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## Exchange Rate Regime Transitions

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**IMF Working Paper**

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**Abstract**

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The “hollowing-out,” or “two poles” hypothesis is tested in the context of a Markov chain model of exchange rate transitions. In particular, two versions of the hypothesis—that hard pegs are an absorbing state, or that fixes and floats form a closed set, with no transitions to intermediate regimes—are tested using two alternative classifications of regimes. While there is some support for the lack of exits from hard pegs (i.e., that they are an absorbing state), the data generally indicate that the intermediate cases will continue to constitute a sizable proportion of actual exchange rate regimes.

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## I. EXCHANGE RATE REGIME TRANSITIONS

Some have argued that the only sustainable regimes are free floating and hard exchange rate commitments—essentially currency boards or monetary unions (Eichengreen, 1994, 1998; Obstfeld and Rogoff, 1995). For instance, Eichengreen (1994, pp. 4–5) says that “... contingent policy rules to hit explicit exchange rate targets will no longer be viable in the twenty-first century ... Countries ... will be forced to choose between floating exchange rates on the one hand and monetary unification on the other.” Similarly, Obstfeld and Rogoff (1995, pp. 74) state “... there is little, if any, comfortable middle ground between floating rates and the adoption of a common currency.” Hence, in the view of these authors, in the future we will see a disappearance of the middle ground that corresponds to soft commitments to some sort of intermediate exchange rate regime—adjustable pegs, crawling pegs, or bands, and perhaps also managed floating. This view is sometimes called the “two poles” or “hollowing out” (e.g., Eichengreen, 1994, pp. 6) theory of exchange rate regimes, and is based on the observation that higher capital mobility makes exchange rate commitments increasingly fragile. However, like the optimal currency area literature, which is essentially static, an explicit or implicit assumption is made that regimes are chosen to last forever, and from this perspective, one would only choose a regime that could be sustained once and for all. Only the hardest peg and the absence of any exchange rate commitment whatsoever are likely to qualify on that basis. Thus Eichengreen (1994, pp. 5), states “This will rule out the maintenance *for extended periods* of pegged but adjustable exchange rates, crawling pegs, and other regimes in which governments pre-announce limits on exchange rate fluctuations ...” (italics added).

However, exchange rate regimes, like other aspects of economic policy, are not chosen once and for all. In fact, history shows us that countries change their regimes frequently, either voluntarily or involuntarily.<sup>2</sup> A particular exchange rate regime may suit the country’s needs at the time—for instance, a peg may be the only way to halt a hyperinflation—but eventually be abandoned even though inflation has been brought down, because there has been a substantial loss of competitiveness.<sup>3</sup> This is the typical sequence with exchange rate based stabilizations—only rarely do they lead to “permanent” pegs. For instance, Poland in 1990 introduced a fixed peg to the dollar to provide an anchor for the price level, which was followed a year later by a crawling band introduced to limit appreciation of the real exchange rate, and, more recently, has moved to flexibility of the zloty exchange rate. Similarly, Brazil succeeded in eradicating hyperinflation in the mid-1990s through the “real plan,” which involved a dollar peg with a very slow rate of crawl. Since 1999, this regime has been replaced by a flexible rate accompanied by inflation targeting. Only if we believed that countries will never be in the situation of using an

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<sup>2</sup>For instance, Klein and Marion (1997) look at the duration of *pegs* (not *regimes*, as is done here), and find that the Latin American pegs in their sample last on average 10 months.

<sup>3</sup>There have been few formal attempts to model transitions between regimes. A notable exception is Bhandari, Flood, and Horne (1989).

exchange peg to disinflate (or never again suffer strong inflationary shocks) would it make sense to argue that countries will never use adjustable pegs as a temporary strategy, but instead will always be at one of the two poles.<sup>4</sup>

Regimes intermediate between a hard fix and a clean float may also be chosen as part of a regional integration strategy. The Exchange Rate Mechanism (ERM) of the European Monetary System, and its predecessor, the Snake, are examples of this. While the ERM has led to membership in a currency union (one of the poles) for 11 of the countries concerned, it lives on in the form of the ERM2 for countries that may subsequently want to join European Economic and Monetary Union (EMU). And it remains an open question whether for other regions integration may stop short of monetary union, and only involve limiting fluctuations among members' currencies.

Transitions between regimes may also reflect the shifting preferences of policymakers (and the public): a populist government may attempt to stimulate output at the expense of exchange rate stability, only to be followed by a more conservative and stability-oriented administration. The exchange rate regime chosen in each case need not be at one or another of the poles. Indeed, for many developing countries, free floating is not a viable option because of a lack of well-developed financial markets and institutions, including a deep foreign exchange market, while the hard constraints of currency boards are not politically acceptable. As a result, the exchange rate regime is not necessarily stable, but fluctuates among various alternative intermediate regimes, depending on the relative weight given to sustaining activity or limiting inflation, and on the shocks hitting the economy.

It is therefore useful to think of exchange rate regime choice not as a once-and-for-all decision but rather in terms of the likelihood of moving from one regime to another. In what follows, it is assumed that the probability of being in one or another regime next period depends only on the current regime. While somewhat restrictive, it supposes that the typical country will face the same likelihood that some shock will push it from its current regime to one of the others—independent of past history. As a first approximation, this would seem an adequate framework for testing hollowing out, which is a hypothesis concerning the direction of transitions, not their cause. Here, the historical data gives us some evidence on the transition between regimes. If we divide the regimes into three categories: hard pegs, floating, and a middle category that includes adjustable or crawling pegs and bands, and managed floats, we can see what the likelihood was in the past of remaining in each of the regimes, or of moving to the two others.

At any point in time, the distribution of regimes reflects these probabilities. However, if the probabilities have changed over time (for instance, as a result of increased capital mobility), the current distribution may not be the same as the *steady-state distribution* of

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<sup>4</sup>Of course, using a peg in this way requires an exit strategy, something considered in Eichengreen, Masson, et al. (1999).

regimes.<sup>5</sup> The latter is of interest also, because it tells us what the long-run equilibrium should look like, if the current transition probabilities remain unchanged. This steady-state distribution is the natural way to test the hollowing-out hypothesis, since the latter implies that the proportion of countries in the middle should be zero in the long run.

We can begin by asking whether there are any cases of exits from hard pegs or pure floats to intermediate regimes. As a notable dissenter to the hollowing-out hypothesis, Jeffrey Frankel (1999), notes, there have been exits from monetary unions (when Czechoslovakia broke up, and when the ruble area became limited to Russia after the CIS states left it). If one goes back further, Canada, which had a free float in 1951–62, had an (adjustable) peg from 1962 until 1970, when it went back to a float. Also, a number of colonies which had currency boards abandoned them upon independence in favor of intermediate regimes, but this was arguably a specific historical episode.

A more systematic test of the hypothesis would involve looking at the probabilities of regime transitions, and projecting them into the future. The two poles view would be strictly correct (if the past is a guide to the future), if there were no exits from either hard pegs or floats (or if so, only to each other). We can test these restrictions on the transition matrix formally, and also calculate the long-run probabilities of the regimes; if the hypothesis is correct, the long-run probability of the middle regime would be zero.

In what follows, data on exchange rate regimes over the past two-and-a-half decades are used for constructing transition matrices, whose properties are then examined, to see whether they support the hypothesis of the disappearance of intermediate regimes. Because classification of regimes is difficult and contentious, we use two different sources. In neither case do the data support a substantial or continuing move away from intermediate regimes.

## II. PROPERTIES OF MARKOV CHAINS AND TRANSITION MATRICES

### A. Definition and Basic Results

It is useful to start with some definitions and basic results (see Feller 1957, chapter 15). We assume that the stochastic process for the choice of exchange rate regimes can be described by a Markov chain, such that the probability of a given country being in each of the  $n$  regimes depends only on its regime in the most recent previous period.<sup>6</sup> It is convenient to write the probability of regime  $s_t=j$  given  $s_{t-1}=i$  as  $p_{ij}$ , and to collect the transition

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<sup>5</sup>In addition to the fact that our sample of countries is finite, so that the observed frequency distribution of regimes may not correspond to the theoretical population density.

<sup>6</sup>However, by augmenting the state space, dependence of probabilities on the regime in earlier periods can be nested in a first-order Markov chain.

probabilities in a matrix  $P=\{p_{ij}\}$ , with the sum across each row equal to unity. In our case, we can represent the transition matrix as follows:

*General Case*  
Probability of Regime in period t

Regime in period t-1	Fix	Intermediate	Float
Fix	$p_{11}$	$p_{12}$	$p_{13}$
Intermediate	$p_{21}$	$p_{22}$	$p_{23}$
Float	$p_{31}$	$p_{32}$	$p_{33}$

A transition matrix (and associated Markov chain) has an *absorbing state*  $i$  if there is no way to reach other states from that state. This would be evidenced by a row with  $p_{ii}=1$  and all other elements 0. For instance, it could be that currency boards are permanent, so that once one was adopted there would be no transitions to other states. If there was a positive probability of going from other regimes to a currency board, therefore, the world might end up being dominated by that regime (if there were no other absorbing states). This could be depicted as follows:

*Fix as an Absorbing State*  
Probability of Regime in period t

Regime in period t-1	Fix	Intermediate	Float
Fix	1	0	0
Intermediate	$p_{21}$	$p_{22}$	$p_{23}$
Float	$p_{31}$	$p_{32}$	$p_{33}$

More generally, there could be a *closed set* of states C such that no state outside of C can be reached from any state in C. The hypothesis of the hollowing out of intermediate regimes would be consistent with fixing and floating together constituting a closed set, from which there were no exits to intermediate regimes:

*Closed Set of Fix and Float*  
Probability of Regime in period t

Regime in period t-1	Fix	Intermediate	Float
Fix	$p_{11}$	0	$1-p_{11}$
Intermediate	$p_{21}$	$p_{22}$	$p_{23}$
Float	$1-p_{33}$	0	$p_{33}$

Thus, transitions between hard fixes and floats could occur, but none back to the intermediate soft pegs, dirty floats, or bands. The hollowing-out hypothesis is satisfied if either fixes or floats are absorbing states, or if together they constitute a closed set. A transition matrix without closed sets (including absorbing states) is termed *irreducible*, that is, every state can be reached from every other state.

Finally, for a given Markov chain we can calculate the *long-run distribution* of regimes by repeatedly applying the transition matrix. If we start with some initial distribution of exchange rate regimes (in the three categories, fix, intermediate, and float)—call this the row vector  $\pi_0$ —then the distribution of regimes in period 1 will be  $\pi_1 = \pi_0 P$  and in period 2,  $\pi_2 = \pi_1 P$ , etc. So the limiting (long-run) distribution will be  $\pi = \lim_{n \rightarrow \infty} \pi_0 P^n$ . The long-run distribution for an important subset of Markov chains,<sup>7</sup> is independent of the initial distribution, and is also called the *invariant distribution* (it is equal to any row of the matrix  $\lim P^n$ , as  $n$  goes to infinity). For all of the subcases consistent with the hollowing-out hypothesis, the long-run distribution is invariant, and implies no regimes in the intermediate category.

It is relevant in any case to compare the current distribution to the long-run distribution. An interesting possibility, for instance, would be that the invariant distribution implied much greater regime polarization than what prevails now (even if the hollowing out hypothesis is not strictly true). As is well known from the persistence in the use of reserve currencies, exchange rate regimes are slow to change, so that the effects of a new economic environment (involving for instance capital account liberalization) might take a long time to be visible in the number of countries in each regime category. Thus, a trend toward polarization might not yet be evident in the actual regime distribution though it would show up in the invariant distribution (and in the transition matrix). Thus, testing of the hollowing-out hypothesis is best done using the latter.

### B. Testing the Hollowing out Hypothesis

The hypothesis that eventually all regimes do converge to fixed or floating means that the intermediate regime gets a zero weight in the invariant distribution, and this is equivalent to the zero restrictions on the transition matrix described above. Strictly speaking, the existence of transitions toward the intermediate regime from fixes and floats (i.e. non-zero transition probabilities) would be incontrovertible evidence that the hypothesis is false. However, the approach to hypothesis testing taken in Bhat (1972) is to ignore those transition probabilities which are zero under the null, and instead test whether the remaining probabilities are consistent with the hypothesis. The relevant test of the hollowing-out hypothesis is that either fixes or floats are absorbing states or that fixing and floating together form a closed set. An absorbing state for one of the two regimes and a closed set constituted

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<sup>7</sup>Those for which the  $P$  matrix has a single unit eigenvalue.

by the two of them together each involves two zero restrictions on the transition matrix. For an absorbing state, there are no transitions away from the regime in question, while for a closed set, there can be transitions from intermediate regimes to fix or float and the latter between themselves, but not from the latter to the intermediate regimes.

Ordering the three states as above into fix, intermediate, and float, respectively, we estimate two transition matrices, the first one unrestricted,  $P = \{ p_{ij} \}$ , and the second one  $P^0$  with two restrictions. In the case that fixed rates are an absorbing state, the restrictions are  $p_{12}=0$  and  $p_{13}=0$  (so  $p_{11}=1$ ). Only this case is relevant, since (as we will see below) the data firmly reject the hypothesis of floating as absorbing state. For the hypothesis of fixes and floats jointly constituting a closed set, the restrictions are  $p_{12}=0$  and  $p_{32}=0$ .

The log likelihood function for each of the estimates can be written as:

$$L(P_{ij}) = \ln B(n_{ij}) + \sum_i \sum_j n_{ij} \ln P_{ij}$$

Maximum likelihood estimates of the two matrices correspond to the sample frequencies of transitions between the regimes, with only the non-zero transitions being included in the restricted case (Bhat 1972, pp. 99). A likelihood ratio statistic equal to twice the difference in the maximized values of log likelihood functions in the two cases is distributed as a chi-square with degrees of freedom equal to two, the number of restrictions. Since the first term (in  $B$  above) is common to both, the likelihood ratio can be written

$$2 \sum_i \sum_j n_{ij} \ln P_{ij}^0 / P_{ij}$$

where the summation is taken only over the non-zero cells.<sup>8</sup> If this statistic is significant, we reject the hypothesis of hollowing out.

### III. CLASSIFICATION OF REGIMES

The problems with the official classification (tabulated in the IMF's *International Financial Statistics* and in more detail in the *Annual Report on Exchange Arrangements and Exchange Restrictions*) are well known. The official classification often does not correspond to the reality of exchange rate fluctuations. For instance, a number of Asian countries were classified as floaters before the 1997-98 crisis, even though de facto they were pegging to the

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<sup>8</sup>The likelihood ratio has to be greater than zero, since the constrained estimates of the probabilities of transitions between fixes and floats will necessarily be greater than the unconstrained ones (and only those cells of rows 1 and 3 are included in the summation), while the estimates for the intermediate regime (the second row) are identical in the two cases.

U.S. dollar. The fact that they were then forced to float does not therefore appear as a transition in the official data. A proposal to make the official classification more relevant is contained in IMF (1999), and the new classification has now been adopted. However, it mainly concerns the classification of the intermediate exchange rate regimes, bringing them more in line with actual practice and providing information on monetary policy strategies. Moreover, data only exist for 1997 and subsequent years.

We estimate transition matrices using two data sources that modify the official classification, due to Ghosh et al. (1997) and Levy Yeyati and Sturzenegger (1999). Their methodologies are very different, which should provide some sense of whether the results are robust. The former relies to some extent on the official classification, while the latter classifies regimes solely on the basis of the behavior of exchange rates and foreign exchange market intervention.

#### A. Ghosh et al. Data

The Ghosh et al. (1997) study looks at actual exchange rate behavior as well as the official classification, and is available from 1960 to 1997 for a broad range of countries. Pegs are distinguished between single currency, SDR pegs, other official basket pegs, and secret basket pegs, and differentiated by the extent that parity adjustments are absent, infrequent or frequent (using as input an analysis of historical data). There is a separate category of cooperative arrangements the European Monetary System (EMS) and its predecessor the Snake, while more flexible arrangements are divided into crawling pegs, target zones, managed floating (with or without heavy intervention), and independent floats.

Since we are interested in the three-way classification of hard pegs, floats, and intermediate regimes, we need to compress their classification. As in all work in this area, there can be serious debate about whether a particular country's regime should fall in one or another of the categories. We include among the hard peggers only those countries with a currency board, and announced pegs with virtually no changes in parities.<sup>9</sup> Those with some parity adjustments (frequent or infrequent) and secret basket pegs are included with the intermediate arrangements. We include in the other polar case only the "independent floats", and all other types of managed or dirty floats are included among the intermediate regimes. This latter group also includes the EMS, which historically has included parity changes and occasional wide fluctuations (in particular after the widening of the bands of fluctuation in July 1993).

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<sup>9</sup>The CFA franc zone countries are classified in the Ghosh et al. data as hard peggers. Despite some changes in the composition of the zone, there have been no changes in parity among the African CFA franc countries (except for Comoros) since 1948, and only one adjustment of the peg to the French franc, in 1994.

In defining fixes and floats relatively narrowly, we are guarding against biasing the test of hollowing out towards rejection. A somewhat wider definition would tend to produce more transitions *away from* the poles, leading to a greater probability of rejection (as we will see below, there have been no exits from currency boards or monetary unions during the 1990s, which is consistent with fixes being an absorbing state). Of course, if the two poles were defined very widely, so that intermediate regimes did not exist in our sample, then hollowing out would follow automatically. But we are far from that extreme.

The transition matrix is first estimated using the whole of the post-Bretton-Woods sample, that is, using data from 1974 through 1997. The matrix is constructed on the basis of 3453 observations: 24 years and 167 countries (not all countries' regimes are available for all dates). Of these 3453 observations, 754 correspond to initial fixes, 418 floats, and 2281 intermediate regimes. The matrix in Table 1 is clearly irreducible: all regimes can be reached from each state. However, each of the 3 regimes is highly persistent, with at least a 90 percent chance of remaining in that regime in the following year. Interestingly, the float regime is the least persistent, however, and the intermediate one the most (based on the relative sizes of the diagonal elements).

Table 1. Transition Matrix, 1974–97

0.9430	0.0544	0.0027
0.0114	0.9601	0.0285
0.0072	0.0885	0.9043

A criticism of using such a long run of data may be that the early years of generalized floating involved some experimentation with regimes, as well as being affected by the turbulence following the oil price shocks. Starting in 1980 at least partially avoids this problem. It can be seen from Table 2 that the transition matrix is little changed, though fixes are somewhat more persistent, while intermediate regimes and floats are somewhat less.

Table 2. Transition Matrix, 1980–97

0.9490	0.0474	0.0036
0.0097	0.9549	0.0354
0.0078	0.0940	0.8982
Test of fixes and floats being a closed set: $2 \cdot \log \text{likelihood} = 119.3$ (p-value < 0.0001)		
Test of fixing as absorbing state: $2 \cdot \log \text{likelihood} = 54.5$ (p-value < 0.0001)		

Table 3. Invariant Distribution and Current State

	Fix	Intermediate	Float
Regimes in 1997	0.1677	0.5749	0.2575
Invariant distribution, 1980–97	0.1529	0.6246	0.2224

Interestingly enough, the long-run (invariant) distribution of regimes looks much like the distribution that prevailed at the end of 1997. In fact, the former implies a somewhat higher frequency of intermediate regimes, and fewer fixes and floats, than prevailed in 1997, suggesting that we will see a move toward, not away from, intermediate regimes.

We now turn to what is arguably the most relevant time period for considering the hollowing-out hypothesis, the 1990s, since it comprises a period during which many developing countries increased their integration with international capital markets, exposing their intermediate exchange rate regimes to greater risk of speculative attack.

Table 4. Transition Matrix, 1990–97

0.9909	0.0000	0.0091
0.0055	0.9234	0.0711
0.0066	0.1093	0.8841
Test of fixes and floats being a closed set: $2 \cdot \log \text{likelihood} = 62.3$ (p-value < 0.0001)		
Test of fixing as absorbing state: $2 \cdot \log \text{likelihood} = 3.98$ (p-value = 0.137)		

Table 5. Invariant Distribution and Current State

	Fix	Intermediate	Float
Regimes in 1997	0.1677	0.5749	0.2575
Invariant distribution, 1990–97	0.3954	0.3554	0.2492

Using 1990–97 data provides somewhat greater support for the two poles, or hollowing-out, hypothesis. Over this period, according to the Ghosh et al. data, there were no exits from fixed rates to intermediate regimes, so one of the constraints needed for hollowing out is satisfied in the sample. Nevertheless, the matrix is irreducible, since there are transitions from fixes to floats and from floats to intermediate regimes, and a formal test of the two constraints of the closed set overwhelmingly rejects it (though with a somewhat lower chi-square statistic). Turning to the hypothesis that fixed rates are an absorbing state, we can only reject this hypothesis at the 13.7 percent significance level given the few transitions away from fixes.<sup>10</sup> There are only two in the data: Trinidad and Tobago in 1992 (from a

<sup>10</sup>John Williamson has pointed out to me a problem with a classification that includes among the hard fixes only those with no changes in parity: this guarantees no transitions away from such regimes! However, the Ghosh et al. data also includes more objective criteria, such as the establishment of monetary unions or currency boards, and their data do not show any transitions away from these.

single currency peg to a float) and Sao Tomé and Príncipe in 1994 (from an official basket peg to a float). Despite this, the invariant distribution, while it gives greater weight to the two poles than one calculated over 1980–97, still gives considerable weight to the middle—indeed, more than to floating rate regimes. Thus, though this data set does provide some support for the hypothesis that the past decade’s experience foreshadows a reduction in the future of the proportion of intermediate exchange rate regimes (and also floats), it is not overwhelming.

Given that the trend is to a somewhat greater support for the hypothesis, it is also of interest to test the stability of the transition matrix when the 1990s are compared to the 1980s. Accordingly, we calculate a likelihood ratio test for the null hypothesis that the two subperiods have the same parameters.<sup>11</sup> The value of the test statistic, 86.6, is significant with a p-value < .0001, so that there is evidence of structural instability. Thus there is some question whether a stable Markov process describes the data, and whether the lack of support for hollowing out even using the most recent data will persist into the future.

### **B. Levy Yeyati and Sturzenegger Data**

These authors completely ignore the official classification and use three variables—monthly percentage changes in the nominal exchange rate, the standard deviation of monthly percentage changes in the exchange rate, and the volatility of reserves—to classify countries into four exchange rate regimes (flexible, dirty float, crawling peg, and fixed) plus an “inconclusive” group in which the variability of reserves seemed to be irrelevant for exchange rate fluctuations. Exchange rate changes are calculated with respect to the US dollar, the French franc, the deutsche mark, the pound sterling, and Japanese yen, as well as, where relevant, some “local” anchor currencies (such as the Indian rupee for Nepal and the South African rand for Namibia). Cluster analysis is used to identify the groups; flexible rate regimes are assumed to be associated with large average percentage changes in the exchange rate, high exchange rate volatility, and low reserves volatility, and fixed rates the opposite constellation. The time period is 1990–98; the list of countries (110 of them) includes all countries for which the relevant data were available in the IMF’s *International Financial Statistics*. Since not all observations were available for all years, there is a total sample of 955 observations.

For our purposes, we need a three-way classification. We drop the inconclusive observations, and group the dirty float and crawling pegs in the intermediate regime. We lose 1 observation per country for the initial state, and calculate the transition matrix over 1991–

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<sup>11</sup>The test statistic is given in Bhat (1972), equation (5.3.23). As discussed in section 5.3 of that book, observations of the transition matrix which are zero are ignored in the calculation, and the number of degrees of freedom is reduced accordingly (by two in this case, since for the first subperiod,  $P(1,3)=0$ , while  $P(1,2)=0$  in the second subperiod. This yields a chi-square with 4, rather than  $(T-1)*n*(n-1)=6$  degrees of freedom.

98. This gives 590 observations, of which 208 initially involve fixes, 227 floats, and the rest (155) in the intermediate regime category. The results for the transition matrix and the invariant distribution are given in Tables 6 and 7.

Table 6. Transition Matrix, 1991–98

0.8413	0.0913	0.0673
0.1935	0.5290	0.2774
0.0440	0.1894	0.7665
Test of fixes and floats being a closed set: $2 \cdot \log \text{likelihood} = 113.5$ (p-value < 0.0001)		
Test of fixing as absorbing state: $2 \cdot \log \text{likelihood} = 60.5$ (p-value < 0.0001)		

Table 7. Invariant Distribution and Current State

	Fix	Intermediate	Float
Regimes in 1998	0.3614	0.2289	0.4096
Invariant distribution, 1991–98	0.3865	0.2294	0.3840

There is a notable difference with the Ghosh et al. data.: regimes are much less persistent than in the latter study, as captured by smaller diagonal elements in the transition matrix. This may well reflect the reality that actual regimes changed even though official pronouncements did not, perhaps because the official regime did not initially reflect reality. However, an example of this that was cited above, Thailand, is classified as an intermediate regime in 1997 and 1998, while in 1996 and before it was in the inconclusive range, and hence was dropped from our sample. Another reason for the apparent lower persistence in regimes is due to a difference in methodology, since fluctuations in exchange rates and reserves reflect external forces as well as the intentions of the authorities. So when exchange market pressures occur, the authorities' commitment is put to the test and the actual regime may diverge from the official one.

It is also notable that the intermediate regime has a lower probability of continuing next period than either fixed or flex. However, there is no evidence that fixes or flexes are absorbing states, or together form a closed set; the data strongly reject these hypotheses (only the absorbing state hypothesis applied to fixed rates is reported). On the contrary, the probability of moving to the middle regime in any given year is about 10 percent when starting from a fix and 20 percent from a float, and as a result the invariant distribution attributes a weight of about a quarter to the intermediate regime, and three-eighths to each of the poles, very similar to the actual distribution, suggesting that no major changes are in the pipeline. Thus, there is no support here for the hollowing-out hypothesis, as Levy Yeyati and Sturzenegger themselves note.

### C. Emerging Market Countries

An objection that can be made to the above empirical exercise is that it concerns a large and heterogeneous set of countries, while the hollowing out hypothesis may be intended specifically for the more advanced countries that are most open to international capital flows. In addition, it could be hypothesized that with the passage of time, more and more countries would be included in the category of advanced countries, so that hollowing out would extend eventually to the whole world. In this view, looking at the historical data on all regime transitions would not give a good indication of future trends, since it reflects the shifting composition of the set of countries. The rejection of structural stability between the 1980s and 1990s for the Ghosh et al. data might reflect this.

A useful way of examining this issue is to restrict the set of countries to the “emerging market countries,” which are integrated with world capital markets. Therefore, the same transition matrix approach was applied to the 27 countries making up the JP Morgan Emerging Markets Bond Index Global.<sup>12</sup> These countries include the larger and most active developing country issuers of international bonds.<sup>13</sup> Of course, one might also include the industrial countries in this group, but interpreting the results would depend very much on whether the creation of EMU was viewed as a unique event or an example for other regions. The creation of the euro on January 1, 1999, is not in fact reflected in the data, which extend only to 1997 or 1998, and which therefore do not include a transition away from the intermediate regime constituted by the EMS towards monetary union. Hence, we focus on the emerging market countries.

Results for the 1990s are presented in Table 8 for both the Ghosh et al. and Levy Yeyati-Sturzenegger data. The table contains also a stability test for the former classification, when the 1980s are compared to the 1990s (this could not be done for the latter classification, given the shorter sample period). Interestingly enough, a stability test does not reject the hypothesis that the two decades’ data in the Ghosh et al. classification are drawn from the same sample.

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<sup>12</sup>The more widely quoted EMBI+ index only includes a representative handful of countries, for ease in updating the yield spread.

<sup>13</sup>The countries are Algeria, Argentina, Brazil, Bulgaria, Chile, China, Colombia, Cote d’Ivoire, Croatia, Ecuador, Greece, Hungary, Lebanon, Malaysia, Mexico, Morocco, Nigeria, Panama, Peru, the Philippines, Poland, Russia, South Africa, South Korea, Thailand, Turkey, and Venezuela.

Table 8. Emerging Market Countries in the 1990s:  
Transition Matrices and Tests of Hollowing Out

<b>Ghosh et al. Data</b>		
1.0000	0.0000	0.0000
0.0097	0.9578	0.0325
0.0143	0.0857	0.9000
Test of structural stability, 1980s vs 1990s: $2 \cdot \log \text{likelihood} = 2.14$ (p-value=0.55) Test of fixes and floats being a closed set: $2 \cdot \log \text{likelihood} = 11.5$ (p-value=0.003) Test of fixing as absorbing state: $2 \cdot \log \text{likelihood} = 0$ (p-value=1.000)		
Long run distribution (distribution in 1997):		
1.0000 (0.1538)	0.0000 (0.6154)	0.0000 (0.2308)
<b>Levy Yeyati and Sturzenegger data</b>		
0.6667	0.1905	0.1429
0.1569	0.5490	0.2941
0.0192	0.3269	0.6538
Test of fixes and floats being a closed set: $2 \cdot \log \text{likelihood} = 34.9$ (p-value<0.0001) Test of fixing as absorbing state: $2 \cdot \log \text{likelihood} = 11.4$ (p-value=0.003)		
Invariant distribution (distribution in 1998):		
0.2046 (0.1875)	0.3844 (0.3125)	0.4110 (0.5000)

The test of the hollowing out hypothesis gives markedly different results in the two classifications. It is soundly rejected by the Levy Yeyati-Sturzenegger data, but a variant of hollowing out—namely that fixed rates are an absorbing state—is satisfied by the Ghosh et al. data. This results from the fact that there are no transitions away from hard fixes in the Ghosh et al. classification, even though there are transitions to the intermediate regimes from floats. As a result, the Markov chain predicts that after a very long transition, all countries would have pegged rates, and there would be no floats or intermediate regimes. The short sample period and the restricted set of countries suggest caution in accepting this result; its relevance to the entire population of countries relies on the subsidiary hypothesis that all will eventually resemble this set of emerging market countries. Moreover, it should be noted that since intermediate regimes are very persistent, as evidenced by a value of 0.9578 on the diagonal of the transition matrix, it takes 83 years before the proportion of intermediate regimes, which is 62 percent initially, is reduced to 25 percent (and 166 years to 10 percent).

The Levy Yeyati-Sturzenegger classification, based on actual exchange rate and reserves behavior, has starkly contrasting implications. There are frequent transitions away from fixed rates, to both the intermediate regime and to floats, and the transitions from floats are mainly to the intermediate regimes. As a result, the hollowing out hypothesis in either form is soundly rejected, and the invariant distribution implies proportions of roughly 0.2,

0.4, and 0.4, for the three regimes, implying some future increase in the proportion of fixes and intermediate regimes, at the expense of floats.

#### IV. CONCLUSION

Historical evidence of regime transitions gives an indication of whether the trend towards the poles of exchange rate regimes, which some commentators have divined in the 1990s, will eventually lead to the disappearance of intermediate regimes. Projecting transitions into the future does not produce such a hollowing out. The hypothesis that there are only transitions toward the two poles, and not toward the middle, can generally be overwhelmingly rejected by data samples based on the widest possible set of countries. We have guarded against the danger of arbitrary classification of regimes by using two different data sets that depart from the official classification. Both data sets suggest that a range of exchange rate regimes will be present for the foreseeable future, and will constitute roughly a quarter to a third of all regimes, though the Ghosh et al. data for the 1990s cannot reject the hypothesis of fixed rates as absorbing state. The Levy Yeyati-Sturznegger data set, which is based on what governments do, not what they say, overwhelmingly rejects all variants of hollowing out.

Of course, using historical data for transitions raises the danger that we are using data which are no longer relevant, or that the trends in capital mobility, which have affected some countries (emerging markets) will spread to others in the future, producing an irreversible movement toward the poles. We therefore also look at a restricted set of countries, those classified as emerging markets, in the 1990s. Results for the Ghosh et al. data set suggest that eventually fixed rates will prevail as the single exchange rate regime for these countries. This result emerges because of the small number of hard pegs and the short time period, leading to the absence of any exits from this regime. As mentioned in the introduction, there are earlier examples of breakdowns of both monetary unions and currency boards, and this experience is still relevant to an environment with higher capital mobility (capital mobility can be expected to make all exchange rate commitments, including fixes, more fragile). The starkly different implications of the Levy Yeyati-Sturznegger data set, which strongly rejects the two forms of hollowing-out hypothesis for even this restricted set of countries, also throw doubt on hard pegs as the solution for all countries. The evidence of transitions thus suggests that intermediate regimes will continue to constitute an important fraction of actual exchange rate regimes.

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