The Nature of Exchange Rate Regimes*

by

Michael W. Klein
Fletcher School, Tufts University and NBER

and

Jay C. Shambaugh
Dartmouth College

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Abstract: The impermanence of fixed exchange rates has become a stylized fact in international finance. The combination of a view that pegs do not really peg with the "fear of floating" view that floats do not really float generates the conclusion that exchange rate regimes are, in practice, unimportant for the behavior of the exchange rate. This is consistent with evidence on the irrelevance of a country's choice of exchange rate regime for general macroeconomic performance. Recently, though, more studies have shown the exchange rate regime does matter in some contexts. In this paper, we attempt to reconcile the perception that fixed exchange rates are only a "mirage" with the recent research showing the effects of fixed exchange rates on trade, monetary autonomy, and growth. First we demonstrate that, while pegs frequently break, many do last and those that break tend to reform, so a fixed exchange rate today is a good predictor that one will exist in the future. Second, we study the exchange rate effect of fixed exchange rates. Fixed exchange rates exhibit greater bilateral exchange rate stability today and in the future. Pegs also display lower multilateral volatility, which may explain why exchange rate regimes have an effect on a number of different macroeconomic variables.

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The choice of an exchange rate regime, and the consequences of this choice, traditionally represents a central topic in international finance. But, recently, research has called into question the relevance of this line of inquiry. This is demonstrated by two of the more evocative titles in international finance articles published in the last decade, “The Mirage of Fixed Exchange Rates” (Obstfeld and Rogoff 1995), and “The Fear of Floating” (Calvo and Reinhart 2002). Obstfeld and Rogoff (1995) suggest that fixed rates are not all that fixed, writing “literally only a handful of countries in the world today have continuously maintained tightly fixed exchange rates against any currency for five years or more.” [p. 87] Calvo and Reinhart (2002) argue that floating rates do not really float, rather governments that claim to allow market forces to determine the value of their currencies actually act to minimize exchange rate fluctuations.

Taken together, these influential articles suggest that the exchange rate regime is, in practice, unimportant and perhaps irrelevant for the actual behavior of the exchange rate. This conclusion is bolstered by empirical research that finds little role for exchange rate regimes in determining major macroeconomic outcomes beyond the real exchange rate (see Mussa (1986), Baxter and Stockman (1989), and Flood and Rose (1995)). Altogether, based on these works, there is a general impression that exchange rate regimes – in spite of all the attention they receive – are in some ways unimportant.

Several strands of more recent research, however, demonstrate a relevant role for the exchange rate regime. Most of these papers, in part motivated by Calvo and Reinhart (2002), used *de facto* classifications to determine pegging status. In the realm of trade, Rose (2000) finds that currency unions stimulate trade, and Klein and Shambaugh (forthcoming) find similar results for fixed exchange rates which, of course, exhibit less permanence than currency unions. In the context of macroeconomic policy, Shambaugh (2004) and Obstfeld, Shambaugh, and Taylor (2005) find that fixed exchange rates significantly limit monetary autonomy. Broda (2004) and Edwards and Levy-Yeyati (2005) find that the exchange rate regime affects the transmission of terms of trade shocks, and Broda (2006) finds the exchange rate regime affects national price levels. Ghosh, Gulde, and Wolf (2002) note effects on inflation. Other recent research finds a role for the exchange rate regime on growth (see Aghion, Bachetta, Ranciere and Rogoff 2006, Levy-Yeyati and Sturzeneggar 2003, Husain *et al.* 2005, di Giovanni and

Shambaugh 2006, and Ghosh *et al*. 2002) or growth volatility (Ghosh *et al.* 1997). This new set of evidence on the economic impact of the exchange rate regime calls for a re-examination of the common impression, based on earlier research, that exchange rate regimes are irrelevant.

This paper demonstrates the extent to which exchange rate regimes really do matter for exchange rate outcomes, and thus helps explain the source of effects of recent research demonstrating trade and macroeconomic consequences of exchange rate regimes. It provides a bridge between the view of the irrelevance of exchange rate regimes and the newer empirical evidence by examining the nature of *de facto* exchange rate regimes themselves, studying their duration, dynamics, and the extent they affect the exchange rate. If exchange rates regimes do not last, they should not affect the economy. Even if they last, if they do not have an appreciable impact on the exchange rate (perhaps due to fear of floating behavior) they would still be irrelevant. In essence, we try to provide a new set of stylized facts on exchange rate regimes that helps explain why the new wave of empirical evidence on their effects can occur. We generate a number of results that demonstrate that while not infinitely lived, fixed exchange rates do provide a stability of the exchange rate notably different from floating countries. These results are robust across a variety of exchange rate regime classifications. Differences in results across classifications demonstrate how these classification schemes diverge and the types of questions that each are best suited to address.

We begin, in Section 2, by explaining how we use a modified version of the Shambaugh (2004) classification scheme to obtain *de facto* fixed exchange rate spells and floating (i.e. non-fixed) exchange rate spells for 125 countries over the period 1973 to 2004. In Section 3 we then demonstrate that, while almost half of the fixed exchange rate spells do not last more than two years, the expected duration of a peg increases dramatically if it survives past that age. Consequently, at any one time, the set of countries that are pegged includes a large proportion of those with a peg lasting for a relatively long duration.

We also demonstrate, in Section 3, that the distribution of floating exchange rate spells is similar to the distribution of fixed exchange rate spells, with a large number of short-lived floating exchange rate spells and a smaller number of long-lived floating exchange rate spells. An implication of this is that when an exchange rate switches from a peg to a float, the float itself may be quickly changed back into a peg. This dynamic behavior of exchange rate regimes, when combined with an analysis of the duration of fixed exchange rate spells and floating exchange rate spells, paints a different picture than one would expect from the well-known "mirage" of fixed exchange rates.

In addition, pegs and nonpegs do look quite distinct in terms of exchange rate volatility. This is not to argue that no countries manage their nonpegged exchange rates, or that no countries mis-declare their regimes, but to say that some countries actually do float and their exchange rates are notably more volatile than the pegs.

A consequence of these characteristics concerning the duration and the dynamics of exchange rate regimes is that a country that has a fixed exchange rate today can be expected to exhibit greater exchange rate stability, both today and over the course of time, than a country that currently has a floating exchange rate, notwithstanding the fact that exchange rate pegs break with some frequency and a country that has a fixed exchange rate today may find its currency floating tomorrow. In particular, we show that a country that is pegged today will have lower bilateral exchange rate volatility in the future than a country that is floating. An implication of this result is that firms have a reasonable expectation that a current fixed exchange rate will last. This helps explain why, for example, Klein and Shambaugh (forthcoming) find that fixed exchange rates are associated with greater bilateral trade in a gravity model, even given the fact that there are a large number of short-lived exchange rate spells.

The lower volatility of a bilateral exchange rate extends to multilateral volatility as well (beyond the reduction in multilateral volatility due to a reduction in bilateral volatility with the base country). Pegging the exchange rate tends to prevent extremely high bilateral volatility outcomes which, due to a high correlation in the volatility across all major exchange rates, can lead to high multilateral volatility. However, but for cases of extreme volatility, there is not strong evidence that a bilateral peg reduces multilateral volatility. There are important implications of this distinct effect of pegging on bilateral and multilateral volatility for trade and macroeconomic outcomes since bilateral trade, and macroeconomic stability obtained by an exchange rate anchor, only require bilateral stability while broader results across many sectors, for example economic growth, may be somewhat situation or time dependent.

II. Exchange Rate Spells, Fixed and Floating

A central part of this study, or any other one that focuses on the role of the exchange rate regime, is its definitions of the regimes themselves. It has been well documented that the governments' declarations to the International Monetary Fund as to the exchange rate regimes in place are not always accurate (see, for example, Calvo and Reinhart 2002). Therefore, in this paper we rely on *de facto* exchange rate behavior rather than *de jure* declarations of whether a country has a fixed or a flexible exchange rate.

The basis of our coding a country as having a fixed or a floating (i.e. not a fixed) exchange rate is a modification of the classification scheme used by Shambaugh (2004) who, in turn, closely followed the method employed by Obstfeld and Rogoff (1995).[1] In this paper, we considered a country as having a fixed exchange rate, with its currency pegged to the currency of a base country, if its month-end official bilateral exchange rate stays within a ± 2 percent band over the course of a given year.[2] The coding is annual and, therefore, the peg must last for a full calendar year for a country to be classified as pegged for that year. Pegs that last less than a full year are classified as nonpegs.[3] The base country is determined through the pegging history of a given country as well as through tests against a variety of countries, the declared intent of the country, and readings of various currency histories. For the purpose of comparative bilateral volatility tests, we need a "base" country for countries that float. In these cases, the base is the country to which the country with the floating exchange rate pegged in the past, or a major industrial country with which it has a prominent economic relationships (for

[1] In an appendix we provide detailed analysis of alternate classifications and the robustness of our results. Two other prominent studies that developed a classification scheme for exchange rate regimes are Levy-Yeyati and Sturzeneggar (2003) and Reinhart and Rogoff (2004). The classification used by Levy-Yeyati and Sturzenegger (2003) uses information on reserves as well as currency values such that stable rates in the absence of reserve changes might not be called pegs while somewhat volatile exchange rates paired with extensive intervention may be considered as pegged. Reinhart and Rogoff (2004) use parallel market rates and focus on the conditional probability of staying within a range over a five year period, a method that could bias our results to finding long lived pegs. We compare our classification with Reinhart and Rogoff and the declared status countries report to the IMF below. We make some comparisons to the LYS work, but due to holes in the data caused by occasional observations marked inconclusive by the coding, it is difficult to do duration analysis on the LYS data.

[2] The size of the band is not overly important. Most of the pegged observations stay within an even tighter band, but 2% is consistent with bands used in Bretton Woods, the EMS, and in Obstfeld and Rogoff (1995).

[3] For example, a country with a peg lasting from June 2001 to May 2005 would be classified as floating in 2001 and 2005 and pegged from 2002 – 4. By including in the float sample years of partial pegging, this should bias against finding any difference between pegs and floats. While there may be pegs, or attempted pegs, shorter than one year, our view is that for the time spans less than one year it becomes increasingly likely that the stability one would find in the data is an accident and not a peg – false positives would rise. Also, we posit that market participants will not have detected or believed a peg until it has lasted more than a few months.

details see Shambaugh 2004).[4] We drop from our sample countries with a population of less than 400,000 in 1999. We also drop observations that represent currency unions (but for the members of the single currency in Europe from 1999 onwards) in order to keep these episodes from biasing the sample towards long-lasting fixed exchange rate pegs.[5] The United States is not included in the data set.

In this work, we focus on the differences between actually being pegged and not being pegged. We do not attempt to distinguish among a set of intermediate regimes because this would necessarily introduce more errors to a classification scheme since the boundary between a *de facto* peg and a nonpeg can be fairly clearly draw while the lines separating one intermediate regime from another is much less distinct. For example, some of the most freely floating countries manage their exchange rate to some extent, but it is difficult, in practice, to distinguish these managed floats from target zones with wide and movable bands.

Table 1 presents statistics on the prevalence of fixed and floating exchange rates in our panel data set. This first two columns show that this data set is drawn from the experience of 125 countries, 21 of which are classified as major industrial countries.[6] Of the 3,924 country / year observations in this data set, 47.53 percent are pegs.[7] Pegs are more prevalent among developing countries than among industrial countries, with 49.22 percent of the developing country / year observations representing pegs but only 39.34 percent of the industrial country / year observations representing pegs.

[4] Shambaugh (2004) required that a country stayed pegged longer than a year to insure that spurious pegs were not misclassified. A requirement that pegs last more than one year to be classified as a peg would bias our results by eliminating the shortest lived (single year) pegs. In addition, one-time discrete devaluations (one month with a change in the exchange rate greater than 2%, but 11 months exactly equal to zero) were considered pegs in Shambaugh (2004), but here we count these as breaks in the peg to avoid a bias towards finding long lasting pegs. This leaves the coding quite similar to the way Obstfeld and Rogoff classified countries. Considering a devaluation a break in the peg is important. We make the decision so as to not artificially increase the length of peg spells. For example, a country that devalues every other year but otherwise stays pegged may be the same policy over a decade, but it does not have the same peg. This coding differs from Reinhart and Rogoff, Shambaugh, and de jure classifications which allow devaluations. The Appendix shows our results using these classifications and shows the difference this can make.

[5] Obstfeld and Rogoff (1995) identify 27 small countries with long lasting pegs in their Tables 2 and 3. By dropping countries with small populations, and currency unions, we retain only 8 of these 27; Bahrain, Djibouti, Lesotho, Namibia, Oman, Qatar, Swaziland, and United Arab Emirates. We set the population hurdle at 400,000 in order to retain in our data set the smallest country that Obstfeld and Rogoff keep (Luxembourg) and yet to exclude most of the countries they exclude.

[6] Iceland is the only OECD member not included in our data set, and is dropped because its population was less than 400,000 in 1999.

[7] There are 3,924 observations, rather than 125 × 32 = 4000, because 76 observations represent (non-Euro) currency unions.

Table 1 also presents some basic statistics on fixed exchange rate spells and floating exchange rate spells. A fixed exchange rate spell is a set of consecutive years during which a country continually pegs its currency, and a floating exchange rate spell is a set of consecutive years during which a country continually does not peg its currency. These spells are the basic unit of analysis in this paper. We focus on spells to understand the extent to which a particular peg lasts as opposed to over-arching policy regimes. The minimum spell duration is 1 year, and the maximum spell duration is 32 years. The statistics in Table 1 show that there are 398 peg spells in our panel, with an average of 3.18 peg spells per country, and 395 float spells, with an average of 3.16 float spells per country. The median duration of both peg and float spells is 2 years, and the mean durations are also similar, with the average peg spell lasting for 4.67 years and the average float spell lasting for 5.21 years. There are not dramatic differences in these statistics between the 21 major industrial countries and the 104 other countries included in the sample. The differences between the means and the medians of peg and float spells, and the size of the standard deviations relative to the means for both types of spells, suggests a skewness in the distribution. This is demonstrated in the histograms in Figures 1 and 2 that show that both peg and float spells are characterized by a large number of spells with very short duration, and a smaller number of spells with longer duration.[8]

If one allows a peg that devalues to a new value to count as a continuous peg (Obstfeld and Rogoff did not, and from the perspective of economic agents such moves may be importantly different from continuous pegs) obviously the mean length of pegs and floats will increase as peg spells are increased and there are fewer one year floats that were devaluations. Thus, with Reinhart and Rogoff, Shambaugh, or *de jure* codings, we see much longer means. Reinhart and Rogoff in particular strive for less flipping of regimes by focusing on 5 year rolling windows thus there is relatively little changing in their coding. Husain *et al.* use the Reinhart Rogoff coding in their paper and include a small section on duration. They report an average peg spell duration of 28 years. There are a number of reasons beyond coding for such a large average. They have a much longer sample and as such, very long regimes will affect the average (medians are not reported). In addition, they include very small countries

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[8] Klein and Marion (1997) show that exchange rate pegs among Latin American and Caribbean countries are also characterized by a large number of very short pegs and a smaller number of long-lived pegs.

(eliminated in Obstfeld and Rogoff) which have much longer spells and include some long run currency unions (such as Panama). Appendix A shows comparable statistics with our data sample across the classifications. The Reinhart Rogoff coding yields a peg median of 7 and mean of 11 years (floats are even more durable with a mean and median of 19 years). As the appendix discusses, focusing on regimes as opposed to spells and smoothing regimes over time (as in Reinhart and Rogoff) results in longer pegs durations. The Shambaugh (2004) coding which also allows devaluations and drops single year pegs but focuses on annual patterns and does not try to smooth regime switches generates a peg spell median of 5 years and mean of 9 years (floats have a median of 7 years and mean of 11).

The large number of both peg and float spells that have short duration in our data, where the focus is on peg spells with non-changing rates, is also evident from the statistics in Table 2. These statistics show that about 56 percent of the peg spells, and about 65 percent of the float spells, survive for at least two years; of course, this means that 44 percent of the peg spells and 36 percent of the float spells last for only one year. Somewhat fewer than a third of the peg spells (30.14 percent) and a little more than a third of the float spells (33.97 percent) last for at least 5 years. While the view that pegs frequently break is not uncommon, the result presented here that floats are equally fleeting is more novel. As seen in the 4th column of table 3, a large number of broken pegs have repegged by the third year after breaking the peg (only 48% of floats last 3 years).

The general finding, that over 70% of peg spells do not last over five years confirms the basic idea of Obstfeld and Rogoff (1995) that a majority of pegs are short-lived. On the other hand, a fair number do last long term, perhaps more than "handful" suggested by Obstfeld and Rogoff,[9] and certainly more than that suggested by the stylized fact that all pegs break. There are two sources of the difference in our results from those of Obstfeld and Rogoff (1995). First, we have included some countries that Obstfeld and Rogoff did not include through our use of a strict population cutoff. Far more importantly, though, is the timing of Obstfeld and Rogoff's study. Their paper was, in part, motivated to explain why pegs were, in the mid-

[9] Obstfeld and Rogoff (1995) write "The striking conclusion from Table 2 is that aside from some small tourism economies, oil sheikdoms, and highly dependent principalities, literally only a handful of countries in the world today have maintained tightly fixed exchange rates *against any currency* for five years or more." (p. 87, italics in original).

1990s, not lasting, as evidenced by the fact that many countries in the EMS that could have defended their pegs chose not to do so and reflecting the notion that the large and swift-moving capital markets of the day had made pegging more difficult. The timing in 1995 meant that many longstanding pegs had ended in the past few years due to the EMS crisis, the Tequila Crisis, and the devaluation of the CFA countries against the franc. Despite the size and speed of capital markets, though, many of these pegs were re-established and new ones lasted as well such that by 2000, there were just as many long-lived pegs as there were in 1990. Figure 3 shows that our coding shows the period from 1994-8 as the low point of long-lived pegs with only an average 17 in those years (out of roughly 125 countries in the sample)[10] vs. a post Bretton Woods average of 32 and 36 by the year 2000.[11] Thus, a focus on the entire post–Bretton Woods era, rather than the situation in 1995, and on peg spells, rather than countries, alters the impression one has of the durability of exchange rate pegs.[12]

A more complete characterization of these spells involves an analysis of their survival rates, duration dependence, and factors that affect their duration dependence. We next turn to these issues.

III. Exchange Rate Spells: Survival Rates and Hazard Functions

The statistics presented in Tables 1 and 2 offer a sketch of the unconditional characteristics of spells, such as their mean and median duration. But these might not be the relevant measures for considering, say, how an importer at a particular moment views the likelihood of a fixed exchange rate being maintained between that time, when a contract is signed, and some time in the immediate future when delivery is taken and payment is made. In this section we offer analyses of peg and float spells that more closely reflects how economic

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[10] The panel is roughly balanced with between 122 and 125 countries in the sample. The slight variation comes from the fact that currency unions are eliminated from sample with the exception of spells that began as pegs and converted to currency unions (some EMU observations)

[11] Pegs lasting at least 5 years in 2000 includes some oil countries and the CFA countries, but also many EU nations, Argentina, China, and El Salvador. The full list is: Argentina, Austria, Bahrain, Belgium, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, China, Comoros, Congo (Republic of), Cote D'Ivoire, Denmark, Djibouti, El Salvador, Equatorial Guinea, Gabon, Hong Kong, Jordan, Lebanon, Lesotho, Luxembourg, Mali, Namibia, Nepal, Netherlands, Niger, Oman, Qatar, Saudi Arabia, Senegal, Swaziland, Syria, Togo, UAE.

[12] As demonstrated by the figures in the appendix, other classification schemes also show the early nineties as a low in terms of the number of long pegs and all show today as a post Bretton Woods high. Given that the other classifications allow a discrete devaluation, they do not show a large drop in the number of 5 year pegs after the EMS and CFA crises, but the overall message is the same.

agents view the likely permanence of a peg or the continuation of a policy of allowing the exchange rate to float.[13]

The statistics in Table 3 present a first look at the conditional likelihood that a current peg spell or a float spell will be maintained in subsequent years. The first rows of that table shows that about 82 percent of the countries in the sample that are pegging their exchange rate in any given year continue to peg the exchange rate in the subsequent year, and about 83 percent of countries that have a floating exchange rate in any given year continue to float in the subsequent year. At a longer horizon, 65.75 percent of countries that peg their exchange rate in a given year have pegged continuously for three more years, and 55.29 percent have pegged continuously for five years from the initial given year. The statistics for countries that have a floating exchange rate are quite similar, with 65.08 percent floating in a given year continuing to do so three years hence, and 54.07% of those continuing to float five years hence. This high persistence of maintaining a state of pegging or floating, especially relative to the fact that nearly half of the peg spells and more than a third of float spells end within their first year, reflects the fact that the statistics in this table are based on annual cross sections, rather than spells, and there is a large weight given to long-lived spells in these annual cross sections. Given that analysis of exchange rate regime's effects on growth or other variables involves annual observations, they too will draw a long peg observation more often which is why these statistics may be more important than the spell based ones.

Based on these statistics, we may think of an importer or an exporter as viewing spells as fairly durable. But the statistics in Table 3 are based on annual data alone, and are only conditioned on whether a country was pegged or had a floating exchange rate in a previous year. Economic agents have more information than this and, in particular, they know how long a peg spell or a float spell has been in effect. Thus, it is useful to consider a spell-based method

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[13] Masson (2001), Masson and Ruge-Murcia (2005) and Eichengreen and Razo-Garcia (2006) are related to this analysis, although these papers are focused on the question of whether the international monetary system is moving toward an "empty middle" consisting of mainly currency unions, on the one hand, and free floats, on the other, or, alternatively, whether transitions are slow and countries shift back to the middle, not exclusively away from it. These papers look at switching propensities across hard pegs, intermediate regimes (including pegs) and floats. Their results are related to our observations that neither pegging nor floating is an absorbing state and flipping back and forth is common. The focus in these papers on extreme polar cases, and the inclusion in the broad middle band of what we define as both pegs and nonpegs, however, distinguishes this paper from those works.

for addressing the issue of the likelihood that a country has a pegged or floating exchange rate this year, conditional on its currency arrangement in the previous year. One method of doing this involves survival analysis. In Table 4 we present statistics that show the probability of a spell surviving through Year *t*, given that it has survived up until the beginning of that time (that is, the peg was maintained or the float continued through Year *t – 1*). Survival probabilities are presented for the full sample, as well as for the subsamples of the 21 industrial countries and the 104 developing countries, for the conditional survival rates in Years 2 through 6 (as discussed in Section II, all pegs must survive for one year, by definition, and for purposes of this table, this initial year is called Year *1*). The statistics in this table show that 55.9 percent of all peg spells, and 65.8 percent of all float spells, survive to their second year. Of those that survive this long, a larger proportion (70.7 percent of pegs and 75 percent of floats) survive until the third year. The proportion of those peg and float spells that survive into their fourth year, conditional on surviving their third year, again rises. Once a peg has been in existence for a few years, there is a very strong chance (>85%) that it will last another year.

One tool used in survival analysis is the hazard function. In this context, a hazard function, $h(t)$, represents the likelihood that a peg that has lasted up until year $t - 1$ ends in year t when the currency begins to float or, alternatively, the likelihood that a floating exchange rate that has lasted up until year $t - 1$ switches to a peg in year t. A set of spells is said to exhibit positive duration dependence and a decreasing hazard if $h'(t) < 0$, negative duration dependence and an increasing hazard if $h'(t) > 0$, or constant duration dependence and a constant hazard if $h'(t)=0$.[14] Thus, the statistics in Table 4 imply a decreasing hazard, and positive duration dependence, for both peg spells and float spells.

Beyond the duration dependence of spells themselves, we are interested in the question of how quickly a country that goes off of a peg returns to a fixed exchange rate after a period of floating, and the associated question of the effect of time spent on a previous peg on the duration dependence of a float spell. This issue of the dynamic nature of switching from peg

[14] For a distribution of stochastic durations, T, the probability distribution of durations is $F(t) = Pr(T<t)$. A Survivor Function is $S(t) = 1 – F(t) = Pr(T \geq t)$. S(t) is the likelihood that a spell will last up to period t. The Hazard Function is the probability that spells will be completed (i.e. pegs will end, or floats will end) at duration t, conditional on the fact that they have lasted up until moment t. The hazard function is the derivative of the natural logarithm of the survivor function with respect to t, $h(t) = - d \ln S(t) / dt$. For a good introduction to duration data and hazard functions, see Kiefer (1988).

spells to float spells, or from float spells to peg spells, can be best addressed by estimating the effect on a hazard function of the time spent on the immediately preceding spell. To do this, we estimates a Weibull hazard function that takes the form

$$h(t,\lambda,\mathbf{x},\beta) = \lambda t^{(\lambda-1)} \exp(\mathbf{x}\boldsymbol{\beta})$$

where t is the time in the spell, $\mathbf{x}$ is vector of covariates that shift the hazard function, $\boldsymbol{\beta}$ is a vector of coefficients associated with these covariates, and λ is a parameter in the baseline Weibull hazard function, $\lambda t^{(\lambda-1)}$. A larger value of a particular covariate, x_i, increases the hazard (i.e. it makes it more likely that a spell will end in period t, given its survival to period $t-1$), if its associated coefficient, β_i, is positive, and conversely. The baseline hazard function is decreasing in t (and thus exhibits positive duration dependence) if $\lambda < 1$, while it exhibits negative duration dependence if $\lambda > 1$, and constant duration dependence if $\lambda = 1$.

The central covariate of interest for our analysis is the time spent in the immediately preceding float spell, when estimating a peg spell hazard function, or the time spent in the immediately preceding peg spell, when estimating a float spell hazard function. A positive value of the coefficient associated with the length of the immediately preceding float spell in an estimate of the peg spell hazard function implies that a shorter previous float is associated with a lower subsequent peg spell hazard; that is, peg spells tend to last longer if the immediately preceding float spells are shorter (as we have seen, a high proportion of float spells last for only one year). Also, a positive value of the coefficient associated with the length of the immediately preceding peg spell in an estimate of the float spell hazard function implies that longer peg spells are associated with shorter subsequent float spells.

Table 5 presents the estimates of the coefficients for the covariates of the length of the immediately preceding spell, as well as a dummy variable that equals 1 for spells associated with the 21 industrial countries in the sample, and, for peg spells, another dummy variable that equals 1 if the base country is the United States. This table also presents the estimate of the hazard function parameter λ. The estimated λ is .84 and is statistically significantly less than one. This confirms the statistical robustness of the observation that both pegs and floats become more durable over time.[15]

[15] The estimated λ is less than one and significant even if no covariates are included. For peg spells: 0.798 with a s.e. of 0.032 and for float spells: 0.845 with a s.e. of 0.034.

The estimates presented in Table 5 show that the coefficient on the previous float spell is positive and significant for peg spells, and the coefficient on the previous peg spell is positive and significant for float spells. As discussed above, these coefficients imply that, for the estimated peg spell hazard, short float spells are associated with longer subsequent peg spell (since the hazard is lower) and also, from the estimated float spell hazard, that a long peg spell is associated with a shorter subsequent float spell. The results in this table also show that pegs to the United States dollar have a higher hazard rate, *ceteris paribus*, than pegs to other bases.[16]

The results presented in this section suggest a greater durability of exchange rate spells than one might expect from other research and, even when pegs break, they tend to re-form. Next, we will show that this matters because exchange rate behavior under a pegged exchange rate differs dramatically from under a float, and the number of years spent with a peg is a determinant of the volatility of the exchange rate over the sample period.

IV. The Exchange Rate Consequences of Pegging

Currency pegs, by definition, exhibit more bilateral exchange rate stability than floating exchange rates; but how much more? The "fear of floating" result suggests that this difference is not large. Furthermore, is bilateral stability from a peg with a base country associated with greater multilateral stability with non-base exchange rates? For a peg to matter for some outcomes such as growth, it seems a difference across the trade weighted exchange rate, not just one bilateral rate, is important. Finally, in light of the dynamic behavior of exchange rate spells, whereby pegs break but then re-form, what is the exchange rate volatility in the future for a country pegged today? For forward looking behavior to change, pegs must tell us something about the future. In this section we address these questions regarding the exchange rate effects of fixed exchange rates.

One might view results regarding the bilateral volatility across regimes as tautological. That pegs have lower bilateral volatility should be a given, but it is not generally accepted that the difference is striking. Calvo and Reinhart's paper "Fear of Floating" is one of the more cited and influential papers in the field in the last decade. The paper shows that many countries

[16] The United States is the base country for 51percent of the pegs in this sample. The other base countries include France (the base for 27 percent of the pegs), South Africa (6 percent), the United Kingdom (2 percent), Belgium (1.5 percent), India (1 percent), Portugal (less than 1 percent), Malaysia (less than 1 percent), and Australia (less than 1 percent).

that say they float do not really do so. It has sometimes been taken more broadly to mean that floats do not really float at all. We agree that many countries mislabel themselves – hence our use of a *de facto* coding – and instead are focused on determining if countries that are actually not pegging (*de facto* nonpegs) look dramatically different from pegs – the question is one of magnitudes, not simply sign or statistical significance.

Calvo and Reinhart examined a variety of measures and often used the benchmark of Australia or Japan to show that few countries floated as freely as these idealized floats. While Japan is certainly not a pure free float (its reserves demonstrate the magnitude of its interventions), the yen has moved considerably over three decades and from year to year. The yen/dollar exchange rate has ranged from 360 to 80 and the average range in a given year is 16% and average change over a year is 11%. This is clearly a fairly volatile rate. Strikingly, in our data set, the spells for Australia, Japan, and Germany (another country viewed as a free float against the dollar) fall between the 50th and 60th percentile for floats in terms of volatility.[17] That is, they have fairly typical volatility for spells of actual floating. Countries that actually do not peg (as opposed to claiming they do not) show a fair difference from pegs, even using these true floaters as a benchmark. In contrast, looking at declared floats, we find results much like Calvo and Reinhart. If we substitute *de jure* coding for the *de facto* classification used in our regressions below, the PEG coefficient is not significantly different from zero.[18]

Ghosh *et al*. (2002) also examine volatility across regimes. Their work on this issue is limited to examining declared regimes, and they look only at the trade weighted exchange rate. They find that pegs do in fact have lower volatility than nonpegs. Canales-Kriljenko and Habermeier (2004) focus on structural features when studying nominal effective exchange rates but also control for declared exchange rate regime, providing some evidence that declared independent floats have higher volatility.[19] In our work below, we will compare the results

[17] If we drop the first year of floats, this rises to these countries being in the 60-70th percentiles.
[18] See appendix A for discussion of different classifications and results using these classifications.
[19] There is also a literature on exchange rate regime's impact on real effective exchange rates. As noted above, Mussa's famous 1986 result was that real exchange rate volatility differed across regimes. Some subsequent work (e.g. Grilli and Kaminsky (1991)) claimed there was no such difference while others have supported Mussa. For more recent support of Mussa and a review of the literature, see Carrera and Vuletin (2002).

across bilateral and multilateral indices as well as focus on the magnitudes of differences and what part of the distribution drives the results.

IV.1 Nonparametric estimates: where do pegs and nonpegs differ ?

We begin by simply demonstrating that pegs and nonpegs occupy different parts of the volatility distribution. We generate quintile indices for both the annual and spell datasets for both bilateral and multilateral volatility.[20] That the two groups are distinct is not a given because the volatility measure used is the standard in the literature, the standard deviation of the monthly percentage change in the exchange rate (see Lane and Devereaux (2003), Rose (2000) etc.) whereas the peg coding is simply based on staying within a tight range. Countries that depreciate steadily may have a low volatility score despite moving outside a 2% band. Table 6 shows that for a country to have the lowest bilateral volatility, it must peg. We show the results both for spells and for annual observations. A small number of countries that do not peg are in the second quintile with very low volatility. Most of these cases are truly crawling pegs where the rate of crawl pushes them out of the annual +/-2% bands, but the percentage change is very similar from month to month.[21] But, there is distinct separation where no pegs have high volatility and nearly no nonpegs have low volatility. Pegging completely removes the possibility of being in the higher quintiles and guarantees a fair bit more stability than not pegging. Thus, any differences in means seen are not simply driven by some outliers or odd distributional properties, but nearly all floats have higher volatility than nearly all their pegged counterparts. This is true of both spells and annual observations.

While it is sensible that an exchange rate peg can limit bilateral exchange rate volatility, trade, foreign investment, and import prices depend on more than one bilateral rate. Thus, when asking whether pegs experience more stable exchange rates, it is also relevant to see if there are differences in multilateral exchange rate volatility across pegs and nonpegs. For multilateral volatility, though, the picture is different. While pegs always had lower bilateral

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[20] The bilateral exchange rate used is line ae from the IFS database, the month end official exchange rate, converted to be the bilateral exchange rate against the relevant base country. The multilateral rate is the trade-weighted multilateral exchange rate index. The data used is the volatility index generated in di Giovanni and Shambaugh (2006) which is based on the IMF WEO database. The data is the same as that from the IFS but it has better country coverage.

[21] Leaving these crawling pegs in with the floats should make it less likely that we see a difference between the pegs and the nonpegs.

volatility and never had high volatility, this is not the case for multilateral indices. Forty percent of the lowest quintile (using annual observations) are nonpegs. Roughly a third of the fourth quintile are pegs. There is only a slight skewing of pegs showing lower volatility in the lower 80% of the observations.

The one place where a difference is present is with respect to the high volatility outcomes. Only 10% of the highest volatility observations are pegs. Thus, pegging seems associated with somewhat lower multilateral volatility, not by reducing it to levels floats cannot achieve or by reducing it close to zero, but instead by avoiding very high volatility outcomes that can sometimes hit floating countries.[22] Further analysis shows that 75% of the highest quintile bilateral volatility annual observations are highest level multilateral volatility observations (83% for spells).[23] Importantly, the converse is also relevant. Unlike bilateral volatility, which simply is never at low levels for floating countries, a large number of floating countries are in the lower two quintiles of multilateral volatility. Not pegging does not mean large exchange rate volatility effects on the overall economy.[24]

We now turn to investigate the crucial question of the magnitude of the difference between pegs and nonpegs.

IV.2 How much do floats float ?

While we can see that pegs and floats occupy different parts of the volatility distribution, we want to determine how much more volatile floats are. Again, while seeing some difference between pegs and nonpegs is expected, our emphasis will be on the magnitude of the gap. We first analyze the differences in exchange rate stability between peg spells and float spells. The basic structure of our analysis of exchange rate volatility is to regress exchange rate volatility on a peg dummy and other controls. A significant difference between our work and that which studies bilateral volatility overall is our focus on volatility against the

[22] Industrial countries rarely hit high levels even when floating. Only 10% of floating industrial countries are in the overall sample top quintile and none of these are in the top decile.

[23] The converse is also true. 75% of high-level multilateral observations are high level bilateral volatility outcomes.

[24] The appendix shows these results across classifications. The general pattern is similar with differences quite logical given classification differences. For bilateral volatility, there are pegs in the highest volatility quintiles if a coding allows devaluations to still be considered pegged, and the de jure classification give weaker results given its tendency to mix up actual pegs and nonpegs.

base country.[25] Our reasoning is that with respect to exchange rate regimes, only one of the over 100 bilateral rates a country has is actually a choice variable, the rest are residuals. Given this, and our inclusion of country fixed effects (CFE) to control for unobservables, most covariates used in other studies: distance, colonial relationship, etc., are moot. We do include covariates such as inflation and capital controls in some specifications.

The country fixed effects also address many aspects of endogeneity concerns. If a particular country has no logical base or is generally unstable, it may have high volatility and rarely peg, leading to the impression that floats have high volatility. Likewise, a country which often pegs may maintain the peg because it has naturally low volatility and there is little cost to pegging. In both cases, the country fixed effects will take into account the country's relationship with the base and identification will come from strictly comparing the times it is pegged with the times it is not. The basic specification, then, is:

$$EVOL_{it} = a + a_i + bPEG_{it} + u_{it}$$

Where the subscript t represents a spell in the spell regressions or time in the annual panel regressions.[26]

We focus on the difference in conditional means across the two groups and pay particular attention to the effect of outliers. Thus, the regressions are intended to show the average volatility for pegs compared to floats, in order to show the exchange rate volatility differences across the regimes. The data set is quite skewed as a limited number of spells show very high volatility in comparison to the rest of the spells. For this reason, we cannot suggest that a typical country will see a treatment effect based on the size of the coefficient. Also, we cannot claim that a choice to peg is the only policy in place. Clearly some countries may be unable to peg due to policy weakness or chaos. If a country can stay pegged, it has lower

[25] Lane and Devereaux (2003) is a leading example of tests of bilateral volatility across many country pairs. In their work, the goal is to explain why countries may try to lower exchange rate volatility, rather than the impact of exchange rate regimes as we study here. Many of their variables (such as distance or debt burden) are time invariant across countries or close to being so. As such, our use of country fixed effects eliminates most comparisons between the work. They find that bilateral external debt is a significant explanatory variable in explaining volatility for developing countries, and that general optimal currency variables (trade, correlation of shocks, country size) are more important for industrial countries.

[26] Standard errors are clustered at the country level. This allows for an unstructured autocovariance matrix that can correct for heteroskedasticity and autocorrelation issues in the data. The dependent variable EVOL is persistent, but nowhere near unit root levels (autocorrelation coefficients range near .3) suggesting this correction is sufficient to handle time series issues relating to the use of panel data. See Bertrand *et al.* (2004) for discussion.

volatility; the state of being non-pegged may be a combination of a choice not to peg and an inability to peg.

Table 7 includes regressions in which the unit of observation is the average annual volatility during a peg spell or a float spell. In the full sample, pegs on average show an annual volatility which is .16 lower than nonpegs and highly statistically significantly different from zero. Combining the coefficient and constant we see that pegs on average have volatility between 0 and 1% and floats roughly 16% generating the full sample mean of roughly 8%.[27] The standard deviation of the full sample is quite large (roughly 70%) largely due to a few outliers which had very high volatility.

To put the numbers in context, a volatility (annual standard deviation of monthly percentage change) of 1% suggests that monthly changes in the -1% to 1% range and 16% would suggest monthly changes of roughly -16% to 16%, a very large range. These estimates are made assuming half the changes are at one extreme and half at the other. Because the measure is the standard deviation not the range, the ranges could certainly be larger. If some monthly changes are in between, the extremes could be even bigger.[28] Two examples are useful. Paraguay in its 1984-6 float is quite close to the average for floats. Paraguay was trying to peg, but had repeated devaluations. Over 1984-6, monthly exchange rate changes ranged from 0% to 72% with changes over 25% four times. Combined with the many 0% changes, the EVOL was .16. Another example is Chile's 1973-9 float. A typical year was 1975 [annual EVOL = .11], where changes in the exchange rate ranged from 0 to 45% with most falling between 7% and 19%.

While these examples are near the average for floats when outliers are included, removing the extremes gives us a better picture of a typical float. To remove outliers, we

[27] The regression has country fixed effects, but the average country fixed effect is close to zero meaning the sample averages reported at the bottom of the table can be recovered from adding the coefficients despite the presence of country fixed effects. This happens because the technique used ("areg" in stata) will generate a constant which makes the prediction calculated at the means of the independent variables equal to the mean of the dependent variable. The fact that there are an equal number of pegs and floats is what then makes this dummy equal to the population mean.

[28] That is, if one takes the standard deviation of 6 months where the percentage change is 16% and six months where it is -16%, the result is roughly .16. On the other hand, if not all the observations are at the boundaries, the range could be larger. That is, .16 is also the standard deviation if 3 months are 21%, 3 months are -21%, 3 months are 7% and 3 months are -7%. Thus, the volatility measure does not directly translate into range, but gives us a sense for the size of the range.

typically use a sample that drops the 1% largest volatility spells. As seen in column 2, the mean of the sample drops considerably and standard deviation drops dramatically. Now the coefficient on PEG drops, but it is still statistically significant and is now nearly equal to the standard deviation of the dependent variable. That is, once outliers are removed pegs have a roughly one standard deviation lower volatility than floats. Also, once outliers are removed, the R^2 jumps up to .31 with only the PEG and CFE in the regression, despite the fact that the dummy PEG variable clearly can say nothing about the difference in volatility within the float group. Looking at the coefficients, pegs have roughly zero volatility and nonpegs nearly 7%, again suggesting at minimum a range of -7% to 7%. Many floats with an annual volatility of 7% show a range in most months of -3% to 5% with one month in the mid 20% range (e.g. Spain 1977, New Zealand 1984, Fiji 1998).

We see that this magnitude is robust to a number of changes in the regression. Dropping CFE makes little difference. Also, if we drop the first year of floats so that a crisis year is not included in the overall subsequent float spell, we see that some of the volatility is indeed from the first year of floats, but the gap between pegs and floats is still highly significant, still helps explain a good chunk of volatility, and still suggests that floats are a good bit more volatile than pegs with a coefficient of -.045. Thus, while there certainly may be fear of floating behavior, there is a clear difference between spells of countries that peg and float.

Returning to the question of whether pegging lowers multilateral volatility significantly, we run the same regressions using multilateral volatility. In table 6, we saw a difference across pegs and nonpegs but not as strong as for bilateral volatility. Column 6 of Table 7 shows that pegs also have a statistically significantly lower multilateral volatility than nonpegs. As with the bilateral volatility (in column 2) the gap (roughly 2%) is roughly 80% of the standard deviation. Compared to the mean, though, the impact on bilateral volatility is much larger, twice the mean for bilateral, one times the mean for multilateral. Moreover, the gap in volatility is simply smaller for the trade weighted volatility. Whereas the gap between pegs and nonpegs is 7% in bilateral rates, implying fairly wide swings for floats and zero for pegs, the multilateral volatility gap is only 2% with pegs showing volatility of 1.2% and floats 3.2% (the medians are even closer). In column 7, we add bilateral volatility to the equation and the result suggests that multilateral volatility is not lower simply because bilateral is lower, but is lower in addition to this. Thus, while pegging can bring some measure of stability to the overall exchange rate, the effect is not dramatic.

Shifting the analysis to annual panel data (table 8) allows us to include year effects (to take into account that some years may have seen broad volatility across the globe) and annual covariates that align directly to our data (as opposed to including averages over the course of long spells). We also separately mark first year floating such that the comparison group for the pegs becomes floats that are not first year floats (so as to not simply show that pegged annual observations have less volatility than crises years).

Beginning with the sample dropping 1% outliers, we see that annual volatility is 5% less for pegs, when controlling for first year floats, this drops to 4.2%, while first year floats have volatility on average 2.3% more than other nonpegs. The median for floats is close to Japan 1984 (2% volatility) where the monthly percentage changes ranged from -4% to 3% and the dollar yen rate began at 235 went down to 220 and as high as 250. The mean for non first year float floats was 3.8% which is similar to Germany in 1981 when monthly changes ranged from 8% to -4% and the DM ranged from 2.1 to 2.46 marks to the dollar. These were not crisis driven years, but represent the average volatility of floats, considerably different than the pegged countries staying in the 2% bands where behavior is usually close to 1% up or down a month. It is important to note that these "classic" floats, as mentioned above, are near the middle of the distribution. They are not unusual floats in terms of the magnitude of volatility. They are fair descriptions of the experiences of floats. When adding covariates, inflation is positively correlated with volatility as is having capital controls, but in both cases, a peg is substantially more stable than a non-peg with little change to the magnitude of the PEG coefficient.[29]

Returning to multilateral volatility, we see similar results as before. The impact is smaller for multilateral volatility, but is definitely present. When we include bilateral volatility, in column 7, though, there is now no difference between pegs and floats. Column 8 includes trade share with base and the interaction with pegging. If multilateral volatility were only lowered through large trade shares with the base country and the subsequent impact on the

[29] Results hold across industrial countries and non-industrial countries with means and coefficients smaller for industrial countries and first year floats not associated with higher volatility for rich countries

weighted average, we would expect this term to dominate, yet the peg variable has roughly its typical magnitude when these additional terms are included.[30] From a policy perspective, it does not matter whether pegs have more stable multilateral volatility due to more stable bilateral rates (and a large trade share with the base) or because of high cross-correlation of major exchange rates meaning stabilization against one stabilizes to some extent against many. The important point is the multilateral rate is more stable, just not dramatically so.[31]

IV.3 Volatility Over Time

To understand why an exchange rate peg might cause different outcomes for variables that depend on agents forward looking expectations (such as trade or investment) we would need to think that agents rationally expect pegs to not only have lower volatility at present, but also in the future. In some ways, this question studies the combination of the mirage and fear of floating views. If pegs do not last or if they are not very different from floats, then we would never expect a current peg to imply lower volatility going forward.

We repeat regressions like those in table 8 but regress volatility on successive lags of pegging to see if a peg today is associated with a difference in volatility in the future. Figures 4 and 5 summarize the results. The first point in figure 4 shows the coefficient reported in column 1 of table 8 – the coefficient on a contemporaneous peg with two times standard error bands providing confidence intervals.[32] The next point shows the coefficient on a lagged peg alone in a regression. We are not asking whether pegging last year in addition to this year has a lower volatility, but instead, if one was pegged last year, regardless what has happened to that peg, what is volatility this year. The coefficient is weaker, but still notably different than zero. As the horizon stretches out, the effect stays in the range of 1%, though only at the margin of

[30] Again, see Appendix for results across classifications. Including the devaluations in the peg sample now moves a number of the higher volatility instances out of first year floats and into the peg category. This weakens the differences across the regimes, but they are still present. Using the *de jure* coding, there is no statistically significant difference across pegs and nonpegs.

[31] Once again, results hold across industrial countries and non-industrial countries with means and coefficients smaller for industrial countries and again first year floats not associated with higher volatility for rich countries. The means are small enough for rich countries that while statistically significant; it is simply quite rare for rich countries to demonstrate high enough volatility to be problematic. This may help explain why in work such as Aghion *et al*. (2006), countries with highly developed financial systems (rich countries) are less impacted by pegs. Even when not pegging, they simply do not experience too much multilateral volatility (the channel in Aghion *et al*. through which pegging affects growth).

[32] The top 1% outliers are excluded as in column 1 of table 8. We do not include the first year float variable. By controlling for these separately, when we look at lagged pegs, we would eliminate some of the largest volatility outcomes for previous pegs and thus artificially increase the difference between lagged pegs and floats.

5% statistical significance. This is not simply a function of the likelihood that a peg breaks, as the timeline stretches, there is also the large probability that a broken peg will reform.[33] Given the propensity of first year pegs to break, if one simply eliminates first year pegs (increasing the likelihood that a peg lasts another year) the effect over time is increased substantially.

Given that bilateral volatility is lower for at least another year and especially for mature pegs, we can see why results such as Klein and Shambaugh (forthcoming), that find an increase in bilateral trade from pegging even when controlling for contemporaneous volatility, hold. Knowing that a country is pegged today gives an economic agent information about the volatility going forward.[34]

On the other hand, the impact for multilateral volatility, shown in figure 5, is weaker over time. Even at one lag, the effect is only half of a percent, notably smaller than the bilateral effect. Thereafter, it is not distinct from zero and is roughly a quarter of a percentage point. This represents both the fact that pegs may break and that pegging does not guarantee low multilateral volatility, it simply lowers the odds of very high volatility.

V. Conclusion

There has been a flurry of new work examining the impact of the exchange rate regime on a variety of macroeconomic outcomes. This work, which finds substantial effects of exchange rate regimes on a variety of outcomes, does not square with previous stylized facts that pegs do not really peg and floats do not really float – suggesting little impact of exchange rate regimes on the exchange rate, let alone other outcomes. This paper provides a new set of empirical regularities regarding the extent to which fixed exchange rate regimes are relevant for exchange rate related outcomes – in some sense a prerequisite for them affecting any other outcomes.

We find that despite the fact that many pegs break very quickly, a fair number of pegs last beyond the short term (over five years) and these are clearly observed more often in panel

[33] We eliminate new pegs from the regression, that is countries floated at time zero but begin to peg subsequently. Thus the result is a comparison of pegging at time zero to countries that float throughout. The idea is to show not whether pegs at time zero have lower volatility than floats at time zero – many of the floats will start to peg – but rather to show whether pegs at time zero have lower volatility than floating countries in general over time.

[34] Ghosh *et al*. (2002) also examined volatility over time and also found lower volatility for pegs, but they restricted themselves to regimes that stayed pegged or stayed floating, eliminating the important role of pegs breaking or repegging.

studies due to their longer histories. In addition, once past the first year or two, the probability a peg lasts another year begins to rise dramatically, giving agents a much better sense that pegs will last than simply by looking at the average length of a peg spell. Finally, floats have similar properties of quick ends, meaning that many broken pegs return to pegging fairly quickly.

Which state a country is in does matter as the pegs and floats generate quite different exchange rate outcomes. The pegs show no bilateral volatility compared a large degree for the bulk of floating countries. The difference is significant despite controlling for country, year, inflation behavior, or capital controls. The difference also persists into the future – a peg today predicts lower volatility for a number of years out. Finally, there is some impact on the multilateral exchange rate as well. Pegs have on average a lower multilateral volatility. In contrast to bilateral volatility, though, this difference in a trade weighted average seems to come largely from pegs avoiding high volatility outcomes, not an across the board difference between all pegs and floats.

Policymakers should note that while pegging does seem to imply greater stability, a new peg will not necessarily last, and exits from pegs can be high volatility outcomes. In addition, a peg is not necessary for a stable multilateral rate, it simply prevents high volatility, which any number of stable institutional structures should be able to do. On the other hand, economic agents observing a current peg should recognize that once a peg has lasted more than a year or two, it is likely to last much longer and even if it breaks, it is likely to reform quickly.

These results help explain why more recent empirical work has found the exchange rate regime can matter in a variety of contexts. In addition, highlighting the distinction between the effects of fixed exchange rates for multilateral and bilateral exchange rates is important in a number of modeling contexts. Current debate in the New Open Economy Macroeconomics literature revolves around the appropriate exchange rate regime choice, often focusing on the ability of pegs to stabilize prices and consumption across countries. However, in these two country models, multilateral and bilateral volatility are the same. Our results show that the multilateral rate will be stabilized, but cannot be stabilized perfectly. The peg has a weaker effect on the multilateral rate and many pegs still have fairly volatile multilateral rates. Thus, we need to take care when using tractable two-country models to recall when results involving a peg require the peg to stabilize the bilateral rate or the multilateral rate.

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Tables:

Table 1: Basic Statistics on Peg Spells and Float Spells													
	No. of Annual Obs.	No. of C'ntry	% peg obs.	No. of peg spells	Peg Spell / C. Av'g	Peg Median	Peg Mean	Peg s.d.	No. of float spells	Float Spells / Country, Av'g.	Float Median	Float Mean	Float s.d.
Full Sample	3924	125	47.53	398	3.18	2	4.67	6.42	395	3.16	2	5.21	6.69
Industrial Countries	671	21	39.34	56	2.67	2	4.63	6.81	61	2.90	3	6.67	8.88
Developing Countries	3253	104	49.22	342	3.29	2	4.68	6.37	334	3.21	2	4.95	6.18

Sample includes countries for which population > 400,000, USA not in sample, Industrial countries are those with IFS code < 200 but not Turkey nor South Africa, Developing Countries are those with IFS code > 200 and Turkey and South Africa, Currency Unions not included in sample.

Table 2: Peg Spell and Float Spell Survival Statistics (Unconditional), by Spell						
	Peg Spells			Float Spells		
	All Countries	Industrial	Developing	All Countries	Industrial	Developing
At least 2 years	55.89%	56.36%	55.81%	64.38%	72.88%	62.75%
At least 3 years	40.27%	32.73%	41.61%	48.49%	54.23%	47.39%
At least 4 years	34.52%	32.73%	34.84%	38.36%	42.37%	37.58%
At least 5 years	30.14%	32.73%	29.68%	33.97%	37.29%	33.33%
> 5 years	27.67%	32.73%	26.78%	30.41%	32.20%	30.07%
No. of spells	365	55	310	365	59	306

Sample includes countries for which population > 400,000, USA not in sample, Industrial countries are those with IFS code < 200 but not Turkey nor South Africa, Developing Countries are those with IFS code > 200 and Turkey and South Africa, Currency Unions not included in sample.

Table 3: Probability of Switching Spell State Next Year, and of Remaining in Same Spell 1, 3, or 5 years in Future, Annual Data							
	All Countries	Industrial	Developing		All Countries	Industrial	Developing
Float(t)|Peg(t-1)	18.43%	17.13%	18.65%	Peg(t)|Float(t-1)	16.76%	13.28%	17.63%
Peg(t)|Peg(t-1)	81.57%	82.87%	81.35%	Float(t)|Float(t-1)	83.24%	86.72%	82.38%
Peg(t)|Peg(t-3)	65.75%	71.11%	64.92%	Float(t)|Float(t-3)	65.08%	70.23%	63.76%
Peg(t)|Peg(t-5)	55.29%	61.69%	54.34%	Float(t)|Float(t-5)	54.07%	60.82%	52.28%

Years in Peg Spell or in Float Spells.
Sample includes countries for which population > 400,000, USA not in sample, Industrial countries are those with IFS code < 200 but not Turkey nor South Africa, Developing Countries are those with IFS code > 200 and Turkey and South Africa, Currency Unions not included in sample. Sample up through 2003 for next year conditional probabilities, up through 2001 for 3 years hence conditional probabilities, and 1999 for 5 years hence conditional probabilities. Countries must remain in same state continuously; that is, Peg(t)|Peg(t-3) suggests staying pegged in (t-3), (t-2), t(-1) and (t). Countries that flip in and out of a state are considered to have broken the state.

Table 4: Conditional Survival Rates by Spell **Probability (in percent) of Surviving to year *t*, given still pegged at year *t-1* (initial year of peg or float is Year 1)**						
	Peg Spells			Float Spells		
	All Countries	Industrial	Developing	All Countries	Industrial	Developing
Year 2	55.90%	56.14%	55.86%	65.81%	73.77%	64.39%
Year 3	70.70%	58.06%	72.83%	75.00%	72.73%	75.48%
Year 4	86.09%	100.00%	84.21%	79.89%	78.13%	80.26%
Year 5	87.69%	100.00%	85.71%	88.97%	88.00%	89.17%
Year 6	91.82%	100.00%	90.22%	89.52%	86.36%	90.20%

Years from Beginning of Peg Spell or Beginning of Float Spell.
Sample includes countries for which population > 400,000, USA not in sample, Industrial countries are those with IFS code < 200 but not Turkey nor South Africa, Developing Countries are those with IFS code > 200 and Turkey and South Africa, Currency Unions not included in sample.

Table 5: Estimates of Weibull Conditional Hazard Functions				
	Peg Spells		Float Spells	
	Coefficient	Standard Error	Coefficient	Standard Error
Previous Spell	**0.033**	0.011	**0.047**	0.014
Industrial Country	0.256	0.190	0.211	0.175
US Base Dummy	**0.650**	0.135		
λ	**0.844**	0.034	**0.912**	0.041
Number of Spells	397		332	

Bold means significant at better than the 95% level of confidence for null hypothesis of $\beta = 0$ for covariates and $\lambda = 1$ for baseline hazard function parameter.

Table 6: Quintiles

	Bilateral Volatility				Multilateral Volatility			
	Annual		Spell		Annual		Spell	
	Range	%peg	Range	%peg	Range	%peg	Range	%peg
1	.000 – .000	100%	.000 - .001	99%	.000 - .007	61%	.002 - .008	76%
2	.000 - .004	87%	.001 - .007	92%	.007 - .011	59%	.008 - .011	73%
3	.004 - .013	44%	.007 - .015	58%	.011 - .015	53%	.011 - .016	56%
4	.013 - .027	1%	.017 - .031	3%	.015 - .025	34%	.016 - .027	37%
5	.027 – 40.0	0%	.031 - 15.0	0%	.025 – 1.8	11%	.027 - .582	13%

This table shows the % of observations (annual and spell) that are pegged when the data is divided into quintiles by volatility.

Table 7 Exchange Rate Volatility in Spells

	1	2	3	4	5	6	7
dep variable	bilateral volatility	bilateral volatility	bilateral volatility	bilateral volatility no first year	bilateral volatility post 79	multilateral	multilateral
sample	full	drop 1%	drop 1%	drop 1%	drop 1%	drop 1%	drop 1%
FE	CFE	CFE	none	CFE	CFE	CFE	CFE
peg	-0.15767	-0.06817	-0.0647	-0.04518	-0.08115	-0.02216	-0.00753
	0.05119**	0.00750**	0.00717**	0.00635**	0.00998**	0.00278**	0.00148**
spell_bilateral volatility							0.20893
							0.02852**
Constant	0.1614	0.0706	0.06890	0.0488	0.0824	0.03322	0.01823
	0.02573**	0.00380**	0.00698**	0.00389**	0.00512**	0.00143**	0.00157**
Observations	792	785	785	649	616	590	590
R-squared	0.17	0.31	0.14	0.3	0.35	0.45	0.74
Smpl mean	.082	.036	.036	.021	.041	.022	.022
Smpl sd	.689	.086	.086	.052	.097	.026	.026
Smpl med	.010	.010	.010	.008	.010	.013	.013
Peg mean	.004	.004	.004	.004	.004	.012	.012
Peg sd	.004	.004	.004	.004	.004	.009	.009
Peg med	.003	.003	.003	.003	.003	.010	.010
Nonpeg mean	.161	.069	.069	.048	.079	.032	.032
Nonpeg sd	.971	.112	.112	.075	.128	.033	.033
Nonpeg med	.025	.024	.024	.023	.023	.019	.019
* significant at 5%; ** significant at 1%							

Note: standard errors clustered at the country level, CFE means country fixed effects, drop 1% drops the 1% largest volatility observations to reduce the impact of outliers.

Table 8 Exchange Rate Volatility in Annual Panel data

	1	2	3	4	5	6	7	8
Dependent vbl	bilateral	bilateral	bilateral	multilateral	multilateral	multilateral	multilateral	multilateral
Sample	Drop 1%	Drop 1%	Drop 1%	Drop 1%	Drop 1%	Drop 1%	Drop 1%	Drop 1%
FE	CFE, YFE	CFE, YFE	CFE, YFE	CFE, YFE	CFE, YFE	CFE, YFE	CFE, YFE	CFE, YFE
peg	-0.04851	-0.04234	-0.03749	-0.01648	-0.01399	-0.01381	-0.00052	-0.01672
	0.00459**	0.00401**	0.00315**	0.00190**	0.00181**	0.00177**	0.00121	0.00271**
1^{st} year float		0.02391	0.02923		0.00934	0.01	-0.00159	0.01086
		0.00608**	0.00670**		0.00246**	0.00262**	0.00152	0.00278**
inflation			0.00007			0.00003		
			0.00001**			0.00000**		
Trade w/ base								-0.00741
								0.01075
Peg* Trade w/ base								0.00876
								0.00976
Bilateral volatility							0.36134	
							0.02054**	
Capital controls			0.01063			0.00424		
			0.00443*			0.00243		
Constant	0.03461	0.032	0.02650	0.02515	0.0227	0.01523	0.01211	0.026
	0.00236**	0.00207**	0.00536**	0.00161**	0.00131**	0.00226**	0.00126**	0.00255**
Observations	3816	3816	3572	3008	3008	2869	3001	2472
R-squared	0.25	0.26	0.34	0.29	0.3	0.34	0.7	0.31
Smpl mean	.023	.023	.024	.021	.021	.021	.020	.021
Smpl sd	.056	.056	.056	.025	.025	.025	.025	.026
Smpl med	.008	.008	.009	.012	.012	.012	.012	.013
Peg mean	.002	.002	.002	.012	.012	.012	.012	.012
Peg sd	.003	.003	.003	.011	.011	.011	.011	.011
Peg med	.000	.000	.000	.010	.010	.010	.010	.010
Nonpeg mean	.042	.042	.043	.027	.027	.027	.027	.028
Nonpeg sd	.072	.072	.072	.030	.030	.030	.030	.031
Nonpeg med	.020	.020	.020	.017	.017	.017	.017	.017
* significant at 5%; ** significant at 1%								

Notes: Standard Errors clustered at the country level. CFE means country fixed effects, YFE means year fixed effects, drop 1% drops the 1% largest volatility observations to reduce the impact of outliers. Trade with base is the percentage of trade with the base country. Col 7 also drops 1% evol outliers (an additional 7 observations)

Figures:

Figure 1

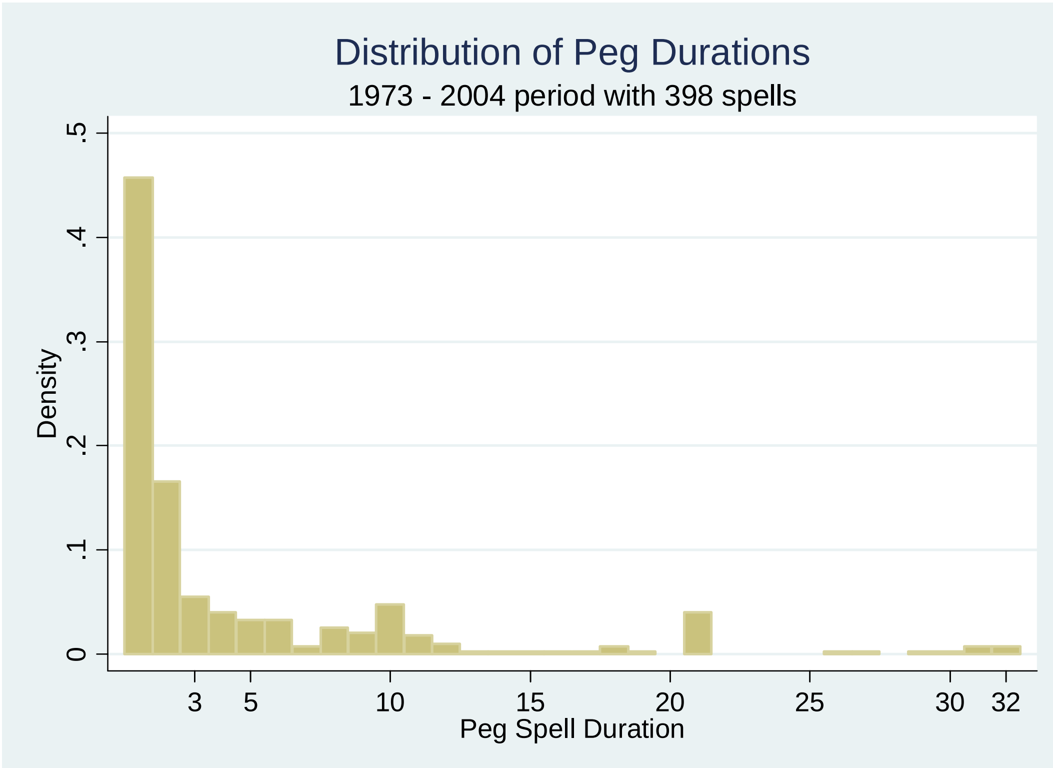


Figure 2

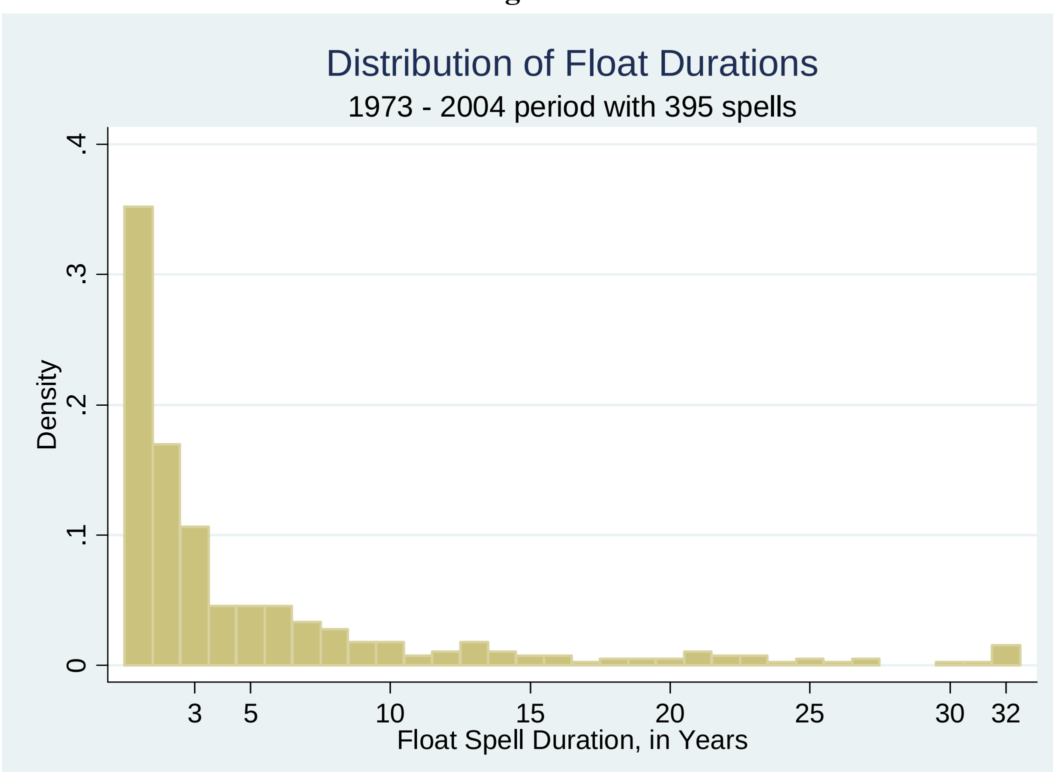
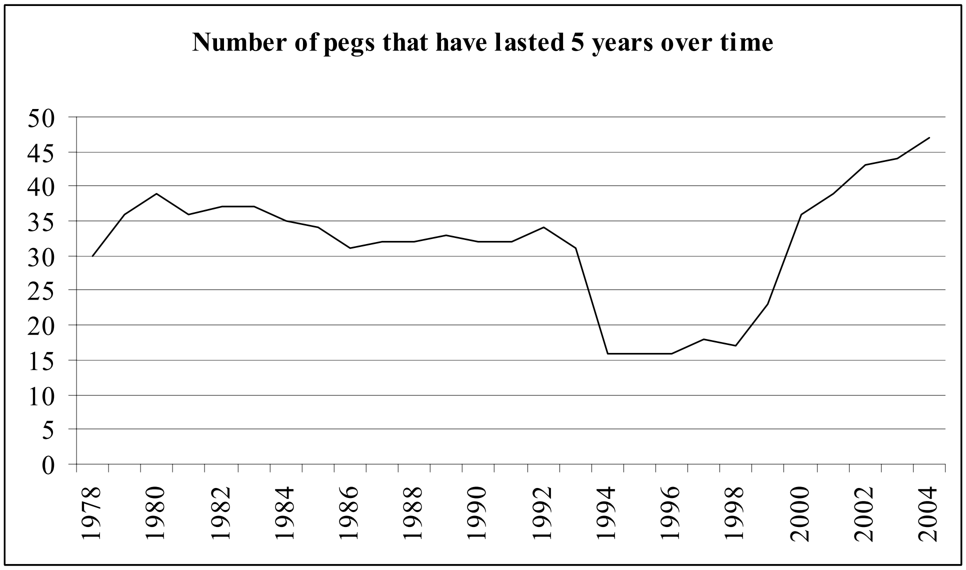


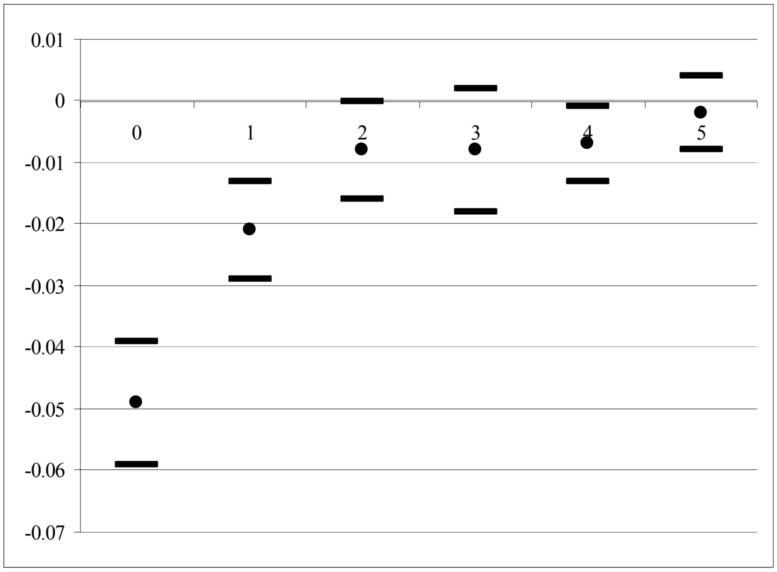
Figure 3 Long-lived pegs



	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
broken long pegs	3	0	4	3	1	3	2	3	0	1	1	1	2	1	4	16	1	0	1	1	0	2	0	1	0	1
new long pegs	9	3	1	4	1	1	1	0	1	1	2	0	2	3	1	1	1	0	3	0	6	15	3	5	1	4

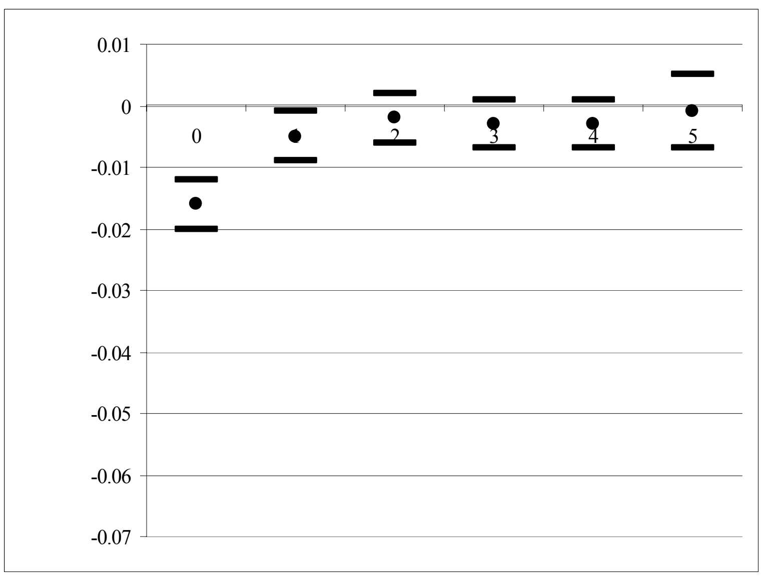
Figure shows the number of countries in a peg that has lasted for more than 5 years at that moment. The panel is roughly balanced with between 122 and 125 countries in the sample. Currency unions are eliminated from sample with the exception of spells that began as pegs and converted to currency unions (some EMU observations). The table below shows the number of long pegs which broke in a given year and the number of peg spells that first surpass 5 years in length in a given year.

Figure 4: Bilateral Exchange rate volatility over time



Note: time zero represents the contemporaneous coefficient of exchange rate volatility on pegging. Time 1 represents the coefficient on a lagged peg and so on. Thus the point at "2" represents the difference in volatility for a country that was pegged two years ago (whether it has remained pegged or not). Country and year fixed effects are included. The dark lines represent 2 times standard error bands where standard errors are clustered on country. To insure that the comparison is with nonpegged observations, new pegs that are not repegs are excluded.

Figure 5: Multilateral Exchange rate volatility over time



Note: time zero represents the contemporaneous coefficient of exchange rate volatility on pegging. Time 1 represents the coefficient on a lagged peg and so on. Thus the point at "2" represents the difference in volatility for a country that was pegged two years ago (whether it has remained pegged or not). Country and year fixed effects are included. The dark lines represent 2 times standard error bands where standard errors are clustered on country. To insure that the comparison is with nonpegged observations, new pegs that are not repegs are excluded.

Appendix: Results across classifications*:*

Different Classifications:

As noted throughout the paper, we consider a principal coding in the paper designed to identify particular peg spells. We also examine the Shambaugh (2004) coding (hereafter "JS"), the Reinhart Rogoff (2004) coding (hereafter RR), the Levy-Yeyati and Sturzenegger (2003) coding (hereafter LYS) and the declared or *de jure* regimes (hereafter "DJ"). We do not use a classification from Obstfeld and Rogoff (1995) or Calvo and Reinhart (2004) despite their importance as motivation for both the paper and for the creation of *de facto* classifications because neither paper provides an extensive classification of all countries as pegged or not pegged but rather focus on specific episodes for their analysis. As noted, the coding in this paper is methodologically similar to Obstfeld and Rogoff.

Principal differences from the coding used in this paper and the JS classification is that the JS classification excludes one year pegs but allows discrete devaluations. Thus, comparisons to the JS coding will show how important those two decisions are but within a generally similar classifications scheme which identifies peg vs. nonpeg at the annual frequency (focused on month-end exchange rates staying within 2% bands over a one year horizon).

RR uses the black market rate, but also focuses on the conditional probability of the exchange rate staying within a given range over a five year period. Thus, in addition to differing for countries that have dual market exchange rates, their coding allows devaluations and generally smoothes exchange rate regimes over time. (also see Section II and its footnotes for a discussion of the codings).

LYS is a different approach altogether as it includes information on reserves. They use cluster analysis and information on reserves/M2 volatility, exchange rate volatility, and volatility of the change in the exchange rate to sort observations into pegs, intermediates, and floats. Many countries with a perfectly flat exchange rate are left inconclusive by such a procedure (due to no reserves volatility or lack of reserves data) but are clearly pegged, so they are added to the pegged group. Thus, many of the pegs (~50%) do not show reserves volatility but are what LYS refer to as "ad hoc" pegs. LYS code far more pegs than other classifications, often including as pegs country year observations with a fair amount of exchange rate volatility due to changes in reserves/M2. They do not, though, include most discrete devaluations from one fixed rate to another as pegs because the change in the exchange rate is too large when compared to the reserves volatility. Thus, they do not include as pegs many of the highest volatility outcomes that RR and JS allow.

The DJ coding represents the regime declared to the IMF and reported in the IMF's annual yearbook on exchange rate arrangements.

Below, in Table A1, we show the percentage of observations for which binary versions of each classification agree with one another.[35] The codings are broadly similar, but differ in somewhat systematic ways that generate different results on a number of areas of our analysis. See also Shambaugh (2004) or Frankel (2003) for comparisons of different *de facto* classifications.

[35] For RR, mgcode = 1 is considered a peg (this includes pre-announced pegs, horizontal bands that are narrower or equal to +/-2%, and de facto pegs. For DJ, peg is defined as pegs, limited flexibility, and cooperative agreements (the EMS).

Table A1: Percentage agreement of various coding methodologies for our sample:

	peg	jspeg	rrpeg	djpeg
peg	1			
jspeg	93%	1		
rrpeg	79%	81%	1	
djpeg	81%	86%	80%	1
lyspeg	81%	80%	73%	74%

Note: this table shows the percentage of observations where different codings yield the same result as one another. "peg" is the classification used in the paper. "jspeg" is the Shambaugh (2004) coding, "rrpeg" is the Reinhart and Rogoff (2004) coding, and "djpeg" is the *de jure* coding and lyspeg is the Levy-Yeyati and Sturzenegger (2003) classification. All codings are collapsed to a binary peg and nonpeg coding.

Spell Lengths Across Coding:

The spell length and number of spells is the category for which the results differ most across classification.[36] The RR classification exhibits a great deal of smoothing, identifying overall policy regimes as opposed to specific peg spells due to the focus on the conditional probability of staying within a range over a five year period.[37] As such, they identify far fewer spells and far more stability. The JS coding is in between the coding used in the paper and RR. The paper focuses exclusively on a particular peg, the JS coding also has an annual focus, with no attempt to smooth over time, but it does allow discrete devaluations preventing overidentification of regime switches. An example is France, which RR code as not pegged at all from 1973-86 and pegged throughout thereafter. The coding in the paper and the JS coding identify the short-lived pegs in 1979-80 and 1984-5. As such, practitioners interested in whether a country is pegged and stable in a given year may see advantages from the JS coding, those interested in absolute stability of the peg in the coding used in the paper, and those interested in over-arching policy regimes smoothed over time in the RR coding. Below, we show table 1 reproduced for the different codings. As noted in the paper, the RR coding generates very stable spells (and relatively few of them) while the JS coding identifies more spells with shorter pegs and much shorter floats than RR, but still more stable spells than those identified in the paper.

After table A2, we reproduce figure 3 across classifications to show the number of > 5 year pegs in existence at any point in time (see end of section II for discussion).

Table A2 Basic Statistics Across Classifications

	No. of Annual Obs.	No. of C'ntry	% peg obs.	No. of peg spells	Peg Median	Peg Mean	Peg s.d.	No. of float spells	Float Median	Float Mean	Float s.d.
Full Sample	2779	104	33.39	89	7	11.15	10.0	99	19	18.81	8.63
	3924	*125*	*46.02*	*199*	*5*	*9.16*	*9.75*	*191*	*7*	*11.09*	*10.10*
	3924	**125**	**47.53**	**398**	**2**	**4.67**	**6.42**	**395**	**2**	**5.21**	**6.69**
Industrial Countries	587	21	27.43	16	6.5	9.21	9.21	20	25	22.4	6.44
	671	*21*	*35.62*	*31*	*6*	*7.55*	*8.08*	*36*	*5.5*	*12.0*	*11.79*
	671	**21**	**39.34**	**56**	**2**	**4.63**	**6.81**	**61**	**3**	**6.67**	**8.88**
Developing Countries	2192	83	34.99	73	8	11.45	10.2	79	19	17.90	8.90
	3253	*104*	*48.17*	*168*	*5*	*9.46*	*10.0*	*155*	*8*	*10.88*	*9.70*
	3253	**104**	**49.22**	**342**	**2**	**4.68**	**6.37**	**334**	**2**	**4.95**	**6.18**

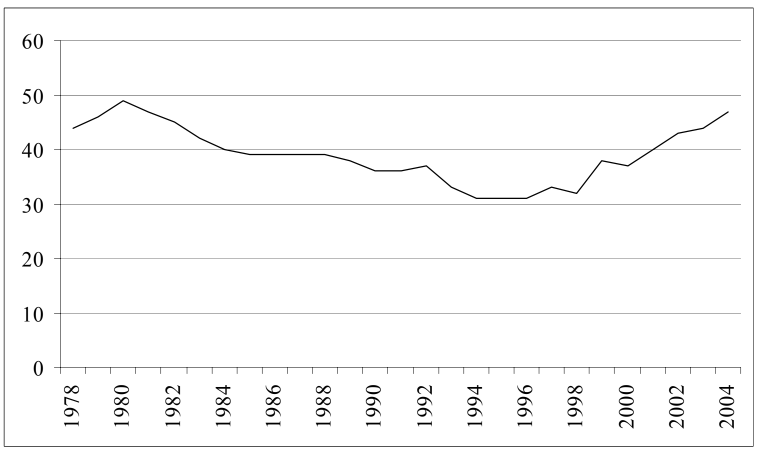
Note: figures in bold reproduce statistics from table 1, figures in plain text are for the Reinhart Rogoff coding and figures in italics are for the JS classification.

[36] Occasional "inconclusives" in the LYS coding leave too many holes to do the same type of duration analysis.
[37] See Husain, Mody, and Rogoff (2005) who comment in footnote 8, "the Natural Classification [RR] attempts to identify longer term regimes rather than short term "spells".

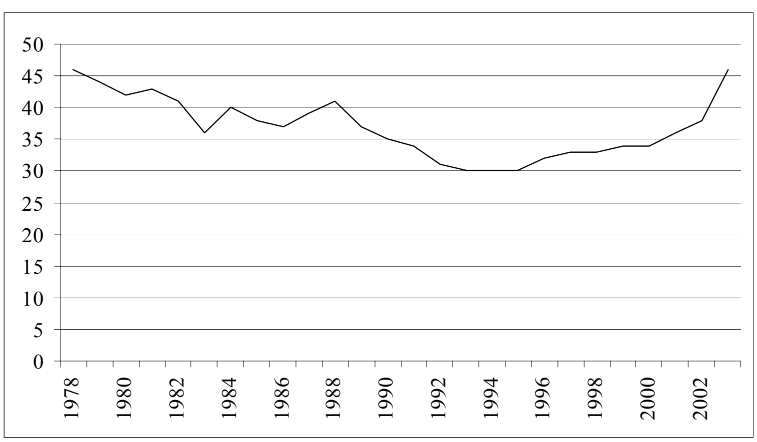
Long lasting pegs over time: For comparison to classification used in paper, see figure 3.

Reinhart Rogoff classification:

Shambaugh 2004 Classification



De Jure Classification



Figures show the number of countries in a peg that has lasted for more than 5 years at that moment. The panel is roughly balanced with between 98 and 104 countries in the Reinhart Rogoff sample and 122 and 125 countries in the other samples. Currency unions are eliminated from sample with the exception of spells that began as pegs and converted to currency unions (some EMU observations).

Exchange Rate Outcomes Across Classifications:

The results do not differ as dramatically when examining the exchange rate outcomes as opposed to the duration. The one exception, and most notable result across classifications, is that the coefficients on the *de jure* peg variable in the regressions are never distinguishable from zero.

Turning to the quintile analysis, the major change when examining the JS coding is allowing the devaluations to count as pegs means some of the most volatile annual bilateral volatility outcomes are from pegs, but still only ~10%. Consequently, the percentage of high multilateral volatility outcomes that are pegs rises to roughly 20% (from 10%). The RR classification does not count all stable official rates as pegs (due to the use of secondary market rates), and thus many of the most stable outcomes are nonpegs (32%). Devaluations can still count as pegs, so the RR results look similar to JS with regards to the percentage of high volatility outcomes that are pegs. Note also that far fewer of the observations are pegs for RR. The multilateral results for RR are similar to the story for PEG. There clearly is a skewing in the quintiles with pegs more likely to appear in low volatility quintiles, but the result is not as strong as for bilateral and there clearly is room for nonpegs to have low volatility. Again, allowing the devaluations to count as pegs means that there are more pegs in the high volatility outcomes.

The DJ coding results are as expected. They trace the general story but a fair number of DJ pegs are highly volatile as countries declare pegs that they do not come close to holding and 11% of the lowest volatility observations are nonpegs as a fair number of countries maintain a peg they do not declare. As noted, LYS allow more pegs in general and more volatility in pegs, witness the 21% pegs in the top quintile. These high volatility pegs are not discrete devaluations but simply moderate to high volatility outcomes. The overall pattern, though, is the same.

Appendix Table A6 Percentage pegged by exchange rate volatility quintile

	Peg	JSpeg	RRpeg	DJpeg	LYSpeg
	Bilateral				
1	100%	99%	68%	89%	99%
2	87%	83%	62%	66%	93%
3	44%	31%	16%	21%	41%
4	1%	1%	6%	9%	39%
5	0%	11%	12%	20%	21%
total	47%	45%	33%	41%	58%
	Multilateral				
1	61%	53%	53%	47%	78%
2	59%	54%	43%	46%	65%
3	53%	50%	33%	38%	58%
4	34%	32%	16%	27%	51%
5	11%	18%	12%	22%	29%
total	44%	41%	31%	36%	56%

Like Table 6, the table shows the percentage of annual observations pegged in each quintile of exchange rate volatility. The top half shows the bilateral volatility quintiles and the bottom half shows multilateral volatility.

When looking at the regression analysis, we see results lining up as expected. Allowing devaluations to be considered pegs means that the differences in volatility across pegs and nonpegs is lessened. Hence, the coefficient on peg for the JS and RR codings is weaker than the one reported in the paper. Furthermore, due to the misidentifying of regimes, the coefficient on the DJ peg is not distinguishable from zero. LYS results are weaker than those in the main paper due to including more volatile observations as pegs, but stronger than RR or JS because LYS does not include the very large devaluations as part of the peg samples. Regressions matching those in columns 2 and 5 in table 8 are reported below to demonstrate these features.

Table A8. Exchange Rate Volatility in Annual Panel Data across classifications

	1	2	3	4	5	6	7	8
variable	bilateral	bilateral	bilateral	bilateral	multilateral	multilateral	multilateral	multilateral
Sample	drop 1%	drop 1%	drop 1%	drop 1%	drop 1%	drop 1%	drop 1%	drop 1%
coding	JS	RR	DJ	LYS	JS	RR	DJ	LYS
Fixed effects	CFE, YFE	CFE, YFE	CFE, YFE	CFE, YFE	CFE, YFE	CFE, YFE	CFE, YFE	CFE, YFE
Peg	-0.02491	-0.01515	-0.0013	-.03251	-0.00648	-0.00599	0.00352	-0.01311
	0.00396**	0.00478**	0.00474	0.00374**	0.00210**	0.00299*	0.0028	0.00234**
1st year float	0.02695	0.01469	0.03505	0.03443	0.01053	0.01522	0.02281	0.01548
	0.00729**	0.01188	0.01040**	0.0066**	0.00387**	0.00710*	0.00489**	0.00329**
Constant	0.02029	0.02456	0.01336	0.03059	0.01934	0.01987	0.01664	0.02501
	0.00264**	0.00407**	0.00320**	.00318**	0.00158**	0.00230**	0.00271**	0.00196**
Observations	3816	2727	3704	3088	3008	2115	2901	2560
R-squared	0.18	0.17	0.15	0.31	0.26	0.27	0.26	0.33

Note: this table reproduces columns 2 and 5 from table 8. There are country and year fixed effects included, 1% outliers are dropped, and standard errors are clustered at the country level. The change in observations across columns 1-3 and 4-6 is due to the fact that multilateral volatility is only available from 1979 on. The variation within 1-3 and 4-6 is due to different availability of the classifications.