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**Working Paper**  
**Classifying exchange rate regimes**

Claremont Colleges Working Papers, No. 2002-22

**Provided in Cooperation with:**  
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*Suggested Citation:* Nitithanprapas, Isriya; Willett, Thomas D. (2002) : Classifying exchange rate regimes, Claremont Colleges Working Papers, No. 2002-22, Claremont McKenna College, Department of Economics, Claremont, CA

This Version is available at:

<https://hdl.handle.net/10419/31425>

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*Updated September 2002  
Preliminary Draft  
Comments Appreciated*

*For Presentation at the Annual Meetings of the Western Economic Association  
Seattle, July 2002*

## **Classifying Exchange Rate Regimes**

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## **1. Introduction**

This draft is a very preliminary and partial exposition of the state of our work on an approach to the behavioral classification of exchange rate regimes. Its purpose is to share our initial ideas with other researchers in this area and to get feedback. The best ways of classifying regimes are likely to vary, depending upon the purpose. Our primary purpose in developing this approach is the study of the relationships between exchange rate regimes and currency crises as a part of a larger study directed by David Leblang and the latter author on the political economy of exchange rate regimes.

In recent years, there has been great interest in developing classifications of exchange rate regimes that go beyond the official designations of regimes reported by national governments to the IMF. The recent research in this area has been devoted to behavioral classifications based explicitly or implicitly on the idea of considering to what degree governments respond to exchange market pressure with official intervention versus allowing the exchange rate to adjust. Our approach is similar in spirit but we argue that the previous efforts have not given sufficient attention to the microanalytic foundations of the measures and that this has led to problems.

We particularly highlight three types of problems. One is the inappropriateness of using standard deviations or variances when there are trends in the data such as would occur under crawling pegs or discrete breaks such as occur with adjustable pegs.<sup>1</sup> In such circumstances we need more than one parameter to describe regimes. The second is that the concept of the propensity to intervene in the face of exchange market pressure is clearly defined only in the case of intervention that leans against the wind (with fixed

rates being complete leaning). Quite a number of observations of reserve and exchange rate changes have the wrong signs, however. Variance ratios, for example, pay no attention to this problem. Ways of dealing with wrong sign observations are discussed but these does not appear to be any one best method.

The third issue is the extent to which exchange rate policy is mutually determined with monetary policy. Just as a preannounced crawling peg or band may differ substantially from one based on ex post adjustments (in a study on exchange rate based stabilization, Martin, Westbrook, and Willett (1999) find that the former is more prone to crises than the latter), so also would it make considerable difference whether intervention is systematically tied to domestic monetary policy. While not yet incorporated into our empirical work we believe that for the study of currency crises the degree to which exchange rate market intervention is sterilized or not should be quite important (See Willett (2002)).

There is a fairly large literature on the classification of exchange rate regimes for other proposes (See table 1 for the summary of empirical studies on exchange rate classifications). Initially, considerable use was made by researchers of the official IMF classifications of exchange rate regimes, but the IMF's original coding was soon recognized to be subject to serious problems of two kinds. First, these classifications did not distinguish among all of the major different categories of exchange rate regimes that are relevant for research.

A second problem was that the IMF's coding was based on national government statements of their exchange rate policies and these official descriptions often different greatly from the actual policies that governments pursued. For example, a number of

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<sup>1</sup> This problem is also addressed in Calvo and Reinhart (2002) on footnote 5 (p.384)

countries that officially classified themselves as having floating rates in fact managed their exchange rates in ways identical to narrow band pegs.<sup>2</sup>

Increasing recognition of this measurement problem has led to two types of responses. One alternative to the original IMF coding is a new set of more detailed classifications published in 1999 by the IMF. These are far superior to the old IMF system, both in the delineation of categories of regimes in a more analytically useful manner and in categorization based on the best judgments of the IMF's country experts.

See table 1 for the categories<sup>3</sup>

The other alternative, developed primarily by academic researchers, has been to develop behavioral measures of exchange rate regimes based on the actual behavior of exchange rates and/or official intervention (typically proxied by changes in international reserves). A prominent example of this approach is the work of Calvo and Reinhart (2002) who consider the variability of nominal exchange rates, international reserves, and interest rates in order to evaluate whether or not official classifications are useful in practice. They find evidence that the variability of reserves and interest rates is high relative to the fluctuations in the exchange rate. Their conclusion that in many cases

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<sup>2</sup>The Philippines during 1996 is one of these examples. In practice the Philippines' bilateral exchange rate between Philippine Peso and Dollar moved within a narrow range from Peso 26.17 to Peso 26.29 during 1996.

<sup>3</sup> Unfortunately in the only version of the new IMF classifications to be published so far (as reported in World Economic Outlook 1997 section IV Developments in Exchange Rate Arrangements and Markets and in IMF Annual Report 1999), a few of the categorizations are open to question. For example, Brazil (as of Dec 31,1997 ) was classified under "Pegged exchange rates within horizontal bands" category (Real\$0.97-Real\$1.06/US\$). However, in practice its regime seemed more like a crawling peg. The nominal rate was devalued at a rate of roughly 0.6 percent per month from the end of 1996 and the end of 1998. China (as of Dec 31, 1997) was classified under "Pegged exchange rates within horizontal bands" (+-0.3%) category. However, in practice, it seems like it could also be classified under "convention fixed peg arrangement (including de facto peg arrangements)" category. The distinction between these two categories does not seem clear. Another example is Pakistan (as of April 1999) was classified under "managed float" category. However, in practice its regimes seems similar to a peg to the dollar since the exchange rate was constant during the first four month of 1999 and subsequently devalued in a large step. After that the rate moved within a narrow range from (Rupees 51.69-51.78/US\$).

central banks are trying to stabilize the exchange rate is undoubtedly correct, but in classifying currency regimes the behavior of nominal exchange rates and foreign reserves should be related to the concept of exchange market pressure.<sup>4</sup> Where exchange market pressure is high, both exchange rate and reserves may show considerable volatility. In contrast, where pressure is low, both may show little variability. As we illustrate below, while the reduced variability of the Korean Won in the recent period has been widely interpreted as reflecting substantially increased management of the exchange rate, our analysis casts some doubts on this assumption.

Our analysis and comparisons with the classifications of others suggests that in many cases it is difficult to judge the correctness of particular classifications. There are frequently substantial gray areas. This turns out to be particularly important for interpretations of the role of exchange rate regimes in the Asian crisis. Many of the crisis countries were practicing neither the classic narrow band adjustable peg of Bretton Woods (Thailand is an exception) nor highly flexible rates, nor announced crawling bands. Countries such as Indonesia and Korea officially stated their regimes as managed floats but in practice followed forms of unannounced crawling bands. Depending on whether one classifies these as more pegged or more flexible, one can find that pegged rates did or did not significantly contribute to the Asian crisis (see Nitithanprapas, Rongala and Willett (2002). Because of the limited degrees of freedom and ambiguities of classifications, we believe that the only strong conclusion one can draw from the Asian crisis about the relation of exchange rate regimes to currency crises is that moving from

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<sup>4</sup> Later in their paper Calvo and Reinhart present a model in which policy credibility is reflected in second rather than first moments. They use this to derive an index of exchange rate flexibility based on the ratio of the variance of the exchange rate to the sum of the variances of interest rates and reserves.

the dead center of narrow band adjustable pegs to de facto crawling bands was insufficient to protect countries from currency crises in that instance.

A more appropriate measure of the flexibility of the exchange rate regimes is the ratio of currency market pressure taken on changes in reserves versus changes in the exchange rate; what we call the propensity to intervene.<sup>5</sup> A number of studies have made use of this basic idea to construct behavioral indices of the degree of exchange rate flexibility using relative volatility ratios (See table 1 for the summary of these studies).<sup>6</sup> These studies vary in a number of (likely minor) technical details such as the use of average absolute changes versus standard deviation and variances, the normalization for reserve changes, and the exchange rate measures used. Probably more importantly, however, almost all of the measures used share two major problems – they fail to deal with the problem of trends<sup>7</sup> and they do not relate their statistical measures directly to the concept of exchange market pressure (Waymark [1997] is an important exception).<sup>8</sup>

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<sup>5</sup> Changes in reserves are an imperfect proxy for official intervention in the foreign exchange market, but they are the only one available for a substantial number of countries. See Calvo and Reinhart (2002) p.388 and Ghosh et al (2002) for discussions of this problem. There is also the issue of what exchange rate to use. While some applications have used average exchange rates, most have focused on bilateral exchange rates against the dollar or another international currency such as the French franc for a number of African countries or the German mark (now the Euro) for many Central and Eastern European countries. Our initial focus will follow this latter approach, but we plan to supplement this with the use of composite exchange rate indices such as the IMF's measure of effective exchange rates where they are available. We will also do a much more detailed analysis for several sample countries where more than one international currency may be relevant such as the dollar and the DM for countries such as the Czech Republic, Poland, and Turkey, and the dollar and yen for some Asian countries.

<sup>6</sup> See Al-Marhubi (1994), Bayoumi and Eichengreen (1998), Glick, Kretzmer, and Wihlborg (1995); Haussman et al (2001), Hernandez and Montiel (2001), Holden et al (1979), Levy-Yeyati and Sturzenegger (2000a)(2000b), Domac and Peria (2000), and Porison (2001)

<sup>7</sup> The exception here is Glick et al (1995) which looks at unanticipated variations in reserve and exchange rates. Their statistical measures for distinguishing between anticipated versus unanticipated change roughly corresponds to detrending the data. Their purpose in this paper was to look at the informativeness of alternative exchange rate regimes.

<sup>8</sup> Another important approach is the enormous project by Reinhart and Rogoff (2002). This gives a detailed history of changes in exchange rate regimes for a large set of countries for most of the post war period. In addition to the careful intrayear dating of shifts in regimes, this study makes an important conceptual

## **II. The Problem of Trends**

It is well known that in the presence of trends the standard deviation/average absolute changes can give a very misleading picture of variability. For example, when the rate of crawl is accelerated or decelerated over time, the standard deviation of detrended change in exchange rates will not equal to the standard deviation of change in exchange rates. For example, Argentina had a de facto decelerated crawling peg during 1979- 1980. While the standard deviation of change in exchange rate is 1.3, the standard deviation of detrended change in exchange rate is 0.6. The average absolute changes also give a wrong picture of variability in the presence of time trend. For example, in a case of perfect steady depreciation, the average absolute detrended change in exchange rate will be lower than the absolute change in exchange rates. Brazil had almost a perfect steady depreciation during 1995-1998. Without trend, the average absolute change is 0.6. The detrended average absolute change is reduced to 0.09. For many countries, there are substantial trends in exchange rates and/or reserves. In such instances standard variance ratios can be highly misleading and we need multiple parameters to characterize exchange rate regimes – the trend parameters and the coefficient of the propensity to intervene with respect to deviations from trend.

## **III. Propensity to Intervene as the Ratio of Exchange Market Pressure Taken on Reserves**

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contribution by distinguishing between unified regimes of various forms of pegs or managed floats and those cases where controls have led to major parallel or black markets. They also distinguish between floating rates and the free falling rates that occur under inflation. In combination these innovations offer very different views of changes in the prevalence of different exchange rate regimes over time and of the relationship between exchange rate regimes and growth and inflation.

The concept of exchange market pressure assumes that intervention is used to limit exchange rate fluctuations. The propensity to intervene is the degree to which authorities allow pressures in the currency market to move the exchange rate versus intervening to damping its movement. Thus if there is downward pressure on a currency, the authorities under a fixed rate, would buy domestic currency in the foreign exchange market, i.e. sell international reserves, in order to keep the value of the currency constant (i.e. propensity to intervene of one) or under a completely free float let the currency depreciate with no intervention (propensity of zero). Some combination of the two implies a coefficient between zero and one. The same holds in reverse for upward pressures on a currency, i.e. the authority would do nothing or sell domestic currency thereby gaining international reserves.

With a managed float or some form of movable peg, the authorities could choose a mix of response by intervening to take some but not all of the pressure off of the exchange rate by channeling it onto changes in reserves. Such leaning against the wind could be light or heavy and steady or sporadic. By looking at the ratio of changes in exchange rate to changes in reserves, we have a continuous variable index of the propensity to intervene in the foreign exchange market that varies between zero and one.<sup>9</sup>

There is no analytically clear guideline for drawing the boundaries between heavy or high and light or low propensities to intervene. Initially we plan to experiment with a three-way classification of heavy, light, and intermediate, with the dividing line being drawn in part by how the estimated coefficients correlate with cases where there is wide

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<sup>9</sup> Our index of the propensity to intervene is one minus the degree of exchange rate flexibility. The degree of exchange rate flexibility is the absolute percentage change in exchange rate divided by the absolute percentage change in reserves plus the absolute percentage change in the exchange rate. This index is

spread expert agreement that heavy or light management is being practiced. One issue we will investigate is the degree to which the distinction in the new IMF classification between managed and independent floats corresponds to heavy versus lightly managed floats.

In interpreting the economic meaning of the intervention coefficient, one faces the same problem as for the relative weights of the variables in the construction of the indices of currency crises (discussed in section four below).<sup>10</sup> In each case, what one would like to have is the slope of the excess demand curve for foreign exchange.<sup>11</sup> Since reliable estimates for the slope and shift coefficients do not exist for a broad sample of countries and in addition are likely time varying in important ways, we cannot interpret a coefficient of 0.5 on the propensity to intervene as being the true mid point on the scale. This would be true only if the elasticity of the excess demand schedule is such that a one percent change in the exchange rate would have the same effect as a one percent changes in reserves as occurs in the strong form of monetary models.<sup>12</sup> The comparison of

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similar to Popper and Lowell (1994)'s methodology except that their index has a range of negative infinity to positive infinity and they do not consider time trends in calculating the index.

<sup>10</sup> Of course, using indices constructed from the same variables on both the right and left hand sides of our regressions raises econometric concerns, although our preliminary analysis suggests that this may not be a major problem. In the crisis index, the variables are added together while in the regime index their ratio is taken. We do need to investigate, however, to what extent, if any, the ratio of the variables is a function of the size of the pressure index. We have reason to believe that at least in some instances this will be the case. Consider, for example, the case of a wide band. With the exchange rate is in the center of the band, we would expect the propensity to intervene be low while close to one of the edges of the band we would expect the propensity to intervene to be high. We plan to test for such relationships in a subset of our sample.

<sup>11</sup> See Eichengreen et al (1994), Waymark (1997), and Nitithanprapas (2000). For interest rates the relevant measure is the size of the shift in the excess demand curve for a unit changes in the interest rate.

<sup>12</sup> In a strict monetary model such as Girton and Roper (1977) used to introduce the concept of exchange market pressure, the mid point of the degree of flexibility would be 0.5 because under the assumptions of that model sterilized intervention would have no effect. (Sterilized intervention occurs where the domestic monetary effects of the intervention are offset by government actions). With unsterilized intervention there will be an equivalent effect on the domestic money supply and prices in the strict monetary model. Despite some initial support the weight of subsequent empirical research has shown that the pure monetary model is much too restrictive. (See for example, Isard (1995). Thus we propose to use a model free specification and test for the sensitivity to different parameter values

coefficients across countries makes the weaker but still heroic assumption that while the excess demand elasticity is unknown, it is the same across countries and time.

An advantage of this approach is that we can obtain a ratio of changes in exchange rate to changes in reserves each month, allowing us to investigate changes in regimes on an intra year basis. Most other methods have been used only to provide classifications for annual or longer periods. Of course there may be a great deal of variability and/or noise in the monthly ratios. Typically we would look at an average over longer time periods (along with its variance) but plots of the ratios should be quite helpful in classifying shifts in regimes and may be especially useful for investigating mild changes in regimes such as changes in the slopes of crawling peg regimes.

A problem of using the variance ratio measure is that it will misclassify adjustable peg exchange rate regimes when there is a substantial change in parity. When exchange rates are pegged and then largely devalued during the period of consideration, the measured variances of the exchange rate changes will be high even if there is a narrow band around each parity. In such circumstances, variance measures will yield high value on the degree of exchange rate flexibility index. This is similar to the problems of standard deviation and variance measures in the face of trends. Clearly we cannot always accurately classify degrees of exchange rate flexibility with just one parameter.

For the characterization of parity regimes with trends in the exchange rate, it is necessary to use at least two parameters to capture both in the rate of crawl and the width of the band around parity. Levy-Yeyati and Strurzengegger, LYS (2000) show awareness of this problem. They divide the exchange rate regimes into 5 groups: inconclusive, flexible, dirty float, crawling peg, and fixed according to the behavior of average

percentage changes in the nominal exchange rate, the volatility of exchange rate changes, and the volatility of foreign reserve changes. Under purely fixed exchange rate regimes, there will be low average percentage changes in the exchange rate, low volatility of exchange rate changes, and high volatility of reserve changes. On the other extreme, under purely flexible regimes, there will be high average percentage changes in the exchange rate, high exchange rate volatility, and low reserve volatility. Under crawling peg regimes, there will be significant changes in reserves and exchange rates. However, the incremental changes in exchange rates are steady. Under dirty float regimes, there will be high incremental changes in exchange rates corresponding with high volatility of changes in exchange rates and reserves. For countries that have low volatilities in those three variables, their exchange rate classification cannot be decided.

In addition to the problem of time trend considerations discussed earlier, a disadvantage of LYS classification is that the wide band crawling peg cannot be distinguished from dirty float regimes. In addition, their classification does not address the problem that rate of crawls may change over time.

Even though LYS provide a classification used for empirical work on exchange rate regimes, the limitation of its classification as well as IMF classification for the study of currency crises is that the coding of the year before the regimes changes has to be used instead. The reason is that they classify the regimes for countries during a calendar year. In a year that the regimes or the parity changes, the yearly number will reflect a combination of both regimes. In addition, they do not exclude the instability period, the initial period where the regime changes. (This of course is just a problem with using

LYS's classifications for purposes such as studying the effects of exchange rate regimes on the Asian crisis. The LYS methodology can not be applied to any time period).

Taking the timing of shifts in regimes to consideration, Reinhart and Rogoff (2002) provide a very useful reference on 153 individual country exchange rate classifications including historical chronologies from 1946-2001. They classify the exchange rate arrangements into 14 categories based on descriptive statistics and chronologies. These categories are no separate legal tender, preannounced peg or currency board arrangement, preannounced horizontal band that is narrower than or equal to +/-2%, de facto peg, pre announced crawling peg, preannounced crawling band that is narrower than or equal to +/-2%, de facto crawling peg, de facto crawling band that is narrower than or equal to +/-2%, preannounced crawling band that is wider than or equal to +/-2%, de facto crawling band that is narrower than or equal to +/-5%, moving band that is narrower than or equal to +/-2% ( i.e., allows for both appreciation and depreciation over time), managed floating, freely floating, and freely falling.<sup>13</sup>

They use country histories to separate whether or not countries have dual or multiple rates or parallel markets. If they do, they are classified exchange rate regimes using market-determined exchange rate data (from Pick's currency yearbook, Pick's Black MK year books, and Pick's World Currency Report). When the exchange rate is unified, the IMF's monthly data is used to classify the exchange rate regime.<sup>14</sup> Then they

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<sup>13</sup> They differentiate between pre-announced peg/crawling peg/ crawling band from de facto since the announcement can act as a channel that generates speculative attacks. However, this issue is open to question depending on the purpose.

<sup>14</sup> As Carmen and Rogoff (2002) noted on p. 18, the reason is that the official exchange rate data (from IMF) often give a wrong picture of the underlying monetary policy and the ability of the economy to adjust imbalance. For example, if monetary policy is more lax than is consistent with maintaining the official exchange rate unchanged, one would expect the market-determined rate to start depreciating ahead of the official realignment. When the official realignment occurs, it is simply a validation of what had previously transpired in the free market.

use the statistical measures of volatility to classify the regimes. If the absolute monthly percent change in the exchange rate is equal to zero for 4 consecutive months or more, that episode is classified as a de facto peg if the exchange rate is unified. To distinguish among pegs and bands, they calculate the probability that the monthly absolute percent exchange rate change remains within a one percent band over a rolling period. If the probability is 80% or higher, then it is classified as a peg regime. If the exchange rate has no drift, it is classified as a fixed parity; if there is a drift, it is labeled as a crawling peg; and if the exchange rate goes through period of both appreciation and depreciation, it is termed a moving peg.

They also distinguish between exchange rate arrangement that has high exchange rate volatility under low inflation floating regimes and other regimes that have high volatility due to high inflation. If inflation is above 40%, they classify it under a “freely falling” category (with the exceptional cases when the market rate follows a confirmed preannounced regime: since a country that has inflation above 40% often adopted a crawling peg as a nominal anchor). They also classify an exchange rate as “free falling” for the cases where a crisis generates a sudden transition from a fixed regime to managed or independent float regime accompanied by a large depreciation.

For countries that are not classified as peg/band and that are not included in the free falling category, Reinhart and Rogoff proxy the composite degree of exchange rate flexibility to distinguish between managed float and free float.<sup>15</sup> However, this degree is

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<sup>15</sup> The degree is  $e / \Pr(e < 1\%)$  where the numerator is the mean absolute monthly percent change in the exchange rate over a rolling five-year period and the denominator is the probability of small changes. As we discussed earlier, they also note the problem of using variance measures that overstate the degree of exchange rate flexibility over the long periods when there are large devaluations.

based on the actual behavioral of exchange rate not the propensity to intervene in foreign exchange markets.

Similar to Reinhard and Rogoff's methodology of distinguishing among narrow peg, horizontal band, crawling peg, and crawling band, we must use at least two parameters to capture both in the rate of crawl and the width of the band around parity that are easily interpreted in terms of the institutional characteristics of exchange rate regimes. The coefficient of the country-specific time trend on the log of the bilateral exchange rate is a proxy for the rate of crawl. The minimum and the maximum of the disturbance in the time trend regression is a proxy for a bandwidth.<sup>16</sup> The traditional narrow band peg of the Bretton Woods system would have a zero rate of crawl and a narrow band width. A horizontal band would also have a zero rate of crawl but a substantial width. A narrow band crawling peg could have a substantial rate of crawl but a low value for band width, while a crawling band would have substantial parameters for both. It is clear that the first (narrow band) and fourth (crawling band) of these categories are more fixed and more flexible respectively than the middle two, but the appropriate ranking of the middle two on institutional grounds is ambiguous<sup>17</sup>. Here behavioral classifications are needed.

#### **IV. The Problem of Observations that are Undefined in the Exchange Market Pressure (EMP) Concept.**

In the EMP framework where government policies lean with rather than against the wind the concept of the propensity to intervene is not well defined, i.e. where reserve

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<sup>16</sup> To allow for soft bands we could substitute the edge highest and lowest disturbances in order to discount outliers.

declines occur during a period of currency appreciation or reserve increases during a period of depreciation. A preliminary look at the data for several countries shows that these combinations occur fairly frequently. When the series are detrended, the frequency of these wrong sign months tends to decline, but remains fairly common. One of the most striking examples is Uruguay during 1990-2001. During this period, there is a clear trend in both exchange rate and reserves. When those series are detrended, the number of wrong sign decreases (from 76 observations to 53, out of a total of 133).

It is not easy to decide how these wrong sign observations should be treated. Wrong signs can be caused by imperfections in the reserve change proxy as well as by episodes of leaning with the wind or of extreme form of leaning against the wind. Actual leaning with the wind in a downward direction is classic beggar thy neighbor policy and is discouraged by the IMF's guidelines except for cases where a currency is judged to be seriously overvalued. Leaning with the wind in the upward direction may be justified during periods in which country's currencies are considered to have overdepreciated and previous reserve losses need to be recouped. The aftermath of the Asian crisis is a prominent example of this phenomenon. See Willett (2000).

Where imperfect proxies are the cause of the wrong sign, the best solution would likely be to drop these observations. With true leaning with the wind, one could argue either that this is a case of government management or that it should be considered as super flexibility. Which interpretation is better may depend on the use to be made of the classification.

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<sup>17</sup> Of course there is a problem of changes in both stated and behavioral regimes over time. Both trends and propensities to intervene around trends can change. We will pay considerable attention to attempting to identify such shifts in our analysis.

Wrong signs could also result from an extreme form of leaning against the wind, i.e., instead of allowing domestic currency to depreciate in the face of excess supply in the foreign exchange market, the government could actively appreciate the exchange rate. Likewise despite an excess demand in foreign exchange market, a mercantilist government could force down the exchange rate. It would seem that these should be treated as cases of government management or of super fixity. Thus depending on the cause of the wrong sign, it can be argued that a value of zero or one should be assigned or that the observation should be deleted.

In general, we will not be able to distinguish between wrong sign observations due to imperfect proxies and those due to leaning with the wind or extreme forms of leaning against the wind. Thus at least initially we propose to delete the observations. It will likely prove useful to undertake some careful case studies for episodes where there are a number of wrong signs to see if some clues about the reasons can be discovered.

Another approach has been suggested by Waymark (1997). This involves using a full range of estimates from plus to minus infinity rather than the zero to one bounds that we discussed. We see difficulties with Waymark's approach, however. Waymark (1997) relates the degree of exchange market intervention to the concept of exchange market pressure. She defines the degree of intervention as the proportion of exchange market pressure absorbed by exchange market intervention. Waymark's index has a range from  $-\infty$  to  $+\infty$ . When the sign of changes in exchange rate and reserves is correct (Exchange rates depreciate and reserves decline), Waymark's index has a range from 0 to 1, with values closer to 1 indicating higher degree of fixity. When the exchange rate changes are the same sign but have a greater absolute magnitude than the changes that would have

occurred in the case of no intervention, Waymark's index is negative. When the exchange rate appreciates (depreciates) with excess supply (demand) of domestic currency, Waymark's index is greater than one.

According to Waymark's index, the interpretation of the degree of intervention in cases of wrong sign observations is questionable. For example, consider two cases of domestic currency appreciation given the same excess demand on domestic currency and elasticity. For simplicity, assuming the elasticity of excess demand in the foreign exchange market equals  $-1$ . In Case A the domestic currency appreciates  $0.5\%$  and reserves decline by  $2.5\%$ . In Case B the domestic currency appreciates  $5\%$  and reserves decline  $7\%$ . With the same speculative pressure equaling to  $2$ , Case A and case B will have a measured degree of intervention of  $1.25$  and  $3.5$  respectively. From Waymark's definition, the higher the index, the higher is the degree of intervention. Therefore, case B is interpreted as having a greater degree of intervention than case A. However, if one considers the ratio of speculative pressure taken on reserves versus on the exchange rates, Case B has a lower degree of intervention than case A. From this perspective, the absolute value greater than one of Waymark's index should be interpreted as less intervention as the absolute values are closer to  $1$ .

Waymark estimates the bilateral intervention statistics to characterize exchange rate regimes for Canada over the period 1975-1990. The intervention statistics are the mean value of the degree over the entire sample periods. As stated in the previous paragraph, the value of the degree has a range from  $-\infty$  to  $+\infty$ . Since the mean value is calculated over sample periods, the overall high mean value can not be interpreted as a high degree of fixity in cases which the value of at least one sample period falls outside

the range of zero and one. Therefore, it is rather difficult to determine the true level of the degree of intervention.

Waymark estimates the mean value of Canada's degree of intervention equaling to approximately 0.94. Using the average time path of exchange rates (described in terms of different equation) resulted from the mean value of intervention, she interpreted the value of 0.94 as Canada adopted a “managed float” regimes since the Bank of Canada tried to “limit the quarter by quarter changes in the external value of Canadian dollar, while at the same time allowing the Canadian dollar to drift slowly towards its underlying value” (p.73).

According to the convergence condition for the solution of difference equation, Waymark's intervention statistics can be interpreted as when the absolute value of mean value of intervention is less than 1, the exchange rate policy is described as managed float since this range of value will allow for convergence to free-float equilibrium. However, it does not say anything about how heavily the float is managed.

## **V. Two-Way Classifications Are Not Fine Enough**

One key issue is how many exchange rate categories to use. Economists often talk of pegged versus flexible exchange rates. For some purpose this may be useful, but it is not for consideration of the relationships between exchange rate regimes and currency crisis. There clearly is a need to distinguish between fixed rates and hard pegs such as currency boards (even though there have not proven to be immune to speculative crises as Hong Kong and Argentina illustrate) and adjustable pegs such as the Bretton Woods regime. One of the key issues concerning intermediate regimes in the extent to which crawling band can avoid crises. With a two way classification it is unclear

whether they should more appropriately be leveled as flexible or pegged. An example of this problem is given in the recent paper by Grier and Grier (2001) on the Asian crisis.

They classify countries in samples as either peggers or floaters according to their exchange rate movements in the first two months of 1997.<sup>18</sup> For example, they classify Hungary and Venezuela as adopting floating regimes. These countries, however, were following forward-looking crawling band systems. Therefore, the use of only a two-way classification leads them to lump together some crawling band and floating regimes.

They also lump together some crawling peg and narrow peg regimes. For example, they classify the crawling peg/band regimes in Brazil, Chile, and Korea as peg regimes.

Following their approach to classification but using a different model of the fundamentals, a different indicator of crisis, and a somewhat different set of countries, we confirm their finding that pegged exchange rates contributed significantly to the Asian crisis. However, when we use what we consider to be roughly equally plausible classification scheme that puts the Asian crawling bands into the flexible category, we find that the sign on flexible rates turns from negative to positive (although it losses its significance). See Nitithanprapas, Rongala and Willett (2002).

Of course it is easy to criticize classifications as being too aggregative, but there is also the danger of making some many distinctions that they lose their analytical usefulness and/or end up yielding two few observations to reach solid generalizations.

In general we find the new IMF classifications to be extremely useful for analytical purposes. A likely exception, however, is the distinction between independent floating and managed floating. The difference in these two categories described in the

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<sup>18</sup> A country is a pegger if its exchange rate was flat, or moved in a predetermined pattern. If it moved in a non-predetermined pattern, a country is a floater.

IMF Annual Report is that under the “independent float” category, the exchange rate is market determined with any foreign exchange intervention aimed at moderating the rate of change and preventing undue fluctuations in the exchange rate, rather than at establishing a level for it. Under “managed float” category, the monetary authority influences the movements of the exchange rate through active intervention in the foreign exchange market without specifying, or precommitting to a preannounced path of exchange rate.<sup>19</sup> It is not clear to us that this is a useful distinction for analytical purposes. More fruitful we suspect would be to attempt to distinguish between lightly and heavily managed floats and to consider the degree to which intervention influences domestic monetary policy.

In his widely read paper on the unstable middle, Stanley Fischer (2001) uses a three way breakdown of regimes into hard fixes, flexible, and intermediate. As a first cut to warn of the dangers of narrow band adjustable pegs, this was a very sensible strategy. For our more ambitious purposes of investigating the breath of the unstable middle, we must make more distinctions about categories of middle regimes, however. Once one moves beyond narrow band pegs, there are no completely unambiguous dividing lines for making analytically relevant distinction and even in this case the choice of how wide a narrow band can be is open to debate.<sup>20</sup>

## VI Our Initial Strategy

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<sup>19</sup> See also Bofinger and Wollmershauser (2001) for discussion of a methodology to distinguish among “pure float”, “managed float”, and “independent float” categories. They construct the index of floating as the ratio of the sum of effective changes in reserves to the sum of absolute changes in reserves. When the value is close to plus or minus one, it can be considered as managed floating. They interpret such value as a central bank has tried to influence the trend of exchange rate. However this can be a misleading interpretation since they do not consider the behavior of the exchange rate.

<sup>20</sup> We are prepared to argue strongly that a five percent total band should be labeled narrow and the thirty percent total band width of the post crisis European Monetary System should not be. This leaves a wide

Our basic strategy for classifying intermediate regimes is to start with several fairly broad categories and then try to develop finer distinctions within these as the data allows. For our initial categories, we plan to use:

- 1) Hard Fixed
- 2) Narrow Band Sticky Pegs (the Dead Center)
- 3) Crawling pegs/bands<sup>21</sup>
- 4) Heavily managed float
- 5) Lightly managed float

Freely flexible exchange rates are, of course, the limiting case of lightly managed. We know of no case where a country has abstained completely from any intervention for a prolonged period of time, although US management over some periods has been extremely light, often going more than a year with no intervention.

We should clarify that in this context we use management and intervention to refer only to official intervention in the foreign exchange market to prop up or push down a currency through the sale or purchase of foreign exchange. Countries often use other policy tools such as interest rate policy to influence developments in their currency markets.<sup>22</sup>

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range, however. We will start by making use of the IMF's classification of horizontal bands to make the distinction.

<sup>21</sup> We will further try to distinguish between forward-looking crawling pegs/band (decelerated rate of crawl) and backward-looking ones (accelerated rate of crawl).

<sup>22</sup> It was traditionally assumed that interest rate defenses would be stronger under pegged rates, but there is strong evidence from recent experience that efforts to use monetary policy to limit depreciation under flexible rates are common – See Calvo and Reinhart (2002). Nor does this necessarily imply fear of floating as opposed to a rational application of OCA analysis. It can be argued that countries which score at intermediate levels on the OCA criteria should adopt flexible rates, but give more weight to exchange rate developments in the formulation of monetary policy, the more open in the economy-See Willett (2001). For these reasons we will not use the behavior of interest rates in our initial classification of regimes, although we do plan to make use of interest rate data in the construction of some of our crises indices. Interest rate behavior may prove to be important in the linkage of exchange rate and monetary policy.

Following the spirit of the new IMF classification and Reinhart and Rogoff [2002], we will also distinguish between formally announced and de facto regimes under the assumption that typically de facto regimes will be more flexible. Under our category of heavily managed floats, we will in some cases be able to classify countries as following de facto crawling pegs or bands.

Under our crawling pegs/bands category we will also include indication of crawls that are constant speed or variable speed and whether there are discrete adjustments along with the crawls. For crawls that go in both directions over time, we adopt Reinhart and Rogoff's terminology of movable bands.

We also suspect that the stability of intermediate regimes will be related to the degree to which intervention to influence exchange rates is consistent with domestic macroeconomic policy See Willett (2002). One aspect of this is the extent to which exchange market intervention is sterilized. We hope to include work on this issue in a later stage of the project.

We will also use institutional criteria to check our classification of exchange rate regimes. For the purpose of studying the unstable middle hypothesis, however, it is crucial to distinguish between hard pegs (which are one corner solution) and narrow band pegs that can be adjusted (which represent the dead center of the middle from an analytic perspective). This is a delineation that cannot be made on behavioral criteria without lapsing into tautology, i.e., defining a hard pegs as one that survives in tact and a soft or adjustable peg as one where partly adjustments are forced. In this form, the unstable middle hypothesis would be tautologically true. We will thus use institutional criteria

such as the legal difficulty of changing parity (this is greatest for common currencies and strong forms of currency boards).<sup>23</sup>

## VII Some Preliminary Empirical Results from our Exchange Rate Classifications

Preliminary empirical results using our approach suggest that in some cases it yields substantially different results from other methodologies. An illustration is given in tables 2 and 3 which compare classifications from our approach with those of the IMF LYS, and Reinhart and Rogoff for a number of countries prior to the Mexican and Asian crises. (For the latter Grier and Grier's classifications are included as well). For example, Our initial judgment, LYS and Reinhart and Rogoff classify Malaysia during 1997 as employing a float regime, while Grier and Grier (2001) classify it as adopting a peg regime. In addition, LYS classify Korea during 1996 as adopting fixed regime, while we as well as Reinhart and Rogoff classify it as adopting crawling peg regimes. The classification of Korea before Mexican crisis is unclear. If we consider the period 92-95, Korea seems to adopt a narrow peg regime. However, if only period 94 is used, it seems to adopt a crawling peg regime. Classifications using different methodologies also yield different results for India. Grier and Grier (2001) and Carmen and Reinhart classify India during 1997 as adopting a peg regime, while LYS classify it as employing a floating regime.

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<sup>23</sup> There will of course be some gray areas in this type of classification. For example, Austria is widely believed to have adopted a hard peg to the German DM although this was due to the strength of public commitments to a hard peg rather than formal legislation. On the other hand while maintaining a fairly rigid peg for a number of years, the government of the Czech Republic did not commit to maintaining the peg. For a valuable analysis of the effects of different degrees of commitment to pegs see Cukierman et al (1995). On the Austrian peg see Hochreiter and Winckler (1995) and on the Czech peg see Hrncir (1999) and Burdekin, Nelson, and Willett (1999).

In tables 2 and 3, LYS refers to the classification by LYS. They divide the exchange rate regimes into 5 groups: inconclusive, flexible, dirty float, crawling peg (CP), and fixed. “Coeff trend” Column shows the coefficient of the country-specific time trend on the log of bilateral exchange rate (using our judgement). It is a proxy for the rate of crawl. If the error of this regression has the maximum or minimum less than 1 percent, we consider it as a peg regime. The maximum and minimum of the disturbance, the absolute percent change in exchange rate, the standard deviation of percent change in exchange rate, the standard deviation of percent change in reserves, and the degree of intervention is calculated over the period 1994m1-1994 m10 as reported on table 2 and over the period 1996m1-1997m5 as reported on table 3. The degree of intervention is calculated using both variance and average measures. The degree of intervention using the variance measure is  $1 - [\sigma^2 \Delta E / (\sigma^2 \Delta E + \sigma^2 \Delta R)]$ . The degree of intervention using the average measure is the mean value of  $1 - [\text{absolute } \Delta E / (\text{absolute } \Delta E + \text{absolute } \Delta R)]$  for the period of considerations. We also calculate the degree of intervention over correct sign observations. If there is a time trend in exchange rates and/or reserves, we use detrended changes in these variables instead of the changes themselves.

The degree of intervention falls within the range of zero and one. The intervention is heavily managed when the value is closer to one. As explained earlier, we can not interpret 0.5 as the mid-point.

In our measures the country’s bilateral nominal exchange rate against the dollar is used. The calculations will also be redone using effective exchange rates.<sup>24</sup> From the standpoint of studying the relationships between exchange rate regimes and currency

crises both may be relevant. (This is an issue which needs more attention). Of course for some countries the dollar should be replaced with other major currencies.

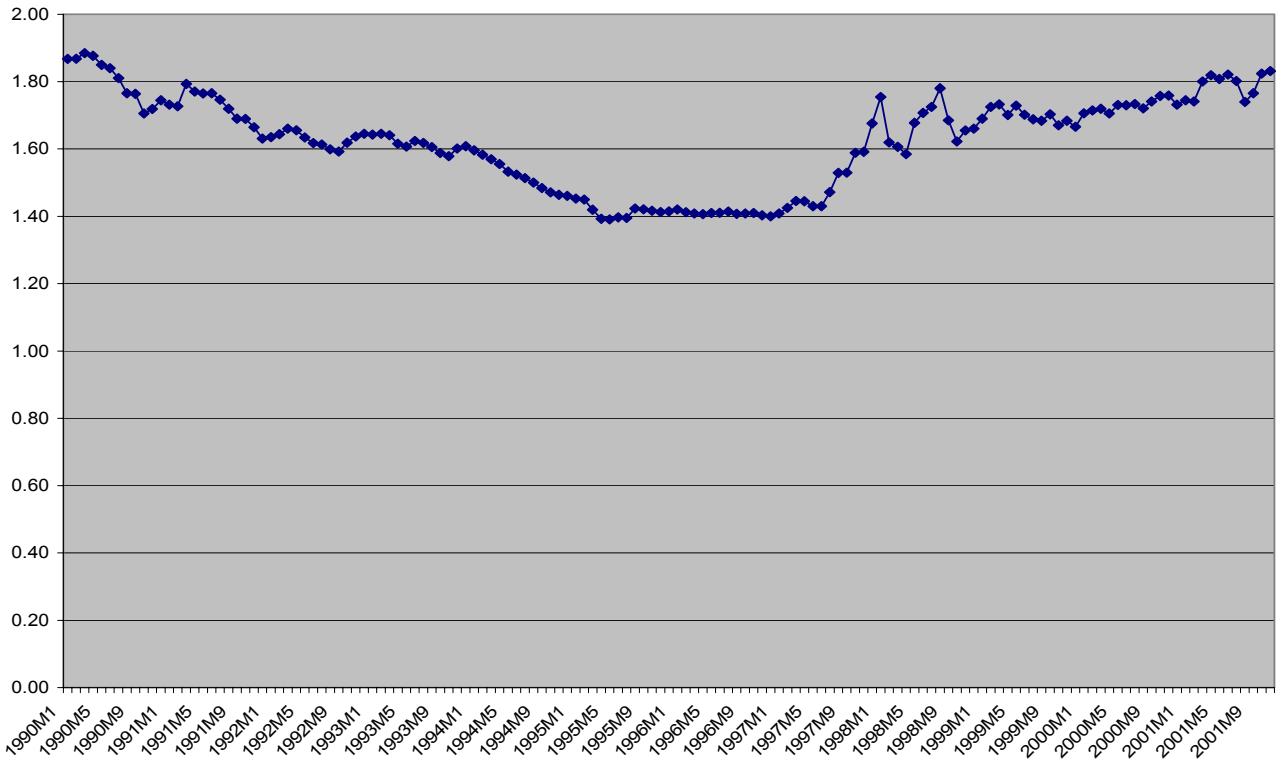
## VIII Regime Changes as Trend Changes

The use of our approach highlights issues of the time periods used for analysis and the problems of change in trends. Consider the case of Singapore. Looking at the behavior of the exchange rate over the whole 1990-1997 period, one would be likely to classify it as having a fairly flexible regime. However, we find only a small movement of exchange rate during 1996-1997 before the Asian crisis. From this perspective, Singapore seems to have abandoned a managed float before the crisis. It could be possible that during 1996, Singapore had few shocks so that nominal exchange rate did not have to move. Here, our intervention coefficient and the coefficient of time trend may help classifying exchange rate regimes. There is a change in trends in exchange rate during 1995 August. On average, Singapore had an intervention coefficient of 0.6 during 1996 with a downward trend of 0.001. In comparison the intervention coefficient during 1994, was 0.4 with a downward trend of 0.004. Hence, during 1996, Singapore appears to have adopted a less flexible regime as is shown in the following chart, after considerably greater flexibility immediately after the crisis, the degree of variability began to decline again. This issue of post crisis changes in flexibility will be discussed further in the next section.

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<sup>24</sup> Using nominal effective rate may yield different classifications from using bilateral exchange rate. For example, while Brazil can be classified as adopting crawling peg using bilateral exchange rate, it can be considered as employing horizontal bands using nominal effective rates during 1997.

## Singapore Exchange Rate



## IX Post-crisis Exchange Rate Policies in the Asian Crisis Countries

It is fairly clear that the immediate result of the Asian crisis was a switch to highly flexible exchange rates for most of the hardest hit countries. The fear of floating hypothesis predicts that this shift would only be temporary, however, and that over time many countries would begin to more heavily manage their exchange rate again. This has certainly been the case for Malaysia that formally adopted a new narrow band pegged regime in September 1998. There have also been numerous reports of more recent moves to greatly increased official management in Korea and Thailand.<sup>25</sup>

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<sup>25</sup> This perceived change for Thailand is widely believed to have resulted from the change in Governor of the Thai central bank which occurred in May 2001.

The major study so far of post crisis exchange rate policies in Asia is by Hernandez and Montiel (2001). Based on the data within twenty-four month after January 1999 to twenty four month thereafter, they conclude using their measure of the ratio of exchange rate volatility to reserve volatility that “For Korea and Thailand, the post crisis period was relatively tranquil one. These countries moved to substantially greater exchange rate flexibility in the post-crisis period than in the pre-crisis period, though they appear to manage their bilateral exchange rates against the U.S. Dollar to a significantly greater extent than have industrial-country “pure floaters”.

Over the eighteen months after 1999, Korea and Thailand’s exchange rates moved approximately 10 percent compared with the 20-30 percent range for Germany and Japan. Hernandez and Montiel calculate the degree of exchange rate flexibility, which has a range from zero to infinity, by comparing the volatility of exchange rate with the volatility of reserves using the data within twenty-four months after 1999. They find that Korea and Thailand had degrees of exchange rate flexibility of 1.44 and 1.26 respectively where as Japan and Germany had degrees of exchange rate flexibility of 0.85 and 1.98 respectively. We calculate the degree of exchange rate flexibility using the data within eighteen months after 1999. Our index, which has a range between zero and one, is the average value of the average value of the ratio of percentage change in exchange rates to sum of the percentage change in reserves, plus the percentage change in the exchange rate. We find that Korea and Thailand have degrees of exchange rate flexibility of 0.54 and 0.58 respectively where as Japan and Germany (Euro) have degrees of exchange rate flexibility of 0.58 and 0.44 respectively. Our measures of the degree of exchange rate flexibility indicate that Korea and Thailand had a similar degree of exchange rate

flexibility as Japan but a greater degree of exchange rate flexibility than Germany (EURO). On the other hand, Hernandez and Montiel found that Korea and Thailand had a greater degree of exchange rate flexibility than Japan, but less than Germany.

To investigate the hypothesis that Korea and Thailand have begun to manage their exchange rate much more heavily, we look at the behavior of exchange rates and reserves over the period September 2001 to March 2002 for Thailand and January 2001 to March 2002 for Korea. We find that during those periods exchange rates moved within a relatively narrow range compared with 1999-2000. Our measure of exchange rate flexibility shows that Thailand had exchange rate flexibility of 0.33 during 2001-2002. This is substantially less than the degree of 0.58 during 1999-2000. However Korea's degree of exchange rate flexibility of 0.62 during 2001-2002 was little different from the degree of 0.58 during 1999-2000.

For Indonesia and the Philippines, Hernandez and Montiel conclude that “the post-crisis period has proved to be more turbulent in foreign exchange markets than the pre-crisis one. These countries have responded by allowing the exchange rate to move, by intervening in foreign exchange markets, as well as by using domestic policies to defend the value of the exchange rate. However, the relative weight placed on exchange rate movements as endogenous responses to shocks increased greatly in the post-crisis period, implying that these countries, like Korea and Thailand, have also moved toward more flexible exchange rate regimes. However, like Korea and Thailand as well, they have targeted the exchange rate to an extent that appears to be substantially greater than practiced in the industrial country “pure floaters” (p.15 :Version March 2001)”.

During the eighteen months after 1999, Indonesia's exchange rate moved substantially. The range was 33 %, which is higher than the 25% and 18% ranges for Germany and Japan respectively. The Phillipines' exchange rate moved within a 14 percent range, which is lower than for Germany and Japan. Hernandez and Montiel find that the Philippines has a smaller degree of exchange rate flexibility (0.65) than both Germany (1.98) and Japan (0.85). We find similar results that Indonesia has a degree of 0.37 which is greater than the degrees in Japan (0.58) and in Germany (0.44).<sup>26</sup>

## **X Ranking Intermediate Degrees of Flexibility and Creating Indices of Flexibility.**

Several papers have developed rankings of different degrees of flexibility. In most cases such rankings are clear cut, but some cases seem to us to be more ambiguous than previous authors have noted. For example, how should a wide band with a slow rate of crawl be rated against a narrow band with a rapid crawl? As argued above we believe that we do not have any good way at present to develop a coefficient to translate between rates of change and variability around such trends.

Even where we can agree on ordinal rankings, there may be important difference in the behavioral distances between categories and of course the appropriate distances may vary depending on the purpose. Thus, for example, in Reinhart and Rogoff's fine grid there is likely little distance between preannounced crawling band that is wider than or equal to 2 percent (rank 9) and de facto crawling band that is narrower than or equal to 5 percent (rank 10) respectively (and indeed some version of the latter might be more

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<sup>26</sup> It is noted that our degree of exchange rate flexibility of Germany is relatively lower

flexible than the former). Likewise the differences in going from pre-announced horizontal band that is narrower than or equal to 2 percent (rank 3) to no separate legal tender (rank 1) would seem likely to be much more greater than from pre-announced crawling band that is wider than or equal to 2 percent (rank 9) to de facto crawling peg (rank 7).

## XI Concluding Remarks

This paper suggests a methodology for classifying exchange rate regimes, compares it with other measures, and discussed a number of problems of implementation. Where meaningful official descriptions of exchange rate regimes are not formally announced, there can be important gray areas where the best exact characterization is unclear. This problem is particularly acute in cases of small changes in de facto regimes.

We highlight the issue of trends and argue that at least two parameters – coefficients for trend and for deviations around trend – are necessary for the general classification of exchange rate regimes. Because of shifting trends issues of changes in regimes and the appropriate time periods for analysis become important. There is likely no single best answer to such issues and the best answer is often likely to vary depending on the question at hand. We agree with LYS that researchers should be willing to make use of the ambiguous category when classifying regimes. (Typically this will be ambiguous with respect to classification between two particular categories, not complete uncertainty about the regime).

The lack of full correspondence between changes in reserves and actual exchange market intervention is a major problem. We emphasize the frequency with which the data

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than those reported in Hernandez and Montiel paper.

on changes in exchange rates do not fit within the leaning against the wind framework implied by the concept of exchange market pressure. How to classify such “wrong sings” observations is especially problematic. We believe one path to progress is careful country studies which investigate these wrong sign observations and attempt to gain insight into the extent to which these results from actual intervention behavior versus weaknesses in changes in reserves as a proxy for intervention. The role of official borrowing in this regard will also be important to study.

In closing, we should raise another important dimension of classification. This is the extent to which monetary policy is adjusted to external considerations. The extent to which intervention is sterilized or not should have important implications for the stability of exchange rate regimes (see Willett (2002)). Thus we ultimately need to be concerned not with exchange rate regimes *per se*, but with monetary crisis exchange rate regimes. The inclusion of sterilization measures and/or interest rate behavior in such broader classifications is an important area for further research.<sup>27</sup>

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<sup>27</sup> see, for example, Calvo and Reinhart (2002), Hernandez and Montiel (2001), and McCauley (2001).

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