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Exchange Rate Arrangements and Volatility of Real Exchange Rate Depreciation: Panel Evidence for the G7 and 8 Latin American Countries

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Abstract

In this paper we study the relationship between nominal exchange rate (NER) arrangements and volatility of real exchange rate (RER) depreciation, using monthly information for the G7 and 8 Latin American countries, over the period 1970-2001. In relation to the existing empirical literature, this study attempts to contribute in two important aspects. First, the relationship is characterized across regimes over the entire sample period and volatility is explicitly modeled as a conditional heteroskedastic (GARCH) process. Second, the study uses a new typology of NER arrangements proposed by Reinhart and Rogoff (2002) that is more accurate than previous classifications. We find a significant relationship between NER arrangements and volatility of RER in both cases although with markedly different patterns.

Resumen

En este artículo se estudia la relación entre los regímenes de tipo de cambio y la volatilidad de la depreciación del tipo de cambio real, utilizando información mensual para el G7 y 8 países latinoamericanos durante el periodo 1970-2001. En relación a los trabajos empíricos existentes en esta área, este artículo busca contribuir en dos aspectos importantes. Primero, la relación está caracterizada entre los diferentes regímenes, a lo largo de todo el periodo, modelando explícitamente la volatilidad como un proceso de heterocedasticidad condicional (GARCH). Segundo, este estudio utiliza la nueva clasificación de regímenes cambiarios propuesta recientemente por Reinhart y Rogoff (2002) la cual es más precisa que clasificaciones previas. Se encuentra evidencia de una relación significativa entre regímenes cambiarios y volatilidad del tipo de cambio real en ambos casos, aunque con marcadas diferencias.

Introducción

In this paper we study the relationship between nominal exchange rate (NER) regime and real exchange rate (RER) volatility using panel data information on the G7 and 8 Latin American (LA8) countries. Theoretically, this relationship depends on the specific modeling assumptions chosen and, therefore, empirical work is quite relevant in order to characterize this phenomenon adequately.

Although the number of empirical papers in this area is sizeable, most efforts are focused on RER volatility under flexible NER regimes. Only a few papers study the differences on RER volatility across NER regimes. Some of those, for example Baxter and Stockman (1988) and Flood and Rose (1995), find that flexible NER regimes are positively correlated with the short-term RER volatility. Other papers such as Kent and Naja (1998) use effective RER and also find that flexible NER regimes have higher RER volatility than fixed exchange rate regimes. This last paper also points out that there is no significant increase in RER volatility when moving to more flexible exchange rate regimes. On the other hand, some papers as the one by Grilli and Kaminsky (1991) state neutrality of NER regime and argue that RER volatility depends on the specific historical period of time. A similar result was found by Singh (2002) for the case of India.

This paper attempts to contribute to the empirical literature on the behavior of RER volatility under different NER arrangements in two important aspects. First, we use a new typology of NER regimes proposed by Reinhart and Rogof (2002), which distinguishes exchange rate regimes more accurately than previous classifications and, therefore, may enable us to obtain different results than in previous studies. Second, we explicitly model volatility of RER as a time dependent variance process within a panel data framework. Specifically, we consider a model that combines typical panel pooling assumptions with well-known multivariate GARCH models.[1] In addition, the study is focused on two groups of countries with marked differences in macroeconomic stability thus offering an interesting scenario for comparison.

The rest of the paper is organized as follows. In section 2 we present an overview of the related theoretical and empirical work. Section 3 describes the econometric model. Section 4 reports the main empirical findings and, finally, Section 5 concludes.

1 This approach has been proposed by Cermeño and Grier (2002).

Theoretical and Empirical Background

There are several interpretations of RER in the existing literature. The most common is the interpretation of the RER as the rate of price level deviation from the purchasing power parity (PPP) but also it is interpreted as the ratio between prices of tradable and non-tradable goods. In line with these interpretations, from a theoretical point of view, there are basically two groups of models that find non-neutrality of NER regimes. One of them considers price stickiness and the other group explicitly includes tradable and non-tradable goods (these are referred to as T-NT models).

The former group of models is based on the idea that in order to have the RER in its equilibrium level, the PPP implies flexible price levels. When prices are not flexible RER volatility appears. These models are the so-called sticky-price models and include the well known Dornbusch (1976) model, and also Frenkel (1981) and Mussa (1982), which find greater nominal and real volatility under flexible than under fixed NER regimes.

Following the same Mundellian approach as in the models just cited, other sticky-price models that analyze exchange rate crises, find that after a real shock fixed regimes generate overshooting of nominal parity that leads to greater ex-post RER volatility.

From another point of view, T-NT models consider that non-neutrality of NER regimes is explained by imperfect competition in the tradable market. This is the case of Cuddington and Liang (2003) who find that volatility of commodities prices in terms of manufactured goods depends on the NER regime. Also, there are equilibrium models such as in Lucas (1982), Helpman (1981) and Stockman (1980) that support the NER regime neutrality in the sense that it does not affect real variables.

Many empirical studies find that flexible NER regimes are positively correlated with the short-term RER volatility. This is the case of Flood and Rose (1995) and Baxter and Stockman (1988). These two papers also find that there are no significant changes in output, money or prices across NER regimes concluding that these macro aggregates are not true fundamentals for exchange rates.

The previous authors use bilateral RER measures but some papers like Kent and Naja (1998) use effective RER and agree with the existence of positive correlation between flexible NER and RER volatility. In fact, this work finds that short-term variance of bilateral RER is, on average, two times higher under flexible NER. This paper also states that, despite this result, there is no significant increase in RER volatility when moving to more flexible exchange rate regimes.

Some related empirical work supports the idea that NER regime and RER volatility have no significant correlation. For example, Grilli and Kaminsky (1991), working with data from 1885 to 1986, finds that differences in RER volatility across NER regimes are only significant in post World War II period. This work has been criticized by Liang (1998) whose approach belongs to the former group of models. In particular this last paper uses data from 1880 to 1997 finding a positive correlation between flexibility in NER regime and volatility.

It is important to mention some significant empirical work on the relationship between NER regime and RER volatility related to a particular period and place, where a different model seems to be suitable in each particular case. Kutan and Dibooglu (1998), for example, study Poland and Hungary cases between 1990 and 1998 and find that the behavior of the RER in the case of Poland could be explained by sticky-prices models while in the case of Hungary case could only be explained by RER equilibrium exchange rate models like Stockman's (1980) model.

Lothian and McCarthy (2001) using annual data over the period 1922-1998 for Irish punt, find that RER volatility is higher under floating. This paper is particularly interesting because Irish NER regimes have changed considerably during that period and the results obtained are quite significant and easily interpreted. On the other hand, Moreno (2001) finds that, in contrast to other regions, for East Asia during the period 1974-1999 pegging is not associated with lower RER volatility. Similarly, Singh (2002) finds neutrality of the NER regime in India's case using quarterly data from 1975:02-1996:03.

Bleaney (1992), despite insisting on the limited importance of the short-run RER volatility, mentions empirical work like in Artis and Taylor (1988), Cobham (1989), Macdonald and Zis (1989) and Ungerer et. Al. (1986), where it is found that short-run RER volatility is much smaller under the European Monetary System (EMS) than under floating rates. Bleaney (1992) itself finds that "…evidence is very strong that EMS has reduced real exchange rate volatility in the conventional, short-run sense".

Finally it should be also mentioned another class of empirical work that has characterized the behavior of RER, for different cases and time periods, as a mean-reverting process. This is the case of Lothain and Taylor (1996), and Diebold, Husted and Rush (1991) among others.

Econometric Model

In this section we specify the econometric model that will be used to evaluate the relationship between NER regime and RER depreciation volatility. Given the diversity of empirical findings in the existing literature we consider that studying several countries over the longest possible time span can enable us to characterize the relationship across regimes more accurately. As it is shown below, this task can be accomplished by using a panel data setting. Although some attempts have been made in this direction the approach proposed in this paper differs from most empirical work in the related literature in two important aspects. First, we attempt to characterize the RER depreciation process as a pooled $AR(p)$ time series thus focusing strictly on the dynamics of the process. Second, we model volatility of RER depreciation as a conditional variance (GARCH) process where its relationship with NER regimen is captured through regime-specific effects. Thus, the paper attempts to characterize the previous relationship in a comprehensive way within a single panel data framework as it is detailed below.

Let $\mathbf{u}_t$, $t = 1,\cdots,T$, be the N-dimensional vector of disturbances from a dynamic panel data model, with typical element:[2]

$$u_{i,t} = y_{i,t} - \mu_i - \beta_1 y_{i,t-1} - \cdots - \beta_p y_{i,t-p}\ ,\ i = 1,\cdots,N \qquad (1)$$

Where the RER depreciation rate $y_{i,t}$ is modeled as an $AR(p)$ process, which is assumed stationary. It can be shown that this implies assuming that all the characteristic roots of the polynomial $(1-\beta_1 L - \cdots \beta_p L^p) = 0$ lay outside the unit circle. Both, $\mu_i, i = 1,\cdots,N$ and $\beta_h, h = 1,\cdots,p$ are parameters. Assume that the vector $\mathbf{u}_t$ has a multivariate-normal distribution with mean zero and variance-covariance matrix $\mathbf{\Omega}_t$ with typical diagonal and off-diagonal diagonal elements given respectively by:

$$\sigma_{i,t}^2 = \alpha_i + \delta\sigma_{i,t-1}^2 + \gamma u_{i,t-1}^2 \qquad i = 1 \ldots N \qquad (2)$$

$$\sigma_{ij,t} = \rho_{ij}\sigma_{i,t}\sigma_{j,t} \qquad i \neq j \qquad (3)$$

This specification is a modified version of the panel GARCH model proposed by Cermeño and Grier (2002). In this case, we consider the same covariance structure as in the conditional constant correlation (CCC) multivariate GARCH

2 See Baltagi (2001) for a comprehensive review of the recent panel data literature.

model by Bollerslev (1990).[3]

The log-likelihood for $\mathbf{u}_t$ is simply given by:

$$L_t = -\frac{N}{2}\log(2\pi) - \frac{1}{2}\log\left|\mathbf{\Omega}_t\right| - \frac{1}{2}\mathbf{u}_t{}'\mathbf{\Omega}_t^{-1}\mathbf{u}_t \qquad (4)$$

It can be shown that $\mathbf{\Omega}_t = \mathbf{Z}_t^{-\frac{1}{2}}\mathbf{R}\mathbf{Z}_t^{-\frac{1}{2}}$, where $\mathbf{Z}_t = diag\{\sigma_{1,t}^2, \cdots, \sigma_{N,t}^2\}$ and $\mathbf{R}$ is a conformable correlation matrix with ones in its diagonal and with ρ_{ij} as typical off-diagonal elements. Substituting the previous equality in (4), adding and subtracting $\mathbf{u}_t{}'\mathbf{Z}_t^{-1}\mathbf{u}_t$, and rearranging terms we can obtain the following log-likelihood:

$$L_t = -\frac{N}{2}\log(2\pi) - \frac{1}{2}\log\left|\mathbf{Z}_t\right| - \frac{1}{2}\mathbf{u}_t{}'\mathbf{Z}_t^{-1}\mathbf{u}_t - \log\left|\mathbf{R}\right| - \mathbf{e}_t{}'\mathbf{R}^{-1}\mathbf{e}_t + \mathbf{e}_t{}'\mathbf{e}_t \qquad (5)$$

Where $\mathbf{e}_t = \mathbf{\Sigma}_t^{-\frac{1}{2}}\mathbf{u}_t$. Thus, the log-likelihood for $\mathbf{u}_t$ can be expressed as the sum of a volatility component given by the first 3 terms in (5) and a correlation component given by the remaining, also 3, terms. A similar decomposition is formulated by Engle (2002) in the context of a general multivariate GARCH model with conditional correlation (DCC model), who also proposes a two-step estimation method consisting of: (i) Maximizing the volatility component (ii) Taking the results of the first step as given and maximizing the correlation component. This estimation method is consistent but inefficient. However, it can be very useful in panel data where the cross-sectional dimension N is relatively large and/or the researcher's interest is mainly on the volatility process.

Since we are interested in the relationship between ER arrangements and the volatility of RER depreciation, in this paper we will only focus on the volatility component of the previous log-likelihood. However, we need to explicitly introduce the regime-specific effects into the model. Let $s = 1, \cdots, K$ be an indicator variable that denotes the NER arrangement prevailing in economy i at time t, which is assumed to be exogenous.

The volatility component of the log-likelihood for the complete panel is:

$$L = -\frac{NT}{2}\log(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\log\left|\mathbf{Z}_t\right| - \frac{1}{2}\sum_{t=1}^{T}\mathbf{u}_t{}'\mathbf{Z}_t^{-1}\mathbf{u}_t \qquad (6)$$

But now, (1) and (2) are reformulated respectively as:

3 For a detailed survey on existing Multivariate GARCH models see Bauwens and Rombouts (2003).

$$u_{i,t} = y_{i,t} - \mu_i - \beta_1 y_{i,t-1} - \cdots - \beta_p y_{i,t-p} - \theta_r \quad (7)$$
$$\sigma^2_{i,t} = \alpha_i + \delta\sigma^2_{i,t-1} + \gamma u^2_{i,t-1} + \phi_r \quad (8)$$

Where the terms θ_r, ϕ_r with $r = 1, \cdots, K$ are the regime-specific effects in the conditional mean and conditional variance processes respectively. In this paper, the effects of the different ER arrangements are modeled as parametric shifts only, which implies including a set of $K-1$ dummy variables (in order to avoid perfect collinearity) in the conditional mean and conditional variance equations.[4] In this way, we will be able to distinguish the effects of the ER arrangements on the mean depreciation rates from those on its associated volatility process.

Estimation of the model will be based on direct maximization of the volatility component of the log-likelihood function given by (6) using numerical methods.[5] The variance-covariance matrix of the estimated parameters will be approximated by the negative inverse of the Hessian of L evaluated at the values of the estimated parameters.

Empirical results

In this section we briefly describe the data set as well as some relevant characteristics of the exchange rate arrangements and RER depreciation process; then present the estimation results for the proposed econometric model.

The Data

One important aspect of the present study is the use of a new typology of ER arrangements recently proposed by Reinhart and Rogoff (2002). Using monthly as well as annual data these authors revise previous classifications considering market determined dual/parallel exchange rates as opposed to officially declared rates in order to categorize the exchange rate regimes more properly. The classification is made using a fine grid that includes up to 15 different regimes and a more compact or coarse grid which includes 5

4 Further study should use more complex specifications, i.e. exploring possible effects on slope coefficients. Also, given the relatively large time span, possible structural breaks should be explored.

5 We use the GAUSS Optimization module.

different exchange rate regimes. In Table 1 at the end of the paper we present a detailed list of this classification.

Although Reinhart and Rogoff`s classification includes 153 countries and goes back to 1946, in this paper we will consider two groups of countries only, the G7 and 8 Latin American (LA8) countries, and use monthly data from 1970:01 to 2001:12 due to the following reasons. First, our interest is on the relationship between ER regime and volatility of RER depreciation and this phenomenon is likely to be observed in monthly data rather than in annual data. Second, readily available data on RER, taken from the USDA web page, only covers this last period.[6] Third, the two groups of countries have marked differences on macroeconomic stability and therefore constitute an interesting scenario for comparison. In this paper we will only use Reinhart and Rogoff's coarse grid classification, which includes 5 different regimes. For simplicity, in this paper we name them as follows: R1 (fixed), R2 (quasi-fixed), R3 (quasi-flexible), R4 (freely floating) and R5 (freely falling).[7]

Overview of ER arrangements and RER depreciation

In Tables 2 and 3 we present the chronology of ER regimes for the G7 and LA8 respectively.[8] We can observe various important differences. First, the LA8 countries seem to have experienced more regime changes than the G7 countries. Second, the freely floating (R4) regime has been experienced in the G7 (basically, by U.S., Germany and Japan) during a considerably large time span; however, none of the LA 8 have fallen into this category. Third, while the free falling regime (R5) has been present in practically all of LA8 countries (except Colombia) during important lapses of time this regime has only actually happened in Italy and for a few months (from 1992:09 to 1993:03).

In Tables 4 and 5 we present a brief description of the RER depreciation rates during the period of study which is divided into the sub-periods 1970:01-1979:12, 1980:01-1989:12 and 1990:01-2001:12. Two important differences are noticeable. First, the mean devaluation rates are higher in the LA8 than in the G7 countries, particularly during the 70's and the 80's. Second, the variances over each sub-period are generally much higher in the case of the LA8 countries.

6 The RER data for this study has been downloaded from http://www.ers.usda.gov/data/exchangerates.

7 The last one is a new category and includes cases where the twelve month inflation rate is higher than 40% and also those that correspond to the six month period following currency crises episodes. See Reinhart and Rogoff (2002) for more details.

8 In the case of the LA sample we have also included a sixth regime R6 as defined in Reinhart and Rogoff (2002). See Table 1 for details.

In sum, we observe that in both groups of countries there has been a considerable variation in ER regimes as well as RER depreciation rates, suggesting a possible connection between them, which we explore next.

Estimation results

The estimation results for the G7 and LA8 are summarized in Tables 6 and 7 respectively. We have considered 2 panel GARCH specifications, with and without regimen specific effects. For comparison, we also report the estimation results for the corresponding pooled regression model, which only accounts for the mean equation parameters.[9] The inclusion of a single intercept in the mean equation in both cases was decided on the basis of preliminary testing for individual-specific effects using conventional panel procedures. Specifically, the mean equation alone was estimated and the null hypothesis of no individual effects was evaluated using the Wald test statistic.[10] In both cases, this hypothesis was not rejected. It is important to remark that in order to avoid perfect collinearity we have excluded one regimen specific dummy variable in the estimation of the full model. We have chosen to exclude R1 (fixed regime) and, therefore, the included regime specific effects will be interpreted as changes relative to R1. We should also mention that the mean equation only includes lags 3, 6 and 12 basically in order to economize in the number of parameters to be estimated.

First of all, as it is apparent from Tables 6 and 7, in the case of the panel-GARCH models the value of the log-likelihood is much higher relative to the corresponding pooled regression model. This fact, together with the finding that most coefficients in the conditional variance are significant, suggests that explicitly modeling the volatility process is worthwhile.

Concerning the volatility processes, we observe that for both groups of countries the ARCH and GARCH parameters are quite significant although there is an important difference. While the volatility process is quite persistent but stationary in the case of the G7, in the case of the LA8 sample this process is apparently explosive since $(\delta + \gamma) > 1$, leading us to state that in this case the RER depreciation process can in fact be characterized as unpredictable.

9 Preliminary individual and panel tests reject the null hypothesis of unit root, thus we can treat this panel as stationary.

10 Cermeño and Grier (2002) outline an informal procedure in order to preliminarily determine the best specification for the mean process. In the present application this procedure is particularly relevant since the relatively large time span guarantees that the results from a pooled AR model are consistent.

In terms of the relationship between NER regimes and the mean RER depreciation rates, in the case of the G7 we observe that relative to regime R1 (which is the excluded fixed regime) the regimes R2, R3 and R4 seem to imply lower mean depreciation rates since the regime-specific effects are negative in these cases. However, only R3 is statistically significant suggesting that adoption of pre announced or the facto wide crawling bands, moving bands or managed floating arrangements seems to be associated with lower mean RER depreciation rates. On the other hand, the freely floating regime (R4) does not seem to be related to the mean RER depreciation rates. In the case of the LA8 countries, the relationship of ER regimes with the mean RER depreciation seems to be more pronounced than in the case of the G7 countries. In this case, while the regime-specific effects for R2 and R6 are negative and significant, the R5 (the freely falling regime) is positively related to the mean RER depreciation indicating that large depreciation episodes have been associated to this regime.

Regarding the relationship between NER regimes and RER depreciation volatility, in the case of the G7 we find that, relative to R1, adoption of the more flexible ER regimes (R2, R3 and R4) has been associated with higher volatility levels as the regime-specific effects are positive and significant in these cases. Moreover, the estimated values for the regime specific effects indicate that more flexible ER regimes have been associated with increasingly higher volatility levels. It is interesting to note that the freely floating regime (R4) is associated with the highest increases in volatility levels relative to the fixed ER regime R1. On the other hand, the freely falling regime (R5) does not seem to have been related to the overall volatility process for the G7, which is consistent with the fact that this episode only affected one country (Italy) and for quite short period of time (7 months). In the case of the LA8 countries, we observe a different result in that only one regimen specific effect (the corresponding to regime R3) resulted statistically significant. However, this effect is negative indicating that this regime is associated with less volatility of RER depreciation rates relative to R1. On the other hand, we find that the freely falling regime (R5) is associated with higher volatility levels although this result is only statistically significant at the 17% level approximately.

To summarize, the results of this paper indicate that in the case of the G7 more flexible ER arrangements are clearly associated with increasingly higher volatility of the RER depreciation process. However, in the case of the LA8 we observe a different relationship. In this case, relative to R1, the more flexible R3 regime seems to be associated with lower volatility levels. These results suggest that the G7 and LA8 have experienced markedly different non-neutrality patterns, which may be related to their particular macroeconomic conditions.

Conclusion

In this paper we have attempted to characterize the relationship between NER regimes and RER depreciation volatility using a panel data GARCH framework. The empirical results indicate that the proposed econometric specification may indeed be a useful tool to characterize this relationship.

One of the most important results of this paper is the finding that in the case of the G7 more flexible ER regimes are associated with increasingly higher volatility levels. However, in the case of the Latin American countries we find the opposite result in that the more flexible R3 regime is associated with lower volatility relative to the fixed R1 regime. Although in both cases we observe non-neutrality of ER regimes, the results of this paper suggest that the relationship between NER regimes and RER depreciation volatility could be quite different depending on the particular macroeconomic conditions experienced by both groups of countries.

Further study should focus on exploring the robustness of the previous results to possible structural change underlying the previous processes and consider other or wider samples of countries or time spans.

TABLE 1

CLASSIFICATION OF EXCHANGE RATE ARRANGEMENTS BY REINHART AND ROGOFF

FINE GRID(CODE)	COARSE GRID GCODE)	DESCRIPTION OF REGIME
1	1	NO SEPARATE LEGAL TENDER
2	1	PRE ANNOUNCED PEG OR CURRENCY BOARD ARRANGEMENT
3	1	PRE ANNOUNCED HORIZONTAL BAND THAT IS NARROWER THAN OR EQUAL TO +/-2%
4	1	DE FACTO PEG
5	2	PRE ANNOUNCED CRAWLING PEG
6	2	PRE ANNOUNCED CRAWLING BAND THAT IS NARROWER THAN OR EQUAL TO +/-2%
7	2	DE FACTOR CRAWLING PEG
8	2	DE FACTO CRAWLING BAND THAT IS NARROWER THAN OR EQUAL TO +/-2%
9	3	PRE ANNOUNCED CRAWLING BAND THAT IS WIDER THAN OR EQUAL TO +/-2%
10	3	DE FACTO CRAWLING BAND THAT IS NARROWER THAN OR EQUAL TO +/-5%
11	3	MOVING BAND THAT IS NARROWER THAN OR EQUAL TO +/-2% (ALLOWS FOR BOTH APPRECIATION AND DEPRECIATION)
12	3	MANAGED FLOATING
13	4	FREELY FLOATING
14	5	FREELY FALLING
15	6	DUAL MARKET IN WHICH PARALLEL MARKET DATA IS MISSING

The information has been taken from the readme "Reinhartreadme.txt" file that accompanies the Stata data file "newclassi.dta", which contains the exchange rate classifications as found in the appendix of the Reinhart-Rogoff paper (2002), June 7 version.

TABLE 2

CHRONOLOGY OF EXCHANGE RATE REGIMES FOR THE G7 COUNTRIES

COUNTRIES	1970-1979	1980-1989	1990-2001
CANADA	1 (70:01-70:05), 2 (70:06-79:12)	2 (80:01-89:12)	2 (90:01-2001:12)
FRANCE	2 (70:01-70:12) 1 (71:01-71:08) 2 (71:09-73:03) 3 (73:04-74:06) 2 (74:07-79:12)	2 (80:01-86:12) 1 (87:01-89:12)	1 (90:01-2001:12)
GERMANY	1 (70:01-71:04) 3 (71:05-71:12) 1 (72:01-72:12) 4 (73:01-79:12)	4 (80:01-89:12)	4 (90:01-98:12) 1 (99:01-2001:12)
ITALY	1 (70:01-73:01) 2 (73:02-75:09) 3 (75:10-79:12)	3 (80:01-82:12) 2 (83:01-89:12)	2 (90:01-92:08) 5 (92:09-93:03) 2 (93:04-96:11) 1 (96:12-2001:12)
JAPAN	2 (70:01-71:08) 3 (71:09-71:12) 1 (72:01-73:01) 2 (73:02-77:11) 4 (77:12-79:12)	4 (80:01-89:12)	4 (90:01-2001:12)
U.K.	1 (70:01-72:06) 3 (72:07-79:12)	3 (80:01-89:12)	3 (90:01-90:09) 1 (90:10-92:08) 3 (92:09-2001:12)
U.S.	1 (70:01-71:07) 3 (71:08-73:01) 2 (73:02-78:01) 4 (78:02-79:12)	4 (80:01-89:12)	4 (90:01-2001:12)

Source: Reinhart and Rogoff (2002), using coarse grid classification. The numbers outside the parenthesis indicate regimes and the numbers in parenthesis indicate the corresponding time period.

T A B L E 3

CHRONOLOGY OF EXCHANGE RATE REGIMES FOR THE LA8 COUNTRIES

COUNTRIES	1970-1979	1980-1989	1990-2001
ARGENTINA	1 (70:01-71:03) 5 (71:04-78:12) 2 (79:01-79:12)	2 (80:01-81:02) 5 (81:03-85:05) 1 (85:06-86:03) 5 (86:04-89:12)	5 (90:01-91:03) 1 (91:04:2001:11) 6 (2001:12)
BRAZIL	3 (70:01-75:03) 5 (75:04-79:12)	5 (80:01-89:12)	5 (90:01-94:06) 2 (94:07-99:01) 5 (99:02-99:08) 3 (99:09-2001:12)
CHILE	3 (70:01-71:06) 5 (71:07-78:01) 2 (78:02-79:06) 1 (79:07-79:12)	1 (80:01-82:05) 5 (82:06-82:11) 3 (82:12-89:12)	3 (90:01-2001:12)
COLOMBIA	3 (70:01-74:03) 2 (74:04-79:12)	2 (80:01-83:09) 3 (83:10-89:12)	3 (90:01-2001:12)
MEXICO	1 (70:01-76:08) 3 (76:09-77:02) 1 (77:03-79:12)	1 (80:01-81:04) 2 (81:05-82:01) 5 (82:02-88:11) 2 (88:12-89:12)	2 (90:01-92:04) 1 (92:05-94:01) 3 (94:02-94:12) 5 (95:01-96:03) 3 (96:04-2001:12)
VENEZUELA	1 (70:01-79:12)	1 (80:01-83:02) 3 (83:03-86:11) 5 (86:12-89:12)	5 (90:01-90:03) 3 (90:04-92:09) 5 (92:10-96:06) 2 (96:07-2001:12)
ECUADOR	2 (70:01-70:08) 1 (70:09-71:11) 6 (71:12-73:02) 1 (73:03-79:12)	1(80:01-82:02) 5(82:03-84:04) 3(84:05-87:03) 5(87:04-89:12)	5 (90:01-93:09) 3 (93:10-97:02) 2 (97:03-97:09) 5 (97:10-2000:02) 1(2000:03-2001:12)
URUGUAY	1 (70:01-70:12) 5 (71:01-78:10) 2 (78:11-79:12)	2 (80:01-82:11) 5 (82:12-89:12)	5 (90:01-90:11) 2 (90:12-91:11) 5 (91:12-95:09) 2 (95:10-2001:12)

Source: Reinhart and Rogoff (2002), using coarse grid classification. The numbers outside the parenthesis indicate regimes and the numbers in parenthesis indicate the corresponding time period.

T A B L E 4

DESCRIPTIVE STATISTICS OF RER DEPRECIATION RATES FOR THE G7 COUNTRIES

COUNTRIES	1970-1979		1980-1989		1990-2001	
	MEAN	VARIANCE	MEAN	VARIANCE	MEAN	VARIANCE
CANADA	0.284	6.38	-0.506	7.02	1.481	7.17
FRANCE	-2.045	11.36	0.903	15.91	1.238	12.76
GERMANY	-2.273	12.64	0.971	16.10	1.116	13.13
ITALY	-1.152	9.15	-0.199	14.44	1.525	13.85
JAPAN	-2.290	14.75	-1.074	18.65	0.584	18.35
U.K.	-1.905	13.36	0.653	19.17	0.220	14.66
U.S.	2.117	10.77	-0.800	15.01	-1.212	12.51

The RER data was taken from the ERS/USDA home page: http://www.ers.usda.gov/data/exchangerates/.

TABLE 5

DESCRIPTIVE STATISTICS OF RER DEPRECIATION RATES FOR THE LA8 COUNTRIES

COUNTRIES	1970-1979		1980-1989		1990-2001	
	MEAN	VARIANCE	MEAN	VARIANCE	MEAN	VARIANCE
ARGENTINA	-3.1863	46.26	6.5040	191.14	-4.6189	34.13
BRAZIL	0.6347	10.14	0.0436	22.18	1.8965	46.12
CHILE	25.0451	100.35	2.7902	31.49	0.2278	11.99
COLOMBIA	-0.5643	16.81	2.9699	6.62	-0.4272	13.01
MEXICO	0.9265	50.36	1.7336	41.99	-1.2213	24.95
VENEZUELA	-0.0873	11.02	3.3884	55.95	-2.6077	34.54
ECUADOR	0.2488	32.36	3.5363	37.72	-0.6006	24.37
URUGUAY	9.2998	46.54	4.4070	62.45	-1.1125	9.04

The RER data was taken from the ERS/USDA home page: http://www.ers.usda.gov/data/exchangerates/.

TABLE 6

POOLED REGRESSION AND PANEL GARCH ESTIMATES FOR THE G7 SAMPLE

PARAMETERS	POOLED REGRESSION	PANEL GARCH (1)	PANEL GARCH (2)
	CONDITIONAL MEAN EQUATION		
CONSTANT	-0.0501 (-0.06)	-0.1177 (-0.23)	0.7354 (0.93)
AR(1)	0.2000 (10.40)***	0.2069 (10.14)***	0.2099 (10.26)***
AR(6)	-0.0438 (-2.27)**	-0.0383 (-1.90)*	-0.0383 (-1.90)*
AR(12)	0.0405 (2.08)**	0.0320 (1.62)	0.0294 (1.49)
R2			-1.1587 (-1.27)
R3			-2.7516 (-1.66)*
R4			-0.5975 (-0.46)
R5			0.0788 (0.17)
	CONDITIONAL VARIANCE EQUATION		
μ_1 (CANADA)		13.3672 (3.51)***	0.0000 (0.01)
μ_2 (FRANCE)		43.4357 (3.40)***	53.4025 (3.22)***
μ_3 (GERMANY)		45.4352 (3.41)***	24.5400 (2.16)***
μ_4 (ITALY)		35.9300 (3.37)***	35.4452 (2.88)***
μ_5 (JAPAN)		84.4864 (365)***	78.8388 (3.48)***
μ_6 (U.K.)		59.7177 (3.23)***	66.2080 (2.60)***
μ_7 (U.S.)		37.5994 (3.42)***	9.2326 (1.01)
GARCH (1)		0.8900 (45.17)***	0.8666 (34.00)***
ARCH (1)		0.0667 (5.65)***	0.0678 (5.45)***
R2			19.4167 (3.74)***
R3			28.5135 (2.18)**
R4			54.8540 (2.93)***
R5			1.5191 (0.21)
LOG-LIKELIHOOD	-12625.23	-12396.91	-12388.50

The pooled regression model was estimated by OLS while the Panel-GARCH models were estimated by Maximizing the log likelihood function given by equation (6) using the GAUSS Optimization module. Numbers in parenthesis are t-ratios and *, **, *** indicate 1%, 5% and 10% significance levels respectively.

TABLE 7

POOLED REGRESSION AND PANEL GARCH ESTIMATES FOR THE LA8 SAMPLE

PARAMETERS	POOLED REGRESSION	PANEL GARCH (1)	PANEL GARCH (2)
CONDITIONAL MEAN EQUATION			
CONSTANT	4.3436 (2.05)**	2.8498 (10.36)***	1.5900 (2.68)***
AR(1)	-0.0709 (-3.86)***	-0.286 (-10.29)***	-0.0769 (-2.82)***
AR(6)	-0.0018 (-0.10)	-0.194 (-12.39)***	-0.0871 (-3.62)***
AR(12)	-0.0140 (-0.76)	0.0020 (0.11)	0.0508 (3.20)***
R2			-2.9832 (-2.44)**
R3			-0.5021 (-0.37)
R5			10.0941 (4.91)***
R6			-10.487 (-8.28)***
CONDITIONAL VARIANCE EQUATION			
μ_1 (ARGENTINA)		0.0040 (0.027)	0.0100 (0.03)
μ_2 (BRAZIL)		257.7422 (4.96)***	164.6203 (5.18)***
μ_3 (CHILE)		3968.388 (4.86)***	222.3102 (6.03)***
μ_4 (COLOMBIA)		38.3840 (2.52)**	158.5210 (4.35)***
μ_5 (MEXICO)		2300.326 (9.66)***	1361.860 (9.88)***
μ_6 (VENEZUELA)		2227.601 (8.04)***	1740.820 (9.37)***
μ_7 (ECUADOR)		1502.527 (8.19)***	907.3897 (8.13)***
μ_8 (URUGUAY)		9.8348 (1.26)	0.0099 (0.05)
GARCH (1)		0.4068 (13.98)***	0.6858 (49.44)***
ARCH (1)		1.7258 (11.63)***	0.5673 (14.82)***
R2			1.0303 (0.52)
R3			-148.05 (-4.15)***
R5			69.0728 (1.38)
R6			20.8059 (0.47)
LOG-LIKELIHOOD	-18551.66	-16751.308	-16544.218

The pooled regression model was estimated by OLS while the Panel-GARCH models were estimated by Maximizing the log likelihood function given by equation (6) using the GAUSS Optimization module. Numbers in parenthesis are t-ratios and *, **, *** indicate 1%, 5% and 10% significance levels respectively.

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