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# Classifying exchange rate regimes: Deeds vs. words

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## Abstract

Most of the empirical literature on exchange rate regimes uses the IMF *de jure* classification based on the regime announced by the governments, despite the recognized inconsistencies between reported and actual policies in many cases. To address this problem, we construct a *de facto* classification based on data on exchange rates and international reserves from all IMF-reporting countries over the period 1974–2000, which we believe provides a meaningful alternative for future empirical work on the topic. The classification sheds new light on several stylized facts previously reported in the literature. In particular, we find that the *de facto* pegs have remained stable throughout the last decade, although an increasing number of them shy away from an explicit commitment to a fixed regime (“hidden pegs”). We confirm the hollowing out hypothesis but show that it does not apply to countries with limited access to capital markets. We also find that pure floats are associated with only relatively minor nominal exchange rate volatility and that the recent increase in the number of *de jure* floats goes hand in hand with an increase in the number of *de facto* dirty floats (“fear of floating”).

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## 1. Introduction

The analysis of the implications of alternative exchange rate regimes is arguably one of the most important questions in international economics. However, our knowledge of this issue from a theoretical point of view, which comprises an extensive literature starting with Mundell’s (1961) theory of optimal currency areas, contrasts with the

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1 relatively weak empirical findings linking exchange rate regimes with macroeconomic  
2 performance. One potential explanation for this weakness relates to the way in which  
3 countries are grouped according to their exchange rate arrangements.

4 Most of the empirical discussion on exchange rate regimes has used the *de jure*  
5 (legal) regime as compiled by the IMF, which is based on the regime the country  
6 declares to be running.<sup>1</sup> However, many countries that *in theory* have a flexible rate  
7 intervene in exchange markets so pervasively that *in practice* very little difference exists  
8 (in terms of observable performance) with countries that have explicit fixed exchange  
9 rate regimes. Conversely, periodic devaluations of pegs in inflation-prone countries are  
10 the result of the implementation of monetary policies that are inconsistent with fixed  
11 exchange rates and that make the effective regime resemble a flexible arrangement.<sup>2</sup>  
12 Moreover, countries that appear to behave according to the declared regime during  
13 tranquil times may be tempted to change their course of action once the regime is  
14 under stress. Thus, a very different picture of exchange rate regime choices may appear  
15 once the international context becomes more volatile.<sup>3</sup>

16 In this paper, we address these problems by proposing a new *de facto* classification  
17 of exchange rate regimes that reflects actual rather than announced policies, which  
18 we believe provides an alternative as well as a complement to the standard *de jure*  
19 approach.<sup>4</sup> More precisely, we define exchange rate regimes according to the behavior  
20 of three classification variables: changes in the nominal exchange rate, the volatility of  
21 these changes, and the volatility of international reserves. Underlying the selection of  
22 these variables is a textbook definition of exchange rate regimes, where fixed exchange  
23 rate regimes are associated with changes in international reserves aimed at reducing  
24 the volatility in the nominal exchange rate, and flexible regimes are characterized by  
25 substantial volatility in nominal rates with relatively stable reserves. Thus, the combined  
26 behavior of these three classification variables should be sufficient to determine the  
27 regime to which each country should be assigned at any point in time.

28 To construct the classification we use a cluster analysis methodology that, once the  
29 number of exchange rate regimes to be identified from the data is defined, groups  
30 the cases according to similarity in the behavior of the three variables of reference.  
31 For example, the cluster with high volatility of reserves and low volatility in the

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<sup>1</sup> See the IMF's *Exchange Arrangements and Exchange Restrictions*. An example of the IMF *de jure* classification can be found in any issue of the *International Financial Statistics*.

<sup>2</sup> As Frankel (1999) points out: "Out of 185 economies, the IMF classifies 47 as independently floating and 45 as following rigid pegs... Most of those classified as fixed have in fact had realignments within the last ten years... Similarly, most of those listed as floating in fact intervene in the foreign exchange market frequently".

<sup>3</sup> Indeed, the relatively new literature on the impact of currency unions on economic performance (Frankel and Rose, 2000; Rose, 2000), where exchange rate misclassifications are virtually nil, has tended to deliver stronger results.

<sup>4</sup> Ghosh et al. (1997) move in this direction when they do not consider as "fixers" countries that experienced substantial adjustments of their exchange rates. Frieden et al. (2001) also modify the standard IMF classification to account for frequent adjusters and for different types of crawls for a group of selected countries. The distinction between *de jure* and *de facto* regimes has been as of late recognized by the IMF: The exchange rate regime grouping reported in the IFS in recent years tries corrects in an ad hoc manner for some obvious misclassifications.

1 nominal exchange rate identifies the group of fixers. Conversely, the cluster with low  
2 volatility in international reserves and substantial volatility in the nominal exchange  
3 rate corresponds to countries with flexible arrangements. The procedure allows us to  
4 classify most country-years since 1974. In addition, we extend the classification to  
5 include cases for which data on some of the classification variables are not available  
6 but may still be classified in an uncontroversial manner, either because the country  
7 did not have a separate legal tender (e.g., Panama) or because the *de jure* regime was  
8 readily verifiable (e.g., Hong Kong).

9 To illustrate the differences between the *de jure* and *de facto* classifications, we  
10 address three stylized facts related to exchange rate regimes recently highlighted by  
11 the literature. First, there is consensus that there has been an increase in the use of  
12 floats throughout the post-Bretton Woods period. Second, that intermediate regimes  
13 (including conventional pegs) are inherently vulnerable to capital flows and thus bound  
14 to disappear in a world with increasingly integrated capital markets, a fact dubbed  
15 by Eichengreen (1994) as “hollowing-out hypothesis” and by Fischer (2001) as the  
16 “bipolar view”.<sup>5</sup> Third, that many countries that claim to float do not allow their  
17 nominal exchange rate to move freely, a pattern that Calvo and Reinhart (2000) have  
18 referred to as “fear of floating”.

19 All of these three facts are in principle partially supported by the evidence. A glance  
20 at exchange rate regimes as classified by the IMF shows a substantial decline in the  
21 number of fixers relative to floats. In fact, in a study on exchange rate regimes for  
22 developing countries, IMF (1997) reports that the number of pegs dropped from 86  
23 in 1976 to 45 in 1996, while flexible exchange rate arrangements increased from 11 to 52  
24 over the same period.<sup>6</sup> Eichengreen’s (1994) hollowing-out hypothesis seemed to be  
25 confirmed by the collapse of pegs in South East Asia and Latin America, the swift move  
26 to monetary integration in Europe in the aftermath of the EMS crisis of 1992, and the  
27 recent adoption of the U.S. dollar as legal tender in Ecuador and El Salvador. Finally,  
28 Calvo and Reinhart (2000) show that exchange rate and foreign reserves volatility for  
29 many alleged floats differ significantly (indicating sizable stabilizing intervention) from  
30 that corresponding to undisputed floats.<sup>7</sup>

31 When we revisit the aforementioned “stylized facts” in light of our *de facto* classifica-  
32 tion, we find somewhat different results. First, while there has been a decline in the  
33 number of fixers in the first two decades after the demise of Bretton Woods, the use  
34 of fixed rates appears to have been relatively stable during the 90s, in contrast with  
35 what can be inferred from the IMF classification. In fact, this comparison reveals that  
36 during the 90s many countries that in practice behave as fixers declare a more flexible  
37 regime, possibly in an attempt to reduce the exposure to speculative attacks associated  
38 with explicit commitments. We label this phenomenon as “hidden pegs”.

39 Second, we find evidence supporting the claim that intermediate regimes such as  
40 conventional and crawling pegs have become increasingly uncommon. However, in

<sup>5</sup> See also, Summers (2000) and Obstfeld and Rogoff (1995).

<sup>6</sup> This evidence is further discussed in Edwards and Savastano (1999) and Reinhart (2000).

<sup>7</sup> This pattern has been frequently used by advocates of hard pegs and unilateral dollarization. See for example, Calvo (1999, 2000a, b) and Hausmann et al. (2000).

1 contrast to the *de jure* approach, the *de facto* classification reveals that the hollowing-out  
2 hypothesis does not hold for non-emerging non-industrial countries, confirming that ex-  
3 posure to strong capital flows may be necessary for the pattern to develop, in line with  
the bipolar view argument.

5 Third, we find that *de facto* floats are associated with only small exchange rate  
variability and that among the countries that claim to float, a large number intervene  
7 recurrently to stabilize their exchange rates, providing support for Calvo and Reinhart’s  
“fear of floating” hypothesis. Interestingly, contrary to what is usually assumed, fear of  
9 floating appears to be a relatively common phenomenon dating back to the early 70s.

The paper proceeds as follows. In Section 2, we discuss in detail the methodology  
11 and present a first glance at the new classification. In Section 3, we compare it with  
the standard *de jure* classification obtained from the IMF, and revisit the main stylized  
13 facts discussed above. Section 4 discusses some potential caveats and concludes. In  
Appendix C we report the classification of exchange rate regimes.

## 15 2. Methodology

### 2.1. Classification variables

17 According to the textbook description, flexible exchange rates are characterized by  
little intervention in the exchange rate markets together with unlimited volatility of  
19 the nominal exchange rate. Conversely, a fixed exchange rate regime occurs when the  
exchange rate does not move while reserves are allowed to fluctuate. A crawling peg  
21 corresponds to the case where changes in the nominal exchange rates occur with stable  
increments (i.e. low volatility in the rate of change of the exchange rate) while active  
23 intervention keeps the exchange rate along that path. Finally, a dirty float should be  
associated to the case in which volatility is relatively high across all variables, with  
25 intervention only partially smoothing exchange rate fluctuations.<sup>8</sup>

With this in mind we chose the volatility of the nominal exchange rate, the volatility  
27 of its rate of change and the volatility of international reserves as our three classification  
variables.<sup>9</sup> This includes both outcome and policy variables that allow to assess if the  
29 policy variables are effectively being used to exert a change on the policy variables.

<sup>8</sup> Frankel (1999) identifies nine exchange rate regimes: currency union, currency board, “truly fixed”  
exchange rates, adjustable peg, crawling peg, basket peg, target zone or band, managed float and free float.  
These nine groups can be broadly mapped into the four categories identified in our work, with the first three  
groups corresponding to a fix, the next three to a crawling peg, and the last two to a dirty and a pure float.  
Exchange rate bands may behave either as a crawling peg (when the exchange rate hits one of the bounds), as  
a float (when it fluctuates within the band) or as a dirty float (in the presence of intramarginal intervention).  
At any rate, it is interesting to stress that an increase in the number of clusters in our specification did not  
lead to the appearance of a new and clearly identifiable group, suggesting that, from the point of view of  
the observed behavior of the data, there is no much information to be gained by going beyond our four-way  
classification.

<sup>9</sup> These variables are used by Edwards (2002) to build an index of exchange rate pressures for a large set  
of countries. For a restricted set of (mostly) developed economies Eichengreen et al. (1996) add the interest  
rate.

1 *Exchange rate volatility* ( $\sigma_e$ ), was measured as the average of the absolute monthly  
 2 percentage changes in the nominal exchange rate during a calendar year.<sup>10</sup> The *volatil-*  
 3 *ity of exchange rate changes* ( $\sigma_{\Delta e}$ ), was computed as the standard deviation of the  
 4 monthly percentage changes in the exchange rate.

5 In order to compute these variables we need to find the appropriate currency of  
 6 reference for each country. In some cases the answer seemed to pose no problem (for  
 7 example, we use the U.S. dollar for Mexico or the DM for Italy). But the currency  
 8 of reference is not clearly identifiable in all cases. For example, for the UK or for  
 9 Switzerland, the US dollar and the German DM are, apparently, equally good candi-  
 10 dates. To resolve these cases we use the following procedure. For countries that report  
 11 a fixed exchange rate regime we use the legal peg currency. For the rest, we use the  
 12 currency against which their exchange rate exhibits the lowest volatility.<sup>11</sup> Countries  
 13 that pegged their currency to a basket, were eliminated from the sample unless the  
 14 central peg parity or the basket weights were known.<sup>12</sup> The reference currency for  
 15 each country is presented in Appendix B.

16 Reserves are notoriously difficult to measure and there is usually a large difference  
 17 between changes in reserves and interventions.<sup>13</sup> Thus, our measure of the third classi-  
 18 fication variable, the *volatility of reserves* ( $\sigma_r$ ) requires particular care. To approximate  
 19 as closely as possible the change in reserves that reflects intervention in the foreign  
 20 exchange market we subtracted government deposits at the central bank from the cen-  
 21 tral bank's net foreign assets.<sup>14</sup> More specifically, we define net reserves in dollars  
 as:

$$R_t = \frac{\text{ForeignAssets}_t - \text{ForeignLiabilities}_t - \text{CentralGov.De posits}_t}{e_t}, \quad (1)$$

<sup>10</sup> Choosing a calendar year as unit of account implies that in years where the exchange rate regime changes, the yearly number will reflect a combination of both regimes. Argentina, for example, implemented a fixed exchange rate in April of 1991. Our yearly data takes into account the strong movements in the nominal exchange rate during the first three months of the year and, as a result, the country is classified as a dirty float. Similarly Ecuador, which dollarized in late January 2000 is classified as crawling peg for that year. This improves upon IMF (1997) and Ghosh et al. (1997), which use the legal regime as of the end of each year, thus assigning the country to an ex-post regime that may be, to a large extent, endogenous. See Edwards and Savastano (1999).

<sup>11</sup> For this exercise we considered the US dollar, the French franc, the German marc, the British pound, the SDR, the ECU and the Japanese yen. For some small countries the currency of a large neighbor was also considered.

<sup>12</sup> Fortunately these cases are not that many.

<sup>13</sup> See the careful discussion in Eichengreen et al. (1996) in the context of the European Union.

<sup>14</sup> Oil producing countries and countries with important privatization programs are examples of cases where the latter correction matters. Calvo and Reinhart (2000) indicate other reasons (hidden foreign exchange transactions, use of credit lines, derivative transactions, or issuance of debt in foreign currency) that make it difficult to compute the real movement in reserves. To these one could add coordinated intervention by other central banks (though this should be limited to G-3 economies) and the measurement error introduced by the fact that all accounts are transformed to dollar units: If the Central Bank holds a portfolio of assets with several currencies, changes in the parities between the reserve currencies can be mistaken for foreign exchange interventions. We believe this measurement error problem to be minor as most of the reserves are in dollar denominated assets.

1 where  $e$  indicates the price of a dollar in terms of local currency. All Central Bank items  
 2 are denominated in local currency and the time period for all variables corresponds to  
 3 the end of period for a specific month. Our measure of monthly intervention in the  
 foreign market  $r_t$ , is defined as

$$r_t = \frac{R_t - R_{t-1}}{\text{MonetaryBase}_{t-1}} = \frac{\Delta R}{\text{MonetaryBase}_{t-1}} \cdot e_{t-1} \quad (2)$$

5 Our measure of volatility is the average of the absolute monthly change in  $r$ , i.e. the  
 6 average of the absolute monthly change in net dollar international reserves relative to  
 7 the monetary base in the previous month, also in dollars.<sup>15</sup>

8 Note that the use of both outcomes (exchange rate movements) and policy instru-  
 9 ments (intervention) as classification variables is crucial as, for any given *de facto*  
 10 regime, the intensity of policy response is likely to be intimately related with its ef-  
 11 fects on outcomes. For example, a fixer will respond to small exchange rate shocks  
 with a relatively small intervention, and to large shocks with large interventions. Thus,  
 13 a classification solely based on the policy variable (intervention) may misleadingly  
 group small-shock observations as having more exchange rate flexibility. It is the re-  
 15 lative variation in policy and outcomes what reveals the reaction function underlying  
 policy decisions.<sup>16</sup>

17 A relevant question related to our facts-based approach is the role played by variables  
 other than reserves in the evolution of exchange rates. In particular, it could be argued  
 19 that changes in interest rates, rather than outright foreign exchange intervention, have  
 been used in some cases to reduce exchange rate pressure. Several reasons move us to  
 21 leave interest rates out of the classification process. First and foremost, because most  
 of the changes in interest rates in small open economies are the response to unsterilized  
 23 intervention by monetary authorities. If a Central Bank wants to defend its currency by  
 raising interest rates, it simply has to leave unsterilized the reserve outflows, by doing  
 25 so the money supply contracts, raising interest rates. In other words, interest rate policy  
 is considered in the analysis, but through the changes that unsterilized reserve flows  
 27 induce on monetary aggregates. Thus, whether a positive correlation between interest  
 rates and market pressure should be directly associated with a dirty floating regime is  
 29 not obvious. Countries with inflation targeting and significant pass-through coefficients  
 provide a useful illustration of the point.<sup>17</sup>

<sup>15</sup> In practice we use line 11 from the IFS for foreign assets, line 16c for foreign liabilities and 16d for central government deposits. Line 14 (or 14a if line 14 was not available) lagged one month is used as a measure of the monetary base. *Contrary* to Calvo and Reinhart (2000) we use the changes relative to the monetary base rather than the percentage change in reserves. We believe this is a better measure, as a given percentage change in reserves in countries with low monetization implies a larger relative intervention in forex markets.

<sup>16</sup> As argued below, the consideration of both outcomes and policies is also crucial to take into account the role of the relative size of underlying shocks.

<sup>17</sup> For example, inflation targetters such as Mexico and Canada, which according to our classification have recently behaved as floats, exhibit a positive correlation between the exchange rate and the interest rate that may be entirely motivated by the negative impact of an exchange rate depreciation on the inflation rate rather than by an implicit exchange rate target.

1 More important, we believe that the scope for interest rate policy to alter exchange  
2 market conditions *without a concomitant movement in reserves* is quite limited, both  
3 in duration and strength, as indicated by the lack of success of interest rate defenses  
4 against speculative attacks during our sample period. However, many of the countries  
5 in our sample include cases in which there may have been effective capital controls  
6 and/or segmented capital markets where interest rate policy may have been a more  
7 feasible stabilization instrument. Yet, as is well known, the literature has identified  
8 two channels through which this (sterilized) intervention can affect interest rates: a  
9 signaling-expectation effect and a portfolio risk premium effect.

10 The literature has seen many attempts at measuring the impact of sterilized inter-  
11 vention on exchange rate behavior, generally contradicting the possibility of significant  
12 effects for a long period of time.<sup>18</sup> Thus given the frequency of our data, we believe  
13 we can abstract from interest rates without any significant loss of the accuracy in our  
14 classification.

15 Once the classification variables have been decided, we compute a yearly figure for  
16 each classification variable for all 183 countries that report to the IMF.<sup>19</sup> The period  
17 of analysis is 1974–2000. In all, for this period there are 4604 classifiable country-year  
18 data points. Of these 553 are left out as they belong to undisclosed basket pegs (which  
19 precludes the computation of a meaningful exchange rate) and 1062 lack data for at  
20 least one of the classifying variables. For the remaining 2989 observations we construct  
21 our data set, which corresponds to the number of cases in which country-year data for  
22 the three reference variables could be computed.

## 23 2.2. Classification procedure

24 We use cluster analysis to identify the relevant exchange rate regime groups based  
25 on the previously described classification variables. Cluster analysis is a multivariate  
26 procedure used to identify homogeneous groups of observations, according to simi-  
27 larities (distances) between the sample elements along certain quantitative dimensions.  
28 Thus, it is a natural technique if the objective is to classify observations by comparison  
29 with other data points. The most common examples of the use of this technique come  
30 from the areas in which it is most frequently used: numerical taxonomy of animals and  
31 plants (biology), distinct pathological groups (medicine), people with similar buying  
32 habits (marketing), etc.

33 There are two approaches within the cluster analysis technique. Hierarchical Cluster  
34 Analysis (HC), typically used for small samples, allows for some additional discretion  
35 in determining the way distances are measured, in the order the sample is introduced  
36 and in how the classification itself is constructed. HC starts from a matrix of distances  
37 between pairs of elements (the two closest are grouped in one cluster), and may dif-  
fer in how distances between clusters are estimated *at successive steps*. Alternatively,

<sup>18</sup> See Obstfeld (1988), Rogoff (1984), Flood and Olivier (2000) and the references therein.

<sup>19</sup> This still excludes some fixed exchange rate countries that are not IMF country members such as Andorra, Liechtenstein, Monaco, Nauru, Tuvalu and Vatican City, all of them fixed throughout the post Bretton Woods period (Tuvalu since 1979). See Obstfeld and Rogoff (1995). We also exclude many semi-independent countries, dependencies or territories. On these see Rose (2000). All other countries are included.

1 partitioning methods such as the  $K$ -means cluster analysis (KMC), based on *nearest*  
2 *centroid sorting* (Anderberg, 1973), assigned individual cases to the cluster with the  
3 smallest distance between the case and the center of the cluster (centroid). The num-  
4 ber of clusters,  $K$ , is specified *ex-ante* by the user, and cluster centers are iteratively  
5 estimated from the data.

6 While HC seeks to unveil a nested pattern or grouping of objects, KMC seeks to  
7 find the best  $K$ -group classification of the observations under analysis, with the least  
8 intervention from the researcher (just a definition of  $K$  is needed). Since it is crucial  
9 to our work that the resulting classification entails as minimal a manipulation of the  
10 classification criteria as possible, we choose KMC as our classification method.

11 We use SPSS 8.0 as our computational device. The algorithm for the  $K$ -means  
12 classification proceeds as follows. First, because the procedure is unit dependent, the  
13 data is  $z$ -normalized.<sup>20</sup> The first  $k$  cases in the data file, where  $k$  is the number of  
14 clusters requested, are selected as temporary centers. As subsequent cases are processed,  
15 a case replaces a center if the smallest distance (measured by the Euclidean norm) to  
16 a center is greater than the distance between the two closest centers. The center that  
17 is closer to the case is replaced. A case also replaces a center if the smallest distance  
18 from the case to a center is larger than the smallest distance between the center and  
19 all other centers. Again, it replaces the center closest to it. The procedure continues  
20 until all cases are classified.<sup>21</sup>

21 As mentioned, our original motivation was to construct a *de facto* classification with-  
22 out resorting to ad hoc and potentially contentious quantitative criteria. Discriminant  
23 analysis, an alternative technique to this end, resembles cluster analysis in that in both  
24 the researcher tries to classify a set of observations into groups or categories. However,  
25 while the former starts from a known classification of the sample to derive in turn a  
26 classification rule to be applied to out-of-sample cases, cluster analysis begins with  
27 no knowledge of group membership and constructs groups according to similarities  
28 (distances) between the sample elements.<sup>22</sup> In terms of the purpose of this paper, it  
29 avoids defining quantitative norms for each exchange rate regime, needed to construct  
30 the initial classification of “uncontroversial” cases. More in general, it bypasses the  
31 non-trivial step of defining when a country that exhibits volatility in both exchange  
32 rates and reserves can be classified as a full or as a dirty float in an uncontroversial  
33 way, or when a country displaying very low exchange rate variability could be  
34 reasonably classified as a (full or dirty) float as opposed to a fix.<sup>23</sup>

35 Previous exchange rate classification attempts to correct the misclassifications of the  
36 standard *de jure* approach relied on some chosen criteria. Ghosh et al. (1997), for  
37 example, excluded from the fix group those *de jure* fixes that changed the parity more

<sup>20</sup> The same methodology is used by Eichengreen et al. (1996) and Edwards (2002) to allow comparison of the exchange rate and reserve volatility in their indexes of speculative pressures.

<sup>21</sup> See Norusis (1993). Appendix A describes the algorithm more formally.

<sup>22</sup> Discriminant analysis, based on already classified sample, identifies a linear combination of quantitative predictor variables that best characterizes the differences among groups, that is in turn used to assign new cases to each group.

<sup>23</sup> As mentioned above, we believe that countries that prevent significant exchange rate changes through heavy intervention are closer in nature with fixed regime, and should be classified accordingly.

Table 1

|              | $\sigma_e$ | $\sigma_{\Delta e}$ | $\sigma_r$ |
|--------------|------------|---------------------|------------|
| Inconclusive | Low        | Low                 | Low        |
| Flexible     | High       | High                | Low        |
| Dirty float  | High       | High                | High       |
| Crawling peg | High       | Low                 | High       |
| Fixed        | Low        | Low                 | High       |

1 than once over a year. As a result, the final outcome in those cases depended on  
 3 the researcher's discretion in the definition of these criteria (for example, whether he  
 5 chooses to exclude from the fix category those countries that realign only once, or  
 7 more than twice). In addition, they required *a priori* definitions that are not always  
 9 immediately obvious. For instance, does the size of the devaluation matter and, if  
 11 so, how? Moreover, how can we distinguish between a devaluation that is a deliberate  
 policy decision in the face of increasing market pressure (a behavior closer in nature to  
 a float) and a devaluation that is the result of an massive but ultimately unsuccessful  
 attempt to defend the fixed parity (which will be closer to a fix)? In this regard,  
 cluster analysis has the advantage of avoiding any discretion from the researcher beyond  
 that required to determine the classifying variables and to assign clusters to different  
 exchange rate regimes, once they are identified by the procedure.

### 13 2.3. The exchange rate regime classification

15 Once the three classification measures are computed for our universe of countries,  
 17 we use *cluster analysis* as a way of assigning the data to different groups. We consider  
 19 each cluster as representing a distinct exchange rate regime, independently of the "legal"  
 regime stated by the country that is assigned to this group. Table 1 presents our prior  
 as to how the three classification variables described above map into exchange rate  
 regimes.

21 Note that observations that display little variability along the three variables cannot  
 23 be meaningfully assigned to any particular type of regime, and are thus labeled "in-  
 conclusives". The wording is not arbitrary: if neither the nominal exchange rate nor  
 reserves move, the exchange rate regime that the country is actually implementing is  
 not obvious from direct comparison with the rest of the sample.<sup>24</sup>

25 The classification procedure is depicted in the diagram of Fig. 1. Because KMC relies  
 27 on the relative distance between points it is important that measures be comparable  
 in order to obtain a relevant classification along all dimensions. Therefore, we first  
 eliminate the two percent-upper tail of observations for each of the three classification  
 29 variables, which in practice leave 129 outliers (out of 2989 data points) out of the

<sup>24</sup> Moreover, one may argue that, given the magnitude of the changes involved, the experience of these countries may not tell us much about the specific impact of the exchange rate regime on the behavior of the economy.

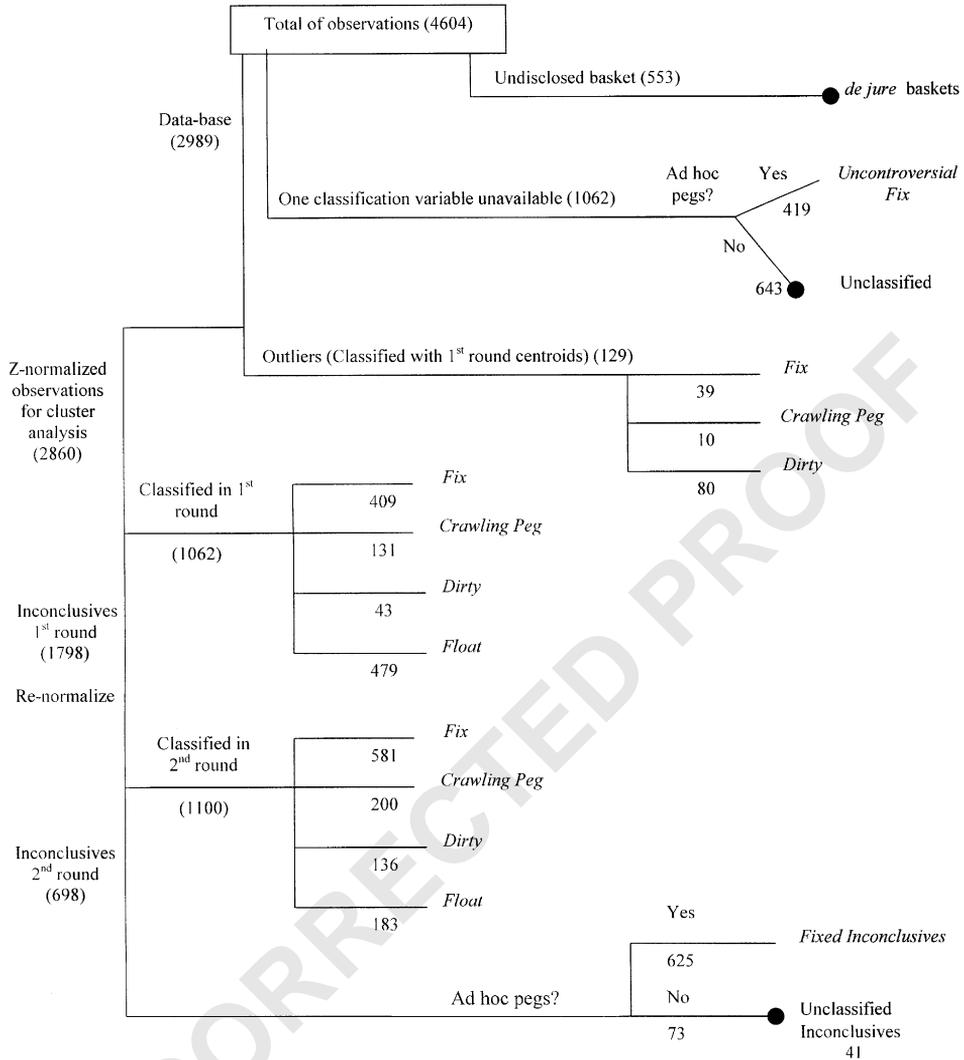


Fig. 1. Exchange rate classification.

1 sample.<sup>25</sup> We then z-normalize the remaining 2860 observations. Next, we use the  
 3 *K*-means algorithm to classify the data into the five clusters described in Table 1.

<sup>25</sup> Because these outliers do not present classification problems, we re-classify these observations ex-post, by assigning them to the cluster with the nearest centroid. In the table countries classified according to this criterion are identified by the indicator (3). The 2% threshold was chosen arbitrarily. Alternative values for this threshold delivered virtually identical classifications.

1 We call this first pass at the data the 1st round classification.<sup>26</sup> The clusters are shown  
2 in Fig. 2.

3 This initial classification assigns a regime to 1062 data points but allocates a high  
4 number of countries within the “inconclusive” category (1798 out of 2860 cases).  
5 However, while variations in the classification variables within this group may be  
6 small relative to the data points clustered in the first round, the data still displays  
7 enough volatility to identify exchange rate regimes among these observations. In order  
8 to unveil these, while maintaining the distinction between high and low variability  
9 cases, we reclassify the “inconclusives” using the same methodology used in the first  
10 round. More precisely, we renormalize the data for these 1798 observations, and apply  
11 the *K*-means algorithm on the new values, again allowing for five groups. We call the  
12 resulting grouping of the “inconclusive” sub-sample the second round classification.<sup>27</sup>  
13 The second round procedure assigns an exchange rate regime to 1100 of the 1798 data  
14 points, with only 698 observations left unclassified. Again, the clusters can be seen in  
15 Fig. 2.

The distinction between first and second round, which mirrors observations with  
17 high and low variability, provides an additional refinement in the classification. By  
18 introducing this variability dimension, this methodology allows to discriminate, albeit  
19 in a crude manner, the *intensity* of the shocks to which the regime is subject, something  
20 that qualitative indexes previously used did not allow for.<sup>28</sup>

21 Consider, for example, two different dirty floats differing in the relative size of their  
22 underlying shocks. The large-shock case will exhibit substantial volatility in reserves  
23 and exchange rates, while the small-shock one will display very limited volatility in  
24 both dimensions. A classification based entirely on outcomes (exchange rate variabil-  
25 ity) will tend to view the high volatility case as having a more flexible exchange rate  
26 regime, while a classification based entirely on policy (intervention) will do exactly  
27 the opposite. Our procedure, in contrast, would group both cases within the interme-  
28 diate categories (dirty/crawling pegs). More precisely, in the first round the procedure  
29 would classify the first case as intermediate (as floats are restricted to have limited  
30 intervention, and pegs are required to have relatively low exchange rate volatility),  
31 and the second as inconclusive. In turn, in the second round, the low volatility case  
32 will be grouped as intermediate (since it exhibits comparable volatility, albeit limited,  
33 along all dimensions). In this way, the combined observation of policies and outcomes  
34 coupled with the flexibility provided by a two-round classification indirectly accounts  
35 for different levels of underlying macroeconomic volatility.

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<sup>26</sup> We start with a number of clusters that we believe should describe all exchange rate regimes. We check robustness of our exchange rate regimes prior by increasing the number of clusters beyond the original five. However, we found that by doing this we simply partition an existing cluster adding no richness to the description of the data. In this sense, the methodology helps identify the right number of regimes that can be distinguished in the data.

<sup>27</sup> In the table, the countries that are classified in this second round are denoted by the indicator (2), to keep track of low variability countries within each category.

<sup>28</sup> This may turn out to be crucial for empirical work, if, as we suspect, policy responses under different exchange rate regimes, and the impact of the regime on other economic variables, depend on the relative magnitude of the underlying shocks.

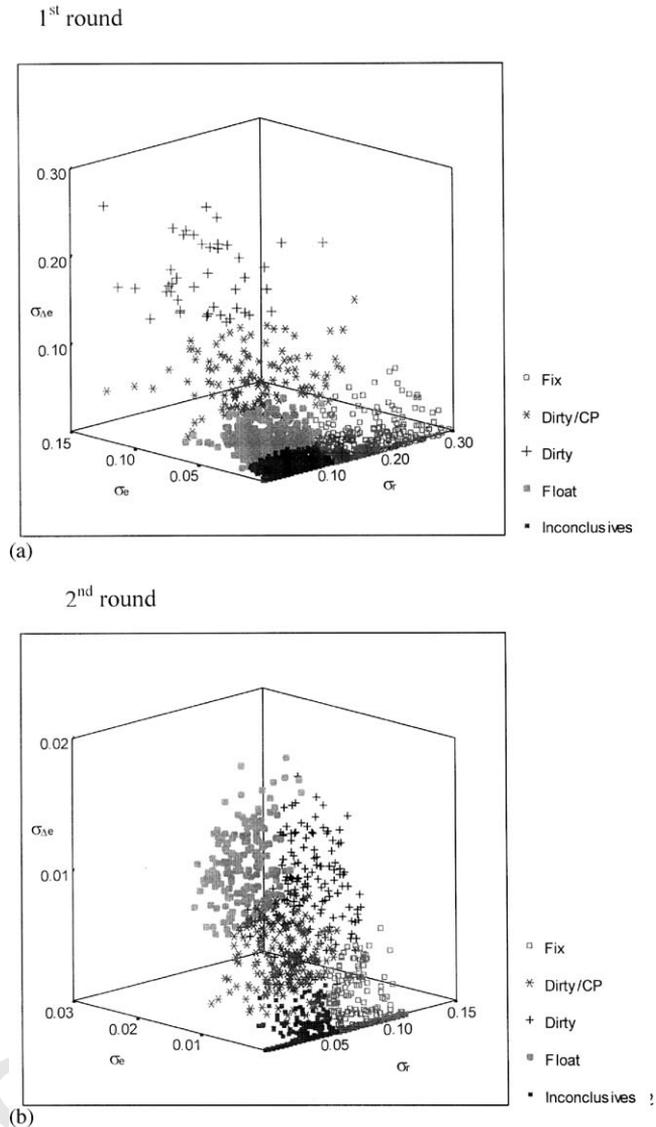


Fig. 2. (a) First round and (b) Second round observations.

1 Table 2 shows, for each cluster, the central values as well as the upper and lower  
 3 bounds of the classification variables. Comparing the centroid values, fixed regimes  
 5 are characterized by relatively low nominal exchange rate volatility (with an average  
 absolute change of 0.20% per month as opposed to 2.31% in the case of floats), and  
 high volatility in reserves (14.68% against 4.59% for floats). The two intermediate  
 groups, on the other hand, exhibit not only substantial intervention in the exchange

Table 2  
Cluster boundaries

|                                | Average monthly volatility in the exchange rate |              |             | Average monthly volatility in the change of the exchange rate |              |             | Average monthly volatility in international reserves (relative to monetary base) |              |             |
|--------------------------------|---|--------------|-------------|---|--------------|-------------|--|--------------|-------------|
|                                | Minimum (%)                                     | Centroid (%) | Maximum (%) | Minimum (%)   | Centroid (%) | Maximum (%) | Minimum (%)  | Centroid (%) | Maximum (%) |
| <i>First Round Boundaries</i>  |   |              |             |   |              |             |  |              |             |
| Float                          | 0.09  | 2.31         | 7.22        | 0.81  | 2.03         | 6.70        | 0.60   | 4.59         | 13.44       |
| Dirty                          | 12.80   | 17.27        | 26.94       | 4.76  | 8.51         | 13.68       | 0.88   | 6.98         | 23.07       |
| Dirty/CP                       | 0.53  | 6.96         | 14.22       | 2.49  | 5.21         | 13.74       | 1.38   | 8.67         | 27.52       |
| Fixed                          | 0.00  | 0.20         | 7.22        | 0.00  | 0.23         | 4.61        | 10.57  | 14.68        | 29.87       |
| <i>Second Round Boundaries</i> |   |              |             |   |              |             |  |              |             |
| Float                          | 0.72  | 1.18         | 2.37        | 0.36  | 0.96         | 1.37        | 0.25   | 3.19         | 6.46        |
| Dirty                          | 0.16  | 0.95         | 1.77        | 0.33  | 0.86         | 1.58        | 5.38   | 7.86         | 10.63       |
| Dirty/CP                       | 0.02  | 0.53         | 1.05        | 0.24  | 0.50         | 1.44        | 0.35   | 4.29         | 7.53        |
| Fixed                          | 0.00  | 0.00         | 0.63        | 0.00  | 0.00         | 0.66        | 5.65   | 7.51         | 11.02       |

1 rate market but also the highest exchange rate volatility. This evidence suggests the  
2 following important point: *Pure floats appear to tolerate relatively minor fluctuations*  
3 *in the exchange rate.* Conversely, as a rule, countries with substantial movements in  
4 the nominal exchange rate usually intervene actively.

5 Table 2 also shows that second round groups present less overlap between fixers  
6 and floaters. While the former exhibit an absolute monthly volatility of the nominal  
7 exchange rate that ranges from zero to 0.63%, the minimum exchange rate volatility  
8 for the latter is 0.72%. Regarding international reserves, floaters display an average  
9 absolute change ranging between 0.25% and 6.46% of the monetary base, in contrast  
10 with a minimum reserve variability of 5.65% for fixers.

#### 11 2.4. An extended classification

12 While the methodology proposed successfully assigns an exchange rate regime to  
13 most data points in our sample, 698 second round inconclusives remain unclassified.  
14 Additionally, our sample includes 1062 country-years for which some of the classifica-  
15 tion variables were not available and that were thus excluded from the classifica-  
16 tion procedure. However, the regime for many of these observations (e.g., Panama's  
17 unilateral dollarization or Hong-Kong's currency board) can still be identified in an  
18 uncontroversial fashion. To include as many observations as possible, we extend the  
19 classification using additional information on specific countries left unclassified by the  
20 previous methodology.

21 Not surprisingly, most of the 698 second round inconclusives can be easily character-  
22 ized as fixed arrangements. In particular, a fixed exchange rate regime was assigned to  
23 all data points within this group that satisfied one of these two conditions: (i) exhibited  
24 zero volatility in the nominal exchange rate, or (ii) were identified as fixers by the IMF  
25 and had an average volatility in the nominal exchange rate smaller than 0.1% (placing  
26 them safely off-limits from the second round floats and dirty floats clusters).<sup>29</sup> As this  
27 criterion classified 625 of the 698 cases, we decided that no additional iterations of the  
28 cluster analysis methodology were necessary. In the end, only 73 cases (2.4%) out of  
29 the original 2989 data points were left unclassified.

30 The same criterion was used to identify fixed arrangements among the 1062 country-  
31 years excluded from the procedure (including those countries without a separate legal  
32 tender),<sup>30</sup> which adds a total of 419 new observations to the database.<sup>31</sup> Extending  
33 the classification in this way brings up the question about how to consider coun-  
34 tries currently within the Euro zone. As none of these countries have an independ-  
35 ent legal tender we choose to classify them as uncontroversial fixes, in line with  
36 Fischer (2001). While this entails no regime switch for most countries, it does imply  
37 a change for Germany: To the extent that it cannot unilaterally change its parity rela-

<sup>29</sup> The cases identified in the data base through this methodology are identified with  $a^*$ .

<sup>30</sup> A list of the latter can be found in Rose (2000) and several issues of the IFS. Note that countries like China, which are not assigned a *de jure* fixed regime but show very small but positive exchange rate volatility were left unclassified.

<sup>31</sup> These countries are identified in the database by the symbol †.

Table 3  
LYS classification

| Regime       | First round | Second round | Outliers | Inconclusives | Ad-hoc | LYS  | IMF  |
|--------------|-------------|--------------|----------|---------------|--------|------|------|
| Float        | 479         | 183          |          |               |        | 662  | 513  |
| Intermediate | 174         | 336          | 90       |               |        | 600  | 937  |
| Fix          | 409         | 581          | 39       | 625           | 419    | 2073 | 1885 |
| Total        | 1062        | 1100         | 129      | 625           | 419    | 3335 | 3335 |

tive to other members of the Euro zone, Germany moves from float to fix starting in 1999.<sup>32</sup>

In the end, unclassified observations comprise pegs to undisclosed baskets (553), and inconclusive observations and countries with missing data (73 and 643, respectively) that cannot be uncontroversially assigned to a particular regime, which adds to a total of 1269 observations for which we cannot improve on the existing IMF *de jure* classification.

Table 3 shows the three-way distribution of observations into floaters, fixers, and intermediate regimes (the latter merging both crawling peg and dirty floats). The distribution of the IMF classification *for the same sample* is presented for comparison. As can be seen, while fixed exchange rates still represent more than half of the sample, we find, somewhat surprisingly, more *de facto* than *de jure* floaters.<sup>33, 34</sup>

The aggregate grouping masks a larger share of floaters in first round observations and a larger number of fixers among second round observations. As the latter correspond to countries that are not subject to substantial volatility in either of the classifying variables, the finding could be interpreted as an indication that, as volatility increases, most countries (are forced to) edge towards more flexible exchange rate arrangements. Conversely, inverting the direction of causality, the result may be interpreted as suggesting that fixed exchange rate regimes are more often associated with greater stability.<sup>35</sup>

<sup>32</sup> A priori, the question of assigning an exchange rate regime to an EMU country resembles that of assigning a regime to any of the 50 states of the US. If we agree that European states today should be classified as having a fixed exchange rate, by analogy one should suggest a fixed exchange rate as the natural regime for any individual state in the US. However, this would imply that the US should be classified as having a fixed exchange rate, whereas it is standard to classify the US as a float. This interdependence between size and exchange rate regime remains an interesting question for future research.

<sup>33</sup> Among the 1269 observations not included in our classification, 553 correspond to basket pegs (which the IMF classifies as *de jure* pegs). The rest of the cases are evenly distributed between *de jure* fixed, float and intermediate.

<sup>34</sup> Note that this does not contradict Calvo and Reinhart's (2000) fear of floating argument, since they focus their discussion only on *de jure* floats.

<sup>35</sup> The discussion of this point is beyond the scope of this paper and certainly deserves a careful econometric analysis.

1 In what follows, we use the extended database to discuss the evolution of exchange  
rate regimes and revisit its main stylized facts.<sup>36</sup>

### 3 2.5. Does our classification accord to conventional wisdom?

5 An informal way of testing the validity of our classification is to track the regime  
followed by particular countries over time according to the new classification.

7 As can be seen, developed economies (e.g., US, Germany through 1998, and Japan)  
usually associated with flexible exchange rate regimes, are identified as such in our  
9 classification. Indeed, the fact that the regime is identified as float in the first round  
indicates that these countries have allowed for a non-negligible degree of volatility  
11 in the exchange rate, relative to their degree of intervention. However, conventional  
wisdom cannot be taken for granted. New Zealand, for example, is classified as a first  
13 round fix since 1992 in spite of significant long term swings in the nominal exchange  
rate, reflecting the fact that it has intervened heavily in foreign exchange markets  
15 to the extent that movements in the relevant variables resemble more closely those  
likely to be found under a peg. Not surprisingly, the responsiveness of New Zealand's  
17 monetary authorities to variations in the nominal exchange rate throughout the 90s is  
a well-documented fact.<sup>37</sup>

19 EMS economies show the expected pattern displaying decreasing degrees of exchange  
rate flexibility vis à vis the DM during the convergence towards EMU. However,  
while France intervened actively to keep its parity in line with the DM after the  
21 EMS crisis of 1992 (thus being classified as a fix), both Italy and Spain allowed for  
greater exchange rate flexibility in the aftermath of the crisis. An interesting exception  
23 within this group is Ireland, which classifies as a fixed exchange rate regime even  
in 1992 when the Irish pound was substantially devalued. Underscoring this finding  
25 is the massive intervention with which the Irish Central Bank defended its currency  
before the collapse.<sup>38</sup> Denmark, on the other hand, is interesting in that, while having  
27 remained outside EMU, has consistently fixed to the DM.

29 Emerging economies, particularly when under stress, are the ones for which the *de*  
*facto* and *de jure* classifications are most likely to differ.<sup>39</sup> According to our classifi-  
cation both Mexico and Chile were floating by 1999. Interestingly, in the case of Chile  
31 the classification indicates that it has virtually run a pure float since the early 80s, in  
spite of a complex system of crawling pegs and exchange rate bands that were finally  
33 discontinued in 1999. This is consistent with the perception that the Chilean pegs and  
bands were managed so that the central parity closely followed market conditions in

<sup>36</sup> The complete database, presented in Appendix 3, is available from <http://www.utdt.edu/~ely> or <http://www.utdt.edu/~fsturzen>.

<sup>37</sup> See Zettelmeyer (2000).

<sup>38</sup> The same argument can be applied to collapsing pegs in emerging economies. A strong defense of the parity may place a country within the fix or intermediate groups even if the currency eventually collapses.

<sup>39</sup> By emerging economies we understand middle income countries with a minimal degree of financial sophistication. We refer to developing countries as all those that are not classified as industrial countries. Industrial and emerging countries are identified in Appendix C.

1 order to minimize exchange rate intervention.<sup>40</sup> On the other hand, Brazil appears not  
 2 to have changed its exchange rate regime substantially after the devaluation of January  
 3 1999. In fact, intervention in 2000 was so intensive that the country is classified as  
 4 a fixed. A similar conclusion can be drawn for the case of Korea that, in spite of  
 5 the strong exchange rate realignment of 1997–1998, had *de facto* fixed by 1999. This  
 6 contrasts with the case of Thailand, which moved to a *de facto* float in 1999, after  
 7 sustaining a crawling peg even through the devaluation of 1997.

8 Finally, small open economies have characteristically fixed their exchange rates to the  
 9 currencies of their main partner(s), something to be expected given their rather limited  
 10 range for an independent monetary policy.<sup>41</sup> Belize, Bahamas and Lesotho illustrate  
 11 this pattern. Cote d’Ivoire, as expected, displays a behavior common to all its partners in  
 12 the WAEMU (West Africa Economic and Monetary Union) zone. These countries are  
 13 classified as fixes except in 1994, when the 100% devaluation of the currency against  
 the French Franc places these countries within the group of intermediate regimes.<sup>42</sup>

### 15 3. A review of the stylized facts on exchange rate regimes

#### 16 3.1. The prevalence of floats

17 The first stylized fact mentioned in the introduction points to a steady decline in  
 18 the number of fixes since the demise of Bretton Woods.<sup>43</sup> This may reflect the fact  
 19 that increasingly global capital markets may have weakened even the strongest pegs,  
 20 forcing a steady movement to more flexible arrangements,<sup>44</sup> and is reflected in an  
 21 increase in the float-to-fix ratio obtained from the IMF regime classification, as shown  
 22 in Fig. 3.<sup>45</sup> According to the IMF classification the number of countries choosing  
 23 fixed rates falls from 75% in 1974 to less than 50% in 2000.<sup>46</sup> The distribution of  
 24 exchange rate regimes according to our classification (Fig. 4) shows that, although the  
 25 long term trends are similar, the composition of *de facto* regimes appear somewhat  
 26 more stable than that of the IMF’s. Particularly contrasting is the stability in the use of  
 27 fixed rates since the early 90s, a point that challenges the view that increasing capital  
 28 market mobility has gradually induced the abandonment of fixed arrangements. The  
 29 difference underscores a significant finding: the number of countries which run a fixed  
 30 exchange rate regime without explicitly stating that they do, a phenomenon which we  
 31 call “fear of pegging”, has increased remarkably over the last decade.

<sup>40</sup> This view was confirmed in informal communications to the authors by Roberto Zahler, then President of the Central Bank of Chile.

<sup>41</sup> It is interesting to note that most of the pegs to currency baskets with undisclosed weights that had to be excluded from the sample belong to this group.

<sup>42</sup> As noted in the introduction, the methodology interprets (we believe correctly) the realignment as an indication of a monetary policy that is inconsistent with the preservation of the *de jure* peg.

<sup>43</sup> See, for example, IMF (1997), Edwards and Savastano (1999), Broda (2000) and Reinhart (2000).

<sup>44</sup> On this, see Obstfeld and Rogoff (1995).

<sup>45</sup> For the sake of comparison, Figs. 3 and 4 merge our two intermediate regimes in a single group and include only the 3335 *de facto* classified observations.

<sup>46</sup> Results are similar when only non industrial countries are included.

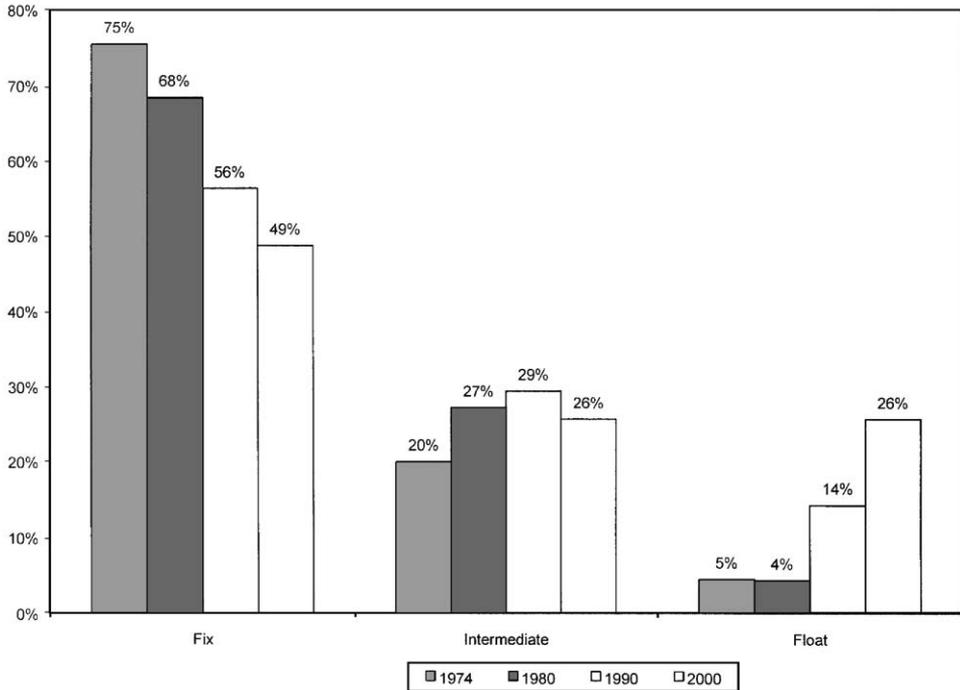


Fig. 3. Distribution of exchange rate regimes IMF classification (1974–2000) for all countries.

### 1 3.2. The bipolar view

3 The second stylized fact relates to the disappearance of intermediate regimes, the  
 5 so-called “hollowing-out” hypothesis or bipolar view. This discussion, however, has  
 7 been framed in terms slightly different than those used in this paper. The bipolar view  
 9 highlights the benefits of super-fixed arrangements or “hard pegs” (such as currency  
 11 boards or unilateral dollarization) as a way of buying the credibility needed to avoid  
 13 speculative attack on the currency. Accordingly, the distinction it makes between hard  
 and conventional pegs, assimilating the latter with the group of intermediate regimes,  
 becomes essential to the debate.<sup>47</sup> While our classification does not distinguish between  
 hard pegs and conventional pegs, the former are readily verifiable and thus can  
 be easily identified from different sources.<sup>48</sup> Once conventional pegs are separated  
 from hard pegs and added to the intermediate group, our *de facto* classification also  
 reveals a “hollowing-out” pattern during the 90s. Fig. 5, similar to those in Fischer

<sup>47</sup> Some authors consider as one the group of managed and pure floats, something we believe is inconsistent with an appropriate definition of the bipolar view. Accordingly, in the following, we leave managed floats within the intermediate group.

<sup>48</sup> See references in footnote 21.

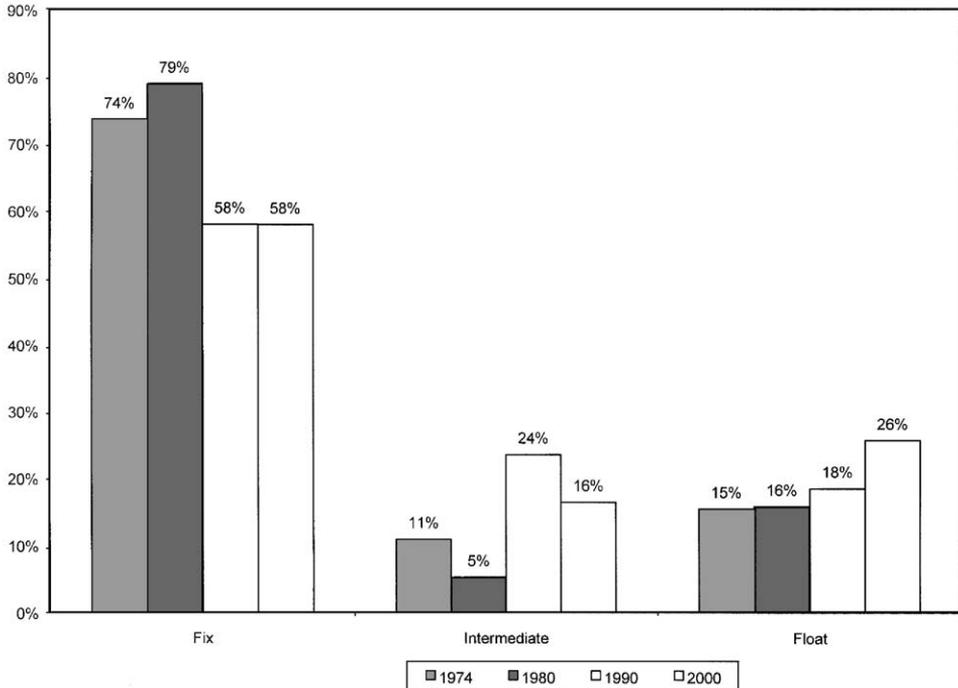


Fig. 4. Distribution of exchange rate regimes. LYS classification (1974–2000) for all countries.

1 (2001), indicates that the phenomenon has been present for developed and emerging  
 2 economies alike. In fact, intermediate regimes fall to about half during the decade. On  
 3 the other hand, Fig. 6 shows a different pattern for other non-industrial non-emerging  
 4 economies, indicating that floats are less prevalent among this group and that the move-  
 5 ment towards the extremes is almost inexistent in this case. This is consistent with the  
 6 view that limited access to capital markets has spared these countries the need to move  
 7 to extreme regimes in order to avoid speculative attacks.

### 3.3. Deeds vs. words: fear of floating and hidden pegs

9 Table 4 compares our *de facto* classification with the *de jure* classification used  
 10 by the IMF. As expected, while we find a high degree of coincidence between both  
 11 classifications (roughly two thirds of the observations are classified identically), there  
 12 are also a substantial number of mismatches. The number of mismatches remains rela-  
 13 tively stable throughout the years, but they are consistently more frequent for countries  
 14 classified in the first round (58% vs. 32%). This, in turn, suggests that, when subject  
 15 to relatively mild shocks, countries are more likely to behave as they claim.

16 Table 4 also provides a first pass at the nature of the discrepancies. We can compute  
 17 the number of countries which claim to be fixers while showing substantial movement

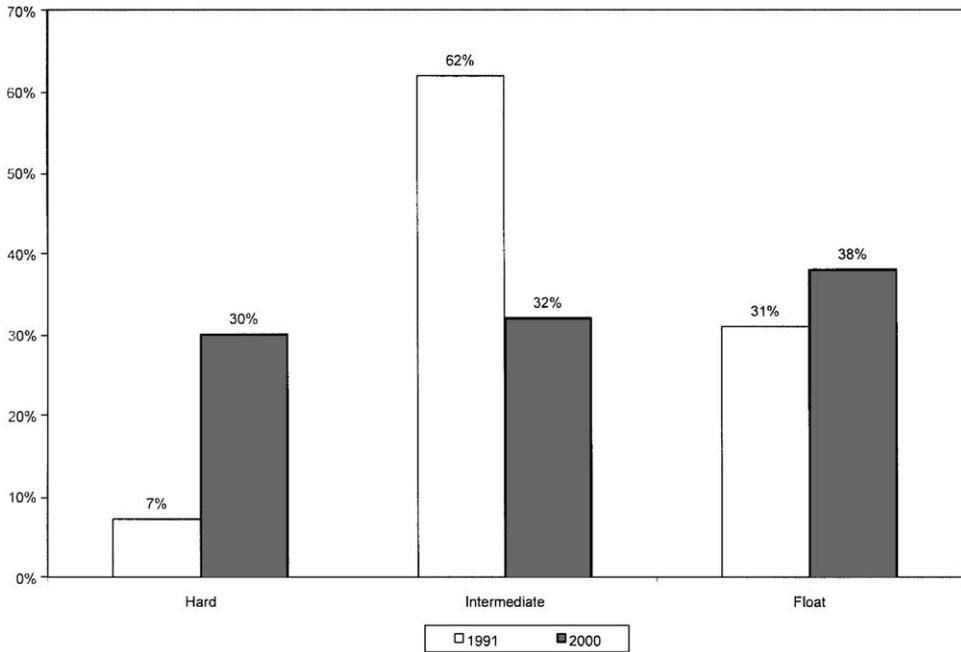


Fig. 5. Developed and emerging countries (LYS classification).

1 in their exchange rates, and similarly, the number of countries that claim to be floaters  
 2 but actively intervene in exchange rate markets to limit the volatility of the nominal  
 3 exchange rate. The latter are particularly interesting as they broadly correspond to  
 4 what Calvo and Reinhart (2000) refer to as “fear of floating”.<sup>49</sup> Fig. 6 shows that the  
 5 number of countries in this category has grown dramatically over the 90s in absolute  
 6 numbers, increasing hand in hand with the use of floating exchange rate regimes. Table  
 7 4 shows, however, that fear of floating, appears to have applied to a relatively large  
 8 fraction of floats even when going back to the early 70s, indicating that it is not, as  
 9 sometimes is suggested in the literature, a recent phenomenon.

10 While our results are similar in nature to those in Calvo and Reinhart (2000), there  
 11 are three basic differences in our methodology to identify fear of floating. First, we  
 12 normalize the reserves data by the monetary base to control for the fact that, for  
 13 countries with different degrees of monetization, a given percentage change in reserves  
 14 may imply different intervention intensities in foreign exchange markets. Second, by  
 15 implicitly using exchange rate volatility relative to foreign exchange intervention, our  
 16 measure avoids the potential ambiguities that may arise from comparing these vari-  
 17 ables separately. In Reinhart (2000), for example, while exchange rate movement for  
 post-Tequila Mexico resembles that of floating exchange rate regimes, reserve behavior

<sup>49</sup> See also Reinhart (2000).

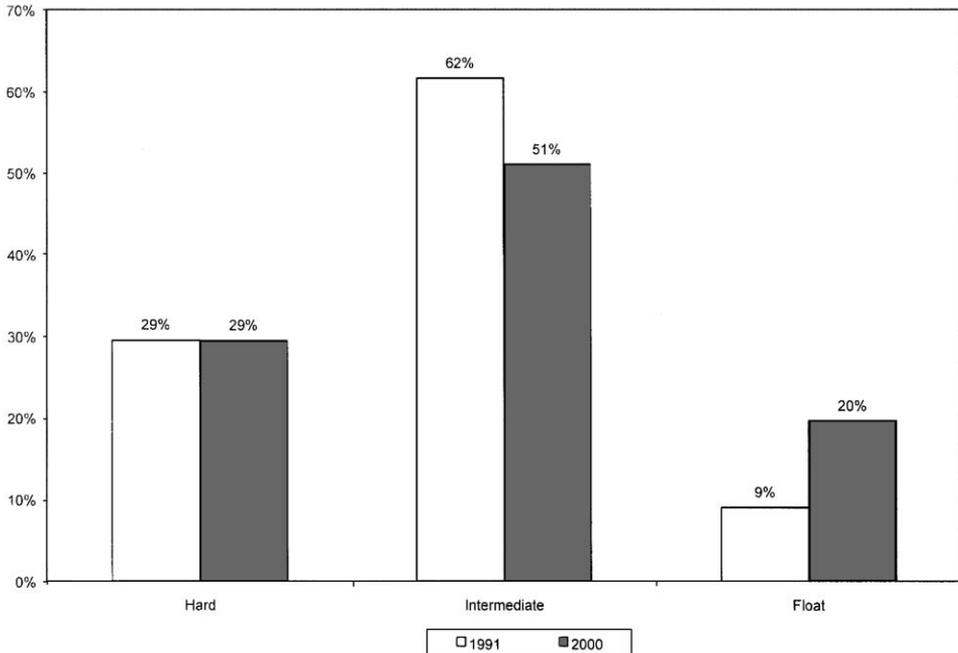


Fig. 6. Other countries (LYS classification).

1 does not, leaving the answer to the question to the discretion of the reader. In con-  
 2 trast, our methodology considers both variables simultaneously, naturally weighting the  
 3 variability of one variable vis à vis the other to provide a unique characterization that  
 4 allows us to infer whether the country is exhibiting fear of floating. Third, our metric  
 5 evaluates the deviations in the classifying variables relative to the “world” norm, rather  
 6 than to some ad hoc reference cases. As a result, we expect to find a slightly weaker  
 7 fear of floating evidence than if the behavior of a particular country was compared  
 8 with that of uncontested floats. Thus, while according to our measure Mexico exhib-  
 9 ited fear of floating in 1995 and 1996, it resembled a standard floating regime thereon.  
 10 Canada, on the other hand, floated throughout most of the period: Despite the fact that  
 11 its exchange rate volatility was smaller than that of the US dollar against the DM or  
 12 the yen (which taken in isolation may suggest the presence of fear of floating), it did  
 13 not intervene in the exchange rate market to smooth out this volatility.

14 Another aspect revealed by the comparison between *de facto* and *de jure* regimes  
 15 is an increasing number of countries that, although in practice display a policy that  
 16 closely resembles a peg, avoid reporting a fixed exchange rate as their official policy.  
 17 These “hidden pegs” may be related (once again) with the fact that, as capital mobility  
 18 increases, official pegs are more likely to be targets of speculative attacks that, given the  
 19 economic (and political) cost of a currency crisis, may discourage governments from

Table 4  
Exchange rate regimes LYS vs. IMF classification (in %)

| Year  | Float/<br>float<br>(%) | Float/<br>interm.<br>(%) | Float/fix<br>(%) | Interm./<br>float<br>(%) | Interm./<br>interm.<br>(%) | Interm./<br>fix<br>(%) | Fix/float<br>(%) | Fix/<br>interm.<br>(%) | Fix/fix<br>(%) | Mismatch<br>(%) | Mismatch<br>first round<br>(%) | Mismatch<br>second<br>round (%) | Fear of<br>peg<br>(%) | Fear of<br>float<br>(%) | Total<br>number<br>of cases |
|-------|------------------------|--------------------------|------------------|--------------------------|----------------------------|------------------------|------------------|------------------------|----------------|-----------------|--------------------------------|---------------------------------|-----------------------|-------------------------|-----------------------------|
| 1974  | 4                      | 8                        | 4                | 1                        | 3                          | 7                      | 0                | 9                      | 65             | 29              | 46                             | 36                              | 12                    | 20                      | 110                         |
| 1975  | 1                      | 4                        | 9                | 2                        | 9                          | 6                      | 0                | 9                      | 61             | 29              | 52                             | 20                              | 13                    | 67                      | 109                         |
| 1976  | 2                      | 8                        | 5                | 1                        | 5                          | 5                      | 0                | 12                     | 62             | 31              | 62                             | 24                              | 16                    | 33                      | 113                         |
| 1977  | 4                      | 10                       | 3                | 1                        | 8                          | 4                      | 0                | 9                      | 63             | 25              | 52                             | 17                              | 12                    | 20                      | 114                         |
| 1978  | 4                      | 14                       | 6                | 0                        | 6                          | 2                      | 0                | 8                      | 60             | 30              | 50                             | 24                              | 12                    | 0                       | 111                         |
| 1979  | 3                      | 10                       | 4                | 1                        | 8                          | 4                      | 0                | 11                     | 59             | 30              | 65                             | 18                              | 15                    | 25                      | 113                         |
| 1980  | 3                      | 11                       | 2                | 1                        | 4                          | 1                      | 1                | 12                     | 66             | 28              | 56                             | 26                              | 17                    | 40                      | 114                         |
| 1981  | 2                      | 11                       | 5                | 1                        | 10                         | 3                      | 2                | 7                      | 59             | 28              | 58                             | 20                              | 13                    | 60                      | 116                         |
| 1982  | 4                      | 9                        | 4                | 2                        | 10                         | 5                      | 0                | 8                      | 59             | 27              | 57                             | 24                              | 12                    | 33                      | 111                         |
| 1983  | 3                      | 9                        | 4                | 1                        | 14                         | 4                      | 1                | 8                      | 56             | 27              | 45                             | 28                              | 14                    | 40                      | 107                         |
| 1984  | 3                      | 11                       | 4                | 2                        | 12                         | 5                      | 1                | 8                      | 55             | 30              | 59                             | 27                              | 14                    | 50                      | 113                         |
| 1985  | 3                      | 12                       | 4                | 2                        | 10                         | 5                      | 2                | 10                     | 53             | 34              | 56                             | 33                              | 18                    | 57                      | 111                         |
| 1986  | 2                      | 11                       | 5                | 4                        | 12                         | 7                      | 3                | 8                      | 48             | 38              | 67                             | 44                              | 18                    | 80                      | 112                         |
| 1987  | 3                      | 7                        | 3                | 3                        | 14                         | 6                      | 3                | 9                      | 52             | 31              | 53                             | 37                              | 18                    | 64                      | 120                         |
| 1988  | 7                      | 9                        | 5                | 3                        | 10                         | 5                      | 0                | 11                     | 51             | 33              | 55                             | 40                              | 18                    | 27                      | 120                         |
| 1989  | 5                      | 12                       | 5                | 5                        | 8                          | 6                      | 2                | 11                     | 48             | 40              | 64                             | 39                              | 21                    | 57                      | 120                         |
| 1990  | 8                      | 8                        | 2                | 4                        | 12                         | 8                      | 2                | 9                      | 47             | 33              | 59                             | 33                              | 19                    | 41                      | 119                         |
| 1991  | 5                      | 10                       | 2                | 10                       | 12                         | 5                      | 3                | 8                      | 47             | 37              | 69                             | 40                              | 18                    | 71                      | 120                         |
| 1992  | 12                     | 6                        | 4                | 9                        | 8                          | 3                      | 8                | 8                      | 43             | 38              | 62                             | 33                              | 27                    | 59                      | 120                         |
| 1993  | 13                     | 10                       | 3                | 8                        | 5                          | 2                      | 10               | 9                      | 40             | 42              | 63                             | 42                              | 33                    | 59                      | 128                         |
| 1994  | 9                      | 6                        | 2                | 15                       | 5                          | 14                     | 8                | 11                     | 30             | 57              | 72                             | 62                              | 40                    | 72                      | 132                         |
| 1995  | 13                     | 11                       | 1                | 7                        | 9                          | 6                      | 11               | 7                      | 34             | 44              | 63                             | 42                              | 36                    | 59                      | 148                         |
| 1996  | 12                     | 11                       | 0                | 9                        | 10                         | 3                      | 9                | 11                     | 36             | 42              | 62                             | 37                              | 35                    | 60                      | 147                         |
| 1997  | 14                     | 12                       | 1                | 11                       | 9                          | 1                      | 6                | 11                     | 36             | 41              | 56                             | 34                              | 32                    | 53                      | 152                         |
| 1998  | 12                     | 13                       | 1                | 7                        | 9                          | 1                      | 7                | 16                     | 34             | 45              | 64                             | 42                              | 40                    | 54                      | 152                         |
| 1999  | 15                     | 9                        | 0                | 5                        | 13                         | 0                      | 7                | 6                      | 46             | 26              | 45                             | 21                              | 22                    | 44                      | 151                         |
| 2000  | 14                     | 11                       | 1                | 7                        | 9                          | 1                      | 5                | 6                      | 47             | 31              | 50                             | 32                              | 19                    | 46                      | 152                         |
| Total | 7                      | 10                       | 3                | 5                        | 9                          | 4                      | 4                | 9                      | 49             | 35              | 58                             | 32                              | 21                    | 54                      | 3335                        |

Note: Float/fix indicates country with *de facto* float and *de jure* fix.



Fig. 7. Fear of floating (number of *de jure* floats that *de facto* are not floats).

1 overtly assuming a commitment with a predetermined parity.<sup>50</sup> Fig. 7. shows how that  
 2 the proportion of *de facto* pegs that reported either an intermediate or a flexible regime  
 3 increased from 15% at the beginning of the 80s to about 40% throughout the 90s (see  
 4 Fig. 8).

5 Both fear of floating and hidden pegs qualify the empirical findings based on the  
 6 standard IMF classification. On the one hand, the former casts doubts on the view that  
 7 countries tend to move towards more flexible arrangements in a context of increas-  
 8 ingly unstable international markets, inasmuch as a growing fraction of those alleged  
 9 floats regimes are characterized by heavy intervention. On the other hand, the latter  
 10 strengthens the increasing awareness of speculative attacks, particularly among small  
 11 open economies. In fact, while many countries still use the exchange rate as a nomi-  
 12 nal anchor, they tend to shy away from an explicit commitment to avoid unwarranted  
 13 vulnerability.

<sup>50</sup> Thus, while fear of floating is associated with *countries that want to float* but only within certain limits that do not compromise inflation targets or financial stability, hidden pegs correspond to *countries that want to fix* while keeping the door open for a realignment or allowing for a limited exchange rate volatility to make speculative attacks more costly. The distinction is not trivial: while the first case is compatible, for example, with inflation targeting regimes (e.g., in countries with high exchange rate pass-through), the second corresponds to a (soft) exchange rate target, with no attempt at an independent monetary policy (the standard example being that of El Salvador before formally dollarizing).



Fig. 8. Fear of pegging (% of *de facto* pegs which are not *de jure* pegs).

#### 1 4. Discussion and future research

Several researches have acknowledged the inadequacy of the *de jure* classification. As Fischer (2001) concisely states:

3 ... authorities own descriptions of exchange rate regimes in *Exchange Arrangements and Exchange Restrictions* is patently inaccurate for some countries...

7 Aware of this problem, Frieden et al. (2001) and Ghosh et al. (1997), to cite two recent examples, have used adjustments to the *de jure* classification in their work on exchange rate regimes. We believe that our classification provides an improvement relative to these partial exercises. First, our approach is less arbitrary as our only classification input is the number of clusters to be identified. Second, our classification balances outcome and policy variables, evaluating whether policy variables are effectively used to generate a certain result in terms of outcome variables. Third we provide a comprehensive database readily available for future empirical work. Fourth, the classification provides a very realistic assessment of exchange rate regimes. Finally, it also contains more information than previous classifications by providing a distinction between first and second round which allows to discriminate, albeit in a crude manner, the *intensity* of the shocks to which the regime is subject, something that qualitative indexes previously used did not allow. More in general, the intensity dimension should help avoid a bias towards the irrelevance hypothesis, particularly likely if the effect of the regime on other variables is significant only at high volatility levels.

1 However, a classification as the one proposed in this paper is bound to have some,  
2 arguably minor, caveats. The role of sterilized intervention, the potential use of cap-  
3 ital control restrictions, dual exchange rates, financial sector intervention, third party  
4 exchange rate intervention are potential criticisms. However the building of a use-  
5 ful classification requires using feasible information. Interest rate data, for example,  
6 is usually of poor quality and unavailable for a large set of countries. For example,  
7 Eichengreen et al. (1996) develop an index of speculative pressures, but data require-  
8 ments allow them to compute this index for just 23 countries. When Edwards (2002)  
9 attempts to extend this to a large sample of countries he is forced to drop the interest  
10 rate from the analysis.

11 The objective of building a classification purely based on policy variables or policy  
12 instruments is another potential criticism. However, this introduces the problem of the  
13 endogeneity of exchange rate regimes. For example, countries with high pass-through  
14 coefficients and an inflation objective are likely to prefer a stable exchange rate, even  
15 though the exchange rate is not the final target. Whether or not we choose to associate  
16 this behavior with fixed exchange rate regimes is still under debate.

17 An alternative classification could be conceived that assigns regimes according to  
18 the (non-observable) targets of the monetary authorities. There, both Canada and (par-  
19 ticularly) Mexico would be deemed managed floats, as will be any country that keeps  
20 the exchange rate in check to limit inflationary pressures. However, the previous dis-  
21 cussion highlights the non-trivial problems involved in defining classification variables  
22 that accurately capture the latent objective function of the central bank.

23 An additional shortcoming relates to countries that peg to undisclosed baskets: With-  
24 out a concrete knowledge of the “target” for monetary policy, it becomes difficult to  
25 assess whether such target is imposing a constraint on macro policy or not. Thus,  
26 whereas we identify these cases (based on a *de jure* criterion), we leave them unclas-  
27 sified. While for these cases the *de jure* information can still be used, our work does  
28 not improve upon the existing classification.

29 The main contribution of the paper is to present an exchange rate regime classifica-  
30 tion which relies heavily on facts rather than on the legal characteristic of the regime.  
31 We believe it may become an important starting point for future empirical work in  
32 the area. Although some basic findings already emerged from the simple inspection of  
33 the new classification, only further empirical research will reveal its real usefulness. In  
34 fact, research on exchange rate regimes has so far revealed a relatively minor impact  
35 of the choice of regime on economic performance.<sup>51</sup> We believe that many of these  
36 “irrelevance” results may change in light of the *de facto* classification reported here,  
37 as some preliminary work using this database already seems to suggest.<sup>52</sup>

<sup>51</sup> See, e.g., Baxter and Stockman (1989), Flood and Rose (1995), and Ghosh et al. (1997).

<sup>52</sup> A previous version of this classification, covering the period 1990–1998, has already been used in Masson (2000), Broda (2000), Hausmann et al. (2000), Domac and Martínez Pería (2000) and Levy Yeyati and Sturzenegger (2001). The expanded classification employed in this paper has also been used by Bordo and Flandreau (2001), Eichengreen et al. (2002), Juhn and Mauro (2002), Claessens et al. (2003), and Levy Yeyati and Sturzenegger (forthcoming), among others.

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## Appendix A. Description of the K-means cluster algorithm<sup>53</sup>

3

The following notation is used throughout this appendix unless otherwise stated:

|                                 |  |
|---------------------------------|--|
| $NC$                            | Number of clusters requested   |
| $\mathbf{M}_i$                  | $i$ Mean of $i$ th cluster   |
| $\mathbf{X}_k$                  | $k$ Vector of $k$ th observation                                     |
| $d(\mathbf{x}_i, \mathbf{x}_j)$ | Euclidean distance between vectors $\mathbf{x}_i$ and $\mathbf{x}_j$ |
| $d_{mn}$                        | $\min_{i,j} d(\mathbf{M}_i, \mathbf{M}_j)$                           |
| $\varepsilon$                   | Convergence criteria   |

5

The computation involves three steps.

### 7 A.1. Selecting initial cluster centers

(a) If  $\min_i d(\mathbf{x}_k, \mathbf{M}_i) > d_{mn}$  and  $d(\mathbf{x}_k, \mathbf{M}_m) > d(\mathbf{x}_k, \mathbf{M}_n)$ , then  $\mathbf{x}_k$  replaces  $\mathbf{M}_n$ . If  $\min_i d(\mathbf{x}_k, \mathbf{M}_i) > d_{mn}$  and  $d(\mathbf{x}_k, \mathbf{M}_m) < d(\mathbf{x}_k, \mathbf{M}_n)$ , then  $\mathbf{x}_k$  replaces  $\mathbf{M}_m$ ; that is, if the distance between  $\mathbf{x}_k$  and its closest cluster mean is greater than the distance between the two closest means ( $\mathbf{M}_m$  and  $\mathbf{M}_n$ ), then  $\mathbf{x}_k$  replaces either  $\mathbf{M}_m$  and  $\mathbf{M}_n$ , whichever is closer to  $\mathbf{x}_k$ .

(b) If  $\mathbf{x}_k$  does not replace a cluster mean in (a), a second test is made:

Let  $\mathbf{M}_q$  be the closest cluster mean to  $\mathbf{x}_k$ , and  $\mathbf{M}_p$  be the second closest cluster mean to  $\mathbf{x}_k$ . If  $d(\mathbf{x}_k, \mathbf{M}_p) > \min_i d(\mathbf{M}_q, \mathbf{M}_i)$ , then  $\mathbf{M}_q = \mathbf{x}_k$ ; that is, if  $\mathbf{x}_k$  is further from the second closest cluster's center than the closest cluster's center is from any other cluster's center, replace the closest cluster's center with  $\mathbf{x}_k$ .

At the end of one pass through the data, the initial means of all  $NC$  clusters are set.

### 19 A.2. Updating initial cluster centers

Starting with the first case, each case in turn is assigned to the nearest cluster, and that cluster mean is updated. Note that the initial cluster center is

21

<sup>53</sup>Based on Hartigan (1975).

1 included in this mean. The updated cluster means are the classification cluster  
centers.

### 3 *A.3. Assign cases to the nearest cluster*

The third pass through the data assigns each case to the nearest cluster, where  
5 distance from a cluster is the Euclidean distance between that case and the (updated)  
classification centers. Final cluster means are then calculated as the average values  
7 of clustering variables for cases assigned to each cluster. Final cluster means do not  
contain classification centers.

9 When the number of iterations is greater than one, the final cluster means in step 3  
are set to the classification cluster means in the end of step 2, and step 3 is repeated  
11 again. The algorithm stops when either the maximum number of iterations is reached  
or the maximum change of cluster centers in two successive iterations is smaller than  
13  $\varepsilon$  times the minimum distance among the initial cluster centers.

## 15 **Appendix B. Currencies of reference**

### *B.1. To the US dollar*

17 Afghanistan, Algeria, Angola, Antigua and Barbuda (77–), Argentina, Armenia,  
Aruba, Australia, Azerbaijan, Bahamas, Bahrain, Bangladesh (89), Barbados (75–),  
19 Belarus (95–), Belize (77–), Bolivia, Brazil, Brunei, Bulgaria (94–95), Burundi (74  
–83;92–), Cambodia, Canada, Chile (74–89;99–), China, Colombia, Democratic Re-  
21 public of Congo, previously Zaire, (74–75;83–), Costa Rica, Djibouti, Dominica (79  
–), Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, The Gambia (86–),  
23 Georgia, Germany, Ghana, Grenada (77–), Guatemala, Guinea (86–), Guyana (76–  
) , Haiti, Honduras, Hong Kong, Hungary, India (75–), Indonesia, Iran (74–80, 93–),  
25 Iraq, Israel, Jamaica, Japan, Jordan (88–), Kenya (74;87–), Korea, Kyrgyz Republic,  
Lao PDR, Lebanon, Liberia, Libya (74–86), Lithuania, Malawi (74; 84–), Malaysia,  
27 Maldives, Marshall Islands, Mauritania, Mauritius (83–), Mexico, Micronesia, Mong-  
olia, Mozambique, Nepal, Netherlands Antilles, New Zealand, Nicaragua, Nigeria,  
29 Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Poland (74–  
79), Qatar, Romania, Russia, Rwanda (74–82;94–), Sao Tomé and Príncipe, Saudi  
31 Arabia, Seychelles (96–), Sierra Leone (83–), Singapore, Solomon Islands, Somalia,  
South Africa, Sri Lanka, St. Kitts and Nevis (77–), St. Lucia (77–), St. Vincent and  
33 the Grenadines (77–), Sudan, Suriname, Syrian Arab Republic, Tajikistan, Tanzania  
(74; 79–), Thailand, Trinidad and Tobago (76–), Turkey, Turkmenistan, Uganda (74  
–78; 81–), Ukraine, United Arab Emirates, United Kingdom (74–86; 95–), Uruguay,  
35 Venezuela, Yemen, Zambia (74–75; 83–), Zimbabwe.

### 37 *B.2. To the British pound*

Antigua and Barbuda (74–76), Bangladesh (74–78), Barbados (74), Belize (74–76),  
39 Dominica (74–78), The Gambia (74–85), Grenada (74–76), Guinea (74–85), Guyana

- 1 (74–75), India (74), Ireland (74–78), Seychelles (74–78), Sierra Leone (74–77),  
 2 St. Kitts and Nevis (74–76), St. Lucia (74–76), St. Vincent and the Grenadines  
 3 (74–76), Trinidad and Tobago (74–75).

*B.3. To the German mark*

- 5 Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria (96–), Croatia, Czech  
 6 Republic, Denmark, Estonia, Finland, France, Greece, Iceland, Ireland (79–), Italy,  
 7 Macedonia FYR, Moldova, Netherlands, Norway, Poland (80–), Portugal, Slovak  
 8 Republic, Slovenia, Spain, Sweden Switzerland, United Kingdom (87–94), United  
 9 States.

*B.4. To the French franc*

- 11 Benin, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Co-  
 12 moros, Republic of Congo, Cote d'Ivoire, Equatorial Guinea, Gabon, Guinea Bissau,  
 13 Madagascar, Mali, Morocco, Niger, Senegal, Togo, Tunisia.

*B.5. To the SDR*

- 15 Burundi (84–91), Democratic Republic of Congo, previously Zaire, (76–82), Iran (81  
 16 –92), Jordan (74–87), Kazakhstan, Kenya (75–86), Latvia, Libya (87–), Malawi (75–  
 17 83), Mauritania, Mauritius (74–82), Myanmar, Rwanda (83–93), Seychelles  
 (79–95), Sierra Leone (78–82), Tanzania (75–78), Zambia (76–82).

19 *B.6. Other*

Bhutan, Indian Rupee  
 Botswana, South African Rand  
 Chile, Central band parity as published by the Central Bank of Chile (90–98)  
 Cyprus, ECU/Euro  
 Kiribati, Australian Dollar  
 Lesotho, South African Rand  
 Luxembourg, Belgium Franc  
 Malta, Italian Lira/Euro  
 Namibia, South African Rand  
 San Marino, Italian Lira/Euro  
 Swaziland, South African Rand  
 Tonga, Australian Dollar

21 **Appendix C**

The regimes for all countries are given in Table 5.





Table 5 (Continued)

| Country              | 1974    | 1975    | 1976    | 1977    | 1978    | 1979    | 1980    | 1981    | 1982    | 1983    | 1984    | 1985    | 1986    | 1987    | 1988    | 1989    | 1990    | 1991    | 1992    | 1993    | 1994    | 1995    | 1996    | 1997    | 1998    | 1999    | 2000    |         |
|----------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| SOMALIA              | Fix*    |
| SOUTH AFRICA**       | Fix     | Float   | Fix*    |
| SPAIN*               | Fix     |
| SRI LANKA            | Float†  | Float   |
| SUDAN                | Fix†    | Fix*    | Fix†    |
| SURINAME             | Fix†    |
| SWAZILAND            | Fix*    | Fix     |
| SWEDEN*              | Float†  | Interm* |
| SWITZERLAND*         | Interm* |
| SYRIAN ARAB REPUBLIC | Interm* |
| TAJIKISTAN           | Interm* |
| TANZANIA             | Interm* |
| THAILAND**           | Fix†    |
| TOGO                 | Fix*    |
| TONGA                | Fix†    |
| TRINIDAD AND TOBAGO  | Fix     |
| TUNISIA              | Fix     |
| TURKEY**             | Interm* |
| TURKMENISTAN         | Interm* |
| UGANDA               | Interm* |
| UKRAINE              | Interm* |
| UNITED ARAB EMIRATES | Interm* |
| UNITED KINGDOM*      | Interm* |
| UNITED STATES*       | Interm* |
| URUGUAY              | Interm* |
| VANUATU              | Interm* |
| VENEZUELA**          | Interm* |
| VIETNAM              | Interm* |
| YEMEN                | Interm* |
| ZAMBIA               | Interm* |
| ZIMBABWE             | Interm* |

Basket.

■ Not existing or not independent country.

■ One classification variable not available.

Fix † Inconclusives.

Fix\* Uncontroversials.

Interm Dirty.

Interm\* Dirty/CP.

2 Classified in second round.

3 Outliers.

\* Industrial Countries.

\*\* Emerging Economies.

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