The Effects of Exchange Rate Regimes on Real Exchange Rate Volatility. A Dynamic Panel Data Approach

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Resumen

Este trabajo analiza la relación entre régimen cambiario y volatilidad de corto plazo del tipo de cambio real multilateral (TCR). Para ello se combinan varias clasificaciones cambiarias para una muestra de 62 países en el período 1980-1999 con la metodología de Arellano y Bond (1991) para paneles dinámicos. Respecto a las clasificaciones el trabajo discute algunas clasificaciones *de facto* recientes y propone una nueva clasificación que contrasta las clasificaciones *de jure* con las *de facto*. Ello permite detectar posibles inconsistencias entre el compromiso del banco central y el comportamiento observado.

Los resultados confirman la no neutralidad de los regimenes cambiarios respecto a la volatilidad real del TCR. Los resultados muestran también que las fijaciones *de jure* presentan más volatilidad que las flexibles. Cuando se considera la nueva clasificación, las soluciones extremas (fijo consistente y flexible) tienen la similar volatilidad real. Además, esta son las menores de la muestra comparada con el resto de los regimenes. Adicionalmente, mayor apertura, aumentos en el PBI per capita y shock en los términos de intercambio reducen la volatilidad real mientras que shocks monetarios positivos, incrementos en los flujos de capitales y en el gasto público incrementan la volatilidad del TCR. También se obtiene evidencia de la necesidad de diferenciar el comportamiento de los regimenes en países de la OECD respecto a los países emergentes o en desarrollo.

Abstract

This paper seeks to analyze the relationship between exchange rate regimes and short-term volatility of the effective real exchange rate. To these ends, a sample of 62 countries for the 1980-1999 period, the GMM methodology for dynamic panel models proposed by Arellano and Bond (1991) and diverse exchange classifications are used. In relation to the latter, this paper discusses recent regime classifications and proposes a new exchange rate classification that contrasts *de facto* and *de jure* classifications. It allows checking possible inconsistencies between the commitment of the central bank and its observed behavior.

The results confirm the non-neutrality of regime regarding real exchange rate volatility. The findings show that the *de jure* peg induces more volatility than the flexible ones. When considering the new classification, corner solutions have the same real volatility, while the rest of the categories of exchange rate regimes purvey more real exchange rate volatility. It is also found that more openness, increase in per capita GDP and in terms of trade, reduce volatility; conversely, positive monetary shocks and increase in capital inflows and in public expenditure increase this real volatility. Evidence is also obtained that supports the view that the analysis of the dynamics of the exchange rate regimes needs to differentiate between developed and developing countries.

JEL classification: C23, F32, F33, F41

Keywords: exchange rate regimes, effective real exchange rate, volatility, panel data,

internal instruments, GMM.

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1. Introduction

The evaluation of diverse costs and benefits associated with different regimes, has been the source for many debates and continuous to be one of the most important topics in International Economy. In theoretical terms, it is difficult to establish an univocal consensus on these relations, product of the many links –that are partly reinforced and partly counteracted– among the different exchange rate regimes and the macroeconomic variables. Precisely, the relevance of the empirical analysis lies in trying to quantify the relative importance of the different relations involved.

The aim of this paper is to set out the relative importance of these links, specifically by analyzing the exchange rate regime influence on the RER volatility.

There is a great disagreement in international finance literature about the behavior of the RER volatility under different nominal exchange rate arrangements and international monetary contexts. Mussa (1986), Eichengreen (1988), Baxter and Stackman (1989) and Flood and Rose (1995) highlight a positive relation between the shot-term volatility of the RER and the flexibility of the exchange rate regime. On the contrary, Grilly and Kaminsky (1991) criticize these regularities between RER volatility and exchange rate regime, and argue that RER volatility depends on a particular historical period of time, rather than upon the exchange rate regime. They find that the distribution of the monthly rate of change of the RER is the same -under fixed and floating regimes- for the period preceding World War II but it is different for the period following it. Previous papers analyze the relationship between exchange rate regimes and RER volatility using mainly the bilateral RER.

In recent papers, Liang (1998) and Kent and Naja (1998) examine volatility using the effective RER. The former concludes that, in comparison, flexible exchange rate regimes have higher RER volatility than the fixed ones. Kent and Naja (1998) find that for pooled results across countries, effective RER is only twice –statistically significant– as volatile under floating regimes as under fixed regimes. However, results within countries show that, for most of them, there was no significant increase in the RER volatility when moving to more flexible exchange rate regimes, and that for some of them volatility is lower under more flexible exchange rate regimes. If the behavior of the RER is influenced by country characteristics the results of the within analyses are more appropriate. This necessarily should be taken into account in the modelization of our problem.

This paper seeks to contribute to the empirical research on this issue performing a dynamic panel data analysis considering 62 countries for the period 1980-1999. At the same time, it finds evidence on how other variables influence RER volatility and it also analyses the persistence of shocks in RER.

The empirical analysis expands the literature on the topic and contributes to its improvement in many regards:

1. In relation to the question of which might be the best way for analyzing the behavior of

the RER volatility under different exchange rate regimes and international monetary system, this study considers both levels of analysis. Neither the analysis that evaluates the RER volatility among historical periods without any consideration for exchange rate regimes, nor the analysis that evaluates the influence of the exchange rate regimes independently of the international context, seem appropriate. In the former kind of analysis, there might be a problem of identification because they can not work out the effect of other events that modify the RER behavior if they are highly correlated with the change of international regime. The latter type of analysis can not differentiate the performance of the exchange rate regime in relation to the behavior of the rest of the countries. For example, a fixed exchange regime or a currency board does not generate the same results under the gold standard or BW than under an international floating regime as the present one (Carrera, 2002).

2. For this reason, this paper focuses on the period of the international flexible regime according to the classification of Eichengreen (1994). This makes it possible to evaluate the influence of the exchange rate regimes on the RER volatility without adding the effect of change on their properties –caused by a different context.
3. It makes an extensive use of available information on the classification of exchange rate regimes. It expands the dichotomy "fixed vs. flexible" according to *de jure* classification compiled by the IMF. And it also makes use of new contributions by Levy Yeyati and Sturzenegger (2000) that classifies the countries according the observed behavior. Combining both, a new classification of exchange rate regimes is realized, making it possible to cover probable inconsistencies between the commitment of the central bank - to intervene and subordinate its monetary policy to the currency market - and its behavior.
4. The majority of the papers analyze the relationship between exchange rate regimes and RER volatility using the bilateral RER. However, from a macroeconomic view point, the analysis of the effective RER seems to be more appropriate, especially for countries that are away from monetary centers and that have a diversified commerce. This is the case of Sweden, Brazil, Argentina, Australia, South Africa, etc. Besides, the very election of the period of the international flexible regime suggests that the measurement of the RER contemplate the changes generated by the floatation of the rest of the countries. Otherwise, the measurement can be misleading and even generate erroneous results.
5. It is followed a cross country approach using panel estimations. It makes use of a dynamic methodology of estimation (Generalized Method of Moments) which considers endogeneity problems and unobserved specific effects. The use of this dynamic methodology makes the analysis of the persistence of the shocks in the RER possible.
6. It allows, unlike previous analyses, to work out the effect of exchange rate regimes on RER volatility controlling by other variables that can affect this variable.

The paper is organized as follows: Section 2 reviews the most representative theoretical and empirical works on the subject. Section 3 justifies the choice of econometric methodology. Section 4 offers the macroeconomic variables and the exchange classifications used in this paper. Section 5 shows the econometric results. Section 6 presents the conclusions.

2. Theoretical Discussion

The currency crises in Europe, Asia and Latin America in the nineties, as well as the launching of the Euro, generated a renewed interest for the effects of the exchange rate regime over macroeconomic variables and especially over the RER volatility. Already when the system of Breton Woods collapsed and was replaced with a more flexible system, an important interest about the effects that the new international system could have, was expressed not only in theoretical literature but also in empirical investigation.

There are many empirical studies that analyze the impact of exchange rate regimes on different macroeconomic variables, such as inflation and its volatility, real interest rate, and growth and its volatility. An issue that has not been deeply analyzed is the relation between exchange rate regimes and real exchange rate (RER) volatility. This question is especially important because the RER volatility has a strong effect on numerous and relevant economic variables among which the long-term growth[1] through consumption, investment and trade flows[2] should be mentioned (Frankel and Rose, 1995). Yet, there seems to be agreement over the negative character of real volatility in macro terms. In other words, between two countries with identical characteristics, the one having greater volatility of the RER will be in worse conditions than the one having less. For all these reasons, the analysis of the impact of the exchange rate regime over the RER volatility may provide one of the main criteria for the election of a regime. The huge effort that governments make in order to reduce it, is sufficient proof of this.

Empirical evidence seems to show that after Breton Woods, nominal and real exchange rate volatility increased. Many studies, among which are those by Mussa (1986), Eichengreen (1988), Baxter and Stackman (1989) and Flood and Rose (1995), highlight a positive relation between the shot-term volatility of the RER and the flexibility of the exchange rate regime. However, as most of these studies, Mussa's is based on the analysis of the bilateral RER. He analyzes the behavior of 15 industrialized countries and finds that bilateral RER were, on average, almost 14 times higher under floating than under fixed exchange rate regimes.

Grilly and Kaminsky (1991) criticize the validity of the consensus about the empiric regularity between RER volatility and exchange rate regime (i.e. volatility be regime-dependent). They argue that RER volatility depends on the particular historical period rather than on the exchange rate regime. Through their work they examine monthly observations of the RER between the US Dollar and the British Pound between 1885-1986 and find that the distribution of the monthly rate of change of the RER is the same under fixed and floating regimes only for the pre-World War II data, and that when post-World War II data are included, different volatility behaviors across exchange rate regimes are found.

In a recent work, Liang (1998) criticizes the results obtained by Grilly and Kaminsky (1991) and performs and empirical analysis using annual data from 1880 to 1997, and monthly data from 1957 to 1997. He affirms to confirm the suspicion that flexible exchange rate periods have higher volatility of the effective RER than in fixed exchange rate periods. Kent and Naja (1998) analyze the relationship between the short-term volatility of the effective RER and the degree of flexibility of the exchange rate regime using non-parametric tests. They find that, for pooled results across countries, effective RER is only twice –statistically significant- volatile under floating regimes than under fixed regimes. However, results within countries

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[1] Though it is true that there are few papers that concentrate on testing the impact of the RER volatility over growth, there is much evidence concerning the effects of the regimes over issues like growth. While some papers find greater growth in Breton Woods era, Gosh (1997) does not find any relation between regime and growth. By means of a better classification than the simple *de jure* classification, Levy Yeyati and Stuzenegger (2000), observe that the flexible exchange regimes are associated to a greater growth.

[2] Gonzaga y Terra (1997) present an interesting model with exporters adverse to the risk, where greater volatility caeteris paribus reduces competitiveness and increases the average RER level required by an economy to be in equilibrium which, in return, affects inflation. Volatility, then, is an explanatory variable of the equilibrium RER. Some studies carried out by Cushman (1983, 1986, 1988), Akhtar and Hilton (1984), Kenen and Rodrik (1986), and Arize (1995, 1996) support the idea of a depressant effect of the RER volatility on trade. Others like Hooper and Kohlhagen (1978), Gotur (1985), and Asseery and Peel (1991) claim the opposite result. The evidence obtained, nevertheless, is not conclusive.

show that there was no significant increase in effective RER volatility when moving to more flexible exchange rate regimes and that, for some of them, volatility is lower under more flexible exchange rate regimes.

From a theoretical point of view, diverse equilibrium models find the neutrality of the exchange rate regimes (Helpman, 1981; Lucas, 1982), what indicates that the serie's properties are invariant in relation to the exchange rate regime.

The theoretical studies that analyze the non-neutrality of the regimes offer, mainly, two explanations: models that considerate nominal rigidity in prices and models that include tradable and non- tradeable goods.

It is possible to identify two kinds of papers based on nominal rigidity prices. One of them supports the idea of greater nominal and real volatility under flexible regimes. This greater volatility could lead to a distributive inefficiency because if the nominal exchange rate (NER) is changed, the RER is likely to change and, as a consequence, the allocation of factors in the production (Hallwood and McDonald, 1994).

By contrast, other papers demonstrate that having as a starting point a situation of la disequilibrium, for example after a permanent real shock, floatation (or at least nominal corrections in the exchange rate parity) would contribute to an allocation closer to the socially efficient, by drawing the parity near to the new equilibrium. In this case, a fixed exchange rate regime in a context of nominal rigidity of the prices, by limiting nominal and real volatility, has efficiency costs in terms of greater unemployment of the factors while the transition takes place. That is to say, if the fixed exchange rate regimes were incapable of adjusting the shocks, as happened with different exchange rate crises in Europe, Asia and Latin America in the nineties, it would be possible to observe collapses of the fixed regimes that create overshooting of the nominal parity and greater ex post RER volatility. It is important to remark that, in terms of causality, greater volatility corresponds to fixed regimes and not to the flexible or intermediate ones that might have replaced them.

In this way, good and bad volatility of the nominal and real exchange rate (Helpman y Razin, 1982; Neumeyer, 1998) could be distinguished. Taking extreme positions, good volatility is the one associated with adjustments to the NER, that contribute to draw the country near to the equilibrium after a shock. This volatility tells of the inefficiencies generated as a result of being far away from the equilibrium and helps to correct them. Bad volatility is the one that, starting from a situation of equilibrium, takes place due to changes in the nominal parity (normally it is caused by a political shock).

In the second group, that is the T-NT models, they support the idea that imperfect competition in international markets is the main determinant in non-neutrality. The study of Cuddintong and Liang (1998) divides tradeable goods into industrial goods and primary goods and find that a differential fixing of prices in markets, may lead to a dependence of volatility in relation to the exchange rate regime and to changes of the allocation of factors that are socially inefficient.

The study of all this literature suggests some important questions: Are the exchange rate regimes neutral with respect to real variables like the RER volatility? Do fixed exchange rate regimes provide less RER volatility than flexible ones? How do other economic variables, like the openness or capital flows, affect RER volatility? How policy variables affect the RER volatility? How persistent is volatility? Consistent central bankers enjoy less RER volatility? The aim of this paper is to give an answer to these questions.

3. Econometric Methodology

For the selection of the estimation method, three aspects were considered. Firstly, issues concerning data should be considered: due to the availability of panel data -which makes it possible to retain all the information in relation to the use of annual averages- the presence

of the country's unobservable factors must be enabled. Secondly, it is interesting to analyze the persistence of the RER shocks, reason for which the methodology must allow for an inertial behavior of the variable considered. Finally, an element -frequently ignored in empirical works but which is very important- is the so- called "reverse causality". That is, as some of the explanatory variables are likely to be jointly determined with RER volatility, endogeneity of the explanatory variables must be controlled.

Considering these aspects, the appropriate methodology to use is the Generalized-Method-of-Moments (GMM) estimator for dynamic panel data models developed by Arellano and Bond (1991). This estimator deals with country specific effects and potential endogeneity of the explanatory variables. The control for endogeneity is achieved by the use of "internal instruments", that is to say, instruments based on lagged values of the explanatory variables

What follows is a justification for having chosen the present methodology and an account on its benefits in comparison with the alternatives frequently used. The dynamic nature of RER volatility (R) must be represented through a model containing lagged dependent variables among the regressors. To simplify the analysis, a simple autoregressive model with one lag period of the dependent variable is considered:

$$R_{it} = \delta R_{i,\,t-1} + x_{it}'\beta + \upsilon_{it} \qquad i = 1,...,N \qquad t = 1,...,T \tag{1}$$

where δ is a scalar, x_{it}' of dimension 1xk represents a group of variables that potentially affect RER volatility and β is kx1. Assuming that the υ_{it} follow a one-way error component model:

$$\upsilon_{it} = \mu_i + \nu_{it} \tag{2}$$

where $\mu_i \sim \text{IID}(0, \sigma_\mu^2)$ and $\nu_{it} \sim \text{IID}(0, \sigma_\nu^2)$ are independent of each other and among themselves.

Since R_{it} is a function of μ_i, $R_{i,t-1}$ is also a function of μ_i. Therefore, $R_{i,t-1}$, a right-hand regressor in (1), is correlated with the error term. This renders the Ordinary Least Square (OLS) estimator biased and inconsistent even if the ν_{it} are not serially correlated. In relation to the Fixed Effect (FE) estimator, the Within transformation wipes out the μ_i, though $(R_{i,\,t-1} - \bar{R}_{i,\,t-1})$ where $\bar{R}_{i,\,t-1} = \sum_{t=2}^{T} R_{i,\,t-1} / (T-1)$ will still be correlated with $(\nu_{it} - \bar{\nu}_i)$ even if the ν_{it} are not serially correlated. This is because $R_{i,t-1}$ is correlated with $\bar{\nu}_i$ by construction. The latter average contains $\nu_{i,\,t-1}$ which is obviously correlated with $R_{i,\,t-1}$. In fact, the Within estimator will be biased and only if $T \to \infty$ will the Within estimator of δ and β be consistent for the dynamic error component model. The same problem springs with the random effects Generalized Least Square estimator (GLS) because $(R_{i,\,t-1} - \theta \bar{R}_{i,\,t-1})$ will be correlated with $(\upsilon_{i,\,t} - \theta \bar{\upsilon}_{i,\,t-1})$.

An alternative transformation that wipes out the individual effects, yet does not create the above problem, is the first difference transformation. In fact, Anderson and Hsiao (1981) suggested, first, differencing the model to get rid of μ_i, and then, using $\Delta R_{i,\,t-2} = (R_{i,\,t-2} - R_{i,\,t-3})$ or $R_{i,\,t-2}$ as an instrument for $\Delta R_{i,\,t-1} = (R_{i,\,t-1} - R_{i,\,t-2})$. These instruments will not be correlated with $\Delta \nu_{it} = \nu_{it} - \nu_{i,\,t-1}$, as long as the ν_{it} themselves are not serially correlated. This instrumental variable estimation method leads to consistent but

not necessarily efficient estimates of the parameters in the model, because it does not make use of all the available moment conditions as Ahn and Schmidt (1993) show, and it does not consider the differenced structure on residual disturbances (Δv_{it}). A methodology considering country specific effects and the bias of dynamic panel data models is the GMM estimator developed by Arellano and Bond (1991). This estimator works in the following way: first, take first differences of a model like (1) which, generalized to a model containing k lagged dependent variable as regressor, leave:

$$\Delta R_{it} = \sum_{j=1}^{k} \delta_j \Delta R_{i,\,t-j} + \beta' \Delta x_{it} + \Delta v_{it} \qquad (3)$$

where $\Delta R_{it} = R_{it} - R_{i,\,t-1}$. First differencing gets rid of the country specific effects, but leads by construction a correlation between the differenced lagged fiscal variable and the differenced error term. Therefore, these authors propose using lagged levels of the explanatory variables, including the lagged dependent variable, as instruments.

The GMM estimator will be consistent if the lagged levels of explanatory variables are valid instruments for differenced explanatory variables. This will hold if the error term is not serially correlated and the explanatory variables are weakly exogenous. These assumptions can be tested by using the tests proposed by Arellano and Bond (1991). The first is a Sargan test of overidentifying restrictions, which tests the overall validity of the instruments. Failure to reject the null hypothesis gives support to the model. The second, is a test for serial correlation in the error term. If such test does not reject the null hypothesis of second order correlation absence, it can be concluded that the original error term does not have serial correlation.

4. Data

The largest sample embraces a panel of 62 countries[3] –19 OECD countries and 43 non-OECD- for the 1980-1999 period. The source of data used for the macroeconomic variables were the *IMF* and the *World Bank*. The sources of data of exchange rate regimes were the *IMF Annual Report on Exchange Arrangements and Exchange Restrictions* for *de jure* exchange rate classification and *de facto Exchange Rate Classification Database* by Levy Yeyati and Sturzenegger (2000).

4.1. Macroeconomic variables

The RER volatility is obtained by calculating the standard deviation of the effective RER over each year using monthly data. Openness, rate of growth of real per capita GDP, shock in trade terms, change in the capital account, rate of growth of M2, growth of government consumption and different classifications of exchange regimes specifically discussed in the following sub-section are used as explanatory variables[4].

5. Accounting for Exchange rate regimes classification

There are two points that should be taken into account when carrying out an exchange rate classification:

1. The degree of detail in the *de jure* classification. While it is often the case to speak of the "fixed vs. flexible" dichotomy, the *de jure* classification available is broader, covering from

[3] The complete list of countries included in this paper is presented in the Data Appendix 8.1.

[4] For more details regarding the construction of the variables see Data Appendix 8.2.

currency boards or countries not having their own currency, to flexible exchange rate regimes with high, low or no intervention.

There is a pair of questions to add in this way:

The first is associated to the managed float category. It was decided to consider it as floating because for the topics and variables involved, it is more relevant to know whether there is a commitment or not on the part of the central bank than if they effectively intervene or not in the exchange market. In fact, according to Levy Yeyati and Sturzenegger (2000), only few more than 30% of the countries considered to be having a floating exchange rate regime behave as such.

The second question is how to classify the countries participating in the European "snake" in the mid-seventies and later in the EMS. These countries have fixed exchange rate regimes, but they float against other currencies. In agreement with other papers -Ghosh et al. (1997) and Levy Yeyati and Sturzenegger (2000)- they are classified as intermediate.

2. The criterion to follow when carrying out the classification. Economic literature shows two possible options to carry it out: a *de jure* classification, based on the commitment adopted by the central banks and a *de facto* classification, product of the actual behavior. Neither of the methods is entirely satisfactory. The *de facto* classification has the advantage that it is based on the observed behavior, but does not make it possible to distinguish between stable nominal exchange rates resulting from the absence of shocks, and the stability produced by political actions counteracting the shocks. Because of this, it fails to capture what might be the essence of an exchange rate regime -the real quality of the commitment of the central bank to intervene and subordinate its money policies to the exchange market. The *de jure* classification captures this formal commitment, but fails to control macro policies which are inconsistent with this commitment.

Having taken these two points into account, two different exchange rate regime classifications are used:

- In the first step, a three-category *de jure* classification is considered: fixed, intermediate and flexible. The fixed regimes cover: a single currency peg; SDR peg; other official basket pegs; and a secret basket peg, according to the IMF terminology. The intermediate group includes: cooperative arrangement, unclassified flexible, rule based, crawling peg and target zone. While the flexible group includes independent float and managed floating.

- Then, a suggested new exchange rate regime classification, which captures both, the central bank commitment to intervene and subordinate its monetary policy to the currency market and the possible inconsistencies in its behavior is used. For this, the *de jure* classification of the IMF and the *de facto* classification by Levy Yeyati and Sturzenegger (2000)[5] (presented in table A-1) are combined under a grouping criterion. In this way we control for the consistency between deeds and words.

Table A-1 presents the *de facto* classification of Levy Yeyati and Sturzenegger. Tables 9-2 up to 9-4 describe, through the "crossing" of the *de jure* and the *de facto* classifications, the main characteristics of the regimes for the 1974-1998 period in quantitative terms. Some of the most outstanding characteristics are:

[5] Specifically the 1st round classification is considered, as it emerges from a deeper analysis likely to eliminate the possible bias towards the irrelevance of the significance of the regime. The outline of the criterion considered by Levy Yeyati and Sturzenegger (2000)
In this paper, the dirty floating categories and crawling peg by Levy Yeyati and Sturzenegger (2000) have been grouped under the *de facto* intermediate category.

- An important proportion of the *de facto* inconclusive regimes are present for all the *de jure* exchange rate regimes, especially for fixed regimes (table A3). At the same time the greatest proportion of inconclusive regimes are concentrated in *de jure* fixed regimes (table A-2).
- While 63% of the regimes showing a flexible behavior are defined as such, just 28% of the ones behaving as fixed admit being so (table A-2). This behavior, usually called "fear of floating", has shown, according to Levy Yeyati and Sturzenegger (2000), a clear increase since the late eighties (Calvo and Reinhart, 2001).
- Excluding the inconclusive ones, while 62% of *de jure* flexible regimes behave as such, just 39% of the fixed does so (table A-4). This result shows an important difference between the central bank commitment to intervene and the behavior observed according to the exchange rate regimes.

5.1. A new classification: deeds and words

On the basis of the characteristics mentioned above, the theoretical and empirical elements considered for building the new classification of exchange rate regimes are:

- The categories' diversity should balance a trade-off between greater information and limitations imposed by econometric restrictions.
- A clear difference between commitment and behavior according to *de jure* exchange rate regimes is observed, with greater divergence for fixed regimes.
- The categories' diversity should consider the credibility problem involved in the contrast between the observed and de declared behavior. For example, while it seems to be obvious that a country with a *de jure* fixed regime (showing an intermediate or flexible behavior) is inconsistent with this commitment, it is not clear that an economy with flexible regime, behaving as fixed, violates any kind of commitment which makes it inconsistent. In fact if after behaved as a fix, a declared flexible that move the parity is not violating any obligation.

The new suggested classification of exchange rate regimes -with the letters identifying the different categories- is presented in table 1.

Table 1

New classification of exchange rate regimes

		de facto Classification			
		Fixed	Intermediate	Flexible	Inconclusive
de jure Classification	Fixed	a	b	c	d
	Intermediate	e	f	g	h
	Flexible	e	f	g	h

This new classification is composed of eight categories:

- (*a*) *de jure* fixed regimes behaving consistently with the commitment. For example: Lesotho 1980-1998, Bahrain 1992-1997 and Ireland 1976-1978.
- (*b*) *de jure* fixed regimes which, having behaved in the opposite way regards the commitment –have variations on their exchange rates–, had strong movements on their reserves, probably because they were detected as inconsistent and punished for this behavior. For example: Bolivia 1982-1985, Argentina 1975-1977 and Chile 1974-1976.

- (*c*) *de jure* fixed regimes which, even if they have changes on their exchange rates, are not detected or punished for such behavior as they do not show greater changes on their reserve levels. For example: Poland 1992-1995, Burundi 1985-1991 and Sweden 1981-1982.
- (*d*) A priori, they could be thought of as fixed regimes having stable economies, with no greater external shocks or credibility problems. For example: Australia 1974-1983, Panama 1974-1985, New Zealand 1974-1984 and The Bahamas 1974-1998.

The remaining categories have been grouped according to their observed behavior, as in theoretical terms it is not evident that the disagreement between both classifications creates any kind of inconsistency.

- (*e*) economies behaving as fixed, that do not want to be limited or judged by the rules governing the *de jure* fixed regimes. They are linked to the "fear to floating" concept. For example: Finland 1992-1998, Ireland 1987-1998, Denmark 1981-1989 and New Zealand 1992-1998.
- (*f*) they have important movements in their reserves, and changing and volatile exchange rates, but are not engaged with the exchange rate fixation. For example: Argentina 1981-1985, Brazil 1987-1993 and Thailand 1997-1998.
- (*g*) within this classification, it is really close to pure flexible, as it does have important variations in the exchange rate but little movement on its reserves. For example: the United States 1977-1998, Japan 1977-1998, Turkey 1981-1993, Chile 1992-1995 and Uruguay 1986-1988 y 1990-1996.
- (*h*) they include stable economies, with no important or strong enough external shocks as to avoid greater effects on their exchange rates or reserves. For example: Belgium 1974-1998, Canada 1974-1997, Tunisia 1987-1998 and Costa Rica 1993-1998.

6. Empirical results

Figure 1 shows for the *de jure* classification the RER intra-annual volatility vs. nominal ER intra-annual variation. Fixed regime shows lower nominal volatility but a big dispersion in real volatility. On the contrary, flexible shows a higher positive variations and lower volatility. Figure 4 shows density functions for *de jure* classification and figure 5 do the same for the new classification.

Little is known about the RER volatility determinants in specific theoretical models. So, the inclusion of explanatory variables is not derived from a particular model. On the contrary, it is general enough as to test different hypothesis. The empirical model is estimated for the 1980-1999 period and considers, in addition to the lagged of the dependent variable and the exchange rate regimes a mix of independent variables as potential determinants of RER volatility. The structural variables are: openness, rate of growth of per capita GDP, shocks in terms of trade, changes in the capital account. And the policy variables are growth of M2 and growth in government consumption.

Then, the study moves forward in two ways: on one hand, different sub-samples of countries are considered and, on the other hand, the exchange rate regime classification is enriched.

It is worth mentioning that the Sargan test and the serial correlation test cannot reject the null hypothesis for all the models estimated through GMM, supporting the use of appropriate lags of the explanatory variables as instruments for the estimation.

For a proper reading of the exchange rate regimes' coefficients, it is important to say that they refer to their differential compared to their flexible effect –*de jure* flexible regime in the IMF classification and pure flexible regime for the new classification (category g)-. So as an example, a positive sing in fixed exchange rate regime means that this regime causes more

RER volatility than the flexible one.

6.1. Importance in the choice of the estimation method

Models 1 and 2 of tables 9-6 consider the *de jure* exchange regimes –fixed, intermediate and flexible- and differ in the estimate methodology depending on whether it is FE or GMM respectively. The results show the great importance of the proper choice of the method. On the one hand, all variables tend to reduce their significativity and, on the other hand with fixed effects, the effect of the regimes suffers some changes, not only in significativity but also in direction and magnitude (intermediate change from negative to positive).

6.2. Results obtained using the *de jure* classification

The results obtained considering all countries and GMM methodology are presented in models 2 and 3, depending on the exchange rate regime classification used. Model 2 considers the *de jure* classification; while model 3 considers the new regime classification. Setting apart the exchange rate regime variables, both models shows robust results for the rest of the variables. Increase in the capital inflows, shocks in the rate of growth of broad money and growth of government consumption increase RER volatility, while a greater degree of openness, increase in the GDP per capita and improvement in the term of trade reduce it.

- A greater degree of openness reduces RER volatility. This result supports the theoretical prediction by Hau (2000) and Obstfeld and Rogoff (2000) and also the empirical evidence obtained by Hau (2001). The intuition for this effect is as follows: more imported goods provide a channel for a quick adjustment of the domestic aggregate price level. This in turn reduces any short-run effect of money supply or real shock on the real household balances and then the effects on either consumption or the RER.

- An increase in the GDP per capita reduces RER volatility. It seems reasonable that this variable represents an important control variable, due to the various development levels that the data set combines. To obtain higher productivity levels are associated with reducing the RER volatility.

- An improvement in terms of trade tends to reduce RER volatility. This might be indicating that an improvement in the external purchasing capacity requires, eventually, minor nominal devaluations or can reduce prices of import goods. This result could be coupled with the conventional idea was that this effect improve the equilibrium RER (Edwards, 1989).

- Increases in capital inflows increase the RER volatility. Standard open economy models predict that capital inflows lead to an excessive expansion of aggregate demand and that this is likely to be reflected in inflationary pressures due to the fact that non- tradeable goods supply is more rigid than tradeable goods supply.

Regarding economic policy the results confirm some expected relationships.

- A shock in broad money emission is positively associated with RER volatility. This can be accounted for nominal devaluations as well as increases in prices.

- An expansion in government spending tends to increase RER volatility. This expansion appreciates the RER if it increases the overall demand for non-tradable goods. This would be the case if government propensity to consume non-tradable goods were lager than that of the private sector.

The coefficient of the lagged dependent variable in models 2 and 3 reflects a tendency to reduce RER volatility caeteris paribus. It means that, controlling for country-specific characteristics, structural variables and domestic and external shocks; the RER volatility tends to reduce over time. Obviously, this result does not contradict the low positive

correlation (0.312) found for the countries of the sample, due to the fact that this correlation results from a non-conditioned analysis. Then the series of RER volatility is not explosive and converge slowly.

As regards the influence of the exchange rate regimes, this paper supports the non-neutrality idea. Considering the *de jure* classification used in model 2, results show that fixed and intermediate regimes generate greater RER volatility. This is in opposition to the results usually obtained by some papers and to the non-conditioned results displayed in table 9-5[6]. The clear difference between this and previous results in other papers is based on the different questions and different contexts taken into account here. Whereas previous statistical analyses attempt to find out if the RER variability under fixed regimes is higher than under flexible regimes, the present analysis attempts to discover which the effect of the regime is over RER volatility. One of the main points that this analysis has incorporated, taking into account the significativity for the within analysis (Kent y Naja, 1998), is to consider that the RER volatility is influenced by characteristics which vary across countries – regardless of the different control variables introduced-.

6.3. New exchange rate classification: The importance of a classification detecting inconsistencies

To consider the central bank commitment to intervene and subordinate its monetary policy to the currency market, as well as the possible inconsistencies in its performance, the new classification suggested in section 4 is used, and the econometric results are presented in table 9-7, model 3.

Discussion about this new classification allows getting to the bottom of certain behaviors that the *de jure* classification not allows recognizing. The results obtained indicate that *de jure* fixed regimes, that have successfully defend the exchange parity, have the same impact on RER volatility than pure flexible regimes. All the other categories (including the *de jure* fixed regimes that change parity –b-, those that do not allow their reserves to be modified –c- or those that have not suffered significant shocks-d-) show a greater RER volatility in relation to the pure flexible regimes defined as (g) or in relation to the consistent fixed regimes defined as (a). So that corner solutions impact with similar RER volatilities. It is also reasonable to think that inconclusive categories may generate a moderate RER volatility for the fact that these economies are subject to moderate shocks[7].

Table 9-5 showed that, apparently, the intermediate regime has lower volatility, especially in OECD. The results obtained support the idea that extreme regimes, either fixed or floating, generate minor RER volatility. This is in the line of the so called vanished intermediate regimes of Frankel (1999) and show a lower volatility of corner solutions.

6.4. Core vs. Periphery: Are OECD and non-OECD intrinsically different?

Many recent discussions on dynamics of the exchange rate regimes, that are advisable in order to cope with financial instability, rest on the observation that the challenges of globalization are not quite the same depending on whether it refers to developed or

[6] Table A-5 shows that for the totality of the countries, *de jure* flexible regimes have a RER volatility 30% higher in terms of the median.

[7] The greatest RER volatility displayed by the inconclusive regimes (h and d categories) in relation to the pure flexible ones could be a result of having considered the first round classification proposed by Levy Yeyati and Sturzenegger (2000).

developing countries[8]. Specifically, these discussions focus on the role of technological progress in money and finance. They argue that the more financially developed part of the world has been able to exploit to its fullest possible extent its ability to float, while the less financial developed ones have always faced serious difficulties due to the "original sin" and "hollowing out" hypotheses (Hausmann R., M. Gavin, C. Pages and E. Stein, 1999).

Likewise, and in agreement with the previously exposed reasoning, the data for the sample of 62 countries shows a notorious difference in terms of the RER volatility according to the degree of development of the country (See Figure 2). Whereas for the full sample the coefficient of variation of the RER volatility is 5.47, when it is evaluated for the OECD and non-OECD countries, it reaches average values of 0.71 and 4.97 respectively.

For this reason, it is considered appropriate to replicate model 3 but evaluating it in two subsamples according to whether the country be OECD or not. The result obtained for non-OECD countries (table 9-7, model 4) shows similar results to the ones obtained for the full sample. While for the OECD countries almost all variables are of little significance, which might be the result of the little variability of the RER volatility, at least in terms of the non-OECD countries.

In this sense, the results obtained in this subsection are powerful indicators that the OECD and the non-OECD countries should be treated separately. On this line it is possible to understand that, because the RER volatility is not so high in OECD countries, then it appears some contradictory results about the effects of RER volatility on trade and other macro variables. On the contrary, RER volatility seems to be extremely relevant in emerging and developing countries.

7. Conclusions

This paper analyzes the relationship between exchange rate regimes and short-term volatility of the effective real exchange rate.

The results confirm the non-neutrality of regime regarding real exchange rate volatility. It is found that the *de jure* peg induces more volatility than a flexible peg. The intermediate regime also shows more volatility than a flexible regime. When considering the new classification proposed, it is found that whereas fixed *de jure* regimes that have successfully achieved to defend the exchange parity and pure flexible regimes have the same real volatility (corner solutions), the rest of the categories of the exchange rate regimes purvey more RER volatility. So, this introduces a dichotomy in the results of the fixed regimes, when they successfully maintain the commitment the volatility is similar to a flex, but when the fix that fails in maintaining the commitment the volatility is higher. Then differentiate the behavior seems to be a successful strategy.

In relation to the rest of the RER volatility determinants, evidence is found that a shock in openness, in the per capita GDP and in the terms of trade reduce RER volatility; conversely, an increase in capital inflows, a monetary or a public expenditure shock increase this real volatility. The evidence also shows that the dynamics of RER volatility converges slowly to the equilibrium.

Evidence is also obtained that supports the view according to which the analysis of the dynamics of the exchange rate regimes needs to differentiate between developed and developing or emerging countries. In these countries the relationship between volatility and exchange rate regime is a key question in reassuring a stable macroeconomic performance.

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[8] Bordo and Flandreau (2001), Hausmann, et al (1999) and Hausmann (2000).

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9. Data Appendix

9.1. Countries' samples

OECD countries: Australia, Austria, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.

Non-OECD countries: Algeria, Antigua and Barbuda, Bahamas, Bahrain, Belize, Bolivia, Bulgaria, Burundi, Chile, China, Colombia, Costa Rica, Cyprus, Dominican Republic, Ecuador, Fiji, Ghana, Grenada, Guyana, Hungary, Iran, Israel, Lesotho, Malawi, Malaysia, Morocco, Nigeria, Pakistan, Papua New Guinea, Paraguay, Philippines, Poland, Sierra Leone, Slovak Republic, South Africa, St. Kitts and Nevis, St. Vincent and the Grenadines, Trinidad and Tobago, Tunisia, Uganda, Uruguay, Venezuela and Zambia.

9.2. Macroeconomic variables' definitions

σ_{RER}	:	Standard deviation of the Real Effective Exchange Rate over a each year using monthly data *(IFS)*
Openness	:	Total of trade (imports+exports) to GDP ratio *(MTS)*
Δ GPDpc	:	Rate of Growth of real per capita GDP *(WEO)*
Δ Terms of trade	:	Change in terms of trade - exports as a capacity to import *(WDI)*
Δ Capital account	:	Change in the capital account to GDP ratio *(IFS)*
Δ M2	:	Rate of growth of M2 *(IFS)*
Δ Government consumption	:	Growth of government consumption *(IFS)*

10. Table Appendix

Table A-1

***De facto*exchange rate regime classification criteria used by Levy Yeyati and Sturzenegger (2000)**

	σ_e	$\sigma_{\Delta e}$	σ_r
Inconclusive	Low	Low	Low
Flexible	High	High	Low
Dirty Floatation	High	High	High
Crawling Peg	High	Low	High
Fixed	Low	Low	High

Note: σ_e, $\sigma_{\Delta e}$ and σ_r are exchange type volatility, volatility of exchange type variations and reserves' volatility respectively.

Table A-2
***De jure* exchange rate regime percentage per *de facto* categories**

		De facto classification			
		Fixed	Inter.	Flexible	Inconclusive
De jure classification	Fixed	28%	31%	11%	57%
	Inter.	45%	22%	26%	19%
	Flexible	27%	47%	63%	24%
	Total	100%	100%	100%	100%

Table A-3
***De facto*exchange rate regime percentage per *de jure* categories**

		De facto classification				
		Fixed	Inter.	Flexible	Inconclusive	Total
De jure classification	Fixed	6%	6%	4%	84%	100%
	Inter.	19%	8%	19%	54%	100%
	Flexible	8%	12%	32%	48%	100%

Table A-4

***De facto*exchange rate regime percentage per *de jure* categories**

(excepting Inconclusive ones)

		De facto classification			
		Fixed	Inter.	Flexible	Total
De jure classification	Fixed	39%	35%	26%	100%
	Inter.	42%	17%	41%	100%
	Flexible	16%	22%	62%	100%

Table A-5

Median σ_{RER} by the *de jure* exchange rate regime classification [9]

	All regimes	Fixed	Flexible	Intermediate
Full sample of countries	2.43 (1092 obs.)	2.38 (481 obs.)	2.93 (415 obs.)	1.68 (196 obs.)
OECD	1.66 (350 obs.)	1.23 (73 obs.)	2.65 (137 obs.)	1.38 (140 obs.)
Non-OECD	2.85 (724 obs.)	2.71 (408 obs.)	3.16 (278 obs.)	3.33 (56 obs.)

[9] Since the sample includes many countries which exhibit a great RER volatility it seems more reasonable to concentrate the analysis in the medians which are less affected by such extreme values.

Table A-6

Econometric regressions with the *de jure* criteria for the period 1980-1999.

		All FE	All GMM
Model		**1**	**2**
Constant		26.482 **	0.331 ***
σ_{RER}	(t-1)	- 0.033	- 0.059 ***
Fixed		*1.807*	*2.929 ****
Intermediate		*- 3.954*	*5.857 **
Openness	t	- 0.120	- 0.365 ***
	t-1	- 0.217	- 0.514 ***
Δ GPDpc	t	- 0.179	- 0.418 ***
	t-1	- 0.746 *	- 0.964 ***
Δ Terms of trade	t	- 2.530 **	- 3.177 ***
	(t-1)	- 0.876	- 0.871 ***
Δ Capital account	t	- 0.019	0.110 ***
	(t-1)	0.182	0.289 ***
Δ M2	t	33.764 ***	49.205 ***
	(t-1)	- 1.724	13.129 ***
Δ Government	t	28.193 ***	24.539 ***
consumption	(t-1)	- 7.926	- 15.464 ***
Sargan test (p value)			1
Second order serial correlation Test (p value)			0.829
Number of observations		797	728
Number of countries		62	62

Note: *, ** and *** show that the null hypothesis is rejected at significant levels of 10%, 5% and 1% respectively.

Table A-7

Econometric regressions with the new classification criteria for the 1980-1999 period

		All GMM	Non-OECD GMM
Model		**3**	**4**
Constant		0.408***	- 0.551
σ_{RER}	(t-1)	- 0.069 ***	- 0.075 ***
FixedJ-FixedF (a)		*5.747*	*- 29.628*
FixedJ-IntermF (b)		*14.377****	*0.408*
FixedJ-FlexibleF (c)		*16.694****	*22.398 ****
FixedJ-InconclusiveF (d)		*8.947****	*14.757 ****
IntermJ-FixedF o FlexibleJ-FixedF (e)		*7.477****	*10.584 ****
IntermJ-IntermF o FlexibleJ-IntermF (f)		*18.506****	*23.503 ****
IntermJ-InconclusiveF o FlexibleJ-InconclusiveF (h)		*4.145****	*9.134 ****
Openness	t	- 0.497 ***	- 0.491 ***
	t-1	- 0.414 ***	- 0.335 ***
Δ GPDpc	t	- 0.387 ***	- 0.527 ***
	t-1	- 0.804 ***	- 0.732 ***
Δ Terms of trade	t	- 2.952 ***	- 3.081 ***
	(t-1)	- 0.837 ***	- 0.706 ***
Δ Capital account	t	0.134***	0.113 *
	(t-1)	0.276***	0.314 ***
Δ M2	t	47.540***	47.847 ***
	(t-1)	15.100***	7.421
Δ Government consumption	t	25.386***	27.480 ***
	(t-1)	- 16.970 ***	- 8.001
Sargan test (p value)		1	1
Second order serial correlation Test (p value)		0.558	0.363
Number of observations		728	457
Number of countries		62	43

Note: *, ** and *** show that the null hypothesis is rejected at significant levels of 10%, 5% and 1% respectively.

11. Figure Appendix

Figure 1.

***De jure* classification. RER intra-annual volatility vs. nominal ER intra-annual variation**

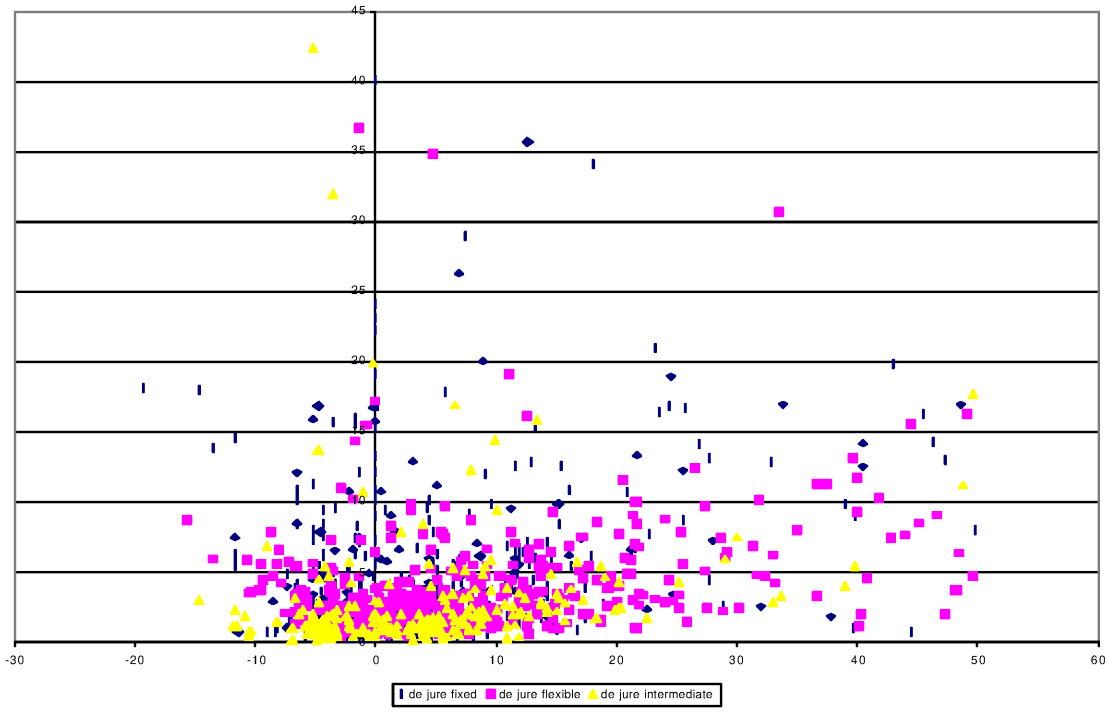


Figure 2.

***De jure* classification. RER intra-annual volatility vs. nominal ER intra-annual variation**

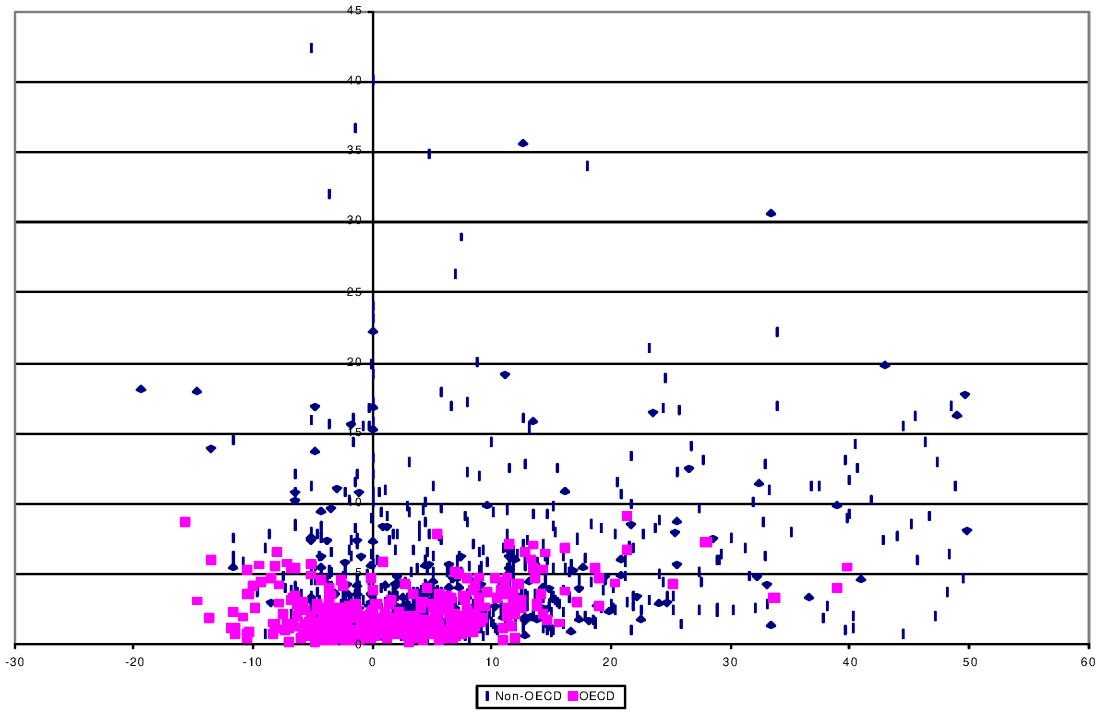


Figure 3.

New classification. RER intra-annual volatility vs. nominal ER intra-annual variation

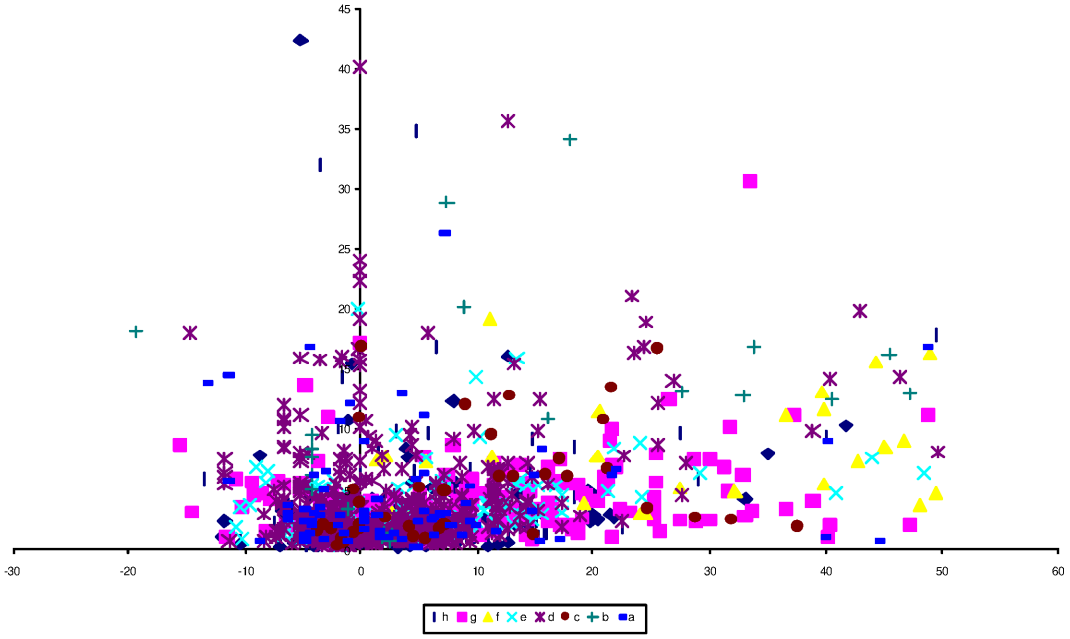
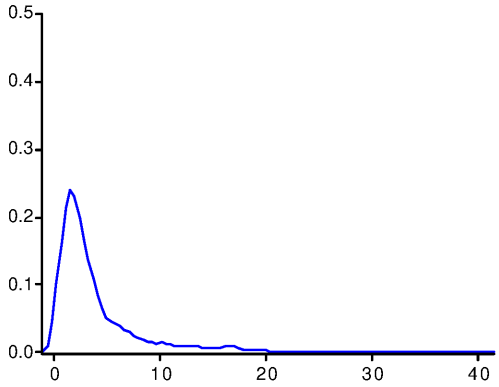


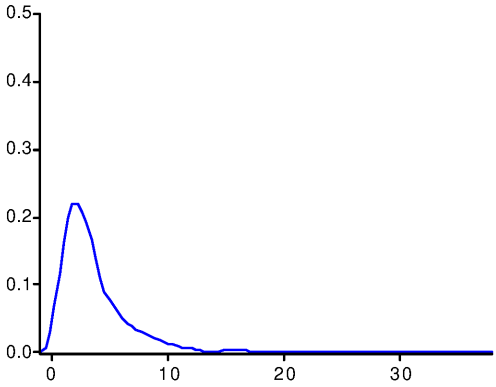
Figure 4.
De jure classification. Real ER Volatility. Density functions

Jure Peg



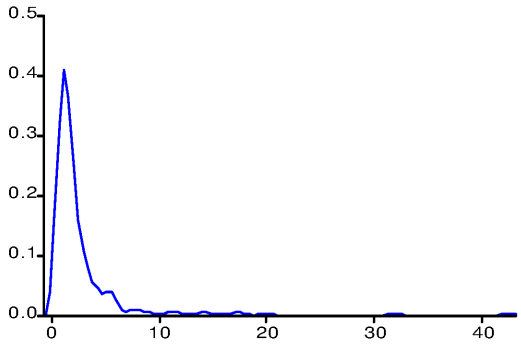
Mean	4.093068
Median	2.440000
Std. Dev.	4.748896
Skewness	3.031546
Kurtosis	15.66390

Jure Float



Mean	3.858993
Median	2.840000
Std. Dev.	3.817055
Skewness	4.186259
Kurtosis	30.01907

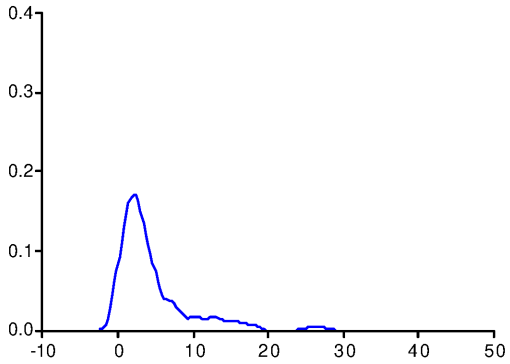
Jure Inter.



Mean	2.688577
Median	1.550000
Std. Dev.	4.192300
Skewness	5.607189
Kurtosis	43.75469

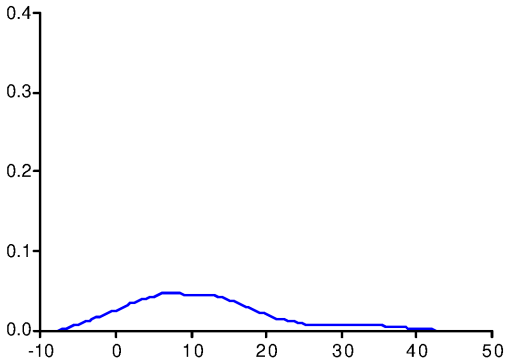
Figure 5. New classification. Real ER Volatility Density functions

Categoria **a** 76 obs



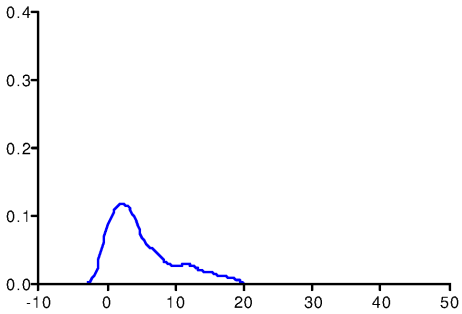
Mean	4.418947
Median	2.905000
Std. Dev.	4.677209
Skewness	2.262776
Kurtosis	8.910626

Categoria **b** 22 obs



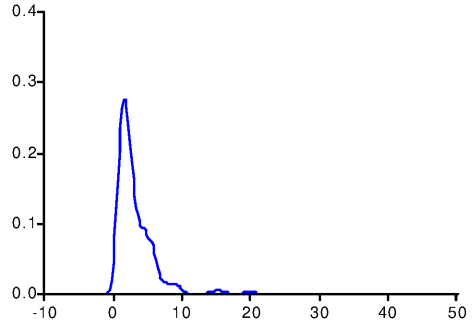
Mean	11.33045
Median	10.20000
Std. Dev.	8.732395
Skewness	0.969929
Kurtosis	3.632258

Categoria **c** 38 obs



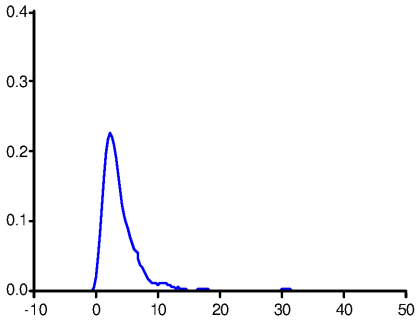
Mean	5.131316
Median	3.040000
Std. Dev.	4.615743
Skewness	1.134643
Kurtosis	3.258015

Categoria **e** 149 obs



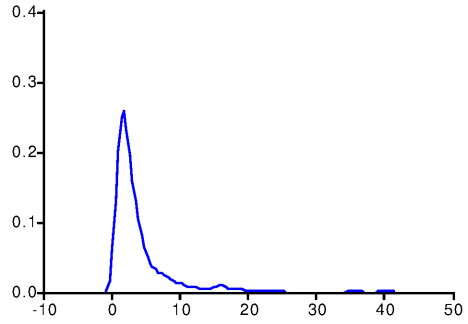
Mean	3.141611
Median	2.200000
Std. Dev.	2.790152
Skewness	2.863284
Kurtosis	14.59461

Categoria **g** 201 obs



Mean	3.838408
Median	3.090000
Std. Dev.	3.192649
Skewness	3.871250

Categoria **d** 555 obs

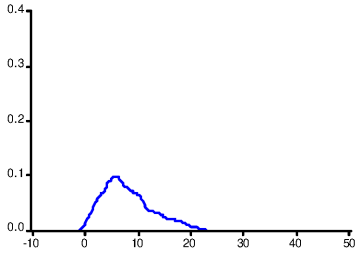


Mean	3.689946
Median	2.310000
Std. Dev.	4.294685
Skewness	3.497553

Kurtosis 28.21131

Kurtosis 20.66520

Categoria **f** 25 obs



Mean 8.106400
Median 7.500000
Std. Dev. 4.480048
Skewness 0.853752
Kurtosis 2.933597

Categoria **h** 332 obs