabilise the market rate within very narrow fluctuation margins[15]. This policy was part of an impressive package of measures directed towards the deregulation and modernization of the Belgian money and capital markets (e.g. abolishment of two-tier exchange market; reduction of withholding tax on interest income; new, more market-based monetary policy techniques, ...).

The results for the last subperiod should reveal whether this new policy was successful at further reducing market pressures. Table 2 shows that average emp increased relative to the previous period. However, this is due entirely to the effect of the 1993 ERM crisis. Without this peak in 1993:3, average emp would have been -0.3720, slightly lower than in the preceding period.

The intensity of the 1993 crisis can be inferred from the fact that the Belgian emp-measure reached a level in 1993:3 that

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[15] The width of this band was never made public, but it is believed to be ca. 0.3% around the parity with the DM.

was at no time realised in the preceding 10-year period and equalled the level in the devaluation quarter 1982:1. However, an important difference between both episodes is the length of the crisis. Whereas in 1981-82 high exchange market pressure was recorded during a number of consecutive quarters, the crisis of 1993:3 stands out as a single event.

By contrast, it is interesting to note that the ERM tensions from August till October 1992 are by no means reflected in the exchange market pressure measure, which proves that the Belgian franc was at no moment under speculative attack. On the contrary, the Belgian monetary authorities intervened massively in support of the weaker ERM currencies (OECD, 1994).

Taken together, these results seem to imply that, apart from the 1993 ERM-crisis, tensions in the Belgian foreign exchange market declined substantially from 1987 onwards. It would appear, however, that there was no *additional* emp-reducing effect from the formal BF-DM link since June 1990.

It is interesting to compare these results with empirical work on the credibility of Belgium's fixed exchange rate policy. Koedijk e.a. (1993) calculate weekly realignment probabilities over the period April 1979-July 1991. These become much smaller after the January 1987 realignment, pointing to increased credibility of the Belgian exchange rate policy after that date. Knot & De Haan (1995) apply Svensson's interest rate corridor tests to monthly data over the period 1980-91. They also conclude that there was a lack of short-run credibility before 1987. Because the samples in both papers end in 1991, they may fail to capture additional credibility effects of the formal BF-DM link. However, according to these authors, 1987 clearly marks a turning point in the credibility of Belgian exchange rate policy.

Halikias (1994), who also performs Svensson tests, finds that short run credibility cannot be rejected over the entire 1982-92 period. The same is true for long-run credibility from 1990 onwards, but only after adjusting the tests for the credit risk term incorporated in interest rate differentials. In contrast to the other two papers (and ours) Halikias's results thus suggest that establishing the formal BF-DM link in June 1990 was essential to gain (long-run) credibility.

5. SUMMARY

The original Girton-Roper model of exchange market pressure is too restrictive. Given the poor performance of fundamentals-based models of the exchange rate, attempts at deriving similar measures from more elaborated models are unlikely to provide reliable alternatives. As the necessary components of any such measure can be inferred from theory as well as practice, adopting an ad-hoc approach to combine these into an overall index of pressure seems a promising way out of the impasse. In this paper, we propose applying the technique of principal components to construct such a general measure.

Our application to Belgium (with Germany as the foreign country) shows that, apart from the general 1993 EMS crisis, the mid-1987 switch from a soft currency to a hard currency option by the Belgian authorities was effective in reducing exchange market tensions. Both the average pressure and relative occurrence of crises declined significantly. There does not seem to be an additional beneficial effect from the official link with the German mark announced in June 1990.

References

CHILD, Dennis (1970), *The essentials of factor analysis*, London, Holt, Rinehart and Winston, 107p.

COMMISSION OF THE EUROPEAN COMMUNITIES (1993), "The ERM in 1992", Study no. 3, *European Economy* no. 54, p. 139-157.

DEL GIOVANE, Paolo (1994), "The Defence of Exchange Rates in the EMS: Instruments and Strategies, 1987-1993", Banca d'Italia *Temi di discussione del Servio Studi* no. 228, 75p.

EICHENGREEN, Barry, Andrew K. ROSE and Charles WYPLOSZ (1994), "Speculative attacks on pegged exchange rates: an empirical exploration with special reference to the European Monetary System", *NBER Working Paper* no. 4898, 49p.

EICHENGREEN, Barry, Andrew K. ROSE and Charles WYPLOSZ (1995), "Exchange market mayhem: the antecedents and aftermath of speculative attacks", *Economic Policy*, no. 21 (October), p. 249-312.

FLOOD, Robert P. and Andrew K. ROSE (1993), "Fixing exchange rates: a virtual quest for fundamentals", *CEPR Discussion Paper* no. 838 (September), 23p.

GIRTON, Lance and Don ROPER (1977), "A Monetary Model of Exchange Market Pressure Applied to the Postwar Canadian Experience", *American Economic Review*, vol. 67, no. 4, p. 537-548.

GORSUCH, Richard L. (1983), *Factor Analysis*, Hillsdale (New Jersey), Erlbaum, 2nd ed., 425p.

GROS, Daniel and Niels THYGESEN (1992), *European Monetary Integration. From the European Monetary System to European Monetary Union*, London, Longman, 494p.

HACCHE, Graham and John C. TOWNEND (1981), "Monetary Models of Exchange Rates and Exchange Market Pressure: Some General Limitations and an Application to Sterling's Effective Rate", *Weltwirtschaftliches Archiv*, vol. 117, no. 4, p. 622-637.

HALIKIAS, Ioannis (1994), "Testing the Credibility of Belgium's Exchange Rate Policy", *IMF Staff Papers*, vol. 41, no. 2, p. 350-366.

HARMAN, Harry H. (1976), *Modern Factor Analysis*, Cicago, University of Chicago, 3rd ed., 487p.

KOEDIJK, Kess G., Philip A. STORK and Casper G. DE VRIES

(1993), "Between Realignments and Intervention: The Belgian Franc in the European Monetary System", *mimeo*, Tinbergen Instituut (Rotterdam), July, 23p.

KNOT, Klaas and Jakob DE HAAN (1995), "Interest rate differentials and exchange rate policies in Austria, the Netherlands and Belgium", *Journal of Banking and Finance*, vol. 19, p. 363-386.

MEESE, Richard A. and Kenneth ROGOFF (1983), "Empirical exchange rate models of the seventies. Do they fit out of sample?", *Journal of International Economics*, vol. 14, p. 3-24.

MOORE, Michael J. and Thomas O'CONNELL (1992), "Monetary Policy in Stage Two of EMU", *CEPR Discussion Paper* no. 616, 30p.

OECD (1988), *Why Economic Policies Change Course. Eleven Case Studies*, Paris, OECD, 122p.

OECD (1994), *Economic Surveys 1993-1994. Belgium-Luxembourg*, Paris, OECD, 145p.

WEBER, Axel (1991), "Reputation and Credibility in the European Monetary System", *Economic Policy*, April, p. 57-102.

WEYMARK, Diana N. (1995), "Estimating exchange market pressure and the degree of exchange market intervention for Canada", *Journal of International Economics*, vol. 39, p. 273-295.

Data Appendix

All series but one were taken from the IMF's International Financial Statistics (IFS) on CD-Rom. Data on the Belgian narrow money supply were provided by the National Bank of Belgium (NBB). The variables used in the graphs and principal components analysis are constructed as follows:

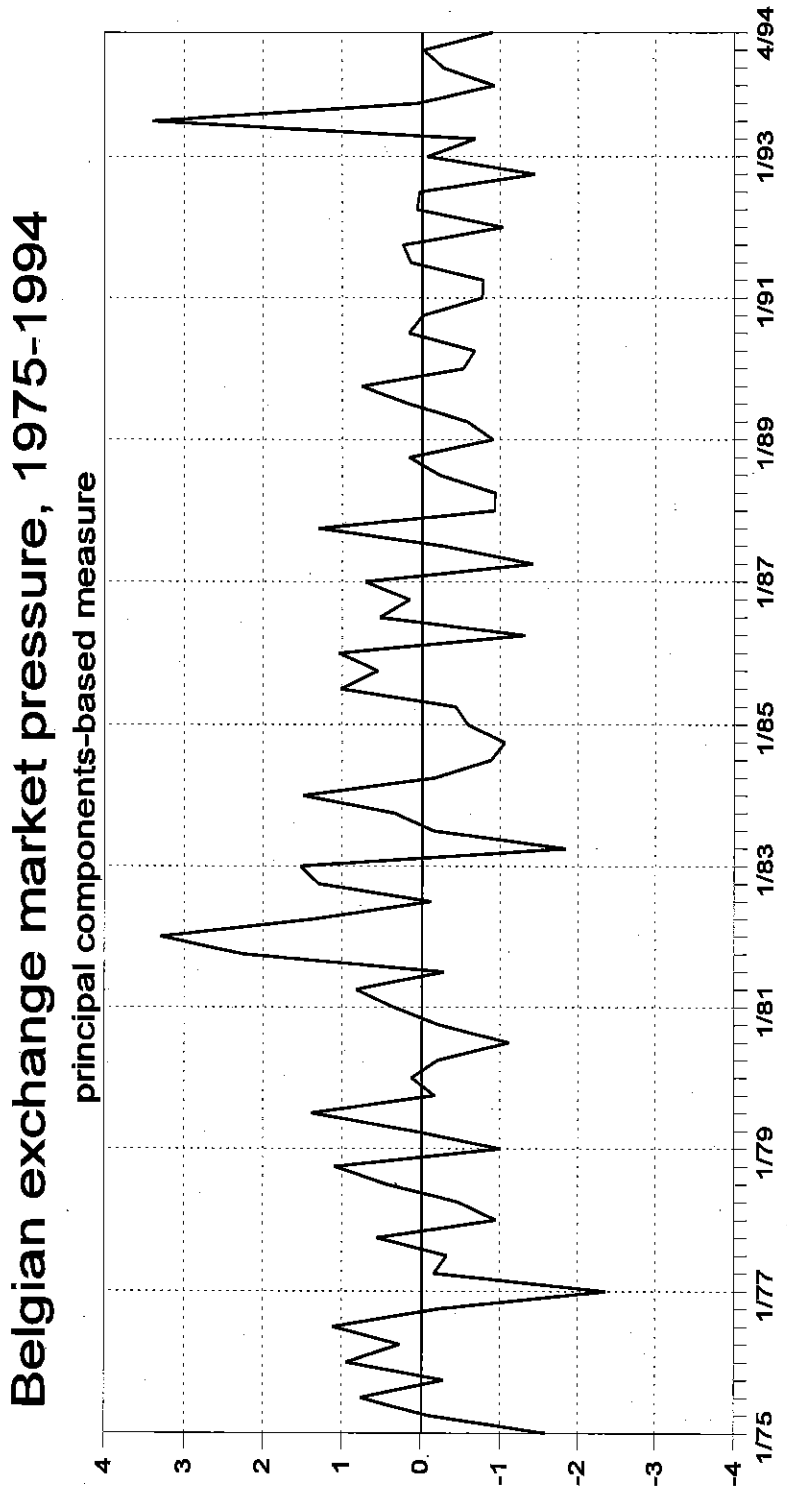
E	bilateral exchange rate of the Belgian franc vis-à-vis the D-mark, measured as the domestic currency price of one unit of foreign currency = cross rate implied by the bilateral end-of-period dollar rates for Belgium and Germany (in IFS-lines ae)
Δe	rate of depreciation of the Belgian franc vis-à-vis the D-mark = (quarter-to-quarter) percentage change of E
Δr	proportional change in Belgian international reserves, adjusted for government foreign borrowing = minus "financing of the balance of payments" (in U.S. dollar, IFS-line 79dad) minus the first difference of "central government foreign debt" (in Belgian franc, IFS-line 85a, converted to U.S. dollars by means of IFS-line ae); the whole was deflated by the seasonally-adjusted Belgian narrow money supply in the previous quarter (seasonally unadjusted in Belgian franc from the NBB, converted to U.S. dollar using IFS-line ae and seasonally adjusted with the SAMA command in TSP version 4.3)
i	Belgian short interest rate = Belgian money market rate (in IFS-line 60b)
Δi	change in the Belgian short interest rate = first difference of i
$(i-i^*)$	Belgian-German short interest rate differential = Belgian minus German money market rate (from IFS-lines 60b)
$\Delta(i-i^*)$	change in the Belgian-German short interest rate differential = first difference of $(i - i^*)$

Table 3: Realignments and changes in the ERM since 1979

		BFR	DKR	DM	DR	PTA	FF	IRL	LIT	HFL	ESC	UKL
13.3.79	The European Monetary System (EMS) starts with BFR/LFR, DKR, DM, FF, IRL, LIT, HFL and UKL. BFR/LFR, DKR, DM, FF, IRL, LIT and HFL participate in the exchange rate mechanism (ERM). They are in the narrow band (2.25% fluctuation) of the ERM, except the LIT in the wide band (6% fluctuation).											
24.9.79	**Realignment 1**	0	-3.00	+2.00	a	a	0	0	0	0	a	b
30.11.79	**Realignment 2**	0	-5.00	0	a	a	0	0	-6.00	0	a	b
23.3.81	**Realignment 3**	0	0	0	a	a	-3.00	0	-3.00	+5.50	a	b
5.10.81	**Realignment 4**	0	0	+5.50	a	a	-3.00	0	-3.00	+5.50	a	b
22.2.82	**Realignment 5**	-8.50	-3.00	0	a	a	0	0	0	0	a	b
14.6.82	**Realignment 6**	0	0	+4.25	a	a	-5.75	0	-2.75	+4.25	a	b
22.3.83	**Realignment 7**	+1.50	+2.50	+5.50	a	a	-2.50	-3.50	-2.50	+3.50	a	b
22.7.85	**Realignment 8**	+2.00	+2.00	+2.00	b	a	+2.00	+2.00	-6.00	+2.00	a	b
7.4.86	**Realignment 9**	+1.00	+1.00	+3.00	b	a	-3.00	0	0	+3.00	a	b
4.8.86	**Realignment 10**	0	0	0	b	a	0	-8.00	0	0	a	b
12.1.87	**Realignment 11**	+2.00	0	+3.00	b	a	0	0	0	+3.00	a	b
19.6.89	The peseta joins the EMS by entering into the wide band of the ERM.											
8.1.90	The Italian lira (formerly in the wide band of the ERM) joins the narrow band of the ERM.											
	Realignment 12	0	0	0	b	0	0	0	-3.6774	0	b	b
8.10.90	Pound sterling enters into the wide band of the ERM.											
6.4.92	The escudo enters into the wide band of the ERM.											
14.9.92	**Realignment 13**	+3.50	+3.50	+3.50	b	+3.50	+3.50	+3.50	-3.50	+3.50	+3.50	+3.50
17.9.92	Pound sterling and the Italian lira suspend their participation in the ERM.											
	Realignment 14	0	0	0	b	-5.00	0	0	b	0	0	b
23.11.92	**Realignment 15**	0	0	0	b	-6.00	0	0	b	0	-6.00	b
1.2.93	**Realignment 16**	0	0	0	b	0	0	-10.00	b	0	0	b
14.5.93	**Realignment 17**	0	0	0	b	-8.00	0	0	b	0	-6.50	b
2.8.93	The ERM fluctuation margins are widened to 15% (the German and Dutch authorities, however, mutually agree to maintain the 2.25% band between their currencies).											

Source: Commission of the European Communities, 1993, p. 157 and *European Economy, Supplement A*, various issues.
Notes: a = currency not in the EMS; b = currency not in the ERM.

Figure 1


Belgian exchange market pressure, 1975-1994
principal components-based measure
4
3
2
1
0
-1
-2
-3
-4
1/75
1/77
1/79
1/81
1/83
1/85
1/87
1/89
1/91
1/93
4/94

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