Volatility in Spanish financial markets: the recent experience

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Introduction

The last two decades have witnessed a tremendous revolution in financial markets. The as yet unfinished processes of deregulation of domestic financial markets, liberalisation of international capital flows and financial innovation, together with the development of rapid and sophisticated computer and telecommunications networks, have made financial markets more global and international than ever before. The economic benefits of this revolution are unquestionable: financial markets are now more able to ensure an efficient allocation of resources by offering investors broader opportunities, lower costs and more effective financial risk management.

However, there is a general perception, mostly among investors and politicians, that the volatility of financial prices is higher now than in previous periods and some have linked this increase to the above-mentioned processes of internationalisation, globalisation and innovation. This perception has been heightened by the observation, at an international level, of episodes of high volatility such as the 1987 stock market crash, the 1992-93 ERM crises, the 1994 international bond prices rally and the 1994-95 Mexican peso crises.

Economists have offered several - not always well proven - explanations of the undesirable economic consequences of higher financial volatility. Volatility matters because investors are concerned about the uncertainty of their future wealth. In this context, higher volatility may increase the prospects of incurring unforeseen future losses. If an episode of high volatility is observed, investors may lose confidence in financial markets, seeing financial asset prices buffeted by excessive swings unwarranted by changes in economic fundamentals or expectations about them. This lack of confidence may lead to an increase in risk premia and (or) to a shift in investors' funds to less risky assets with a concomitant reduction in the liquidity of risky assets markets, which would imply higher transaction costs. The solvency of the financial system may also be threatened, since an increase in interest rate volatility can lead to liquidity problems for financial intermediaries with maturity mismatches between assets and liabilities. Furthermore, the increase in risk premia and in transaction costs may tend to raise the cost of funding investment projects, thus discouraging both domestic and foreign direct investment. International capital flows may be reduced and, moreover, the growth of world trade may slow since the greater uncertainty would tend to raise the price volatility of internationally traded goods.

The concern about an increase in financial volatility and the perception that volatility is undesirable have led to several policy proposals to deal with it. These proposals can be classified in two broad groups: those implying tougher market regulation and those implying greater policy coordination. The first group of proposals is generally based on the notion that speculation, which has been enhanced by financial innovation and by the internationalisation and globalisation of securities markets, can exacerbate price movements. The second group of proposals is based on the notion that changes in expectations play an important role in how financial prices move, so that uncertainty about macroeconomic policies, non-credible targets and policy inconsistencies across countries is rather destabilising. In any case, to have confidence in any of these proposals it is crucial to analyse, first, whether financial price volatility has change remarkably over time, and, second, whether the factors that the proposals seek to modify have, in effect, conditioned such changes in volatility.

In this paper we present evidence on these issues focusing on the Spanish experience. Spanish financial markets are an interesting case study. Although they have developed but relatively recently, they have quickly and effectively become part of the general processes of innovation, globalisation and internationalisation. Also, there have been major economic policy changes affecting the Spanish financial arena, such as the entry, in 1989, of the peseta into the Exchange Rate Mechanism (ERM) of the European Monetary System (EMS) or the opening of derivatives markets in 1990. At present, Spanish financial markets are substantially integrated at the international level, and the important role played by foreign investors testifies to this. Consequently, Spanish financial markets have suffered, on occasions quite severely, the international episodes of financial price swings mentioned above, with the concomitant concern about volatility and how to deal with it.

Our first goal in the paper is to identify the main features of recent volatility in the four major Spanish financial markets (the stock, public debt, interbank deposit and foreign exchange markets) during the period for which data are available, namely January 1988-July 1995. In this connection, we test whether price volatility is characterised by a specific trend, as would be the case if higher volatility were the cost of the aforementioned processes. Also, we examine the degree of volatility persistence and potential common patterns in the various markets. This analysis of the general characteristics of volatility, interesting by itself, will help us in our second goal of studying the impact on financial volatility of some of the most significant events that have occurred in recent years; in particular, the modifications in the peseta exchange rate regime and the opening of futures and options markets in 1990. The findings of these analyses will act as a basis for evaluating policy proposals to curb the volatility affecting exchange rates and derivatives markets.

The paper is organised as follows. Section 1 discusses how volatility should be measured, distinguishing between prices not controlled by policy actions and prices that are, such as the peseta exchange rate since ERM entry. Section 2 studies the general characteristics observed in price volatility in the above-mentioned markets. Section 3 discusses the effect on exchange rate risk of the major recent modifications in the peseta exchange rate regime, and the effect of derivatives trading on price volatility in the underlying spot market. The final section summarises the main findings.

1. How to measure volatility

The common practice in recent financial literature is to measure the volatility associated with the movement of a variable x_t between t and $t+\tau$, i.e. risk, by its conditional variance:

$$h_t \equiv V_t\left[x_{t+\tau}\right] \equiv E_t\left[x_{t+\tau} - E_t(x_{t+\tau})\right]^2, \tag{1}$$

where E_t is the conditional (on information available at time t) expectation operator.

Note that it is the risk perceived by agents which determines their decisions and which, therefore, could have the negative implications mentioned in terms of deterring financial and real flows. In this sense, any measure of volatility must satisfy two requirements. First, it must not reflect all the fluctuations of the series, since those which are foreseeable cannot be a source of risk. And second, it should take into account agents' perception about this future uncertainty, i.e. the expected variability of the unanticipated component of the series. Thus, the advantage of using the proposed measure instead of others such as the unconditional variance is clear.

Consequently, in order to measure the relevant concept of volatility, a model for the conditional mean of the variable is needed. In this paper, we follow the standard approach for financial series, i.e. univariate models. This is because they enable us to draw on the availability of daily data; and because, in general, structural models which incorporate variables observed with lower frequencies have not improved the predictions of univariate models.

Nevertheless, it is important at this point to differentiate variables which can fluctuate freely from others that are controlled by the authorities, who defend a certain regime to which they have committed themselves. For the latter kind of variables, we should take into account not only the observed evolution of the series, but also agents' perception about a possible change in the process followed by the variable due to a change in the regime established by the authorities. If agents consider that the process is likely to change, even though this might not be confirmed later and would therefore not be reflected in the data, the past of the series cannot give an accurate measurement of expectations. As Ayuso, Pérez-Jurado and Restoy (1994) demonstrate, the traditional measure of volatility should be corrected when there is not perfect credibility of the fluctuation regime to take into account this "peso problem".[1] Thus, assume that the controlled series $y_{t+\tau}$ follows a process with conditional mean, at t, μ_t^1, and conditional variance h_t^w. However, agents assigned, at t, a probability p_t to the fact that the regime will change so that $y_{t+\tau}$ will follow another process with a different conditional mean μ_t^2. The corrected measure of risk, derived in the appendix, takes the form:

$$V_t(y_{t+\tau}) = h_t^w + p_t d_t (d_t - p_t d_t), \tag{2}$$

where $$d_t \equiv \mu_t^2 - \mu_t^1 \tag{3}$$

is the expected jump in the conditional mean when the process changes.[2]

Therefore, if a change of regime is expected with a positive probability, the conditional variance of the exchange rate has two components. The first one is the *within-the-regime* conditional variance h_t^w (the conditional variance when regime changes are not taken into account). The second component measures the effect on the risk arising from the possibility of a change in the conditional mean of the process. Several features of the second component are worth commenting on. On the one hand, if credibility is imperfect (p_t>0), the second component is always positive. In such a case, the conditional volatility based only on the observed evolution of the series, i.e. the within-the-regime conditional variance, underestimates unambiguously the risk which agents associate with its future evolution. On the other hand, the higher the absolute expected variation of the conditional mean, the higher the correction term that should be added to the within-the-regime volatility. Finally, the correction term is not monotonic in p_t, reaching a maximum for p_t=0.5, given μ_t^1 and μ_t^2. The intuition of this result is clear: the situation of highest uncertainty about the future is that in which the agents assign the same probability to the maintenance of the current regime and to the jump to the alternative.

To obtain h_t, for free floating variables, and h_t^w, for controlled variables, we follow the standard ARCH methodology, originally proposed by Engle (1982) and generalised by several authors.[3] This methodology has proved to be appropriate to measure conditional variances of financial series. Specifically, we will use the model proposed by Glosten, Jagannathan and Runkle, 1993 (GJR in what follows):

$$\varepsilon_{t+1} = y_{t+1} - E_t(y_{t+1}) \text{ and } \varepsilon_{t+1/t} \sim N(0,h_t)$$

$$h_t = \alpha_o + \sum_{i=1}^{p} (\alpha_i \varepsilon_{t-i+1}^2 + \gamma_i S_{t-i+1}^- \varepsilon_{t-i+1}^2) + \sum_{i=1}^{q} \beta_i h_{t-i} \tag{4}$$

$$S_t^- = \begin{matrix} 1, \; if\, \varepsilon_t < 0 \\ 0, \; if\, \varepsilon_t \geq 0. \end{matrix}$$

1 The name is due to the fact that this problem was first analysed for the Mexican peso exchange rate vis-à-vis the dollar (see Krasker, 1980).

2 Notice that in this case the change is characterised only by a jump in the mean. For a more general case see Ayuso et al. (1994).

3 Bollerslev, Chou and Kroner (1992) and Engle and Ng (1993) review the different models that have been developed within this methodology.

Under the different alternatives included in the ARCH family of models the one chosen has two principal advantages. First, being sufficiently general (the GARCH models are a particular case in point), it imposes linearity. Linearity allows us to compute volatility at horizons longer than one day from the estimates obtained with daily data. This notably increases our sample size. Second, the inclusion of $S_{t-1}^{-}\varepsilon_{t-i}^{2}$ allows for different responses of volatility to positive and negative innovations. Therefore, it is possible to test whether volatility is more sensitive to financial price falls than to financial price rises. This asymmetry, common in other financial markets, should be reflected in a positive value of the coefficients γ_i.

With regard to the correction term that should be added to h_t^w in the case of controlled variables, the methodology should naturally be specific to each case. In principle, the exchange rate and the interbank rate are examples of variables that are controlled - at least partially - by policy actions. Nevertheless, the empirical relevance of the peso problem for measuring interest rate risk depends on the distance between the maturity analysed and that corresponding to the interest rate for which the monetary authority sets its instrumental targets. Thus, the analysis of the official interest rate is clearly subject to a peso problem in that it moves infrequently - only when monetary policy actions are taken - but agents expect more frequent movements that, in fact, do not occur. Nevertheless, as we move along the yield curve, the interest rates, although influenced by the official interest rate, react increasingly to "market forces", including the own expectations about future interest rate jumps. Therefore, for maturities far enough from that corresponding to the official interest rate, clear-cut jumps are rarely observed and, consequently, the empirical relevance of the peso problem tends to disappear. In our case, that empirical relevance is negligible.

In the case of the exchange rate, we use the information contained in the interest rate differential to obtain $p_t d_t$. This information, combined with that of the exchange rate jumps observed around devaluations, provides a separate estimation of d_t. Specifically, if uncovered interest rate parity holds and, in the absence of realignments, the exchange rate follows a random walk, it is obvious that

$$i_t^{\tau} - i_t^{\tau *} = p_t d_t, \tag{5}$$

where i_t^{τ} and $i_t^{\tau *}$ are the domestic and foreign interest rates of τ-day deposits in the Euro-market. Expected jump sizes d_t are taken from Ayuso and Pérez-Jurado (1995), who estimated a panel Tobit model for all the realignments in the ERM since its creation in 1979. In this model, the expected jump sizes depend on a country dummy (with a coefficient of -16.22 in the Spanish case) and the real exchange rate against the Deutsche Mark (with a coefficient of 0.24, constant across countries).

2. Volatility in Spanish financial markets

In this section we apply the methodology described in the previous section to analyse price volatility in the four major Spanish financial markets: the government debt, stock, money and foreign exchange markets. For the first two, we focus on two price indices that include the most actively traded assets in the respective market: the government debt index prepared and released by the Banco de España,[4] and the IBEX-35.[5] For the money market, we look at movements in the three-month interbank rate and, finally, the peseta/Deutsche Mark exchange rate is the representative price chosen for the foreign exchange market. Little additional comment is needed for these last two choices.

As commented on in Section 1, we distinguish between prices that can be controlled - at least partially - by economic policy actions and prices that cannot. In principle, both the exchange rate and the interbank interest rate belong to the first group. Nevertheless, the empirical relevance of the

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4 See Banco de España (1991) for details.

5 See Sociedades de Bolsa (1991).

peso problem when measuring interest rate risk may be considered negligible since the maturity chosen is three months and the Banco de España has instrumental targets in terms of the overnight interest rate. Thus, in what follows, we distinguish between financial prices for which the so-called peso problem is not relevant (the government debt index prepared by the Banco de España, ID_t, the IBEX-35 stock exchange index, IB_t, and the three-month interbank rate, i_t) and the peseta/Deutsche Mark exchange rate, ESP/DEM_t.

2.1 Volatility in the debt market, the stock exchange and the money markets

Although we focus on the risk associated with the course of prices in the following month, the relatively short life of the financial markets considered requires the use of a higher, daily, frequency to have an appropriate number of observations to estimate the relevant parameters. In order to keep homogeneity, our available daily sample spans the period from 1st January 1988 to 31st July 1995.[6]

Following Section 1, we start by consistently estimating the innovation series ε_t in each market. Then we estimate the different GJR processes for each of the three daily residual series. Table 1 shows that autoregressive processes with five lags suffice to eliminate any residual estimated GJR processes fit quite well. Thus, parameter estimates are clearly significant and there is no evidence of residual conditional heteroscedasticity (H1, H5 and H15 tests) or residual asymmetries (AS test). Moreover, the NN and NP tests show that linearity seems a reasonable approach. Finally, Charts 1 to 3 show the (monthly averages of the daily) conditional variances at a one-month term.[7] Some results are worth commenting on:

- Charts 1 to 3 show that volatility in the stock exchange is markedly higher than in both the money and debt markets. Moreover, prices in the government debt market are also more volatile than those in the money market. This result is quite usual.[8]
- According to estimates of γ_1 in Table 2, only the debt index volatility shows asymmetric responses to shocks. This asymmetry in the Spanish government debt market was previously found by Ayuso and Núñez (1995). Thus, unanticipated price falls (negative news) lead to higher increases in volatility than unanticipated price rises (positive news). The absence of asymmetry in the stock exchange is especially striking. Such asymmetry, based on the so-called leverage effect,[9] has frequently been found for several international stock exchange indices.[10] Nevertheless, Alonso (1995) also found symmetric responses in the Spanish stock exchange using a different conditional variance model.

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6 There are no data at all for the ID series prior to 1988. For the other two series, we could have gone back only until 1984. In any case, results do not change if we consider that enlarged sample.

7 $V_t(X_{t+1\ \mathrm{month}})$ is easily obtained from the autoregressive process for the daily conditional mean and the GJR process for the daily conditional variance. See Ayuso et al. (1994).

8 See, for example, Shiller (1988).

9 See Black (1976).

10 See, for example, French, Schwert and Stambaugh (1987) or Nelson (1990).

Table 1

Conditional mean models: goodness-of-fit tests

	$\Phi(L)\Delta x_t = c + \varepsilon_t$		
	$x_t = 100 * \log ID_t$ $\Phi(L) = \Phi^5(L)$	$x_t = 100 * \log IB_t$ $\Phi(L) = \Phi^5(L)$	$x_t = i_t$ $\Phi(L) = \Phi^5(L)$
N	1,874	1,860	1,873
C1	0.00	0.00	0.00
C5	0.10	0.23	0.26
C15	16.20	10.10	11.20

Notes: 1. *ID* is the debt government index, *IB* is the stock exchange index and *i* is the three-month interbank interest rate.
2. Φ^5 is a fifth-order polynomial in the lag operator *L*. Its roots are outside the unit circle. Δ=1-*L*.
3. N stands for the number of observations.
4. *Cx* stands for the Box-Pierce test on residual autocorrelation up to order *x*. Under the null (zero autocorrelation) it is distributed as a χ^2 with *x* degrees of freedom.
5. i_t is in percentage points per annum.

- The parameter estimates in Table 2 imply that, at daily frequencies, conditional variance is highly persistent.[11] However, Charts 1 to 3 show that persistence is not so high when we consider the volatility associated with financial prices in the following month.
- Charts 1 to 3 also reveal other interesting features. First, there are no trends in any of these market volatilities. While we can identify, for each market, periods in which volatility markedly increases, in general, such increases do not tend to last and are followed by later reductions; e.g. the only lasting increase seems to be that in the debt market around the summer of 1992. Second, volatilities in these three markets do not seem to follow, in general, a common pattern, although there are important similarities in some of their responses to certain events. Thus, the peseta's entry into the ERM coincided with the beginning of a relatively stable period in both the money market and the debt market (but not in the stock exchange). This period ended around the summer of 1992, when a simultaneous increase in the volatility in the three markets was recorded. As commented on, this increase seems to be more lasting in the debt market, where volatility has not returned to its previous level since.

In the same vein, the well-known bond crisis in 1994 had a clear effect on debt volatility and a less clear-cut one on the stock market. The money market, however, did not register a similar volatility increase. The period around the peseta's devaluation in March 1995 also shows an important volatility increase in the money and debt markets without any remarkable effect on stock exchange volatility.

These partial similarities in the responses to certain events justify a more rigorous analysis of possible connections among the different market volatilities. We undertake this analysis as follows.

11 That is, $\alpha_1 + \frac{1}{2}\gamma_1 + \beta_1 + \beta_2$ is closer to 1. Following the results in Cai (1994) we allow for some changes in the constant of the GJR model in order to test if this persistence is due to (non-considered) structural changes. Results are contrary to that possibility.

Table 2

Conditional variance models
(daily)

	$\Phi_5(L)\Delta x_t = c + \varepsilon_t,\ \varepsilon_{t+1/t} \sim N(0,h_t)$ $h_t = \alpha_0 + (\alpha_1 + \gamma_1 S_t^-)\varepsilon_t^2 + \beta_1 h_{t-1} + \beta_2 h_{t-2}$		
	$x_t = 100 * \log ID_t$	$x_t = 100 * \log IB_t$	$x_t = i_t$
N	1,874	1,860	1,873
α_0	0.18e-3	0.07	0.03e-3
	(0.2e-4)	(0.01)	(0.5e-5)
α_1	0.09	0.10	0.18
	(0.007)	(0.01)	(0.01)
γ_1	0.07		
	(0.007)		
β_1	0.89	0.84	0.28
	(0.004)	(0.02)	(0.05)
β_2			0.58
			(0.04)
H1	1.44	0.61	3.71
H5	2.51	1.31	8.63
H15	25.70	1.88	14.70
AS	1.11	1.60	- 0.93
NN	0.27	1.17	0.22
NP	- 0.65	- 1.25	- 0.54

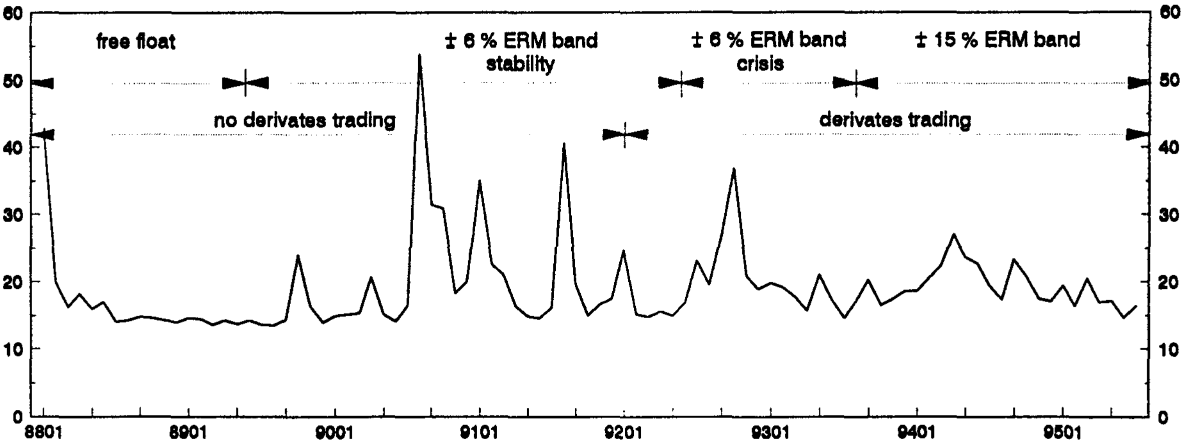
Notes: 1. *ID* is the debt government index, *IB* is the stock exchange index and *i* is the three-month interbank interest rate.

2. S_t^- is a dummy variable that takes the unit value if ε_2 is negative and 0 otherwise.
3. H*x* stands for the LM test on residual heteroscedasticity up to order *x*. Under the null (homoscedasticity) it is distributed as a χ^2 of *x* degrees of freedom.
4. AS, NN and NP are, respectively, the sign bias test, the negative size bias test and the positive size bias test proposed by Engle and Ng (1993). Under the null (absence of such effects) they are distributed as Student's *t*. In the second column, AS could have lost power because the "scores" have not been considered due to multicollinearity problems. In any case, when applied to the original series, the AS test rejects the existence of a sign bias.
5. Standard errors in brackets.

We start by obtaining consistent estimates of the innovations in each market not in an univariate framework but in a multivariate one. Thus, for each price, five lags of the two remaining financial prices are also included as additional regressors in their respective univariate model. We then estimate a new GJR model that also includes lagged squared residuals corresponding to the other two financial markets. If squared innovations in market A do not help to explain volatility in market B, but innovations in market B are significant in the market A volatility model, we directly include in this last model the conditional volatility in market B. Observe that including the conditional variance instead of (past squared) innovations is a way of summarising in a single variable the effects of all the past squared innovations in one market. Table 3 shows the main results of this analysis.

CHART 1

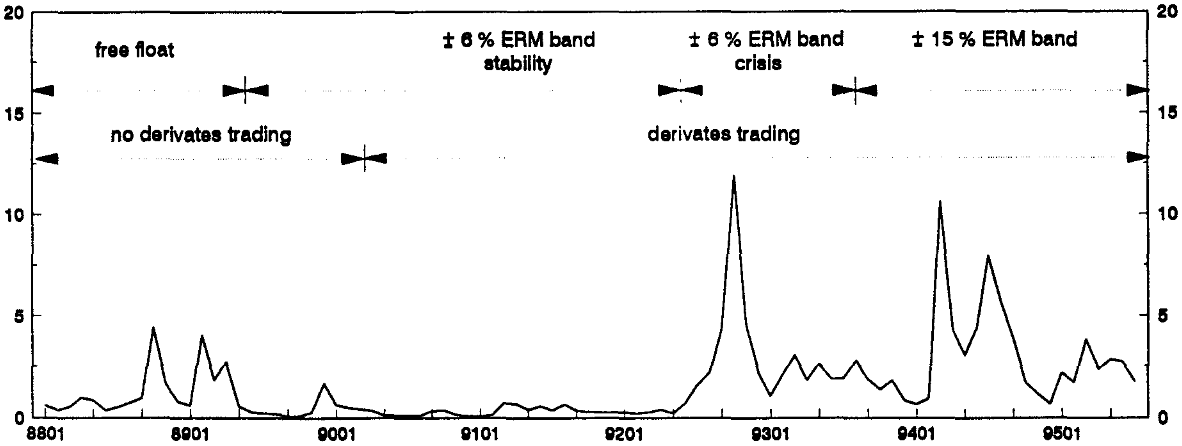
VOLATILITY IN THE STOCK EXCHANGE



NOTE: Monthly averages of daily data

CHART 2

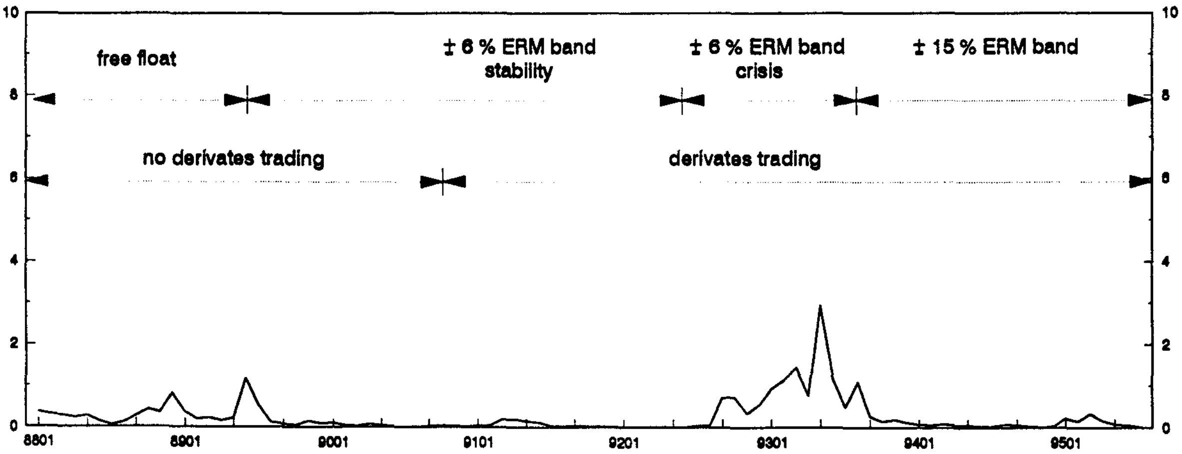
VOLATILITY IN THE DEBT MARKET



NOTE: Monthly averages of daily data

CHART 3

VOLATILITY IN THE MONEY MARKET



NOTE: Monthly averages of daily data

As can be seen, the inclusion of other market squared innovations does not substantially modify the effect of the own innovations. Table 3 shows that the stock exchange volatility seems to be isolated from the innovations in the remaining markets. Nevertheless, both the money market volatility and the government debt market volatility increase when stock exchange market volatility increases. Moreover, the debt market volatility reacts (positively) to innovations in the money market.

In any case, although statistically significant, these effects are quantitatively small. Evaluated at the volatility average values, the short-term elasticities of the money market and the debt market volatilities to changes in the stock exchange volatility[12] are around 0.5%. The short-term elasticity of the debt market volatility to the money market volatility is higher but still small: 2%. Long-term elasticities[13] are also low: 3, 4 and 12%, respectively. Thus, we can conclude from this evidence that there is some contagion in the different markets, but most of each volatility is explained by innovations in the own market.

Table 3

Connections among debt, money market and stock exchange volatilities

	$\Phi_5^i(L)\Delta x_t^i = c + \sum_{j\neq i}(\Phi_5^j(L)\Delta x_{t-1}^j) + \varepsilon_t,\ \varepsilon_{t+1/t}^i \sim N(0, h_t^i)$ $h_t^i = \alpha_0 + (\alpha_1 + \gamma_1 S_t^-)\varepsilon_t^{i^2} + \sum_{n=1}^{2}\beta_n^i h_{t-1}^i + \sum_{j\neq i}\beta_1^j h_{t-1}^j$		
	$x_t^i = 100 * \log IB_t$	$x_t^i = i_t$	$x_t^i = 100 * \log ID_t$
N	1,853	1,853	1,853
α_0	0.07 (0.01)		0.41e-3 (0.13e-3)
α_1	0.10 (0.01)	0.19 (0.01)	0.09 (0.01)
γ_1			0.10 (0.02)
β_1^{IB}	0.84 (0.02)	0.67e-4 (0.6e-5)	0.32e-3 (0.14e-3)
β_1^i		0.22 (0.04)	0.08 (0.02)
β_2^i		0.61 (0.04)	
β_1^{ID}			0.84 (0.01)
H1	0.61	2.89	1.08
H5	1.31	7.44	2.63
H15	1.88	12.10	9.68

Notes: 1. Neither the debt market squared innovations $\varepsilon_{t-k}^{ID^2}$ nor the money market squared ones $\varepsilon_{t-k}^{i^2}$ are significant in the GJR model for IB_t. The same can be said with respect to the presence of $\varepsilon_{t-k}^{ID^2}$ in the i_t model.

2. See notes to Table 2.

12 That is, $\frac{\partial h_t^x}{\partial h_t^{IB}} \frac{\bar{h}^{IB}}{\bar{h}^x}$, $x=i, ID$.

13 That is, $\frac{\partial h_t^x}{\partial h_t^{IB}} \frac{\bar{h}^{IB}}{\bar{h}^x} \frac{1}{1-\beta_1^x-\beta_2^x}$, $x=i, ID$.

2.2 Volatility in the foreign exchange market

In this subsection, we focus on the period of peseta membership of the ERM (19th June 1989 - 31st July 1995), leaving for Section 3 the analysis of the effects of its entry into the mechanism. The existence of a peso problem in the estimate of the univariate process followed by the exchange rate requires a method of analysis other than that followed in the previous subsection. On the one hand, we cannot estimate the exchange rate conditional mean using exclusively past observed exchange rates.[14] On the other hand, as commented on in Section 1, we have to add to the within-the-regime conditional variance a correction term. That term takes into account the fact that agents usually assign a positive probability to a devaluation happening in the near future.

As in Ayuso, Pérez-Jurado and Restoy (1994), we deal with the first problem assuming that the (log) exchange rates follow a random walk and then testing if results significantly change when (some) mean reversion is allowed for.[15] In particular, we allow for the maximum mean reversion which, given the interest rate differential between Spain and Germany, does not imply revaluation expectations.[16] Table 4 shows the estimates for the within-the-regime conditional variance h_t^w. Chart 4 depicts the correction term and Chart 5 shows the evolution of both the within-the-regime volatility h_t^w and the conditional variance h_t.

The correction term follows a decreasing path as from June 1989, thus reflecting a progressive increase in the peseta's credibility. This path breaks around June 1992 and the correction term increases until the ERM reform in August 1993. As can be seen, this reform is associated with an important increase in credibility. Since then, it has held stable until the peseta's latest devaluation in March 1995.

Comparing Chart 5 with Charts 1 to 3, we observe that the exchange rate risk is lower than that corresponding to the stock exchange but still higher than the level that characterises the debt market. As in the other three markets, parameter estimates imply an important degree of (daily) conditional variance persistence, even though we have allowed for two structural changes in June 1992 and August 1993. Again, this persistence decreases when we consider risks at a term longer than just one day.

Chart 5 also reveals that there are no trends discernible in the course of exchange rate risk. We observe, instead, significant increases in periods usually characterised as of exchange rate crisis (the autumn of 1992 or March 1995). But such increases disappear later on. Events in other financial markets such as the bond crisis in 1994, however, do not seem to have any effect on exchange rate risk. Unfortunately, the special nature of the exchange rate risk measure prevents us from repeating an analysis similar to that in Table 3.[17]

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14 See Chen and Giovannini (1992).

15 We can justify this procedure on the basis of the difficulties in statistically discriminating between the random walk and the foreseeable slow mean reversion that characterises these high frequency data.

16 This maximum mean reversion is computed as follows. If the process followed by the (log) exchange rate when there are no devaluations is $(s_{t+\tau}-\bar{s})=\phi(s_t-\bar{s})+v_{t+\tau}$ and uncovered interest parity roughly holds, then a little algebra shows that $E_t(d_{t+\tau})>0 \Rightarrow \phi^\tau > 1+\frac{i_t^\tau - i_t^{*\tau}}{s_t-\bar{s}}$, $\forall s_t<\bar{s}$. For each period between the different peseta central parity devaluations, we estimate $\bar{s}$ as the corresponding sample mean value and ϕ as the minimum value that satisfies the inequality.

17 Observe that news in the exchange rate markets includes two components. It includes, first, the unexpected movement in the exchange rate. But it also incorporates a term, difficult to estimate, capturing the fact that a devaluation has (or has not) occurred, given that some probability was assigned, ex ante, to this devaluation.

Table 4

Exchange rate volatility within the regime

	$\Delta\log(ESP/DEM)_t = c+\phi\Delta\log(ESP/DEM)_{t-1}+\varepsilon_t,\ \varepsilon_{t+1/t}\sim N(0,h_t)$ $h_t=\alpha_0+\sum_{i=1}^{2} d_i S_t^i+\alpha_1\varepsilon_t^2+\beta_1 h_{t-1}$	
	Random walk **c=0, ϕ=1**	**Mean reversion** **c≠0, 0<ϕ<1**
N	1,497	1,497
α_0	0.01	0.01
	(0.001)	(0.001)
d_1	0.02	0.02
	(0.002)	(0.002)
d_2	- 0.02	- 0.01
	(0.002)	(0.002)
α_1	0.41	0.39
	(0.02)	(0.02)
β_1	0.56	0.57
	(0.02)	(0.02)
H1	0.03	0.25
H5	1.89	3.05
H15	6.00	8.12
AS	- 0.35	- 0.37
NN	0.96	1.31
NP	- 0.57	- 0.79

Notes: 1. S^1 and S^2 are dummy variables that take the unit value from 2nd June 1992 and 2nd August 1993, respectively, and 0 otherwise.

2. See notes to Table 2.

3. See text for details on c and ϕ in the mean reversion case.

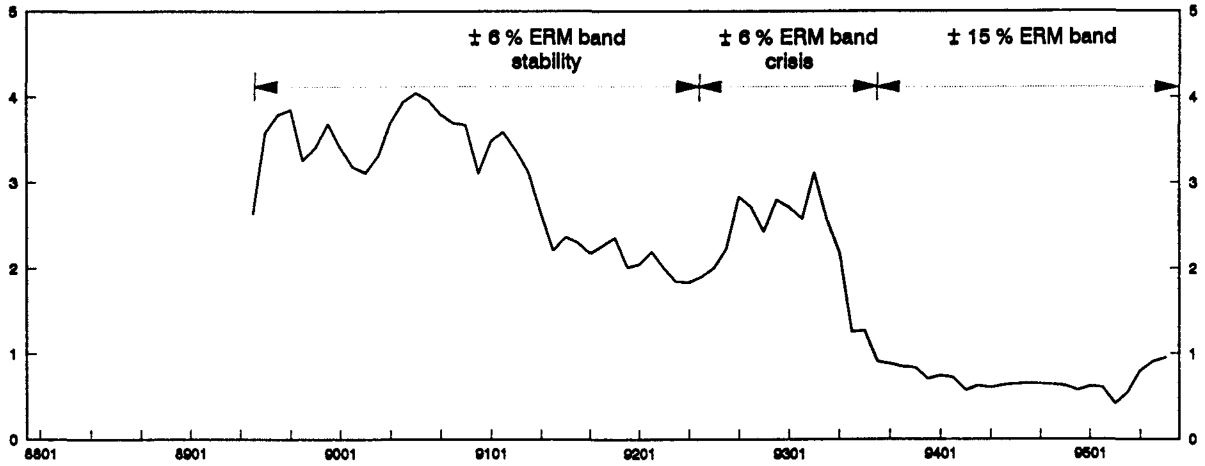
Finally, both the second column in Table 4 and Chart 6 provide evidence favouring the hypothesis that mean reversion in the exchange rate process does not alter the qualitative results concerning exchange rate risk.

Summarising, results in this section show that the processes of liberalisation, internationalisation and globalisation marking present developments in the major Spanish financial markets have not been accompanied by a parallel increase in financial price volatility. We do not observe volatility trends in any of the markets considered. We observe, however, periodical episodes of high volatility. In this sense, our results are in line with the views of several authors who have recently argued that financial markets are not more volatile now than before.[18] Unfortunately, the available data do not allow us to investigate whether, as has also been suggested, these transitory increases in volatility are now higher and more frequent than before.

Moreover, a simple analysis of the interconnections among the different Spanish financial markets shows that day-to-day volatilities seem to react, basically, to news concerning the own market although, when relevant events such as exchange rate crises occur, we observe contagion effects. In that sense, the foreign exchange market seems to be a primary source of financial volatility.

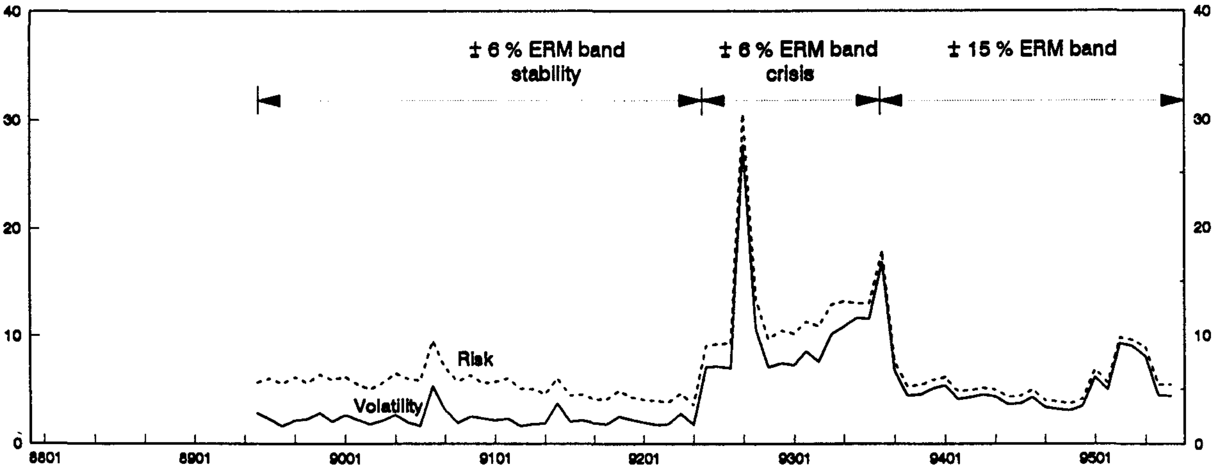
18 See, for example, Crockett (1995), Goodhart (1995) and Shiller (1988).

CHART 4 FOREIGN EXCHANGE MARKET: CORRECTION TERM



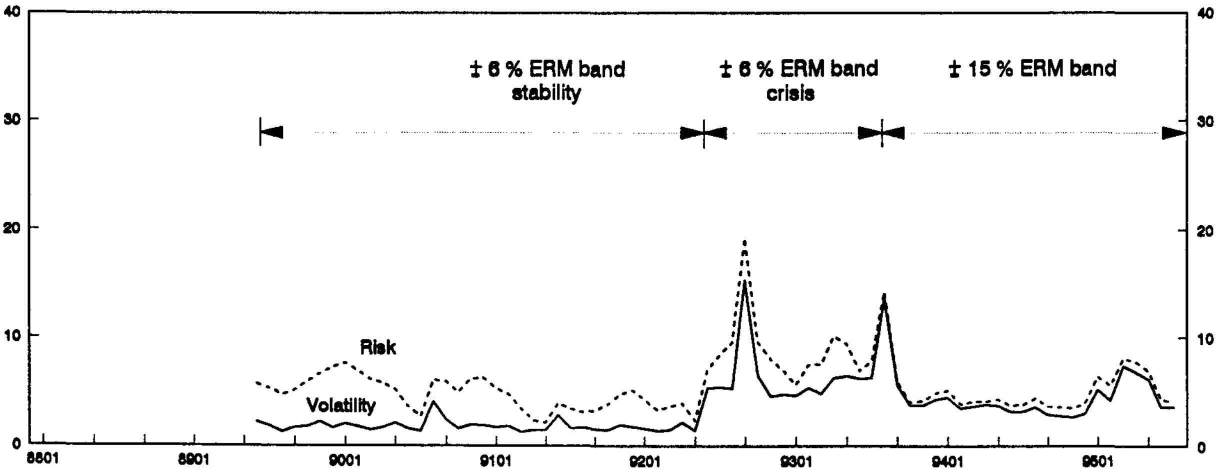
NOTE: Monthly averages of daily data

CHART 5 EXCHANGE RATE VOLATILITY AND RISK
RANDOM WALK



NOTE: Monthly averages of daily data.

CHART 6 EXCHANGE RATE VOLATILITY AND RISK
MEAN REVERSION



NOTE: Monthly averages of daily data.

3. Factors explaining price volatility evolution

One of the main conclusions of the analysis in the previous section is that no upward trend in financial price volatility is found, although there are episodes of considerably high volatility. The observation of these episodes has prompted some concern about the possibility that these peaks could be a potential cause of systemic crisis. In the same vein, it has also been argued that the current levels of volatility, even if they were not higher than before, could be more worrying because economic agents now participate more in the financial markets and, hence, they are more exposed to risk. In any case, these and other arguments have led to numerous proposals aimed at curbing volatility. But for policy-makers to be able to set effective policies in place, the sources of such volatility need to be identified.

Unfortunately, very little is known about what factors determine volatility. The efficient market model does not offer an explanation when prices change due to factors other than a change in the fundamentals or in the expectations about them. While there are theoretical models (informationally efficient and with expectations formed rationally) with equilibrium prices deviating from their fundamental value (speculative bubbles models), there is not yet a well accepted general structural model of volatility.

However, the economic literature points out several potential factors that could partly explain financial price volatility. Some economists argue that speculation, enhanced mostly by financial innovations (like futures and options) but also by the internationalisation and globalisation of securities markets, can be destabilising. The policy proposals to curb volatility derived from this line of thought imply, therefore, tougher market regulation and include proposals such as higher derivatives margin requirements; price limits; restrictions on certain market strategies, such as portfolio insurance; controls on international capital movements; and some even more radical solutions such as stopping derivatives trading.

Other economists emphasise the role played by changes in expectations about price volatility. Following this line of thought, changes in monetary and/or exchange rate regimes affect financial price volatility, and uncertainty about macroeconomic policies, non-credible targets, inconsistency of policies across countries and internationally different market regulation are destabilising for financial markets. Thus, the proposals by those economists advocate greater policy coordination, both inter and intra-nationally, and include exchange rate target zones; globalised financial market supervision and regulation, at both the inter-country and inter-industry level; central banks standing ready to perform their role as lenders of last resort, etc.

In this section we focus on two of these factors which are especially relevant for the recent Spanish experience. In Section 3.1 we examine the effect on exchange rate risk of the major changes in the peseta exchange rate regime in the period 1988-95. In Section 3.2 we analyse the effect on spot market price volatility of the introduction into the Spanish financial arena of successful futures and options markets.

3.1 Exchange rate regimes and volatility

The setting up of target zones is one of the proposals most frequently put forward to reduce instability in foreign exchange markets. This reduction was one of the main objectives pursued by the founders of the EMS and by the countries which, like Spain, later became members. These countries form a highly and increasingly integrated area and, in this context, a high exchange risk perceived by agents could restrict international flows and lead to an inefficient allocation of resources in both geographical and sectorial terms. On the contrary, the reform of the System in August 1993 prompted a concern regarding the possibility that the wider margin of fluctuation available could heighten the exchange risk perceived by agents, thus undermining the benefits of economic integration in Europe. An important question also remains open about the appropriate exchange rate regime to be established for the countries subject to derogation at the beginning of the Monetary Union.

Thus, there is a traditional view which associates stringent exchange rate regimes with low exchange risk and more flexible ones with higher risk. However, as the formulation of the relevant measure of risk for a controlled variable (see Section 1) clearly shows, whereas the degree of rigidity of the exchange rate regime should clearly be a conditioning factor of exchange risk, by limiting observed volatility, the credibility of this commitment can also be determinative in explaining such risk. Furthermore, exchange rate regimes that severely limit the fluctuation of exchange rates could have negative effects on the perceived exchange risk if those regimes are considered to be unsustainable by the market.

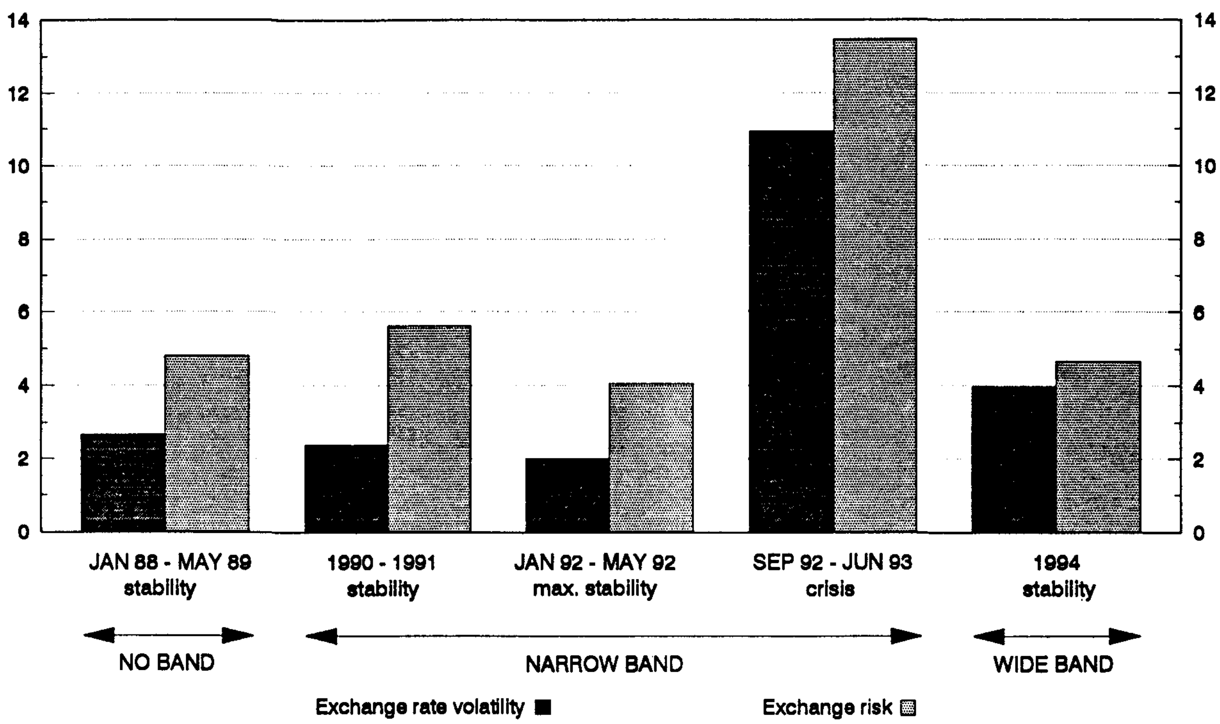
In this section we analyse empirically the relationship between the degree of rigidity of the exchange rate regime and exchange risk, paying particular attention to the role of credibility. We also discuss which variables affecting credibility can, in turn, help to explain how exchange risk develops.[19]

The case of the peseta is particularly useful since there have been two major changes in recent years in its exchange rate regime. Thus, the entry of our currency into the ERM with ±6% bands in June 1989 and the reform to ±15% bands in August 1993 are appropriate examples for comparing free floats with target zones and different degrees of flexibility within the same target zone, respectively. However, there have also been major changes recently in the fluctuation regimes of other European currencies. We will incorporate them into the analysis to see whether the conclusions for the peseta can be extended.

Chart 7

Exchange rate regime and volatility

(peseta/DM at one-month horizon)



19 In addressing this task we will make use of the empirical findings from research recently conducted at the Banco de España: Ayuso, Pérez-Jurado and Restoy (1994), Ayuso and Pérez-Jurado (1995) and Ayuso (1995).

We start by looking at the exchange risk of the peseta around its entry into the EMS. As can be seen in Chart 7, this entry did not have a clear reduction effect on the exchange risk. On the one hand, the fact that the stability of the peseta/Deutsche Mark exchange rate was already being pursued by Spanish policy could explain the small reduction effect on the observed volatility. On the other hand, the initial lack of confidence in the new commitment more than offset this reduction in volatility, leading to an increase in exchange risk. Only in the period of maximum stability of the ERM (January to May 1992) was this risk lower than before entry. The experience of sterling, which joined the ERM in October 1990, is also an example of a step towards a stricter regime, but in this case leading to a pronounced reduction in exchange risk. On the contrary, the switch to a free float made by sterling and the Italian lira in September 1992 was accompanied by a clear increase in their respective risks (see Table 5). Thus, this empirical evidence supports the conventional wisdom that, when comparing target zones with free floats, exchange rate risk is, in general, lower in the former.[20] However, if the target zone suffers from a lack of credibility, this can prevent such beneficial effects from arising.

Table 5

Exchange rate regime and volatility

(exchange rate volatility and exchange risk at one-month horizon)

	January to September 1990 **Free float**	**January to December 1991** **ERM**	**January to May 1992** **Maximum stability ERM**	**January to December 1994** **Free float**
Sterling				
Exchange rate volatility	3.86	1.73	1.69	4.71
Exchange risk	5.34	2.97	2.09	4.71
		January 1990 to December 1991 **ERM**		
Italian lira				
Exchange rate volatility		0.44	0.38	9.12
Exchange risk		2.18	1.85	9.12

The reform of the ERM in August 1993 allows for comparison of different degrees of rigidity within the same target zone. If we compare the period of peseta exchange rate stability with wider bands, in late 1993 and all of 1994, with the period of ±6% bands, the risk characterising the former is 67% lower than during the crisis period, comparable to that of the maximum stability period with narrow bands and 20% lower than during the two-year period at the beginning of ERM membership. Again, comparing this with observed volatility highlights the important role of credibility. The observed volatility of the peseta is clearly higher with a band of ±15% than with bands of ±6%. Thus the gain in credibility of the fluctuation regime after the August 1993 reform had a greater impact on the conditional variance of the exchange rate than the rise in observed volatility. The experience of other currencies provides similar conclusions (see Table 6). Thus, for the French and Belgian francs and the Danish krone the exchange risk was lower with narrow bands than with

20 This view is also supported by results in European Commission (1982), Padoa-Schioppa (1983), Ungerer et al. (1983, 1986, 1990), Rogoff (1985), Artis and Taylor (1988, 1993), Pesaran and Robinson (1993) or Ayuso (1995), among others.

wide bands only in the period of maximum stability, when their regimes had almost perfect credibility. However, in 1990-91, when the bands were not so credible although no speculative attacks were occurring, the exchange risk was higher.

This evidence suggests that, even in the absence of speculative attacks, too rigid commitments governing the fluctuation of exchange rates can lead to negative effects on the perceived exchange risk. Therefore, attempts to reduce exchange rate risk by increasing the rigidity of fluctuation regimes may be unsuccessful if the conditions for this regime to be credible do not hold. Under these circumstances, to reduce the exchange rate risk it may be preferable to adopt less ambitious exchange rate commitments that are flexible enough to warrant an acceptable degree of credibility, even though they might imply greater observed exchange rate volatility.

It follows from the above that, to evaluate the possibility of reducing exchange rate risk by means of establishing - or narrowing the prevailing - fluctuation bands, it is very important to know which are the variables that agents take into account to assess the sustainability of this regime. Several papers in the literature of target zones have addressed this question both theoretically and empirically.[21] The variables pointed out by this literature can be seen as representative of one of the following effects: the increase in the reputation of the authorities when official parities are sustained over time; the general conditions in the system (in the case of the ERM); those macroeconomic imbalances which impose a significant cost on maintaining the parity commitment and which could be eased with a devaluation (the specific imbalances obviously differ between countries); and, finally, there is some empirical evidence in favour of a destabilising effect of the limit of maximum depreciation, i.e. of an adverse effect on credibility of the exchange rate proximity to that limit.

Table 6

Band width and volatility
(exchange rate volatility and exchange risk at one-month horizon)

	1990-91 **Stability narrow band**	January to May 1992 **Maximum stability narrow band**	1994 **Stability wide band**
French franc			
Exchange rate volatility	0.30	0.20	0.43
Exchange risk	0.77	0.34	0.55
Belgian franc			
Exchange rate volatility	0.35	0.08	0.51
Exchange risk	0.65	0.10	0.59
Danish krone			
Exchange rate volatility	0.52	0.25	0.69
Exchange risk	1.18	0.43	0.83

For the Spanish case, Ayuso and Pérez-Jurado (1995) analyse the determinants of the expected rate of depreciation (at a one-month horizon) associated with devaluations. They explain separately the expected size of depreciation and that of the probability of devaluation. According to their results, agents take into account the cumulative losses of competitiveness to form their expectations about the size of depreciation associated with a potential future devaluation. With respect to probability, they conclude that several factors are at play. First, there is a reputation effect since the

21 See, for example, Chen and Giovannini (1991) or Lindberg, Svensson and Söderlind (1991).

time elapsed without devaluing reduces the probability of devaluation and the reputation built up in this way is lost if a devaluation occurs. Second, there is an effect of the general pace of the system since the probability of devaluation of other ERM currencies has an effect on that of the peseta. Third, the exchange rate drawing closer to the limit of depreciation increases the probability of devaluation. Lastly, the impact of the cost of parity maintenance implied by macroeconomic imbalances is represented by a significant influence of the policy dilemma entailing the need for a level of interest rates consistent with the defence of the commitment but not with the position in the economic cycle.

Thus, although it is not realistic to try to explain credibility fully by movements in these variables, it seems clear that they can condition the success of attempts to reduce exchange risk through a tougher exchange rate policy. Notice, finally, that there is an important connection between exchange rate risk and misalignment through the impact of credibility on the former. As mentioned, misalignment (cumulative losses of competitiveness) determines the expected size of devaluation, which in turn determines to some extent the risk perceived by agents. Thus, if in order to reduce the volatility of exchange rates a no-devaluation policy and strict commitment to a certain parity are followed but at the cost of a worsening misalignment, the exchange rate risk perceived by the agents may be very high even in the absence of speculative attacks and with low observed volatility.

3.2 Derivatives trading and spot market price volatility

Derivatives trading is one of the most frequently alleged causes of the perceived increase in volatility. The potential destabilising effect of derivatives has opened an as yet unsettled debate which has prompted a large number of studies and has frequently divided regulators, academics, the financial press and market participants.

The concern about a destabilising effect of derivatives trading has generated several proposals which attempt to reduce this undesirable effect. Proposed measures include higher margin requirements on futures and options, the imposition of circuit-breakers, and restrictions on some trading strategies such as portfolio insurance or index arbitrage.

The arguments attributing a destabilising effect to derivatives highlight the role of speculators and programme-trading techniques. In this connection, it is argued that derivatives attract speculators due to the particular features of these markets: high leverage, centralised trading, low costs and the easiness of offsetting positions and selling short. The activity of speculators, looking for easy and huge benefits, may cause price movements which are unwarranted by the present or the expected value of economic fundamentals and which spill over into the underlying spot market through arbitrage operations. Following the 1987 stock market crash, fears about the destabilising effect of derivatives focused on the effect of programme-trading strategies such as index arbitrage and portfolio insurance.[22] Then, it is argued, price movements can be exacerbated, leading to cascade effects and, in some circumstances, to a massive flow of sell or buy orders on the same side, which markets cannot absorb without dramatic price fluctuations.

The argument about speculation being a destabilising factor has been countered by saying that it forgets the role played by speculators who, by taking a risk the others try to hedge, make hedging strategies and derivatives cheaper. Rational speculators may reasonably be considered to abound, buying when they think prices are low and selling when prices are high, so that speculative trading will tend to stabilise the spot market. Uninformed speculators will not be successful and will be eliminated quickly from the market. Also, there is abundant literature that questions the destabilising effect of programme-trading strategies.[23]

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22 Portfolio insurance is a synthetic put option built by taking a short position in futures (or spot) and a long position in a riskless asset. To achieve the payoff sought (that is, limited losses and unlimited profits), the strategy requires dynamic management by selling the risky asset when prices fall and buying it when prices rise.

23 See, for example, Edwards (1988), Tosini (1988) and Rubinstein (1988).

As additional counterweights to the arguments for derivatives causing a destabilising effect, the economic literature has pointed out several reasons in support of a stabilising effect, based on the beneficial and well accepted contributions of derivatives. Thus, insofar as derivatives offer cheap and accessible hedging, they may provide for a reduction and stabilisation of risk premia built into spot prices, thereby lessening a source of volatility. In addition, this hedging feasibility may encourage institutional investors to take larger positions in the spot market so that the latter becomes more liquid and, therefore, less volatile. Furthermore, the trading of derivatives on centralised, highly visible and fast markets implies that they act as information centres that pick up and disseminate the opinions of all participants. That may, in turn, have a beneficial effect on spot market efficiency, whose participants can base their investment decisions on such new information.

The existence of both arguments and counter-arguments for a destabilising effect of derivatives suggests that the debate cannot be resolved wholly on a theoretical level and so should be analysed empirically. Hence the numerous empirical papers addressing the question (see Table 7). In this section, we empirically test whether the introduction of futures and options in Spain has caused an increase in the volatility of the associated spot market price.[24]

Financial futures and options were first introduced in Spain in March 1990. At present, there is highly active trading on the ten-year Treasury bond contract, three-month interbank deposit contract and IBEX-35 stock index contract.[25] In order to test the effect of the introduction of these futures and options contracts on the underlying spot market price volatility, we use the financial prices analysed in Section 2. However, the peseta exchange rate contracts launched after 1990 were never successful and trading was closed in 1993. The reason for the failure is probably that, when these contracts were launched, an active forward market was already in place and was quite liquid for numerous settlement dates, so there was no need for a futures market with standardised contracts.

Specifically, we analyse the following effects: the effect of government bond futures and options trading on the volatility of the debt index,[26] the effect of interbank deposit futures and options trading on the volatility of the three-month interbank deposit rate, and the effect of IBEX-35 futures and options trading on the volatility of the IBEX-35 index. Unfortunately we are unable to test the effect of foreign exchange forward trading or financial swaps, since those derivatives are traded in OTC markets and there are no data available on trading or prices.

As in the previous subsection, we could analyse the effect of derivatives trading on the associated spot market price volatility simply by estimating such volatility before and after the introduction of futures and options markets. Nevertheless, in this case we take a different approach. In particular, following Ayuso and Núñez (1995), we add to the volatility model an additional explanatory variable which, quantitatively instead of qualitatively, captures the new element entailed by the emergence of derivatives. Ideally, the effect of the remaining variables affecting volatility would be depicted implicitly in the other parameters of the estimated model and the sign of the parameter of this new variable would enable it to test whether derivatives raise or reduce spot price volatility.

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24 Ayuso and Núñez (1995) address the question for the Spanish bond market. Their methodology is adopted here.

25 The first contract launched was a three-year bond contract. Since March 1990 two more bond contracts have been launched: the five-year bond contract (April 1991) and the ten-year bond contract (April 1992). Also, interbank deposit contracts (the MIBOR-90 contract, introduced in October 1990, and the MIBOR-360 contract, introduced in October 1993), stock index contracts (the IBEX-35 introduced in January 1992) and exchange rate contracts (the Deutsche Mark/peseta and dollar/peseta contracts that were introduced in September 1991) have been launched.

26 For the government bond futures and options market, the fact that most (more than 90%) of the trading in futures and options bond contracts is centred on the ten-year contract while spot bond turnover does not exhibit such concentration, suggests that derivatives market participants consider that a single contract suffices for future-spot combined strategies, whatever the maturity of the spot bond. Therefore, it seems more interesting and accurate to analyse the effect of derivatives on the spot debt market as a whole, represented by the debt index, rather than focusing on the effect on just a specific maturity of said market.

Table 7

Empirical research on the effect of derivatives on spot market volatility

Authors	Period analysed	Spot market analysed	Effect on spot price volatility
Figlewsky (1981)	1975-79	GNMA (USA)	increase
Bortz (1984)	1975-82	Treasury bond (USA)	moderate decrease
Moriati & Tosini (1985)	1975-83	GNMA (USA)	non-statistically significant
Simpson & Ireland (1985)	1973-85	Treasury bills	initial decrease, subsequent increase
Edwards (1988a)	1973-87	S&P Index (USA)	decrease
		Value Index (USA)	decrease
		Treasury bills (USA)	decrease
		Euro-dollar 90-day dep. (USA)	decrease
Edwards (1988b)	1972-87	S&P Index (USA)	no effect
Baldauf & Santoni (1991)	1975-89	S&P Index (USA)	no effect
Hodgson & Nicholls (1991)	1981-87	Australian Stock Index	no long-term effect
Antoniou & Foster (1992)	1986-90	Brent Crude Oil (UK)	no effect
Lee & Ohk (1992)	1979-85	NYSE Composite Index (USA)	no effect
	1983-89	Tokyo Stock Exchange Index (Japan)	no effect
	1981-87	FT-SE 100 Share Index (UK)	no effect
	1983-89	Hang Seng Index (Hong Kong)	no effect
Cronin (1993)	1987-92	90-day DIBOR (Ireland)	decrease
	1987-91	Long Gilt (capital 2012) (Ireland)	no effect
	1987-91	Long Gilt (capital 2006) (Ireland)	no effect
	1987-91	Long Gilt (capital 2010) (Ireland)	increase
Robinson (1993)	1980-93	FT-SE All Share Index (UK)	decrease
Ayuso & Núñez (1995)	1988-94	Treasury bond (Spain)	decrease

The quantitative variable that we have selected to capture the effect of derivatives trading on the spot price volatility is the ratio of total derivatives trading (futures and options) to turnover in the associated spot market. The ratio is preferred to total derivatives trading for two reasons. On the one hand, given the eminently nominal nature of this variable, some form of standardisation is needed so that a distinction can be made between genuine increases in trading and what might be generalised increases in trading in all markets, as a result of positive inflation rates. And, on the other, because most of the arguments favouring a destabilising effect of derivatives trading imply an increase in this ratio.

The ratios used in the analysis are the following: for the government debt market, futures and options trading in Treasury bonds contracts on turnover in the spot market among members of the organised public debt market. For the money market, futures and options trading in MIBOR contracts on three-month interbank deposit trading. Finally, for the stock market, futures and options trading in the IBEX-35 index contract on turnover in the Madrid Stock Exchange.[27]

The estimation results including the ratio of derivatives trading to spot trading are reported in Table 8. For the debt market, the coefficient of the derivatives trading/spot trading ratio (δ_1) has a negative sign and is statistically significant at a 95% confidence level, although

27 For the public debt and money markets other ratios have been tried obtaining similar results to the ones reported here.

Table 8

The effects of derivatives on volatility in the spot markets

$$\Phi_5^i(L)\Delta x_t^i = c + \sum_{j \neq i}(\Phi_5^j(L)\Delta x_{t-1}^j) + \varepsilon_t, \varepsilon_{t+1/t}^i \sim N(0, h_t^i)$$

$$h_t^i = \alpha_0 + (\alpha_1 + \gamma_1 S_t^-)\varepsilon_t^{i^2} + \sum_{n=1}^{2}\beta_n^i h_{t-1}^i + \sum_{j \neq i}\beta_1^j h_{t-1}^j + \delta D_t^i$$

	$x_t^i = \log IB_t$	$x_t^i = i_t$	$x_t^i = \log ID_t$
N	1,853	1,853	1,853
α_0	0.07		0.58e-3
	(0.01)		(0.14e-3)
α_1	0.09	0.19	0.09
	(0.01)	(0.01)	(0.01)
γ_1			0.10
			(0.02)
β_1^{IB}	0.84	0.74e-4	0.38e-3
	(0.02)	(0.7e-5)	(0.14e-3)
β_1^i		0.22	0.06
		(0.04)	(0.01)
β_2^i		0.62	
		(0.04)	
β_1^{ID}			0.85
			(0.01)
δ	0.01	- 0.13e-5	- 0.15e-3
	(0.01)	(0.6e-6)	(0.4e-4)
H1	0.74	2.97	1.23
H5	1.39	7.67	2.78
H15	1.90	12.5	9.78

Notes:
1. D^{IB} is the ratio between total trading in derivatives on the IBEX-35 index and total spot trading on the Madrid stock exchange.
2. D^i is the ratio between total trading in derivatives on three-month MIBOR and total deposits at that term in the interbank market.
3. D^{ID} is the ratio between total trading in derivatives on government debt and total spot trading in the government debt market.
4. See notes to Table 2.

quantitatively small.[28] Similar results are obtained for the interbank deposit market, where the estimated parameter δ_1 is quantitatively rather small but of a negative sign and statistically significant. For the stock market, the sign of δ_1 is positive but it is not statistically significant at a 95% or at a 90% confidence level.

These results suggest that, in the period under study, public debt and money market derivatives trading in organised markets has not exerted a destabilising effect on the price volatility of the associated spot market. The result for the IBEX-35 index futures and options is less conclusive but, in any case, of a rather small size. Therefore, the episodes of high volatility experienced during the period 1990-95 in the public debt, money market and stock markets do not seem due to the growing significance of futures and options trading. Although we cannot generalise these results to

28 A negative coefficient is even more relevant on observing that volatility itself may possibly have a positive effect on the volume of trading in the derivatives markets.

other derivatives markets (since we were unable to test the effect of foreign exchange forwards or financial swaps) our findings are in line with those found in the numerous studies addressing the same question[29] and with the arguments supported by numerous economists and central bankers.[30] While the aforementioned studies have quite diverse approaches (different derivatives markets, different periods under study, different measures of volatility, different econometric methods, etc.), their findings are rather homogenous: they generally find that spot market volatility has not been adversely affected by derivatives trading, although the latter may have enhanced some episodes of very short-term volatility ("witching hours" effect or "expiration day" effect).

Therefore, policy proposals designed to curb volatility such as restrictions on derivatives trading, higher futures and options margin requirements and circuit-breakers might not be needed. Furthermore, these measures could have an opposite effect to the one sought.[31] Higher margin requirements and restrictions on some trading strategies would imply a reduction in the ability of certain investors (not necessarily uninformed speculators) to participate in financial markets. This may mean that prices will undergo larger rather than smaller swings since the restricted investors may be exactly the ones that would limit destabilising speculation. Also, higher margin requirements could limit the ability of investors to hedge because of the higher cost of hedging strategies involving futures and options. Furthermore, the imposition of circuit-breakers may prove to be counter-productive as well. Under a circuit-breaker scheme, trading will be stopped when certain predetermined conditions occur. The problem might be that circuit-breakers do not allow markets to adjust fully to new information since when the breaker is activated the determination of equilibrium prices is interrupted. In general, these proposals may make markets less efficient, i.e. less able to respond quickly to new information, which would produce a definite loss of economic welfare.

Conclusions

The negative consequences of high financial volatility have been an important concern recently. Although its empirical relevance has not been proved conclusively, clear theoretic and intuitive arguments justify this concern. Many efforts have been conducted, therefore, to determine which is the relevant concept of volatility and how to measure it, which factors explain the course it follows, and which steps should be taken in order to curb volatility.

Regarding the first question, it is the risk perceived by agents which determines their decisions and which, therefore, could have the negative consequences in terms of deterring the financial and real flows needed for an efficient allocation of resources. Therefore, there seems to be a consensus in the financial literature that the appropriate concept of volatility is the conditional variance which reflects agents' expectations about the future course of the unanticipated component of a series. In this paper we analyse price volatility in the major Spanish financial markets over the last eight years. In doing so we distinguish between variables that can fluctuate freely, for which we estimate a standard conditional heteroscedasticity model based on the observed course of the series, and the exchange rate, for which we also incorporate agents' perception about a possible future change in its fluctuation regime. The main conclusions in this respect can be summarised as follows:

- The recent process of financial innovation, deregulation, internationalisation and globalisation has not been accompanied by an upward trend in volatility. We observe, instead, periodical episodes of high volatility. These volatility increases, however, do not tend to last and are followed by later reductions. The only lasting increase seems to be that in the debt market around the summer of 1992.

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29 See Table 7.

30 See, for instance, BIS (1994), Crockett (1995) and Goodhart (1995).

31 See Edwards (1988) and France, Kodres and Moser (1994) for a discussion on the effects of these proposals.

- In terms of decreasing volatility, the markets ranked as follows: the stock exchange, the foreign exchange market, the government debt market and the money markets.
- Only the volatility in the government debt market shows asymmetric responses to shocks, since it is more sensitive to debt price falls than to price increases.
- Day-to-day volatilities seem to react, basically, to news concerning the own market although, when relevant events like exchange rate crises occur, we observe contagion effects. There is also a significant although small effect of stock exchange volatility on the money and debt market volatilities.

The episodes of high volatility commented on can justify the existence of several proposals to curb volatility if, as has been argued, these peaks can be a potential source of systemic crisis. Others have defended the need for such measures on a different basis: current levels of volatility, even if they were not higher than before, could have more negative consequences if the level of agents' exposure to risk is currently higher. In any case, the rationality of those proposals stands on the identification of certain factors that are assumed to explain to some extent how volatility develops. This is the case of two interesting groups of proposals.

First, the identification of the exchange rate regime as a conditioning factor of exchange rate volatility, associating severe regimes with low volatility and vice versa, leads to the former being advocated to curb volatility. Second, the identification of derivatives trading as a cause of recent increases in volatility has generated different proposals, all of them aimed at regulating and controlling derivatives markets. Therefore, in order to reach a conclusion concerning the pertinence of such measures it is of primary importance to check first whether the empirical evidence supports these assumed effects. We have focused precisely on these proposals because the recent Spanish experience is particularly useful to analyse the above-mentioned effects. In both cases, combining the empirical evidence found in previous work with some extensions developed in this paper, we conclude that the empirical evidence does not support the relations that would guarantee the success of the measures analysed.

In particular, the credibility of the exchange rate regime has brought about a situation where steps towards a stricter regime have not led necessarily to lower exchange risk, even in periods without speculative attacks, and vice versa (this conclusion can be extended to other European currencies). Attempts to reduce exchange rate risk by means of increasing the rigidity of fluctuation regimes may in fact be unsuccessful if the conditions for this regime to be credible do not hold. Conversely, to reduce the risk of foreign currency transactions, it may be preferable to adopt less ambitious exchange rate commitments that are flexible enough to warrant an acceptable degree of credibility, even though they might imply greater observed exchange rate volatility.

We have summarised some empirical evidence which highlights the variables which, by affecting credibility, can condition the success of attempts to reduce exchange risk by a tougher exchange rate commitment. The cumulative losses of competitiveness help to explain expectations about the size of a depreciation associated with a potential future devaluation. With respect to the probability that agents attribute to such a future devaluation, several factors are at play: a reputation effect; an effect of the general pace of the system; the exchange rate proximity to the depreciation limit; and, finally, the impact of the cost of parity maintenance implied by the need for a level of interest rates tailored to the defence of the commitment but not to the position in the economic cycle.

Finally, public debt, stock exchange index and interbank deposit derivatives trading have not had a destabilising effect on the volatility of the associated spot markets. Therefore, the episodes of high volatility experienced since 1990 seem not to be fuelled by the growing significance of futures and options trading. Furthermore, the ratio of derivatives trading to spot trading, if significant in explaining the respective spot price volatility, has a negative sign, although the effect is of a small size. There are no available data to test whether our results can be extended to the case of OTC markets. With this caveat, our findings, in line with those found in the literature, raise serious doubts about the effectiveness of measures aimed at curbing volatility by imposing restrictions on derivatives trading. Moreover, as has been argued, these restrictions could even have an opposite effect to that sought.

APPENDIX

The corrected measure of risk can be derived as follows: assume that $y_{t+\tau}$ follows the process $R1$, with conditional mean, in t, μ_t^1, and conditional variance h_t^w. However, agents assign, at t, a probability p_t to the fact that $y_{t+\tau}$ will follow another process $R2$ in $t+\tau$ with a different conditional mean μ_t^2.

Thus, the conditional mean, at time t, of $y_{t+\tau}$ is:

$$E_t(y_{t+\tau}) = (1-p_t)\mu_t^1 + p_t\mu_t^2 \tag{A1}$$

and the conditional variance can be written:

$$\begin{aligned} V_t(y_{t+\tau}) &= E_t\left(y_{t+\tau} - E_t(y_{t+\tau})\right)^2 \\ &= (1-p_t)E_t\left[\left(y_{t+\tau} - E_t(y_{t+\tau})\right)^2 \middle| R1\right] + p_t E_t\left[\left(y_{t+\tau} - E_t(y_{t+\tau})\right)^2 \middle| R2\right]. \end{aligned} \tag{A2}$$

Substituting A1 into A2 yields

$$\begin{aligned} V_t(y_{t+\tau}) &= (1-p_t)E_t\left[(y_{t+\tau} - \mu_t^1) - p_t(\mu_t^2 - \mu_t^1) \middle| R1\right]^2 \\ &\quad + p_t E_t\left[(y_{t+\tau} - \mu_t^2) + (1-p_t)(\mu_t^2 - \mu_t^1) \middle| R2\right]^2 \\ &= h_t^w + p_t d_t(d_t - p_t d_t) \ , \end{aligned}$$

where $\quad d_t \equiv \mu_t^2 - \mu_t^1$

is the expected jump in the conditional mean.

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