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Real exchange rate misalignments

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Abstract

This paper characterizes episodes of real appreciations and depreciations for a sample of 85 countries, approximately from 1960 to 1998. First, the equilibrium real exchange rate series are constructed for each country using Goldfajn and Valdes (1999) methodology (cointegration with fundamentals). Then, departures from equilibrium real exchange rate (misalignments) are obtained, and a Markov Switching Model is used to characterize the misalignments series as stochastic autoregressive processes governed by two states representing different means. Three are the main results we find: first, no evidence of different regimes for misalignment is found in some countries, second, some countries present one regime of no misalignment (tranquility) and the other regime with misalignment (crisis), and, third, for those countries with two misalignment regimes, the lower mean misalignment regime (appreciated) have higher persistence that the higher mean one (depreciated).

1 Introduction

In the aftermath of Bretton Woods collapse and the advent of flexible exchange rates, many economic models relying on PPP as an equilibrium condition, having it being derived as an outcome or a possible violation, could be easily found. Whenever PPP is admitted to fail, the existence of real exchange rate (RER) misalignments is being implicitly assumed, that is, departures from an equilibrium RER value occur.

In fact, RER misalignments can be found in the core of many of the most studied open economy macroeconomics and international finance issues. Dornbusch (1976), for instance, shows that differential speeds of adjustments between commodity and asset markets produce, in response to nominal shocks, short-run deviations from PPP. In the same framework, real shocks can produce a change in the long run equilibrium RER. Calvo and Rodriguez (1977) and Mussa (1982) are also examples of this class of models.

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This question becomes substantially relevant when the role and possible effects of RER movements over economic and social outcomes are taken into account. Let RER be the relative cost between a common basket of international and domestic goods, measured in the same numeraire. Hence, it can be understood as the *true indicator* of the incentives to the economic agents regarding the production and consumption decisions between domestic and international goods. Therefore, RER movements - under a few theoretical conditions - can affect both national savings and domestic absorption with real economic effects.

In addition, this problem has also been addressed in another perspective. Persistent exchange rate misalignments can generate severe macroeconomic disequilibria usually leading to costly external imbalances corrections. Both theoretical and empirical literatures on speculative attacks, for example, attach a significant position to RER appreciations. Following Krugman (1979) seminal work, first generation speculative attacks models modified versions allowing PPP deviations were developed. This advance leads to RER appreciation as an empirical regularity that should be seen in the run-up of such events. Evidences of RER appreciations as an early warning indicator of possible currency crisis episodes have been recently widely documented.[1]

A broad range of studies has been developed in the recent decades in order to discuss whether and how purchasing power parity (PPP) hypothesis is a reasonable assumption. As stated in Rogoff (1996), few studies suppose that PPP holds in the short-run (continuously). In fact, the literature has been concentrated on whether there exists reversion of real exchange rates towards a long-run mean. The underlying idea on this approach is to investigate if real exchange rate misalignments (appreciations and depreciations) around a long-run equilibrium value vanish.

Goldfajn and Valdes (1999) go beyond this question and assume that RER, as a rule, reverts to a time-varying long run equilibrium value. The authors are especially concerned about how (instead of whether) real appreciations revert to the equilibrium level. Two main questions are addressed in their paper. The first is related to the construction of an acceptable methodology in order to characterize movements on observed RER as deviations from an equilibrium value. The second issue discussed is the assessment of how these appreciations episodes end, that is, which component of the RER (nominal exchange rate or price level differential), after a maximum degree of overvaluation has been achieved, is the main responsible for the return to the equilibrium value.

Two alternative methods for estimating a suitable empirical proxy for the equilibrium real exchange rate (ERER) are employed in Goldfajn and Valdes (1999): a plain Hodrick-Prescott filter on observed RER and the estimation of a long run relationship between RER and economic fundamentals using cointegration techniques. An overvaluation series is then constructed involving the observed RER and the predicted value for both mentioned methodologies. When the overvaluation index is above a certain threshold, the associated period is

[1] See, for example, Eichengreen, Rose and Wyplosz (1995), Kaminsky, Lizondo and Reinhart, (1998).

classified as an appreciation episode. Using a statistical framework, the number and dynamics of appreciations for multiple limits. As expected, they found that the number of appreciations is a negative function of the appreciation threshold. An important drawback of this approach is that the threshold used to identify appreciations is largely arbitrary. Consequently, the methodology used to classify observations may be quite *ad hoc*.[2]

This paper is mainly focused on the characterization of both real appreciations and depreciations episodes trying to set up a methodology that do not depend on individual discretion on the classification of whether a departure from equilibrium RER is big enough to be considered a meaningful economic episode (real appreciation and depreciation). Firstly, equilibrium RER series are constructed using Goldfajn and Valdes (1999) methodology (cointegration with fundamentals) for a large subset of countries covered in their paper.[3] After the departures from equilibrium RER (misalignments) have been obtained, a Markov Switching Model (MSM) is used to model the misalignments series as stochastic autoregressive processes governed by two states representing different means. This specific econometric characterization allows testing the plausibility of two states without an user defined ad-hoc threshold. In theory, each mean can be interpreted as signaling the existence of appreciations or depreciations episodes.

Some important results are found. In first place, some countries do not present statistical evidence that different regimes should be considered for misalignments. Second, the misalignments processes characteristics, jointly with the supposed probabilistic structure, favors the detection, in some cases, of states that can be understood as crises and tranquility states, instead of appreciation and depreciation outcomes.

The results obtained also seem to indicate that the threshold issue discussed above is relevant. Alternative regimes are found for some of those countries whose departures from ERER are not large, using Goldfajn and Valdes (1999) - hereafter GV - metric. Hence, an endogenously determined limit for appreciations/depreciations that takes into consideration the series behavior across time seems to be adequate. Finally, evidence of a different behavior of RER departures under different regimes is found. Lower mean misalignments are reported as having higher persistence than higher mean misalignments.

In the MSM model, at each point of time, the current state of the underlying series is unknown and statistical inference about the likelihood of being on a specific state can be made. Hence, it is also possible to markedly establish starting and ending points for real appreciation and depreciation episodes. A comparison between both methods is made for the whole set of countries and

[2]The authors implicitly acknowledge this problem on the definition of the overvaluation bound and study, using a statistical framework, the number and dynamics of appreciations for multiple limits. As expected, they found that the number of appreciations is a negative function of the appreciation threshold.

[3]With the benefit of additional data, the period covered is extended up to 1998. This allows reporting a supplemental period characterized by large capital inflows to developing countries succeeded by a series of financial crisis.

some remarkable differences appear. Maybe, partially influenced by the above mentioned tranquility/crises pattern, both the number and average duration of misalignments episodes are higher than those figures calculated by GV.

This paper is organized as follows. The next section discusses the estimation of the RER misalignments using the cointegration with fundamentals approach. The third section uses the previous section misalignments estimates as inputs to a two-state Markov Switching Model. The final section concludes.

2 Real exchange rate misalignments estimation

An important effort on RER misalignments studies relies on the proper estimation of the equilibrium real exchange rate. The empirical definition here employed is, to a certain extent, the culmination of a wide debate on PPP deviations. A special strand of the literature, usually interested in predicting nominal and real exchange rates behavior in the long run, assumes that RER series are permanently affected by shocks and adopts the idea that the equilibrium real exchange rate changes over time. [See, for example, Mark (1995)]. As a consequence, the idea of a long run constant mean level underlying PPP is abandoned. The exchange rate continues to return to a target level although it is not the PPP anymore.[4]

A natural extension to this approach is to allow equilibrium exchange rate to be a function of other economic factors – hereafter denominated fundamentals – that have an effect on the equilibrium RER and try to derive a long run equilibrium relationship among all these variables. This is precisely one of the practices adopted in Goldfajn and Valdes (1999) and also used in the present work. Hence, most of the work here performed is similar to that present in GV.

The method basically consists of estimating a cointegrating relation between observed RER and a chosen set of economic fundamentals. Implicitly, there is the assumption that the RER can be decomposed into a permanent component, that is, a non-stationary I(1) series, and another element that has a stationary behavior. The integrated component represents those changes in the RER that do not vanish over time, namely, changes in the ERER. The I(0) elements are the short-run misalignments that disappear over time.[5]

[4] The core inspiration for such change can be attributed to Balassa-Samuelson effects. In this case, a trend in the equilibrium real exchange rate can be derived from differences of productivity growth rates of tradables and nontradables sectors among different countries. The key idea is that in a country in which tradables sector productivity, relatively to nontradables, grows steadily faster than its partners, the price of nontradable goods has a tendency to increase, thus entailing a long-run real exchange rate appreciation. Two hypothesis are crucial to this result: free capital mobility between both countries and sectors and lack of labor mobility between countries, even though it is allowed to move from a sector to another. [See Obstfeld and Rogoff (1996)]

[5] The first step is to test for the existence of cointegration among the series. Then an univariate estimation method is performed to estimate the cointegrating relationship. Differently from GV, OLS estimation is performed here. The authors reveal that " *Stock-Watson approach is preferable to simple OLS estimation because it allows for possibly endogenous fundamentals and corrects for serial correlation of the residuals.*" (GV, p. 234). We do recognize this line

Once a cointegrating vector has been found, an equilibrium RER series is constructed applying the cointegrating vector to the fundamental series. At each point of time, an equilibrium value to the RER is reached and the difference between the observed RER and the calculated equilibrium RER is the real exchange rate misalignment. This task was accomplished for a subset of 85 countries - from a total of 93in GV and the data used is described in the following subsection.[6]

2.1 Data

Following Goldfajn and Valdés (1999), whenever possible – in terms of availability or reliability – WPIs were used to construct the RER series. In other cases, they are replaced with CPIs as specified in GV. The monthly data required for this task – average monthly nominal exchange rates and price indexes – were mainly obtained from International Financial Statistics- IMF covering a period ranging from January 1960 through December 1998. All series were graphically examined in order to avoid data glitches. As in GV, price indexes missing values for some short periods of time were obtained via interpolation.

Bilateral exchange rates for each country were calculated for those countries encompassing more than 4% of total trade. Subsequently, after a suitable normalization of these series to avoid scale problems (Jan/1990 = 100), a multilateral real exchange rate was obtained for each country, properly weighting the bilateral series by their respective relevance on trade.[7]

In accordance with GV, four economic fundamentals are used to capture changes in RER attributable to structural rather than transitory factors: terms of trade, openness, government size and international interest rate. The impacts of these fundamentals on RER as well the characteristics of the data used as proxies to these economic factors are shortly addressed below.

Terms of Trade (TOT): The usual simplification that all countries produce the same varieties of tradable goods is not reasonable in practice. In fact, the goods a country exports has a degree of differentiation from those it imports. Obstfeld and Rogoff (1996) draw attention to the point that terms of trade – the relative price of exports to imports – are one of the main channels of global transmission of macroeconomic shocks. The outcomes of these relative price changes over RER are associated to adjustments on nontradables prices due to demand shifts. Following Diaz-Alejandro (1982) long-established approach, a negative (permanent) TOT shock – that is, an increase in import prices compared to export prices – imparts a nontradables price decrease caused by the fall in real income. A real depreciation is attained in equilibrium.[8] The main source for TOT data used is the World Development Report from World Bank,

of reasoning but we make a case for OLS estimation, as it is also a consistent estimator.

[6] Due to space restrictions, Table 1 in Appendix I presents a sample of the cointegrating relationships estimated for the whole set of 85 countries covered in this paper.

[7] We use the same weights as GV. The resulting multilateral RER was considered available for a specific month only when all bilateral series were available for that month.

[8] We assume this line of reasoning in the subsequent analyses even though an opposite result can be reached depending on whether income or substitution effects prevail.

completed with IFS exports and imports prices when possible. As these data are available in annual basis, the same course of action of GV to convert it to monthly data was employed, that is, yearly data was linearly interpolated using June as the basis month.[9]

Openness (OPEN): This variable is, to some extent, a measure that indicates the degree to which the country is affected by the international environment – how much it is connected to the rest of the world. Here, it is proxied by the sum of exports and imports over GDP. A real depreciation is observed in equilibrium when openness level is higher. The reason is quite simple: a trade liberalization reduces domestic prices of tradables causing a demand shift from nontraded goods towards those that are traded. Under some fairly reasonable cross price elasticities assumptions, nontradables prices must fall and a real depreciation is reached in equilibrium.

Size of Government (GOV): A permanent change in the size of government affects RER whenever it triggers demand swings from tradables to nontradables. Countries where government spending is likely to fall more heavily on nontradable goods relative to private spending should experience equilibrium RER appreciations following an increase in the size of government. [10]

Goldfajn and Valdés (1999) uses, as proxies for the last two fundamentals, the statistics provided by Penn World Tables (PWT 5) identified as Openness and Real Government share of GDP for the period between 1960-1992. From 1992 to 1994, World Bank data is used. We take benefit of a new set of data covering a period up to 1998 (PWT 6.0). Besides the time extension, another advantage follows: the use of two sources of data is avoided.

The series from both data sets were compared for the overlapping periods and remarkable divergences in some cases were found related to level as well as dynamics. The disparities on the series levels are related to different relative price systems among aggregates as a consequence of different starting points (PWT 5.6 data is measured in 1985 prices and PWT 6.0 has 1996 as basis). The constant price share of government spending, for a particular year is different when valued in 1996 international dollars than when valued in 1985 international dollars.[11] This difference, however, does not influence the estimation of the cointegrating vector in order to establish the long-run relationship between RER and fundamentals. The discrepancies observed in the dynamics of the fundamental, however, do have consequences on the equilibrium RER assessment.

[9] The monthly government consumption and the degree of openness were also obtained using this technique.

[10] There is some controversy in this topic, however. Rogoff (1992) argues that as long as capital and labor are fully mobile cross sectors, this effect might be transitory. Essentially, supply factors in place of demand factors should exhibit a long run effect on RER.

[11] PWT data is constructed departing from International Comparison Program (ICP) research where a common basket of goods is defined to a large range of countries. Price levels for the economic aggregates (consumption, government spending, investment and net foreign balance) are constructed in order that national statistics become comparable both across time and countries. As a result, for each country, this measure tracks government spending on a specific consumption basket (constant prices) along a period of time. Therefore, the size of government consumption in the GDP considers the relative price system in a particular year.

It is important to highlight that these changes are not connected to substantial methodological shifts but rather to growth rates adjustments for a subset of countries. National accounts growth rates for a number of countries have been updated, thus altering these indicators dynamics.[12]

International Interest Rate (TBAA3M): A gap between domestic and international interest rates has opposite outcomes on RER when short and long run perspectives are considered. Lower international interest rates strengthen capital flows and thus generate an appreciation tendency in small open economies. On the other hand, in the long-run, as it can be associated with a smaller net assets accumulation, it might be consistent with a equilibrium RER depreciation. The US 3-Month Treasury Bill is used to capture this effects.

Summarizing the arguments discussed above, the following relationships with equilibrium RER are expected to hold in the long-run:

$$\frac{\partial ERER}{\partial TOT} < 0; \frac{\partial ERER}{\partial OPEN} > 0; \frac{\partial ERER}{\partial GOV} < 0; \frac{\partial ERER}{\partial TBAA3M} < 0 \qquad (1)$$

Table 1 in the Appendix presents the estimated cointegrating vectors.[13]

3 Misalignments and MSM

The preliminary assessment of the misalignments previously computed indicates that it can be characterized as stochastic processes with substantial degree of persistence. In fact, for many countries studied, misalignments seem to be up to long swings, that is, to move in one direction for long periods of time. Additionally, these movements are frequently succeeded by sudden shifts on its values towards the opposite direction. This stylized fact is in harmony with GV inertia of RER when the latter is outside its equilibrium path. Besides, it seems to be coherent with the low probability of smooth returns of appreciation episodes.

These long swings followed by sudden reversals suggest the Markov Switching Model as a suitable description for such class of processes. The MSM deals with situations in which discrete shifts in regime are possible, that is, the existence of "*episodes across which the dynamic behavior of the series is markedly different.*" (Hamilton, 1989, p.358). Additionally, no previous knowledge of the state of the stochastic process is required. In fact, this becomes a probabilistic inference problem in which every observation is assigned a probability of being originated from a specific regime.

Many empirical questions are up to be addressed with this model. Hamilton (1989) originally makes use of this framework to estimate the likelihood of

[12] Burundi, Morocco and Syrian Arab Republic are some of the countries where this phenomena is seen on government spending. Openness series are less prone to significant divergences but they can be observed for Bolivia, Algeria and Sierra Leone for example. We do thank Bettina Aten for her invaluable informations regarding the series construction procedures.

[13] All tables in the Appendix presents the results for a subset of the countries in this study, due to lack of space here. The results for all 85 countries are available upon request.

two regimes for US GNP growth. The paper illustrates that a high probability of being in a low growth rate regime, as a general rule, is associated with those periods characterized as recessions by the National Bureau of Economic Research. Martinez-Peria (2002), particularly interested on exchange market pressure, models the mechanics of swings from tranquil to speculative attack regimes (and vice-versa). Engel and Hamilton (1990) develops a MSM model in order to assess shifts on the dollar nominal exchange rate and shows that it has a better predictive performance than a simple random walk model. Finally, Bonomo and Terra (1999), focusing on Brazilian exchange rate political economy, makes use of an extended version of Hamilton's model to obtain, in addition to whether real exchange rate misalignments have different regimes, the political factors that may influence the shifts from one regime to another. Engel and Hakkio (1996) and Kaminsky (1993) are also examples of the use of MSM to exchange rates.

Here, the focus is on whether distinct regimes for misalignments exist. At first, we presume that overvalued and undervalued states will arise. The estimation may either confirm the existence of two misalignment states, or it may show that only one regime is the best description for the misalignment. As already mentioned, a straightforward advantage of this model is that is endogenously determines the existence of alternative regimes. This is particularly relevant if we take into consideration that the level of misalignment that may have effect on economic outcomes can be quite different on a country basis. More clearly, depending on alternative social and economic structures – such as institutions or exchange rate arrangements, for example – the same level of departure from RER may or may not be considered a relevant economic episode (a real appreciation or depreciation). Indeed, it is reasonable to suspect that appreciations and depreciations may have also different cutoffs. These questions are examined here.

The MSM model as well as its empirical implementation to the RER misalignments is presented in the next subsection. Some comparisons of the results obtained with those available from GV then follow.

3.1 Markov Switching Model implementation

The RER misalignment is modeled as following an auto-regressive stochastic process ruled by alternative states which have different means and variances. A Markov Switching Model is used to characterize such process, and it may be described by the following equation:

$$m_t - \mu(s_t) = \phi(m_{t-1} - \mu(s_{t-1})) + \sigma(s_t)\xi_t \tag{2}$$

where m_t is the RER misalignment, $\{\xi_t\}$ is a sequence of i.i.d. $N(0,1)$ random variables, and s_t is an unobserved variable governing both the mean term μ and the variance σ. Basically, the stochastic process is an autoregressive process that fluctuates around two different means. The variable s_t is usually referred as a state variable because it defines the regime in which the stochastic process is at each moment. Hence, the dynamics of the stochastic process is defined by the interaction of the autoregressive coefficient ϕ, the gaussian innovations ξ_t, and s_t.

The variable s_t is modeled as a discrete-valued stochastic process that can assume distinct values and we will admit two states as possible, henceforth labeled states one (depreciated) and two (appreciated). Consequently, the actual misalignment series may have observations that can come from alternative stochastic processes with two different means and possibly also different variances. As usual, s_t is modeled as a first-order Markov process in which the current state depends only on the state in which the stochastic variable was in the immediate preceding period.

Let $\{s_t\}_{t=1}^T$ be the sample path of the Markov process described above. A transition probabilities matrix can be defined by:

$$P = \begin{bmatrix} p_{11} & 1-p_{22} \\ 1-p_{11} & p_{22} \end{bmatrix} \tag{3}$$

where p_{ii} is the probability that the economy will remain in state i next period. We define $p_{ii} = \frac{\exp(\beta_i)}{1+\exp(\beta_i)}$. The transition probabilities, written as logistic functions from parameters β_i, are time invariant. Our main focus in this paper is on the probability of being, in a given point of time, in a specific regime (with a higher or lower mean).

The model is estimated using maximum likelihood. For this reason, some hypothesis might be made concerning the conditional distribution of the misalignments in such a way that a likelihood function can be built. Misalignments sample path $\{m_t\}_{t=1}^T$ are assumed to be a stochastic process characterized as a gaussian i.i.d. mixture that depends on the unobserved state variable sample path. Therefore, the density of m_t conditional on s_t has a normal distribution:

$$f(m_t/s_t = i; \alpha_i) = \frac{1}{\sqrt{2\pi}\sigma_i} \exp\left\{ \frac{[(m_t - \mu_i) - \phi(m_{t-1} - \mu_i)]^2}{2\sigma_i^2} \right\} \tag{4}$$

for $\alpha_i = (\mu_1, \sigma_i, \phi)$ a vector of population parameters and i = 1,2.[14]

The estimation problem reduces to finding a set of parameters that maximizes the log likelihood function subject to the usual constraints on transition probabilities. Once a set of parameter estimates has been found, a sequence of estimates for the (constant) transition probabilities is also available. Such estimates can be used to form filtered probabilities which assess the likelihood of the states at each point of time.[15]

[14] It is important to remember that normality assumption regards the conditional rather the unconditional distribution of misalignments. The actual misalignments series are supposed gaussian mixtures and may have completely different theoretical/empirical distributions. In fact, Jarque-Bera tests were applied for each sequence and the null hypothesis was not rejected for only 9 of the 85 countries sampled.

[15] Alternatively, smoothed probabilities which also take into consideration the information available in the succeding periods (t, t+1, t+2,..., T) can be calculated. As they use the whole set of data available for each country, they are expected to have a higher accuracy and hence provide better inferences on the state realized at each point of time.

3.2 Results

MSM estimation relies basically on an EM algorithm developed in Hamilton (1989) for maximization of the log likelihood in order to avoid the computational intractability issue. Although this algorithm is considered a well-established, robust and stable procedure, some details may be taken into consideration on its implementation.[16]

Diebold, Lee and Weinbach (1994) recalls that, as usually noted in the literature, "*EM algorithm gets close to the likelihood maximum very quickly, but then takes more iterations to reach convergence*" (p. 296). The number of iterations might be closely associated with the maximum likelihood function shape. A flat region neighboring the estimated maximum is found for a considerable part of the series under investigation. Also, whenever convergence is achieved, as the solution is obtained numerically rather than analytically, the resultant maximum likelihood parameter estimates have to be considered, in principle, a local maximum. This implies that alternative start up parameters may be tested to check whether those estimates can be considered a global maximum. For this reason, whenever possible due to computational cost, accuracy might be favored.

After the MSM has been properly estimated, it is necessary to test if misalignments are more likely to have been originated from a random mixture distribution (that is, two regimes) rather than from a standard AR(1) stochastic processes. Hamilton (1994) warns that usual LR tests used to verify misspecification are not appropriate in this context because LR tests regularity conditions may not be attained. The null hypothesis that describes the N^{th} state is unidentified when the researcher tries to fit a N-state model when the data generating process has N-1 states (our plain AR(1) model). Garcia (1998) derives asymptotic statistics of the LR tests for a variety of Markov switching models using the asymptotic distribution theory employed when a nuisance parameter is not identified under the null hypothesis.

The alternative hypothesis of two regimes was tested against the AR(1) null. The likelihood ratio statistics for each country is reported in Table 2 in the Appendix I and the critical values vary with the auto-regressive factor. The null hypothesis of an AR(1), at a 5% confidence level, could not be rejected for 11 of the 85 total sampled countries.[17] Although cross-section comparisons are not made here, loosely speaking, these countries seem to share a common characteristic: the departures from RER are usually smaller when compared to the whole set and this may be interpreted as an indication that those departures should not be considered meaningful economic episodes. In summary, they can be better characterized by a model [AR(1)] in which misalignments fluctuate around a zero mean with a specific (maybe outsized) variance in opposition to a stochastic process that is the combination of other two processes with different

[16] We thank René Garcia for providing a Fortran program used for estimating the Markov Switching Model.

[17] The countries are Bahrain, Bangladesh, Canada, Hong Kong, Liberia, Nepal, Pakistan, Saudi Arabia, Singapore, Sierra Leone and Tunisia.

means (and possibly different variances).[18]

For the remaining 74 countries, 10 were best described by regimes that had not only different means but also dissimilar variances. The relatively small sample is not enough to authorize inferences on whether exists an association of the second moment of the stochastic process with the first moment of the regimes (i.e., if appreciations are less volatile than depreciations). For four countries – Burundi, Central Africa, Denmark and Kuwait - the lower mean regime is also associated with lower volatility. Zaire, Jamaica, Liberia, Mexico and Paraguay illustrates the opposite: lower means are associated with higher volatility when compared to those linked to the higher mean regimes. For El Salvador, however, although likelihood increases when a two-variance model is considered, the difference of the variances is not statistically significant.

As mentioned previously, we are preferably concerned with the plausibility of two means. The two states are expected to take account of RER appreciations *vis-à-vis* RER depreciations. However, although for many cases this result seems to hold, another outcome is also present: the model identifies a regime with a mean quite close to zero and another in which it is very far from zero. Intuitively, they can be understood as a state of tranquility in comparison with another state in which a large departure from equilibrium RER takes place – such as large devaluations triggered by balance of payments crises. Cameroon, Peru and Rwanda are examples of this pattern.[19]

Another chief result is found when the model is estimated for those countries whose RER departures are small using GV metric. Although, as previously discussed, for some of them the AR(1) null cannot be rejected, in many cases the MSM suggests the existence of two regimes and the difference of the means is statistically significant.[20]

Another important comparison relating the MSM and the GV methodology may be made through the evaluation of their ability to express this sort of economic episodes. In the MSM framework, this task can be accomplished using the filtered probabilities mentioned in the previous subsection. When the filtered probability of the depreciated states - given the available data - is close to 1, there is strong evidence that the misalignment is in a depreciated regime. Conversely, when close to 0 there is support to the hypothesis that the observed misalignment comes from a lower mean regime.[21] Therefore, the inference about whether a misalignment may have been originated from one regime or another

[18] Pakistan misalignments, for example, are usually not very large and are subject to a somewhat high degree of volatility, particularly from 1985 onwards.

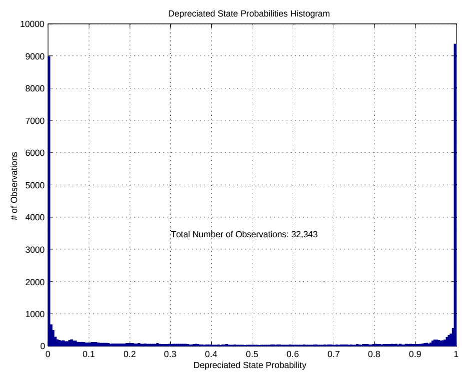
[19] The latter, for instance, has a mean close to zero (μ_2 = -1.52) andanother considerably higher (μ_1 = 149.54). Apparently, it is a sign of a particular deviation incident occurred in 1994. For this reason, substantial asymmetries on the mean parameter for the alternative regimes can be verified.

[20] This is precisely the case of Austria, Belgium and Denmark among others.

[21] GV's overvaluation measure contrasts the actual and the estimated equilibrium RER. When it moves more than the specified threshold (15%, for example) from the ERER for two consecutive months an appreciation is said to start. The end of an episode is defined at the first time when the overvaluation measure gets back to a level less or equal 5% distance from ERER.

can be performed based on these filtered probabilities. However, a certain degree of arbitrariness is involved here: a threshold on filtered probabilities must be also adopted. Most empirical applications available in the literature use a 0.50 threshold. When the calculated filtered probability is above this maximum value, the observation is considered as being from the specific regime.

A different approach is adopted here. A higher cutting edge is defined in order to the observation to be considered a relevant episode. The graph below displays a histogram of the depreciated state filtered probabilities encompassing the 85 countries analyzed. It is clear that most of the estimated probabilities are either close to zero or one and also that movements between the two extremes are fast.



As 89.6% of the 32,343 filtered probabilities calculated are located within a 0.30 distance from the extremes, this border line was adopted. As a consequence, RER appreciation episodes are defined as those observations whose associated appreciation filtered probabilities are higher than 0.70. The same is valid for RER depreciations: the limit for depreciation filtered probabilities is also set at 0.70.[22]

The resulting episodes were compared with those that could be observed if GV methodology was in place. Table 3 in Appendix I tabulates, for each country, the number of episodes and the average duration. Additionally the lower panels of country figures in Appendix II present simultaneously the beginning and ending dates of episodes for selected countries. Again, the MSM results are highly influenced by the factors mentioned before. For most of the countries, these indicators are higher than those calculated using GV methodology. In some cases, this is related to the characterization of tranquility/crisis periods in spite of appreciation and depreciation episodes. In general, tranquility periods are expected to hold for longer periods, being interrupted by the incidence of crisis.

[22]Note that a filtered probability in a two-state model is the complement of the corresponding alternative filtered probability. For instance, a 0.85 appreciation filtered probability is equivalent to a 15% chance that this particular observation has been originated from the depreciated state.

It is worth to mention, however, a negative aspect of using estimated filtered probabilities in order to accomplish this task. Some inertia can be observed on filtered probabilities and sometimes a direct relationship between changes in misalignments and the assigned filtered probabilities cannot be established.

Nevertheless, positive evidence on MSM as an appropriate framework is also found. For many countries that GV methodology did not indicate the occurrence of appreciation or depreciation incidents, the MSM appointed some episodes. This again supports the idea that a common threshold for all countries might be avoided.

4 Conclusions

The main purpose of the present work was the evaluation of whether RER misalignments - defined as deviations from a long run equilibrium relationship – may be characterized by a switching regime that interpret these misalignments as appreciations or depreciation episodes. The basic idea underlying this econometric modeling choice is the avoidance of a limitation of GV model discussed above: a common threshold for all countries. Whenever the latter setup is implemented, appreciation/depreciation episodes are defined when the misalignment surpasses an *ad hoc* limit. Nonetheless, it's far from certain that this common threshold is consistent with different economic structures observed among countries. As a consequence, there is room for an endogenously determined limit. Additionally, behavioral asymmetries on RER misalignments between regimes may exist as the alternative regimes may present diverse patterns of persistence and volatility.

The most usual switching regime model implemented in the empirical literature - a two-state MSM – was implemented on RER misalignments. The latter were obtained through the estimation of a cointegrating relationship between actual RER and a set of economic variables in order to account for changes in RER explainable by fluctuations in fundamentals. A certain degree of divergence from those calculated by GV may be observed due to the following reasons. The period covered was extended and economic fundamentals revisions changed the variables up to be included as participants of the cointegrating vector for some countries. Moreover, the estimation method here employed – OLS rather Stock Watson univariate model – might result in slight alterations on misalignments.

The MSM estimation for each country resulted in similarities as well as some disparities when compared to those available in GV. Firstly, the AR(1) null hypothesis for some countries in which GV would not sign the existence of either appreciation or depreciation cannot be rejected. Conversely, for other countries in the same situation, the null hypothesis is rejected and this can be understood as evidence that countries do not share the same bounds from which misalignments should be considered relevant economic episodes.

When the specific question of appreciation and depreciation categorization is taken into consideration, a drawback emerges. For many countries, the model apparently identifies, as lower and higher means, periods of tranquility and crises against the expected appreciation depreciation pattern. In general, this is observed for countries in which the RER fluctuates around its equilibrium value for a long interval but significant larger departures can be observed. This can be a result of the particular probabilistic structure assumed and suggests the investigation of whether a three-state switching model has a better fit to the available data. Instead of classifying some of the observations as coming from a state in which the mean is close to zero, they would be assigned to a state that could be interpreted as an economic departure. Hence, important economic departures would not be rated as values close to equilibrium.

As a consequence of the preceding mentioned outcome from two-state models, the accurate classification of appreciations/depreciations when filtered probabilities are used is doubtful. Although filtered probabilities between extremes are fast, sometimes these alterations are disconnected from large swings observed in misalignments. This may obscure the regime changes assessment.

It is worth mentioning that it was found support within those countries that can be characterized by the two-state model that sometimes there exists distinction on variance among regimes. Albeit no conclusion could be derived on whether RER volatility may be higher in depreciation vis-à-vis appreciation regimes (or vice-versa) some differences regarding these states configuration appear. In general, as shown by the state transition probabilities, appreciation (lower mean) episodes have higher persistence and thus last longer than depreciations (higher mean). This finding may be consistent with a line of reasoning adopted by GV when they find that undervaluations are usually less prone to move back to equilibrium by means of smooth returns. Downward rigidity of prices together with policymakers different degrees of tolerance with booms and recessions may cause this asymmetry.

Supplementary research is desired in this area and should focus on two main issues. Firstly, as suggested in GV, the comparison from the factors that are dominant on the reversal from undervalued/overvalued states to the RER equilibrium value (nominal and cumulative differential inflation) may shed light over the mechanism that leads to a higher persistence of appreciation episodes. Also, this question can be also examined under the scope of those issues that may influence policymakers' choices, which are partially revealed by the lower persistence of RER depreciations. A line of attack to accomplish this task is the estimation of Hamilton's model extensions in which time-varying transition probabilities are estimated. This would be advantageous not only from the perspective of being able to uncover the questions that policymakers look at when deciding policies. Also, a better model fit may enhance the characterization of RER appreciation and depreciations.

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5 Appendix I

Table 1

Cointegrating Vectors

	Terms of Trade	Government	Openess	Interest Rate	Trend	Constant
Austria	(0.256)	(0.089)	(1.527)	(0.631)		162.179
	0.105	0.078	0.313	0.058		20.825
Belgium	(0.866)	0.394	(0.902)	(1.388)	(0.100)	189.043
	0.099	0.042	0.151	0.105	0.006	11.968
Denmark	(0.038)	(0.060)	(1.557)	0.206		147.000
	0.120	0.105	0.165	0.127		20.607
Finland	(1.109)	0.570	(4.337)	(3.517)	0.068	277.086
	0.124	0.072	0.438	0.170	0.008	17.608
France	(0.287)	0.611			(0.089)	131.655
	0.068	0.130			0.005	10.606
Germany	(0.373)		0.395	(1.299)		144.219
	0.064		0.583	0.159		11.856
Greece	(0.018)	0.667	(1.084)	(1.009)	0.001	89.059
	0.059	0.109	0.329	0.083	0.006	8.151
Ireland	0.139		(1.670)	(0.027)		119.323
	0.031		0.115	0.107		3.221
Italy	0.210	0.896	5.430	0.074		(29.618)
	0.047	0.073	0.503	0.124		13.818
Netherlands	0.526	0.551	2.636	(0.201)		(43.658)
	0.082	0.028	0.123	0.057		11.317
Norway	0.280	(1.901)	(3.093)	0.387		270.035
	0.021	0.102	0.234	0.129		6.810
Portugal	(0.062)	0.756	4.980	0.196	(0.324)	46.595
	0.053	0.052	0.347	0.128	0.012	8.376
Spain	(0.030)	0.750	(0.249)	(1.201)		92.722
	0.029	0.054	0.179	0.121		3.160
Sweden	0.110	(0.053)		(0.062)		101.974
	0.143	0.098		0.241		20.981
Switzerland	(0.077)	0.129	(3.598)	(0.904)	(0.033)	147.521
	0.160	0.126	1.158	0.168	0.014	16.636
United Kingdon	(1.335)	0.967	2.512	(0.894)	0.022	125.227
	0.092	0.096	0.238	0.096	0.005	14.208
Argentina	(0.378)		(0.911)	(1.428)		121.991
	0.042		0.265	0.252		5.852
Bolivia	0.171	2.006	(7.855)	2.230		121.894
	0.087	0.378	0.625	0.644		24.604
Brazil	0.318	3.890	2.614	3.164		(54.253)
	0.030	0.469	0.307	0.393		16.635
Canada	(0.192)	0.341	(0.478)	0.754		108.774
	0.044	0.028	0.245	0.087		5.230
Chile	0.228	0.924	(0.869)		(0.031)	43.498
	0.017	0.091	0.114		0.009	5.553
Colombia		2.688	0.417	(0.966)		(2.943)
		0.143	0.212	0.143		3.264
Costa Rica		0.441	(2.026)	0.166		104.405
		0.031	0.360	0.216		8.013
Ecuador	(0.707)	0.473		2.782		120.952
	0.031	0.143		0.306		10.225
El Salvador	(0.379)	0.318		(3.964)		148.699
	0.063	0.109		0.315		4.937
Guatemala	(0.199)	0.588	1.591	(1.133)		59.713
	0.047	0.067	0.522	0.232		12.320
Haiti	0.066		(0.596)	(0.235)	(0.151)	167.642
	0.059		0.327	0.275	0.005	7.329
Honduras	(0.453)	1.177	(2.668)	(1.549)		160.407
	0.104	0.068	0.537	0.392		16.763
Jamaica	(0.643)	0.850	0.178	(2.768)		70.379
	0.082	0.034	0.134	0.302		4.858
Mexico		(0.228)	2.747			62.977
		0.053	0.344			3.896
Paraguay		0.259	1.438	(1.107)	(0.084)	56.533
		0.055	0.260	0.287	0.011	5.284

Table 1

Cointegrating Vectors

	Terms of Trade	Government	Openess	Interest Rate	Trend	Constant
Peru	2.260	8.450	38.385	(0.000)		(794.825)
	0.193	0.548	1.815	1.057		29.783
Trinidad Tobago	(0.211)	0.433		2.455		88.267
	0.021	0.040		0.356		4.912
United States		4.443	3.354			(43.647)
		0.337	0.616			16.583
Uruguay	0.399	(0.756)	5.037	(0.078)		(31.912)
	0.084	0.264	0.596	0.414		18.223
Venezuela	0.116	1.202	6.241	(2.328)		(82.124)
	0.031	0.089	0.559	0.227		8.426
Australia	(0.667)	1.474	(3.351)	(0.794)		180.013
	0.044	0.139	0.479	0.118		9.969
Indonesia	0.330	0.647	(1.407)	(4.669)		74.141
	0.058	0.209	0.520	0.459		10.733
New Zealand	(1.110)	(0.149)	(8.539)			371.321
	0.070	0.113	0.873			16.521
Papua New Guinea	0.214	0.011			0.086	45.844
	0.023	0.055	0.007			5.708
Bahrain		0.124		0.436		77.306
		0.025		0.172		4.500
Bangladesh	(0.459)	0.553			0.124	87.115
	0.094	0.200			0.016	5.683
Hong Kong	(1.981)	(0.149)	(3.580)		0.074	324.296
	0.408	0.033	2.132		0.016	43.950
India	0.503	6.339	(1.824)	(2.580)		(0.046)
	0.132	0.342	0.344	0.293		24.681
Israel	0.645	0.467	(0.101)			2.511
	0.122	0.040	0.074			13.533
Japan	(0.415)		(5.383)	(1.017)	(0.246)	277.845
	0.045		0.526	0.248	0.010	12.523
Jordan		0.581	0.242	(1.875)		15.470
		0.017	0.139	0.090		6.716
Korea	(0.118)	0.421	(1.594)	(3.105)		131.034
	0.127	0.079	0.273	0.245		17.961
Kuwait		(0.055)	(0.010)	(0.076)	(0.065)	127.356
		0.049	0.048	0.162	0.007	5.232
Malaysia	(0.203)	0.326	0.692	(0.101)		52.255
	0.028	0.006	0.165	0.107		4.590
Nepal			(2.928)	(1.474)	0.244	88.067
			0.213	0.132	0.004	4.046
Pakistan	0.000	1.827	1.706	(1.698)		(5.293)
	0.029	0.130	0.125	0.127		6.895
Philiphines	0.196	(0.030)	3.603	(0.260)		26.951
	0.050	0.030	0.495	0.237		9.599
Saudi Arabia		(0.813)	(0.595)	(2.328)		191.720
		0.081	0.118	0.306		7.025
Singapore	(5.534)	0.042	(0.536)	(0.491)		624.551
	0.409	0.016	0.709	0.120		50.067
Sri Lanka	0.217	(0.107)	(10.215)	(1.085)		273.111
	0.087	0.086	0.446	0.453		15.968
Thailand	(0.076)	0.434	1.520	(1.927)		61.707
	0.041	0.048	0.348	0.179		11.761
Turkey	(0.353)	0.484	1.216	(1.055)		104.267
	0.048	0.108	1.142	0.343		23.275
Algeria		0.994	8.937	(0.695)		(122.775)
		0.059	0.197	0.333		6.792
Burkina Faso	0.055	0.880	(2.782)	(2.388)	0.247	66.318
	0.089	0.290	0.405	0.367	0.019	10.076
Burundi	(0.096)	1.406	2.708	(2.786)	0.137	(42.223)
	0.017	0.148	0.213	0.302	0.015	12.202
Cameroon	0.484		(2.422)	(0.660)		99.845
	0.074		0.874	0.374		13.897
Central Africa	0.111	0.690	(1.813)	(1.572)		143.328
	0.024	0.098	0.140	0.243		3.894
Zaire	0.332	0.662	(1.438)	(4.906)		80.923
	0.068	0.118	0.198	0.442		10.105
Congo	(0.060)	0.489	(0.018)	(1.083)		69.277
	0.008	0.026	0.109	0.163		5.158

Table 1

Cointegrating Vectors

	Terms of Trade	Government	Openess	Interest Rate	Trend	Constant
Egypt	0.119	2.262	(12.751)			174.381
	0.046	0.094	0.710			8.093
Ethiopia	(0.125)	3.875	(4.384)		0.084	109.363
	0.060	0.184	0.214		0.012	9.140
Gabon	(0.035)	0.288		(0.949)	0.004	90.600
	0.019	0.053		0.415	0.007	6.101
Ghana	(0.205)	2.113	(0.460)	0.101		31.752
	0.034	0.075	0.194	0.372		9.149
Kenya	0.065	0.378	(4.243)	(1.059)	0.161	75.200
	0.038	0.055	0.248	0.163	0.009	3.809
Liberia	(0.049)	0.411	(1.024)			97.235
	0.062	0.058	0.152			9.998
Madagascar	(0.292)	2.403	7.144	(4.280)		(52.262)
	0.030	0.137	0.717	0.281		16.324
Malawi		1.813	0.396	(0.015)		(1.763)
		0.156	0.298	0.381		12.472
Morocco		0.114	(0.938)	(0.582)	0.097	69.382
		0.074	0.181	0.124	0.003	2.770
Niger	(0.433)	(0.726)		(0.888)	0.316	84.161
	0.056	0.112		0.512	0.013	4.367
Nigeria	(0.237)	0.355	0.302	0.318		78.618
	0.038	0.068	0.589	0.688		3.566
Senegal	(0.840)	0.044	(6.611)		0.152	269.341
	0.112	0.054	0.365		0.006	12.421
Sierra Leone	(0.664)	(0.526)	11.779			96.645
	0.360	0.333	2.972			48.323
South Africa		0.434	3.113	(2.207)		12.679
		0.096	0.161	0.177		7.149
Sudan		3.461	(1.584)	(8.014)		235.321
		0.726	0.906	1.959		24.831
Togo	(0.102)	(0.563)		(0.639)		160.030
	0.035	0.056		0.350		4.845
Tunisia		0.243			(0.080)	105.233
		0.041			0.004	3.476
Zimbabwe		1.144	1.164	(2.110)		29.301
		0.081	0.247	0.416		9.990
Rwanda	0.115	4.773	5.971			(189.385)
	0.079	0.290	0.622			23.234
Ivory Coast	(0.031)	1.209	(2.200)	(2.299)		80.454
	0.012	0.065	0.279	0.266		4.906
C.S.P	0.60	0.81	0.58	0.82		
C.S.P (GV)	0.56	0.80	0.58	0.63		

C.S.P.: Correct sign proportion
Standard errors below coefficients.

Table 2
Markov Switching Model - Estimation results summary
Dependent variable: exchange rate misalignment

Countries	Mean $\mu(1)$	$\mu(2)^{(*)}$	Constant part of probability $\beta(1)$	$\beta(2)$	Standard Deviation $\sigma(1)$	$\sigma(2)^{(**)}$	Auto-regressive Factor α	Likelihood Ratio Statistic	Maximum Likelihood Function Value (MSM)
Austria	2.470	(1.809)	3.794	3.844	0.898		0.904	43.04	217.56
	15.60	(3.20)	8.82	8.62	38.91		57.12		
Belgium	0.958	(3.179)	4.784	4.101	0.621		0.979	60.28	38.83
	0.71	NaN	7.95	6.48	30.49		NaN		
Denmark	(0.323)	(3.803)	4.297	2.970	1.040	0.775	0.985	30.12	189.76
	11.59	(1.42)	9.33	6.42	14.23	(3.28)	97.01		
Finland	9.747	(5.570)	4.177	5.380	1.531		0.985	91.98	450.59
	54.12	(1.34)	5.54	7.36	32.02		NaN		
France	0.959	(3.429)	3.968	3.023	1.009		0.968	36.84	288.94
	11.71	(2.26)	8.87	6.30	27.67		83.10		
Germany	0.581	(5.557)	5.415	2.541	1.050		0.992	43.75	269.86
	13.23	(1.15)	10.41	3.63	46.07		NaN		
Greece	1.877	(5.912)	5.323	4.059	1.116		0.959	53.05	305.73
	4.17	(2.79)	5.19	5.08	24.92		56.45		
Ireland	0.287	(4.076)	3.827	1.109	1.064		0.969	44.36	318.14
	10.00	(2.47)	9.89	1.18	25.98		83.20		
Italy	6.201	(0.342)	1.253	4.421	1.105		0.963	68.36	302.43
	14.81	(0.24)	2.19	9.70	29.39		73.67		
Netherlands	3.006	(0.520)	0.543	4.578	0.750		0.959	42.25	116.54
	11.81	(0.60)	0.80	9.52	29.58		66.23		
Norway	2.306	(1.685)	3.536	3.432	1.038		0.969	25.04	273.94
	9.62	(0.96)	7.15	5.11	24.77		75.39		
Portugal	1.267	(4.141)	4.117	2.543	1.319		0.956	31.55	391.60
	11.31	(2.75)	9.29	4.80	27.91		66.99		
Spain	2.956	(3.510)	3.643	3.562	1.401		0.928	39.06	440.72
	16.15	(2.88)	8.29	10.88	28.42		40.35		
Sweden	5.659	(4.730)	4.260	4.719	1.350		0.990	25.46	401.68
	17.31	(0.73)	6.80	7.86	30.61		NaN		
Switzerland	2.322	(1.513)	3.906	1.839	1.179		0.984	11.24	343.43
	8.23	(0.40)	7.63	3.24	24.57		94.91		
United Kingdon	5.507	(4.591)	4.346	4.672	1.653		0.958	44.08	495.76
	12.91	(2.28)	6.73	7.61	30.25		66.77		
Argentina	44.264	(41.761)	5.733	6.242	5.758		0.990	68.35	993.49
	15.43	(1.47)	4.79	6.02	33.41		NaN		
Bolivia	4.405	(58.201)	4.630	3.427	6.367		0.951	64.06	537.93
	0.48	NaN	6.36	3.97	20.95		49.87		
Brazil	11.714	(9.869)	3.113	3.591	4.883		0.959	51.59	1,035.08
	14.03	(1.66)	7.76	8.55	27.82		68.56		
Canada	1.223	(1.063)	2.877	2.507	0.800		0.975	(2.89)	209.94
	9.31	(0.70)	5.89	5.88	18.74		89.83		
Chile	6.436	(46.133)	5.256	4.705	3.507		0.990	161.47	838.13
	25.57	(2.71)	7.10	5.40	30.32		NaN		
Colombia	2.784	(11.080)	4.824	3.582	1.255		0.985	152.31	371.05
	26.74	(2.87)	8.20	6.46	30.63		NaN		
Costa Rica	18.223	(0.699)	(0.004)	5.030	2.388		0.953	105.48	662.18
	18.39	(0.29)	-	8.68	30.27		66.54		
Ecuador	8.877	(9.285)	4.204	3.980	2.430		0.972	35.15	351.89
	14.84	(1.66)	5.64	6.43	21.71		57.86		
El Salvador	15.805	(8.158)	4.537	5.311	2.513	2.516	0.983	81.87	682.60
	15.30	(1.24)	5.53	7.25	25.40	0.01	NaN		
Guatemala	165.401	107.813	5.907	6.280	2.186		1.001	197.05	606.59
	26.92	0.28	4.60	5.42	30.83		NaN		
Haiti	21.538	(4.040)	2.368	5.201	3.302		0.973	70.69	659.86
	15.24	(0.65)	3.28	7.26	27.03		72.98		
Honduras	73.347	18.275	5.702	6.320	2.924		1.007	118.47	742.37
	19.27	0.64	4.16	5.76	32.09		NaN		
Jamaica	12.037	(10.823)	4.446	6.076	1.875	4.450	0.980	143.93	626.84
	11.98	(1.78)	5.07	6.04	26.66	7.81	89.15		

Table 2
Markov Switching Model - Estimation results summary
Dependent variable: exchange rate misalignment

Countries	Mean		Constant part of probability		Standard Deviation		Auto-regressive Factor	Likelihood Ratio Statistic	Maximum Likelihood Function Value (MSM)
	μ(1)	μ(2) (*)	β(1)	β(2)	σ(1)	σ(2) (**)	α		
Mexico	12.113	(12.716)	1.387	5.018	2.186	18.050	0.980	280.97	655.58
	19.65	(1.64)	2.16	8.71	30.04	4.84	NaN		
Paraguay	4.062	(3.224)	1.944	4.133	2.275	8.957	0.964	159.17	732.51
	4.58	(1.00)	3.40	9.36	26.64	5.61	73.05		
Peru	71.672	(5.004)	1.241	4.616	13.153		0.947	65.00	1,266.30
	12.01	(0.42)	2.05	8.69	27.09		58.86		
Trinidad Tobago	(5.817)	(20.030)	3.851	4.420	2.030		0.995	39.06	600.28
	18.40	(0.75)	7.13	8.65	29.94		NaN		
United States	3.637	(1.323)	1.762	3.739	1.691		0.981	25.46	530.27
	8.86	(0.32)	3.74	8.73	25.76		NaN		
Uruguay	25.193	(13.363)	2.979	3.844	5.163		0.958	11.24	913.19
	25.04	(2.15)	7.23	9.30	28.25		65.42		
Venezuela	18.769	(6.563)	2.835	4.120	3.659		0.946	44.08	558.71
	17.03	(1.47)	4.37	8.02	23.66		40.81		
Australia	6.105	(0.583)	1.104	3.807	1.647		0.953	42.77	497.70
	13.61	(0.35)	2.33	10.50	26.99		62.54		
Indonesia	(2.054)	(10.752)	3.804	3.736	1.887		0.994	34.26	433.99
	8.46	(0.62)	6.62	5.76	23.37		NaN		
New Zealand	(8.938)	(22.249)	4.125	3.908	1.987		0.994	90.83	576.75
	13.45	(0.98)	8.70	6.34	29.69		NaN		
Papua New Guinea	2.705	(2.337)	2.750	3.104	1.203		0.956	30.20	276.90
	15.93	(1.47)	7.33	7.81	24.79		57.61		
Bahrain	14.019	(1.004)	2.644	5.352	1.248		0.963	4.57	164.51
	16.74	(0.42)	2.70	5.22	NaN		50.23		
Bangladesh	6.399	(13.191)	1.920	5.665	2.263		0.761	(94.86)	541.51
	19.59	NaN	1.92	5.66	2.26		0.76		
Hong Kong	(27.934)	(36.302)	4.768	4.557	1.630		0.997	5.80	334.50
	8.38	(0.34)	6.11	5.21	24.78		96.88		
India	11.648	(2.301)	3.112	4.562	1.956		0.964	49.99	283.22
	13.74	(0.62)	4.58	6.25	20.68		50.93		
Israel	10.461	(1.953)	2.638	4.373	2.207		0.962	55.26	513.87
	14.04	(0.64)	4.85	8.53	26.47		65.91		
Japan	2.356	(3.281)	3.744	2.637	1.763		0.976	12.56	509.50
	8.77	(0.91)	8.26	4.64	25.22		89.55		
Jordan	0.118	(3.984)	3.738	(0.177)	1.141		0.938	16.90	172.04
	9.93	(3.05)	8.03	(0.25)	20.52		40.33		
Korea	21.590	(4.661)	3.932	4.726	2.611		0.972	119.86	649.22
	22.08	(1.02)	6.19	7.96	29.28		85.15		
Kuwait	0.279	(4.823)	4.174	2.097	1.718	1.139	0.935	18.12	175.59
	8.44	(3.40)	7.17	3.17	7.02	(2.29)	38.81		
Malaysia	(2.424)	(6.082)	3.942	2.758	0.797		0.990	39.77	176.30
	14.86	(1.30)	10.17	6.19	29.53		NaN		
Nepal	5.533	(1.116)	1.635	3.878	2.079		0.941	0.40	384.44
	8.06	(0.53)	2.37	7.79	22.39		45.96		
Pakistan	2.483	(0.579)	1.721	2.903	1.392		0.894	(0.74)	218.98
	5.49	(0.56)	2.26	3.83	12.42		27.52		
Philiphines	17.954	(2.129)	3.015	4.631	2.960		0.954	36.79	772.61
	16.80	(0.69)	4.84	9.18	30.24		69.89		
Saudi Arabia	(1.620)	(6.499)	4.361	1.653	1.294		0.987	(4.71)	191.50
	7.20	(0.93)	6.59	2.20	19.65		88.81		
Singapore	1.053	(1.488)	4.857	4.173	0.922		0.952	(0.02)	86.28
	1.76	(0.57)	4.19	2.59	16.97		37.79		
Sri Lanka	14.405	(10.407)	5.863	5.083	1.896		0.986	50.24	531.93
	31.75	(1.92)	6.18	6.21	36.65		NaN		
Thailand	1.855	(3.704)	3.527	3.565	1.323		0.964	27.04	402.56
	11.87	(1.68)	6.25	5.98	27.09		62.52		
Turkey	6.089	(12.509)	4.017	4.103	2.867		0.987	54.24	588.11
	15.12	(0.99)	6.32	7.70	26.54		92.16		
Algeria	15.101	(11.900)	3.331	4.432	3.545		0.981	69.19	553.17
	16.79	(1.03)	5.08	7.54	24.49		75.05		
Burkina Faso	52.445	(0.162)	(13.027)	5.994	4.270		0.945	99.15	791.53
	17.15	(0.04)	(9.96)	5.95	28.23		58.18		

Table 2
Markov Switching Model - Estimation results summary
Dependent variable: exchange rate misalignment

Countries	Mean $\mu(1)$	$\mu(2)$ (*)	Constant part of probability $\beta(1)$	$\beta(2)$	Standard Deviation $\sigma(1)$	$\sigma(2)$ (**)	Auto-regressive Factor α	Likelihood Ratio Statistic	Maximum Likelihood Function Value (MSM)
Burundi	4.724	(4.263)	3.177	3.450	2.802	1.894	0.975	16.19	446.51
	18.30	(1.03)	10.16	17.20	56.51	(7.39)	93.27		
Cameroon	53.602	1.324	(10.555)	5.913	3.435		0.974	82.44	704.96
	21.22	0.20	(1.74)	5.95	27.26		79.77		
Central Africa	0.161	(5.070)	3.422	4.039	(0.872)	(1.190)	0.980	600.01	205.74
	14.34	(1.87)	7.09	7.78	NaN	(2.53)	98.16		
Zaire	29.988	(8.967)	4.225	4.107	3.613	7.067	0.966	102.40	845.74
	21.01	(1.35)	6.96	7.92	20.74	8.24	71.98		
Congo	46.880	(0.245)	(15.706)	6.006	3.223		0.901	124.15	686.81
	20.21	(0.16)	(0.01)	6.13	29.72		42.27		
Egypt	41.089	(10.911)	3.865	4.558	5.002		0.971	144.47	1,017.00
	25.10	(1.38)	6.76	8.90	30.39		92.02		
Ethiopia	30.214	(64.648)	5.428	6.161	3.866		0.996	168.80	739.21
	24.39	(0.73)	3.81	5.51	28.03		NaN		
Gabon	83.807	(12.333)	3.864	6.027	2.643		0.989	269.57	562.09
	34.96	(0.63)	1.66	5.85	27.46		62.98		
Ghana	7.116	(20.700)	3.770	4.330	3.320		0.988	18.12	765.44
	22.15	(1.26)	7.09	8.35	29.36		NaN		
Kenya	0.887	(11.593)	4.794	1.394	2.567		0.911	39.77	558.72
	10.22	(6.05)	8.06	2.09	26.16		41.07		
Liberia	2.942	(0.912)	2.351	3.221	1.473	2.179	0.951	0.40	203.37
	4.20	(0.30)	2.18	4.63	10.24	2.40	37.75		
Madagascar	26.861	(8.460)	3.864	5.293	2.848		0.983	(0.74)	665.74
	21.20	(1.00)	4.45	7.42	28.93		NaN		
Malawi	32.006	(13.097)	4.967	5.598	5.709		0.968	36.79	515.65
	7.67	(1.06)	3.56	4.97	21.35		55.24		
Morocco	1.304	(6.148)	4.136	5.217	1.001		0.992	33.89	256.95
	14.86	(0.95)	6.41	7.20	30.66		NaN		
Niger	65.839	(8.983)	1.883	5.895	4.710		1.111	(0.02)	767.41
	74.79	(8.21)	1.94	5.90	8.62		91.71		
Nigeria	29.865	(8.962)	4.246	5.472	4.054		0.989	50.24	828.80
	1.29	NaN	0.02	6.97	34.78		NaN		
Senegal	115.507	31.178	5.269	6.102	2.917		1.006	27.04	590.11
	28.93	0.65	3.52	5.48	27.99		NaN		
Sierra Leone	2.990	(46.582)	4.018	2.841	7.923		0.921	54.24	327.60
	10.44	(6.49)	9.52	3.78	15.83		31.86		
South Africa	16.720	0.092	1.286	4.730	1.922		0.962	69.19	568.83
	25.61	0.05	1.99	11.43	31.29		78.08		
Sudan	64.618	(6.699)	1.256	3.341	15.207		0.893	17.82	318.41
	9.71	(0.44)	1.13	5.59	13.47		18.64		
Togo	297.748	218.287	5.241	6.034	2.474		1.001	222.91	495.20
	31.72	0.12	3.61	5.45	26.17		NaN		
Tunisia	1.861	(0.907)	3.537	4.534	1.850		0.650	(47.06)	106.75
	2.79	(0.95)	3.54	4.53	2.13		0.79		
Zimbabwe	31.525	10.481	0.785	4.087	4.415		0.981	37.05	524.77
	11.28	0.66	1.12	8.66	22.13		53.27		
Rwanda	149.542	(1.526)	1.369	5.612	9.064		0.908	619.23	752.81
	22.75	(0.25)	1.24	5.67	23.25		34.78		
Ivory Coast	119.985	35.884	5.365	6.332	2.783		1.004	231.13	719.16
	29.91	0.61	3.52	5.78	30.52		NaN		

Asymptotic t-ratios below coefficients.
(*) These are the t-ratios of the difference between the mean of the two regimes.
(**) These are the t-ratios of the difference between the standard deviation of the two regimes.

Table 3
Markov Switching Model - Estimation results summary
Dependent variable: exchange rate misalignment

Countries	Transition Probabilities		Goldfajn e Valdes (1999) Methodology		Markov Switching Model	
			Number/Average Duration		Number/Average Duration	
	p11	p22	Depreciations	Appreciations	Depreciations	Appreciations
Austria	0.9780	0.9790	-	-	7	8
					24	25
Belgium	0.9917	0.9837	-	-	3	2
					107	64
Denmark	0.9866	0.9512	-	-	4	2
					87	34
Finland	0.9849	0.9954	2	-	1	-
			30		374	
France	0.9814	0.9536	-	-	7	5
					46	17
Germany	0.9956	0.9270	1	-	3	3
			44		109	27
Greece	0.9951	0.9830	-	1	2	2
				16	175	51
Ireland	0.9787	0.7519	-	-	8	3
					51	4
Italy	0.7779	0.9881	1	-	4	4
			4		3	106
Netherlands	0.6325	0.9898	-	-	1	4
					6	97
Norway	0.9717	0.9687	-	-	8	4
					24	25
Portugal	0.9840	0.9271	-	-	6	4
					55	12
Spain	0.9745	0.9724	-	-	4	3
					92	18
Sweden	0.9861	0.9912	1	2	-	-
			112	17		
Switzerland	0.9803	0.8629	-	1	10	5
				15	33	6
United Kingdon	0.9872	0.9907	1	-	2	7
			5		91	30
Argentina	0.9968	0.9981	6	7	2	5
			24	16	95	17
Bolivia	0.9903	0.9685	5	5	1	1
			5	6	209	10
Brazil	0.9574	0.9732	6	3	6	4
			19	24	30	34
Canada	0.9467	0.9247	-	-	16	9
					13	8
Chile	0.9948	0.9910	4	3	4	-
			8	14	104	
Colombia	0.9920	0.9729	3	2	2	1
			40	54	189	86
Costa Rica	0.4990	0.9935	3	2	4	4
			22	9	10	103
Ecuador	0.9853	0.9817	4	2	1	-
			9	30	108	
El Salvador	0.9894	0.9951	2	3	2	-
			56	25	110	
Guatemala	0.9973	0.9981	2	2	1	4
			36	20	150	22
Haiti	0.9144	0.9945	2	3	2	2
			32	19	11	176
Honduras	0.9967	0.9982	1	3	1	2
			61	27	105	176
Jamaica	0.9884	0.9977	5	3	7	6
			19	18	22	45

Table 3
Markov Switching Model - Estimation results summary
Dependent variable: exchange rate misalignment

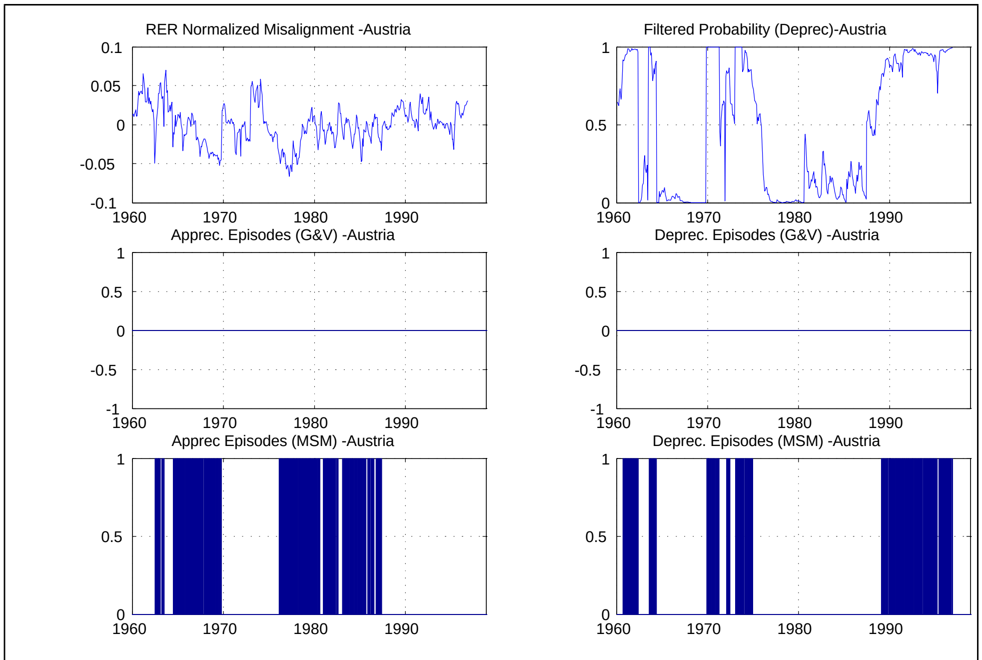
Countries	Transition Probabilities		Goldfajn e Valdes (1999) Methodology		Markov Switching Model	
			Number/Average Duration		Number/Average Duration	
	p11	p22	Depreciations	Appreciations	Depreciations	Appreciations
Mexico	0.8001	0.9934	5	3	5	7
			23	20	12	55
Paraguay	0.8748	0.9842	6	6	5	9
			15	17	3	43
Peru	0.7757	0.9902	9	7	3	5
			12	13	14	66
Trinidad Tobago	0.9792	0.9881	2	3	2	1
			58	15	129	113
United States	0.8535	0.9768	3	2	5	11
			14	29	5	33
Uruguay	0.9516	0.9790	11	5	5	5
			12	22	38	36
Venezuela	0.9445	0.9840	5	4	4	1
			8	7	38	123
Australia	0.7511	0.9783	1	-	8	8
			23		4	46
Indonesia	0.9782	0.9767	1	3	1	-
			113	42	205	
New Zealand	0.9841	0.9803	1	2	3	5
			11	22	65	30
Papua New Guinea	0.9399	0.9571	1	-	5	7
			9		24	16
Bahrain	0.9336	0.9953	1	-	-	1
			17			197
Bangladesh	0.8721	0.9965	1	2	1	1
			10	11	267	22
Hong Kong	0.9916	0.9896	2	2	1	1
			31	39	192	115
India	0.9574	0.9897	1	-	1	1
			14		55	168
Israel	0.9333	0.9875	2	2	5	4
			19	10	19	60
Japan	0.9769	0.9332	4	2	9	6
			8	15	27	12
Jordan	0.9768	0.4559	-	-	9	2
					22	2
Korea	0.9808	0.9912	3	1	2	1
			19	11	193	18
Kuwait	0.9848	0.8906	-	-	4	2
					45	13
Malaysia	0.9810	0.9403	1	1	4	4
			14	5	87	14
Nepal	0.8369	0.9797	2	4	3	8
			9	8	9	25
Pakistan	0.8482	0.9480	-	-	3	15
					2	8
Philiphines	0.9533	0.9903	4	1	2	2
			19	32	106	108
Saudi Arabia	0.9874	0.8392	1	1	2	1
			19	21	105	13
Singapore	0.9923	0.9848	-	-	5	-
					16	
Sri Lanka	0.9972	0.9938	3	2	1	-
			64	80	241	
Thailand	0.9714	0.9725	2	-	4	8
			22		48	15
Turkey	0.9823	0.9837	3	5	4	-
			35	11	46	
Algeria	0.9655	0.9883	2	1	2	2
			17	7	44	96
Burkina Faso	0.0000	0.9975	5	3	1	1
			18	15	3	396

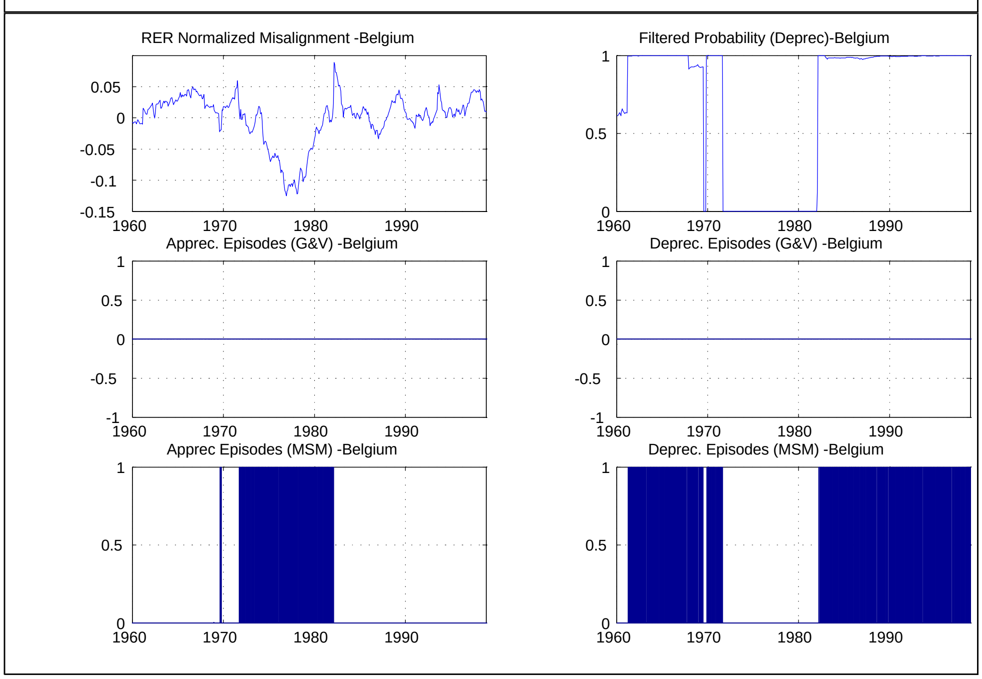
Table 3
Markov Switching Model - Estimation results summary
Dependent variable: exchange rate misalignment

Countries	Transition Probabilities		Goldfajn e Valdes (1999) Methodology		Markov Switching Model	
			Number/Average Duration		Number/Average Duration	
	p11	p22	Depreciations	Appreciations	Depreciations	Appreciations
Burundi	0.9600	0.9692	4	4	5	5
			5	16	30	20
Cameroon	0.0000	0.9973	1	1	1	1
			60	77	4	364
Central Africa	0.9684	0.9827	2	-	3	4
			13		40	53
Zaire	0.9856	0.9838	10	5	4	4
			20	18	55	38
Congo	0.0000	0.9975	2	1	1	1
			11	3	2	401
Egypt	0.9795	0.9896	5	2	1	-
			38	62	239	
Ethiopia	0.9956	0.9979	3	2	1	4
			28	40	74	22
Gabon	0.9795	0.9976	2	2	1	-
			12	27	5	
Ghana	0.9775	0.9870	9	7	2	3
			12	17	118	54
Kenya	0.9918	0.8012	3	3	3	1
			5	5	119	6
Liberia	0.9130	0.9616	-	-	3	6
					3	14
Madagascar	0.9795	0.9950	3	4	1	-
			34	37	137	
Malawi	0.9931	0.9963	4	4	1	5
			8	8	50	26
Morocco	0.9843	0.9946	1	1	1	6
			94	10	141	50
Niger	0.8680	0.9973	4	2	1	-
			25	58	59	
Nigeria	0.9859	0.9958	2	4	2	2
			76	36	48	176
Senegal	0.9949	0.9978	2	1	1	-
			19	27	59	
Sierra Leone	0.9823	0.9448	4	3	1	1
			10	14	96	21
South Africa	0.7835	0.9913	4	1	4	4
			6	14	4	109
Sudan	0.7784	0.9658	4	3	4	2
			7	5	10	18
Togo	0.9947	0.9976	1	4	1	2
			60	15	59	103
Tunisia	0.9717	0.9894	-	-	1	2
					21	43
Zimbabwe	0.6868	0.9835	3	2	4	3
			8	12	2	78
Rwanda	0.7972	0.9964	5	5	1	1
			14	20	4	268
Ivory Coast	0.9953	0.9982	4	2	1	2
			16	10	59	191

Average episode duration below number of episodes

6 Appendix II





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