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A study of the credibility of the Spanish peseta

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Esta versión incluye todas las correcciones sugeridas por el evaluador, las cuales nos han parecido oportunas y por las que le quedamos muy agradecidos.

ABSTRACT

In this paper we study the credibility of the Spanish peseta since its entry in the European Monetary System (EMS) in June of 1989. To do this we estimate the conditional elasticities and the risk premia of the Spanish peseta and the German Mark. The index thus obtained shows less confidence in the system after the entry of the peseta. The periods which exhibit the lowest levels of credibility are October of 1990, after the entrance of the British pound into the EMS, and between September and November of 1992, with the devaluations of the peseta and the exit of the British pound and the Italian lira from the EMS. There also seems to be less credibility around March of 1995 with the devaluation of the peseta and at the end of March of 1996 after the last general elections in Spain.

Keywords: Foreign Exchange, International Monetary Arrangements and Institutions, Credibility, GARCH.

RESUMEN

En este trabajo se estudia la credibilidad de la peseta desde su entrada en el Sistema Monetario Europeo (SME) en junio de 1989. Para llevarlo a cabo se estiman las elasticidades condicionales y las primas de riesgo de la peseta y del marco alemán. El indicador obtenido muestra una menor confianza en el sistema tras la entrada de la peseta. Los periodos que exhiben los niveles de credibilidad más reducidos son los de octubre de 1990, después de la entrada de la libra esterlina en el SME, y entre septiembre y noviembre de 1992, con las devaluaciones de la peseta y las salidas de la lira italiana y la libra esterlina del SME. También parece haber una menor credibilidad alrededor de marzo de 1995,

con la última devaluación de la peseta, y al final de marzo de 1996, después de las elecciones generales.

Palabras clave: tipo de cambio, acuerdos monetarios internacionales, credibilidad, GARCH.

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1. Introduction

The aim of this paper is to study the credibility of the Spanish peseta since its entry in the European Monetary System (EMS) in June of 1989. To do this we estimate the conditional elasticities and the risk premia of the Spanish peseta and the German mark.

Credibility can be defined as the degree of acceptance by economic agents of the announcements made by economic policy makers. Thus there will be no credibility when private agents do not believe public announcements while there will be maximum credibility when they accept them. Applying this general concept to the EMS we associate it to the acceptance of the rules, i.e., to maintain the exchange rate around a central parity with respect to each currency, allowing the fluctuations of that rate within certain limits or bands.

All this is related to the loss of the exchange rate as an instrument of policy to attain real economic objectives. Hence, if the system is credible agents believe that when currencies are close to the bands the situation will generate the intervention of the central banks. Likewise if the system is credible, agents will look at central parities as fixed, not expecting realignments of bilateral exchange rates. If, on the contrary, the system is not credible there will be expectations of realignments.

The relevance of credibility for the EMS stems from the real effects it can have on economic policies. Thus it is argued that a country with a credible exchange rate, and a history of low inflation, may reduce the costs (in terms of production and employment) of a contractive economic policy.

In the last decade there have been, within the literature about exchange rates, many studies which have tried to measure the credibility of the Exchange Rate Mechanism (ERM) in the eyes of private agents. These works have used different measures: they go from the most descriptive and deterministic (as Svensson's simple test) to those which allow for nonlinearity in the behavior of exchange rates. All these studies have been carried out under the theoretical umbrella provided by the literature about exchange rate target zones. This literature has intended to model the behavior of fixed exchange rate systems, within adjustable bands.

This paper is organized as follows. Section 2 reviews a basic model of exchange rate target zones which is the analytical foundation for the bulk of the empirical studies. Section 3 briefly presents the index used in this paper to measure how agents perceive the ERM. Section 4 includes the results of the credibility measure employed in the present study. The last section draws the conclusions and points out future lines of research.

2. A basic model of exchange rate target zones

The research about exchange rate target zones that was developed in the early nineties has become a necessary reference for all the empirical studies on credibility. Krugman's (1991) seminal article provided the basic theoretical model upon which everbody has built in order to model a system of fixed exchange rates including adjustable bands. A more thorough presentation of these models can be found in Garber and Svensson (1995), De Arcangelis (1994) or Bertola and Caballero (1992).

This basic model can be summarized in the following three equations (where all the variables are in logs):

$$m_t - p_t = \boldsymbol{b}y_t - \boldsymbol{a}i_t + \boldsymbol{e}_t \qquad (1)$$

$$s_t = p_t - p_t^* + q_t \qquad (2)$$

$$E_t\left[{ds_t}/{dt} \right] = i_t - i_t^* \qquad (3)$$

The first equation presents the equilibrium condition in the money market, where m_t, p_t, i_t and y_t show the nominal money supply, prices, interest rate and income, respectively; ε_t is a random term in the demand for money. Equation (2) defines the real exchange rate qt, where st provides the nominal exchange rate, given as the number of national monetary units per unit of foreign currency. Equation (3) expresses the uncovered interest parity (UIP). The variables with * refer to foreign values and $E_t(.)$ denotes an expectation taken conditionally on the information available at time t.

Substituting (2) and (3) into (1) we obtain:

$$s_t = m_t + \boldsymbol{a}i_t^* + q_t - \boldsymbol{b}y_t - p_t^* - \boldsymbol{e}_t + \boldsymbol{a}E_t\left[\frac{ds_t}{dt}\right] \qquad (4)$$

where the first six terms are the fundamental component (f_t) of the exchange rate such that $s_t = f_t + \alpha E_t(ds_t/dt)$. Likewise, this component is defined as $f_t = m_t + v_t$, where m_t is the control variable used by the monetary authority, while v_t is the random element which is exogenously given to that authority. Thus, the central bank has influence on the exchange rate of its currency through the control of the nominal money supply. The velocity, v_t, is supposed to follow a Brownian motion (i.e. the continuous-time analog of a random walk) with a drift[1]. Under flexible exchange rates, the nominal

1. This assumption is common in the literature about exchange rates target zones.

money supply will keep unchanged and f_t will be characterized as a Brownian motion. In this case there will be a one-to-one linear relationship between the exchange rate and the fundamental component (Froot and Obstfeld, 1991).

The result is different when the exchange rate is limited by certain bands. Since the Krugman model assumes perfect credibility and marginal intervention by monetary authorities when the exchange rate moves close to the upper band agents will expect from them a reduction of the money supply. In this way, $E_t(ds_t/d_t)$ would be negative, pushing for a lower exchange rate and making it less sensitive to the fundamental than in the case of flexible exchange rates (when that expectation cannot exist). Hence, the exchange rate and the fundamental maintain an S-shaped relationship. In other words, the model of target zones predicts the existence of nonlinearlity in the exchange rate when there is perfect credibility and marginal interventions by the central banks. This relationship between the exchange rate and the fundamental with a slope of less than one makes for a wider range of possible values (than in the case of flexible rates) where f_t can be found. The existence of bands has stabilizing consequences known as the *honeymoon* effect.

Krugman's basic model has been extended in two ways allowing, on one hand, for imperfect credibility and, on the other, for intramarginal interventions. The observation of repeated realignments of EMS central parities made by Bertola and Caballero (1992) introduced the random risk of realignment into the Krugman model. This introduction improved the predictive ability of the model allowing, for instance, for a positive relationship between the interest rate differential and the exchange rate. Moreover, the modified model explained the way in which expectations could force the exchange rate to move outside the bands, making for an unstable system.

Taking into account intramarginal interventions contributes to explain the prediction error of the Krugman model. The latter assumes that the exchange rate has a U-shaped distribution, i.e., with the bulk of the observations near the edges of the bands. In this case, the intramarginal interventions produce a honeymoon effect even though there are no bands, since they create expectations that weaken the relationship between the exchange rate and the fundamental (Garber and Svensson, 1995). The intervention in the edges of the bands amplifies a little bit the *honeymoon* effect, and the S-shaped form is less pronourced than in the Krugman model. Thus when there are interior interventions which imply a reversion to the mean (central parity), the model predicts the empirical distribution is hump-shaped and the relation between the exchange rate and the fundamental becomes more linear.

3. The credibility of the EMS

There are at least two important implications of the exchange rate target zones model for the empirical analysis of credibility. In the first place, it seems relevant to study the degree of credibility of agents with respect to EMS since the results of the model are sensitive to it. Secondly, it affects not only the relationship between the interest rate differential and the exchange rate but also the linearity or nonlinearity of the exchange function with respect to the fundamental, and thus the correct type of measure which should be used to capture the credibility of the EMS.

In the basic model of exchange rate target zones we can observe the existence of nonlinearities in the relationship between the exchange rate and its fundamental component. Nevertheless, the nonlinearities can become smoother when we allow for intramarginal interventions and imperfect credibility. The economic theory which is behind the choice between a linear strategy or a nonlinear approach is not clearly defined. The superiority of one over the other depends, among other things, on the credibility variable, giving rise to some kind of circular reasoning: the theory tells us that the approach, linear or nonlinear, depends on the degree of the credibility, and when we want to measure that credibility we have to decide about the linearity of the exchange rate (Ledesma *et al.*, 1998).

The use of models with heteroscedastic variance has been mainly done in the estimation of the expectations of depreciation within the bands in the drift adjustment method. Nevertheless, the results obtained in many cases are quite implausible (Lindberg, Söderlind and Svensson, 1993).

A different approach was followed by Malliaropulos (1995), with the objective of studying agents perceptions of the degree of integration of several currencies. Malliaropulos procedure provided an index of credibility based on the calculation of the conditional covariances and variances of the returns associated to the exchange rates. Moreover, the estimation of a GARCH-M model permitted the determination of the risk premia.

In the present paper we use a similar strategy to the one employed by Malliaropulos. In our approach, the study of credibility is carried out attending to the evolution of credibility of daily exchange rates. In particular, if agents expect that any change in the parity of currency B with respect to currency A will be replicated in an exact proportional variation in C with respect to A, then these agents believe in a system of fixed exchange rates among the currencies considered. On the contrary, when the anticipated changes do not coincide the weakening of one currency and the relative strenghtening of the other would be expected. Thus, following Malliaropulos, we calculate a conditional elasticity index which intends to measure the degree of integration of the system as perceived by the agents.

Volatility has important consequences within the field of international finance (asset valuation, management of international portfolios, hedging, etc.). Thus, volatility has been modeled through the processes defined by Engle (1982) and has been extended by Bollerslev (1986), through GARCH techniques, with different approaches such as McCurdy and Morgan (1988, 1991), Hsieh (1989), Baillie and Bollerslev (1989),

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in a uniequational context. Nevertheless, and due to the weak results obtained using those models, in the present study we have used multiequational specifications. In general, these usually consider that the joint dynamic evolution of returns and volatilities is determined through vectorial autoregressive specifications for the returns and multivariate specifications for conditional volatilities.

Bollerslev (1990) found, when he studied the effect of volatility upon short-run exchange rates just after the creation of the EMS, that after 1979 both the variance and the conditional covariance among the different exchange rates increased. More recently, Bekaert (1995), Alexander (1995) and Malliaropulos (1995) have analyzed, though with different goals, the temporary variation of expected returns and the volatility in currency markets. In particular, Bekaert (1995) found that future exchange rates were better predicted by the spot rates, something which is not in accordance with the premise that exchange rates follow a random walk. On the other hand, Malliaropulos (1995) studied the behavior of risk premia for several European currencies with respect to the US dollar and found the existence of positive premia in all of them.

Defining s_{1t} as the log of the exchange rate of the Spanish peseta with respect to a currency of reference (cr) and s_{it} as the log of the ith exchange rate with respect to cr, then the anticipated exchange rate of the ith currency is related to the expected exchange rate of the peseta/cr according to:

$$E_{t-1}\left(s_{it}\right) - s_{it-1} = \boldsymbol{b}_{it}\,[\,E_{t-1}\left(s_{1t}\right) - s_{1t-1}\,] \qquad (5)$$

where $E_{t-1}(.)$ is the conditional expectation of the agents to the information available in t-1, and β_{it} is the conditional elasticity of the ith exchange rate with respect to the peseta/cr. Multiplying both sides of equation (5) by $E_{t-1}(s_{1t})$-s_{1t-1} we obtain:

$$\boldsymbol{b}_{it} = \frac{cov_{t-1}\left(\Delta s_{1t}, \Delta s_{it}\right)}{var_{t-1}\left(\Delta s_{1t}\right)} = \frac{h_{1it}}{h_{11t}} \qquad (6)$$

where $h_{1i,t}$ is the conditional covariance of the variation of the log of the ith exchange rate with respect to the peseta/cr (both measures derived from the information available in t-1).

The meaning of β_{it} can be summarized in the following points:

a) If $\beta_{it} = 1$ then the EMS is a system of fixed exchange rates, and there is perfect credibility.

b) If $0 < \beta_{it} < 1$ then an expected depreciation of the cr with respect to the Spanish peseta will be associated with a less than proporcional anticipated depreciation of the cr against the ith rate. In this way, if we expect a strenghtening of the peseta against cr then the same will occur against the other currencies of the EMS. The contrary will occur if we anticipate a weakening of the peseta with respect to the cr.

c) If $\beta_{it} > 1$ then cr will be expected to appreciate more against the ith exchange rate than against the peseta. This will produce a strengthening of the peseta in the EMS.

Furthermore, if we assume that agents exhibit rational expectations we can say that:

$$s_{it} = E_{t-1}\left(s_{it}\right) + \boldsymbol{e}_{it} \qquad (7)$$

This assumption will be captured by the model we are going to estimate in such a way that the prediction error by agents, ε_{it}, will be the difference between the actual and the expected values. Following Malliaropulos (1995), the equation to be estimated will be:

$$\Delta\, s_{it} = g\, h_{1i,t} + \boldsymbol{e}_{it} \qquad (8)$$

where γ is the "risk price", and $h_{1i,t}$ is the conditional covariance between the peseta/cr and the ith exchange rate with respect to the cr. When i is equal to 1, $h_{11,t}$ refers to the conditional variance of the peseta/cr. The risk premium of each currency with respect to cr is the result of multiplying both elements.

In this paper we have estimated the conditional elasticities and the risk premia of the Spanish peseta and the German mark since the entrance of the peseta in the EMS.

4. Data and estimation of the credibility

The data on three-months interest rates and exchange rates were provided by Banco de España for the period going from June 19, 1989, i.e., the day of the entrance of the Spanish peseta into the EMS, to May 8, 1997. We have also considered two subperiods, before and after August of 1993 when the bands were widened from 6% to 15%.

We now present the results of the GARCH estimation carried out in order to obtain a measure of the degree of integration of European currencies as perceived by economic agents. The idea of integration refers to the agents belief in the proportional variations in the rates of return of the currencies of the EMS.

As we saw in section 3 this technique requires choosin a currency of reference (cr) in order to study the proporcionality in the movements of two currencies. The natural candidate as cr would have been the German mark, but the method does not allow the study of the cr in its relations to the rest of the currencies. Thus, we chose the Dutch guilder since this currency exhibited a behavior similar to the mark. This procedure has permitted the study of the expected variation of the peseta with respect to the mark from the estimations of the conditional elasticity β[2]. To estimate the conditional elasticity we have used a bivariate model showing the dynamic behavior of the conditional volatility Ω_t, due to Baba, Engle, Kraft and Kroner (BEKK, 1991). In this way, the matrix of conditional variances and covariances of errors ε_t in equation (8) is modelled as a GARCH (1,1)-M multivariate process, and can be expressed as:

$$\Omega_t = C'C + A' U_t U_{t'} A + G' \Omega_{t-1} G \qquad (9)$$

where $U_t = [\varepsilon_{1t} \varepsilon_{2t}]$ and C, A and G are 2x2 matrices of unknown parameters.

Equations (8) and (9) are estimated by maximum likelihood, where the likelihood log is equal to:

$$\ln L = f - \sum_{t=1}^{T} |\Omega_t| - \frac{1}{2} U'_t \, \Omega_{t-1}^{-1} U_t \qquad (10)$$

where f is a constant and we are assumming conditional normality.

In the analyzed period we have detected some outliers which were influencing the regression carried out on the exchange rate log. Hence to capture the effect of outliers we have included some dummy variables in the estimation. The results show that the exchange rates present asymmetry to the left and leptokurtosis as well as a low level of positive correlation between them.

The estimations were carried out using the BHHH algorithm. The model specification is a VAR(m) and can be expressed by:

$$\begin{aligned} \Delta s_{1t} &= \sum_{t=1}^{`p} \Theta_{1i} D_{it} + gh_{11t} \sum_{j=1}^{m} \Phi_{1j} \Delta s_{1t-j} + \sum_{j01}^{m} a_{1j} \Delta s_{2t-j} \\ \Delta s_{2t} &= \sum_{t=1}^{`p} \Theta_{2i} D_{it} + gh_{12t} \sum_{j=1}^{m} \Phi_{2j} \Delta s_{1t-j} + \sum_{j01}^{m} a_{2j} \Delta s_{2t-j} \end{aligned} \qquad (11)$$

where s_1 and s_2 are the peseta/guilder and the mark/guilder exchange rates, respectively, the D variables are dummies and their parameters as well as the rest of the parameters have to be estimated. In this way, we have jointly estimated equations

2. Furthermore we have carried out an analysis of the Spanish peseta, French franc, and British pound, with respect to the German mark for a different sample period. In future research we want to replicate these estimations for the period studied in this paper.

(9) and (11). We have also estimated the conditional variances and covariances for the peseta/guilder and the mark/guilder[3]. The results presented in table 1 show that the estimation residuals are not normally distributed (using the Bera and Jarque criterium) with ARCH effects since there is structure in the squared residuals (LP2(12)). Moreover, the Lagrange Multiplier test upon those residuals shows a heteroscedastic variance.

In the estimation of equations (9) and (11), presented in table 2, we have included some dummy variables which correspond to the last days of September 1992, when the peseta was devaluated and the British pound and the Italian lira left the EMS. The parameters of the dummy variables are significant. Nevertheless the estimated coefficient g is negative and non-significant in both estimated models.

As it is shown in table 3, the estimation of the BEKK model clearly shows that the multiequational ARCH effects are significant for many parameters: a_{11}, a_{22} and g_{11} for the complete period; a_{11} and g_{11} for subperiod I, and a_{11}, a_{22} and g_{11} for subperiod II[4]. They also verify the restrictions of non-negativity and the conditions of stationarity, even though they are close to integrability in variance given the existence of periods with strong volatility.

Once we have valued the estimated model we build the conditional elasticity. A look at figure 1 (and at table 4, that presents the correspondence between the abscissa numbers and the dates) shows that the value of β_{it} is not centered around 1. Nevertheless, we cannot appreciate clear trends, the mean being between 0 and 1, but closer to 0, and in some cases taking a negative value. This last element points out the existence at the time of important asymmetries in the expected evolution of the variation rates of the peseta/guilder and the mark/guilder, which led to periods of strong instability of the system[5].

The values close to zero indicate that the expected appreciation of the guilder with respect to the peseta was associated with smaller appreciations with respect to the mark. Hence, a weakening of the peseta in relation to the mark was anticipated. On the other hand, the negative values correspond to periods of lack of credibility. Thus, we observe some negative values after the entrance of the peseta into the EMS. Negative values also appear in October of 1990, after the entry of the British pound into the ERM, and between September and November of 1992 detecting the profound crisis of the system. There also seems to be less credibility around March of 1995

3. To choose the length of the VAR, we used the following: the likelyhood ratio test, as well as the Akaike and the Schwarz criteria.

4. Parameters c_{ij}, a_{ij} and g_{ij} correspond to the elements of row i and column j of matrices C'C, A and G, respectively.

5. Due to these assymmetries some alternative strategies (to the one used in this paper), such as Threshold ARCH (TARCH) and Exponential GARCH (EGARCH) models, may be of interest to follow.

with the devaluation of the peseta as well as at the end of March of 1996 after the general elections in Spain and just before the agreement of the Popular party with several regional parties.

Figures 2 and 3 present the evolution of risk premia of the currencies studied, showing that these are very small for the two currencies. This is a confirmation of both the theoretical results obtained by Svensson (1992) and their empirical values reached by Ayuso and Restoy (1992). However there are some relatively great values around the events mentioned before.

5. Conclusions and future lines of research

In this paper we study the credibility of the peseta/mark exchange rate since the entry of the peseta into the EMS. We estimate the conditional elasticities and the risk premia of the Spanish peseta and the German mark. In general, although with some exceptions, this index shows, on one hand, a lower level of confidence in the system after the entry of the peseta into the EMS and, on the other, a worsening in the credibility level at the time of the entrance of new currencies into the EMS. Moreover, the subsequent periods which exhibit the lowest levels of credibility are September and November of 1992 (with the devaluations of the peseta and the exit of the British pound and the Italian lira from the EMS), and the first months of 1995 leading to the last devaluation of the peseta in March of that year. There also seems to be less credibility around March of 1996 after the last general elections in Spain.

Apart from these general conclusions, it is also possible to point out that the conditional elasticity measure is too sensitive and at the end it is extremely complex to obtain clear inferences about the evolution of the degree of credibility of the Spanish peseta.

With respect to future lines of research, we are planning to consider the Hamilton estimation in order to obtain another measure of credibility. Furthermore, we would like to analyze the degree of prior detection of unstable periods through the conditional elasticity index and other measures. In this way, we will be able to study the "credibility of the credibility measures".

Figure 1

β_t Complete Period

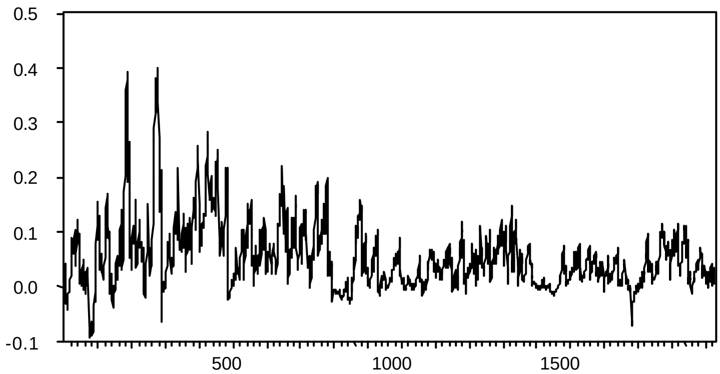

Figure 2

Risk Premium (Spanish Peseta). Complete period

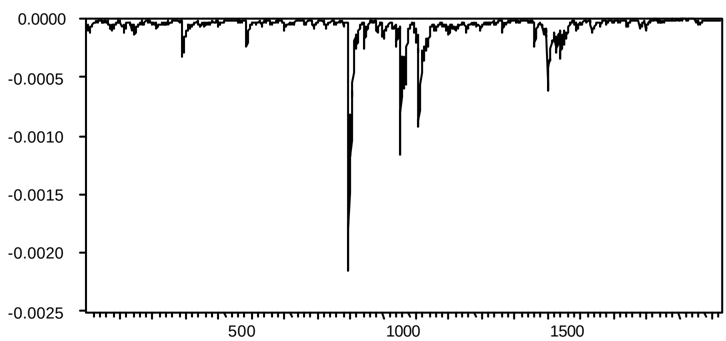

Figure 3

Risk Premium (German Mark). Complete period

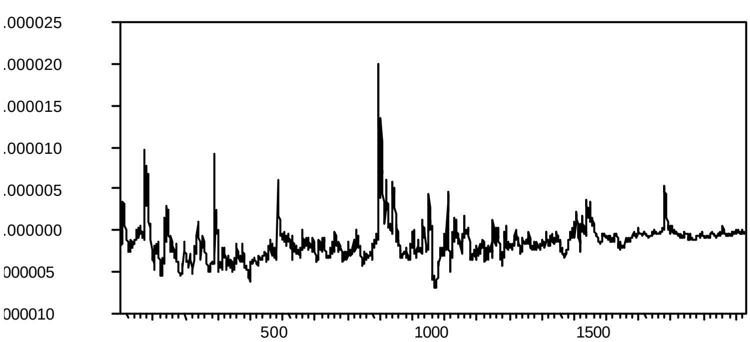

Table 1. Test of the squared errors obtained from equations (11)

	BJ	ARCH(1)	ARCH(12)	A	K	LB(12)	$LB_2(12)$
Complete Period							
Equation 1	480.30	168.20	221.61	1.983	27.13	22.568	285.32
	[0.00]	[0.00]	[0.00]			[0.03]	[0.00]
Equation 2	400.65	22.635	132.9	-0.022	5.233	17.700	145.2
	[0.00]	[0.00]	[0.00]			[0.06]	[0.00]
Subperiod I							
Equation 1	459.9	87.810	120.95	3.374	35.43	14.906	143.70
	[0.00]	[0.00]	[0.00]			[0.24]	[0.00]
Equation 2	85.076	4.089	39.864	-0.083	4.415	9.723	41.314
	[0.00]	[0.04]	[0.00]			[0.28]	[0.00]
Subperiod II							
Equation 1	319.21	99.584	127.95	-0.020	12.12	19.934	199.91
	[0.00]	[0.00]	[0.00]			[0.13]	[0.00]
Equation 2	45.279	4.2195	53.164	0.269	3.942	20.543	78.439
	[0.00]	[0.00]	[0.00]			[0.02]	[0.00]

Note: The p-values are in parentheses. BJ is the Jarque and Bera normality test (null hypothesis of normality), ARCH(1) and ARCH(12) are the values of the Lagrange Multiplier applied on the residuals, A is the asymmetry, K is the kurtosis, LB(12) is the Ljung-Box statistic for 12 lags and LB2(12) is the Ljung-Box statistic for 12 lags of the squared residuals.

Table 2. Estimation of the parameters of equations (11) with a specification VAR(1)-GARCH(1,1)-M with dummy variables.

	D3601	D3602	D3603	s_{1t-1}	s_{2t-1}	γ
Model I						
Eq1	0.0095	-0.0437	0.0302	0.1563	-0.2882	-5.5390
	(2.84)	(-12.9)	(8.63)	(6.99)	(-3.31)	(-0.07)
Eq2	-0.0030	0.0025	-0.0005	-0.0180	-0.4332	
	(-0.42)	(3.18)	(-0.06)	(-3.42)	(-21.1)	
Subperiod I						
Eq1	0.0095	-0.0436	0.0296	0.1437	-0.2607	-2.7552
	(2.71)	(-12.3)	(7.83)	(4.61)	(-2.48)	(-0.02)
Eq2	-0.0003	0.0026	-0.0004	-0.0285	-0.4400	
	(-0.35)	(2.75)	(-0.47)	(-3.40)	(-15.6)	
Subperiod II						
Eq1	—	—	—	0.1722	-0.3613	-6.4471
				(5.37)	(-2.16)	(-0.06)
Eq2	—	—	—	-0.0042	-0.4010	
				(-0.71)	(-13.3)	

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Table 3. VAR(1)-GARCH(1,1)-M estimation.

Parameters	*Period 1989-1997*	*Subperiod I*	*Subperiod II*
c_1	0.0004	0.0010	-0.0004
	(1.17)	(0.26)	(-1.19)
c_2	-7.34e-6	0.0009	0.0000
	(-0.06)	(0.18)	(0.00)
c_3	1.54e-7	0.0000	0.0003
	(0.23)	(0.00)	(0.19)
a_{11}	0.9110	0.8157	0.8998
	(13.9)	(2.58)	(10.6)
a_{12}	8.19e-7	-0.0193	0.0018
	(0.06)	-0.14)	(0.07)
a_{21}	0.1080	-1.0917	0.0866
	(0.93)	(-0.13)	(0.21)
a_{22}	0.9930	0.3429	0.9919
	(48.6)	(0.10)	(21.2)
g_{11}	0.4010	0.4927	0.4222
	(3.19)	(1.63)	(2.35)
g_{12}	-3.79e-3	0.0203	-0.0077
	(-0.10)	(0.15)	(-0.12)
g_{21}	0.2620	0.4466	0.0856
	(0.89)	(0.49)	(0.23)
g_{22}	-0.1070	0.1403	-0.0927
	(-0.92)	(0.22)	(-0.36)

Table 4. Correspondence between abscissa numbers and dates

1	250	500	750	1000	1250	1500	1750	1930
6/19/89	6/25/90	7/4/91	7/13/92	7/19/93	7/22/94	8/2/95	8/9/96	5/8/97

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