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Estimation of De Facto Flexibility Parameter and Basket Weights in Evolving Exchange Rate Regimes

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As is by now well-known, the exchange rate regimes that countries follow in practice (de facto) often depart from the regimes that they announce officially (de jure). Many countries that say they float in fact intervene heavily in the foreign exchange market.[1] Many countries that say they fix in fact devalue when trouble arises.[2] Many countries that say they target a basket of major currencies in fact fiddle with the weights.[3]

A number of economists have offered attempts at de facto classifications, placing countries into categories (such as fixed, floating, and intermediate).[4] Unfortunately, these classification schemes disagree with each other as much as they disagree with the de jure classification.[5] Something must be wrong.

I. The Existing Techniques for Estimating de facto Regimes and their Drawbacks

Several things are wrong. First, attempts to infer statistically a country's degree of exchange rate flexibility from the variability of its exchange rate alone ignore that some countries experience greater shocks than others.

That problem can be addressed by comparing exchange rate variability to foreign exchange reserve variability, as do Calvo and Reinhart (2002) and Levy-Yeyati and Sturzenegger (2003, 2005). A useful way to specify this approach is in terms of Exchange Market Pressure, defined as the sum of the change in the value of a currency and the change in its reserves.[6] Exchange Market Pressure represents shocks in demand for the currency. The flexibility parameter can be estimated from the propensity of the central bank to let these shocks show up in the price of the currency (floating) or the quantity of the currency (fixed) or somewhere in between (intermediate exchange rate regime). But even these papers have a second limitation: they generally impose the choice of a single major currency around which the country in question defines its value, most often the dollar (though some use statistical criteria to help choose which currency). For some countries—to whatever extent the authorities seek to stabilize the exchange rate—there is an obvious candidate for anchor currency. But for others it is much less evident, especially those with geographically diversified trade. In many cases, one cannot presume that the anchor is a single major currency. It would be better to *estimate endogenously* whether the anchor currency is the dollar, the euro, some other currency, or some basket of currencies.

A third set of papers is designed to estimate the anchor currency, or more generally to estimate the currencies in the basket and their respective weights.[7] The approach is simply to run a regression of the change in the value of the local currency against the changes in the values

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[1] "Fear of floating:" Reinhart (2000), Calvo and Reinhart (2002).

[2] "The mirage of fixed exchange rates:" Obstfeld and Rogoff (1995).

[3] Frankel, Schmukler, and Servén (2000).

[4] Important examples include Ghosh, Gulde and Wolf (2000, 2002), Reinhart and Rogoff (2004) and Shambaugh (2004). Tavlas, Dellas, and Stockman (2008) survey the literature.

[5] Bénassy-Quéré, et al. (2004, Table 5) and Frankel (2004, Table 1).

[6] The progenitor of the Exchange Market Pressure variable, in a rather different context, was Girton and Roper (1977). Here we impose the a priori constraint that a one percentage increase in the foreign exchange value of the currency and a one percentage increase in the supply of the currency (the change in reserves as a share of the monetary base) have equal weights.

[7] Examples include Frankel (1993), Frankel and Wei (1994, 1995, 2007), Bénassy-Quéré (1999), and Bénassy-Quéré, Coeuré, and Mignon (2004), among others.

of the dollar, euro, and other major currencies that are potential candidates for the anchor currency or basket of currencies. In the special case where the country in question in fact does follow a perfect basket peg, the technique is an exceptionally apt application of OLS regression. Under the null hypothesis, it should be easy to recover precise estimates of the weights. The fit should be perfect, an extreme rarity in econometrics: the standard error of the regression should be zero and $R^2 = 100$ percent.

The reason to work in terms of changes rather than levels is the likelihood of nonstationarity. Concern for nonstationarity in this equation goes beyond the common refrain of modern time-series econometrics, the inability to reject statistically a unit root. There is often good reason a priori to consider the possibility that the regime builds in a trend. In the context of countries with a history of high inflation, the hypothesis of interest is that the currency regime is a crawling peg, that is, that there is a steady negative trend in its value.[8] In the context of the Chinese yuan in the years since 1994, the hypothesis of interest is a *positive* trend in its value.[9] Working in terms of first differences is a clean way to allow for nonstationarity. One simply includes a constant term to allow for the possibility of a crawl in the currency, whether against the dollar alone or a broader basket.

Although the equation is very well-specified under the null hypothesis of a basket peg or other peg, it is on less firm ground under the alternative hypothesis. The approach neglects to include anything to help make sense out of the error term under the alternative hypothesis that the country is not perfectly pegged to a major currency or to a basket, but rather has adopted a degree of flexibility around its anchor. In other words, the limitation of the implicit-weights estimation approach is the same as the virtue of the flexibility-parameter estimation approach and vice versa. The latter is well-specified to estimate the flexibility parameter only if the anchor is already known, while the former is well-specified to estimate the anchor only if there is no flexibility.

Frankel and Wei (2008) synthesize the technique that estimates the flexibility parameter with the technique that estimates the degree of flexibility. The synthesis technique brings the two branches of the literature together to produce a complete equation suitable for use in inferring the de facto regime across the spectrum of flexibility *and* across the array of possible anchors.[10]

All these approaches, including the synthesis technique, suffer from a further limitation. In practice many currencies, perhaps the majority, do not maintain a single consistent regime for more than a few years at a time, but rather switch parameters every few years and even switch regimes.[11] The official regime of Chile, for example, changed parameters—basket weights, width of band, rate of crawl—18 times from September 1982 to September 1999 (when it started floating), an average of once a year. If such changes always fell on January 1, one might have some hope of being able to estimate the equation year by year, though this would be difficult if one were limited to only 12 monthly observations. Since the parameter changes can come anytime, the standard strategy, of estimating an equation for each year, or each interval of two years, or more years, cannot hope to capture the reality. The frequent changes in regimes and parameters that many countries experience may be the most important reason why different authors' classification schemes give different results among the universe of currencies, and none seems to get fully at the truth.

The next step is to apply statistical techniques that allow for the possibility that the regime

[8] The hypothesis of a constant rate of crawl is readily combined with the hypothesis that the anchor is a basket, and even with the hypothesis of variability around the anchor. The combined BBC regime (Basket/Band/Crawl) has been recommended for a variety of countries (Williamson 2001). It was, for example, the regime followed by Chile in the 1990s, de facto as well as de jure (Frankel, Schmukler and Servén 2000).

[9] In 2005, Chinese authorities announced a switch to a new exchange rate regime: The exchange rate would henceforth be set with reference to a basket of other currencies, with numerical weights unannounced, allowing cumulatively a movement of up to +/− 0.3 percent per day. Initial applications of the implicit basket estimation technique to the yuan exchange rate suggested that the de facto regime continued to be essentially a dollar peg in 2005 and 2006. E.g., Ogawa (2006), Frankel and Wei (2007) and other papers cited there.

[10] Frankel (2009) applies the synthesis technique to data on the Chinese exchange rate from 2005 to 2008, finding that the yuan during the latter part of this period did move away from the dollar peg, shifting some weight to the euro.

[11] Masson (2001).

and parameter governing a currency shifts, and shifts at irregular intervals. If one knows the hypothesized date of a shift, e.g., because it is officially announced, then one can test that the structural break took place de facto by means of the classic test of Chow (1960). More often, however, the structural breaks could fall at any date.

We adopt the estimation technology developed by Bai and Perron (1998, 2003), who provided estimators, test statistics, and efficient algorithms appropriate to a linear model with multiple possible structural changes at unknown dates. Bai and Perron estimate multiple breaks simultaneously, using generalized least squares with an efficient dynamic programming algorithm that globally minimizes the sum of squared residuals. They further develop a procedure to test the null hypothesis of ℓ breaks versus the alternative of $\ell + 1$ breaks, which can be applied sequentially to determine the number of breaks.

II. The Synthesis Equation

Algebraically, if the home currency, with value defined as H, is pegged to a basket of currencies with values defined as $X(1), X(2), \ldots X(n)$, and weights equal to $w1, w2, \ldots wn$, then

$$(1)\quad \log H_{t+s} - \log H_t = c + \sum w(j)\,[\log X(j)_{t+s} - \log X(j)_t].$$

One methodological question must be addressed. How do we define the "value" of each of the currencies? This is the question of the numeraire.[12] If the exchange rate is truly a basket peg, the choice of numeraire currency is immaterial; we estimate the weights accurately regardless. We favor a weighted-average index of major currencies, such as the SDR, for reasons explained in Frankel and Wei (2007).

Our synthesis equation is:

$$(2)\quad \Delta \log H_t = c + \sum w(j) \Delta \log X(j)_t + \delta\{\Delta EMP_t\} + u_t$$

where ΔEMP_t denotes the percentage change in exchange market pressure, that is, the increase in international demand for the Home currency, which may show up in either its price or its quantity, depending on the policies of the monetary authorities. Here we define the total percentage change in exchange market pressure by

$$\Delta EMP_t \equiv \Delta \log H_t + \Delta Res_t / MB_t,$$

where $Res \equiv$ foreign exchange reserves and $MB \equiv$ Monetary Base. The $w(j)$ coefficients capture the de facto weights on the constituent currencies. The coefficient δ captures the de facto degree of exchange rate flexibility. A high δ means the currency floats purely, because there is little foreign exchange market intervention (few changes in reserves). $\delta = 0$ means the exchange rate is purely fixed, because it never changes in value. A majority of currencies probably lie somewhere in between.

Constraining the weights on the currencies to add up to 1 sharpens the estimates. We impose the adding up constraint $w(4) = 1 - w(1) - w(2) - w(3)$, and now make explicit the identities of the four major basket currencies used in this paper:

$$(3)\quad [\Delta \log H_t - \Delta \log £_t] = c + w(1)\,[\Delta \log \$_t - \Delta \log £_t] + w(2)\,[\Delta \log €_t - \Delta \log £_t] + w(3)\,[\Delta \log ¥_t - \Delta \log £_t] + \delta\{\Delta EMP_t\} + u_t.$$

III. An Illustration

We illustrate the technique in Table 1, with an application to the Mexican peso, for which weekly reserve data are available. The Bai-Perron technique yields five structural breaks, though the threshold for statistical significance was set high: at 0.01.

[12] Frankel and Wei (1995) used the SDR as numeraire; Frankel (1993) used purchasing power over a consumer basket of domestic goods; Frankel and Wei (1994, 2006) and Ohno (1999) used the Swiss franc; Bénassy-Quéré (1999), the dollar; Frankel, Schmukler, and Servén (2000), a GDP-weighted basket of five major currencies.

TABLE 1—IDENTIFYING BREAK POINTS IN MEXICO'S DE FACTO EXCHANGE RATE REGIME

Variables	1/21/1999–9/2/2001 (1)	9/9/2001–3/18/2003 (2)	3/25/2003–7/29/2006 (3)	8/5/2006–1/28/2008 (4)	2/4/2008–12/15/2008 (5)	12/22/2008–7/29/2009 (6)
US dollar	0.92***	0.88***	0.62***	1.11***	0.96***	0.20
	(0.09)	(0.12)	(0.07)	(0.10)	(0.19)	(0.22)
Euro	0.14	−0.09	0.30***	0.20*	0.51***	0.51***
	(0.08)	(0.14)	(0.09)	(0.11)	(0.16)	(0.18)
Jpn yen	−0.05	0.22***	0.08	−0.34***	−0.33**	0.18
	(0.06)	(0.07)	(0.06)	(0.06)	(0.12)	(0.13)
$\triangle EMP$[a]	0.14***	0.32***	0.17***	0.02	0.07	0.28***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.07)	(0.04)
Constant	0.00	−0.00***	−0.00*	−0.00	−0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	131	78	168	76	46	29
R^2	0.62	0.86	0.69	0.67	0.54	0.78

Notes: Dependent Variable: $\triangle logH$. All data are weekly—M1:1999–M7:2009. (Robust standard errors in parentheses.)
[a] $\triangle EMP$ is exchange rate market pressure, defined as $\triangle logH + (\triangle Res/MB)$, where $H \equiv$ value of home currency, in terms of SDRs, $Res \equiv$ foreign exchange reserves, and $MB \equiv$ *Monetary Base*.
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

The peso is known as a floater. To the extent that Mexico intervenes a bit to reduce exchange rate variation, the dollar is the primary anchor, but there also appears to have been some weight on the euro starting in 2003. Surprisingly, from August 2006 to December 2008, the coefficient on Exchange Market Pressure is essentially zero, suggesting heavier intervention around a dollar target. But the peso moved away from the currency to the north in the period starting December 2008, after the worst phase of the global liquidity crisis hit and the dollar appreciated.

Applications of the technique to examples of currencies following simple pegs to a basket or to a single currency are available elsewhere.[13] Possible future extensions include providing a classification scheme that includes most or all members of the IMF and applying a threshold autoregressive technique to capture more accurately the right specification for those countries believed to be following a target zone, rather than more general managed floating.

[13] Frankel and Wei (2008) for some basket peggers. Frankel (2009) for the yuan. The full version of the present study (NBER Working Paper No. 15620, 2009) reports details on the Bai-Perron technique for estimating structural parameter shifts and illustrates with results for four more managed-floating currencies: Chilean peso, Indian rupee, Russian ruble and Thai baht.

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