Financial integration in emerging market economies

Gurnain Pasricha

University of California, Santa Cruz

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Gurnain Kaur Pasricha[1]

University of California, Santa Cruz[2]

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Abstract This paper analyzes de-facto integration in some Emerging Market Economies based on behavior of deviations from Covered Interest Parity in the last 10 years. A price-based measure of de-facto integration provides crucial information for answering policy questions related to impact of capital openness and of effectiveness of controls. An Asymmetric Self Exciting Threshold Autoregressive model is used to estimate bands of speculative inaction. The estimated bands follow the pattern expected, and reveal a rational market in the sense that deviations from parity are self correcting. The paper uses information from the estimated models to construct a new index of de-facto integration.

Keywords: Covered Interest Parity, Threshold Autoregression, Financial Integration, Integration Index, Emerging Markets

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[2] Address for Correspondence: Graduate Student, Department of Economics, University of California, Santa Cruz, CA 95064. Email: gpasrich@ucsc.edu. Ph: (821) 419 0044.

The last two decades have seen a massive increase in financial flows around the world, opening up of emerging economies to international capital and creation of markets for financial instruments that never existed before in some of these countries. Emerging market economies increased their average gross external assets from 12.9 percent of GDP in 1985 to 26.7 percent in 1995 and to 53.7 percent in 2004 [3]. Average gross liabilities increased from 32.8 percent to 46.1 percent to 66.1 percent of GDP in the same years. In this world with progressively increasing capital flows, the optimal level of de-jure openness and the design of domestic regulatory mechanisms are two key policy issues facing policymakers in the emerging markets. Economies that realize the benefits of greater risk sharing, and bear the brunt of volatility transmitted through external shocks and of loss of independence in fixing the exchange rate and inflation, feel compelled to revisit their policies of restricting or welcoming capital movements.

The theoretical argument in favor of greater capital flows is akin to that for free trade: it allows for inter-temporal economic efficiency and risk sharing across countries. Moreover, longer term flows in the form of FDI confer the benefits of technology transfer and increased competitiveness on emerging markets. The caveat to these is provided by the theory of the second best, which argues that in the presence of other distortions, an open capital market might not be welfare improving. In practice, governments have used the latter argument to impose controls - to provide infant industry protection to their domestic financial sectors, to allocate credit to favored sectors, to protect the economy from external shocks. In practice also, the controls often become shelters for inefficiencies, when they are not bypassed. The welfare implications of greater openness then become an empirical question and crucial to answering it is a measure of financial integration.

[3] Lane and Milesi-Ferretti (2006)

Financial integration may be measured by de-jure or by de-facto measures. De-jure measures identify openness with the lack of legal restrictions on capital account transactions by residents and non-residents, while de-facto measures use information on the ground - on actual flows and on price convergence. Neither of these alone provides full information and must be taken in conjunction with the others in order to pin down reality. For example, private players often find ways to get around capital controls ((Garber 1998), (Garcia 2006), (Aizenman 2004)). A country with legal restrictions on every transaction in capital account could nevertheless find itself facing the full impact of external shocks[4]. This is not just a theoretical possibility but a very real concern facing, for example, India's policy makers where there is a widespread belief among the practitioners that Indian markets are much more integrated to the world economy than the government allows them to be. In so far as the existing restrictions only make it hard to predict the outcomes of other interventions accurately, while not fulfilling their stated objective of isolating the economy, they need to be re-assessed. Here, a de-jure measure would understate the true degree of capital mobility in the country and a de-facto measure would serve as a reality check.

De-facto measures of integration may be quantity measures or price measures. Quantity measures simply measure the volume of capital flows and again, are less than perfect measures. To take an example[5], two countries could have zero barriers to capital mobility and zero capital flows between them because they are identical and there is no uncertainty. Volume measures of capital mobility would imply zero financial market integration. Yet, in so far as prices are equalized between them,

[4]Aditionally, capital controls may be masqueraded as prudential regulations. For example, India's recent ban on Participatory Notes, thus requiring all foreign investors to register with the Indian regulators was an attempt to stem the inflows rather than to improve transparency. See also Kose et. al. (2006)

[5]Obstfeld and Taylor (2004)

and more importantly because of free mobility, any deviation from equilibrium in either economy would lead to equilibrating flows, the two markets should be considered perfectly integrated. On the other hand, price measures alone are not unambiguous measures of financial market integration. In our two economies above, if there were somehow erected barriers to disallow any trade or capital flows, prices would still be equal in the two, albeit without any current or prospective capital flows. The three kinds of measures of integration are therefore complementary.

There exist two widely used de-jure measures of financial integration, those constructed by Chinn and Ito (2006) and by Edwards (2005) and a quantity measure constructed by Lane and Milesi-Ferretti (2006). Price based cross-country measures of integration are rare and this paper seeks to fill this gap. It constructs a measure of financial integration that ranks economies based on the deviations from Covered Interest Parity (CIP) in the past decade or so. Modifications to CIP condition in the presence of capital controls and their testable implications are derived. The analysis combined with a limited supply of capital implies that measured deviations follow a Self-Exciting Threshold Auto-regressive (SETAR) process whereby deviations that lie within an endogenously determined neutral band are not self correcting and only deviations that constitute large enough profit opportunities engender a flow of speculative capital. The SETAR model is estimated for all emerging markets for which data was available and for some industrialized countries, for comparison. The results are largely as predicted. My estimates of the boundaries of the neutral band (called the thresholds) are non-trivial, asymmetric and are larger in the negative direction for countries known to have imposed controls on capital outflows (Malaysia, India). Also as expected, the thresholds are narrower and enclose a larger percentage of deviations in developed markets. Based on the estimated model, I construct an index of de-facto integration and find that Philippines, Chile, Mexico and

India are high ranked amongst emerging markets in terms of their financial integration, and Brazil, Malaysia and South Africa are the least integrated. These results are largely consistent with the findings of Francis, Hasan and Hunter (2002) who estimate a non-linear model to explain the deviations from Uncovered Interest Parity for some EMEs. The developed markets have narrower bands and fewer observations outside the bands - results consistent with previous studies on CIP deviations for these countries((Frenkel and Levich 1975), (Rhee and Chang 1992), (Balke and Wohar 1998)). The correlation between my index and the de-jure indices of Chinn and Ito (2006) and of Edwards (2005) is high, but that between my index and the quantitative measure of Lane and Milesi-Ferretti (2006) is low, affirming the earlier assertion that price measures are important in assessing integration, that conditions on the ground - enforcement and incentives/opportunities - matter for arbitrage and that the different measures won't always agree.

CIP is a very commonly used measure of financial integration[6], and has been validated within limits set by transaction costs, in numerous studies for industrialized countries. Obstfeld and Taylor (2004) compute covered interest differentials with monthly data vis--vis the Pound Sterling for US and German markets for the period 1921-2003 and find that the differentials were large between 1920 and 1980, but shrank considerably after 1980. Significantly, these differences became lower post 1980 than they were at the peak of the Gold Standard. Other studies show that these differentials have been falling since 1980. Frankel (1991) estimated a time trend in

[6]It is however, not a perfect measure. The modern theory of foreign exchange (Tsiang, 1959; Willett et. al., 2002; Hallwood and MacDonald, 2000) argues that in the presence of less than perfectly elastic supply of capital, the absence of deviations from CIP does not necessarily imply integration. This doesn't make the CIP measure irrelevant, only stresses that it be used in conjunction with quantity measures. My thanks to Thomas Willett for this comment.

absolute value of covered interest differentials for 25 developed countries during the 1980's and found a statistically significant negative trend for 10 of those 25 countries. Other studies that have estimated the differential and tested for presence of profitable opportunities outside of the 'transfer points' include Frenkel and Levich (1975), Rhee and Chang (1992), Clinton (1988), Taylor (1989), Peel and Taylor (2002) and Obstfeld and Taylor (2004). These transfer points have been estimated variously through data on triangular arbitrage, bid-ask spreads and brokerage fees and endogenously through a SETAR model, in Peel and Taylor (2002) and Obstfeld and Taylor (2004). Popper (1993) and Vieria (2003) provide evidence that CIP more or less holds even at longer maturities (more than one year). Deviations were found to be linked to out-of-line fiscal policies.Balke and Wohar (1998) study covered interest differentials between US dollar and UK pound for the period 1974-93 using TAR model, but instead of estimating constant thresholds, they compute time-varying thresholds from those implied by the modified CIP conditions from the data and then compute the AR coefficients for each regime econometrically. In this paper, I estimate constant bands because as discussed below, capital controls and other frictions not entirely captured by the bid-ask spreads also influence the thresholds. In emerging economies which are the subject of my analysis, such restrictions have played a particularly important role. My estimates of the bands would then be an average over the period. Branson and Taylor (2004) is a study of covered interest parity between US and Russia, which finds large bands around the equality using the TAR technique, but these bands are not symmetric. The lower bound is close to zero and the upper bound, which involves borrowing in US dollars and lending in rubles to be large, about 1 per cent. Below, I explain where the asymmetry may derive from. Bulk of the research on financial integration in emerging economies has been confined to testing uncovered interest parity due to lack of conventional forward contracts and market data. With the development of such markets in many of these economies since the late 1990's, there is now enough data to explore the issue of covered arbitrage and to compare the working of the newer markets to those in developed countries.

The paper is organized as follows. Section I describes the theoretical and the empirical models and the construction of the integration index, Section II describes the data and the summary statistics for CIP deviations, Section III presents the results and Section IV concludes.

I. CIP in the Presence of Frictions

In a fully integrated world with perfectly competitive profit maximizing agents and no transactions costs, the following CIP condition would hold in equilibrium:

$$\delta_t = \left(\frac{F_{t+k} - S_t}{S_t}\right) - \frac{i_{t+k} - i^*_{t+k}}{1 + i^*_{t+k}} = 0 \tag{1}$$

where δ_t is the covered interest differential, i_{t+k} and i^*_{t+k} are respectively returns on comparable domestic and foreign assets between time t and t+k, S_t is the domestic currency price of foreign currency, F_{t+k} is the forward rate or the k^{th} period domestic currency price of foreign exchange delivered in that period[7]. Since all the variables in the above equation are known a priori, any deviation from this parity in our model world represents pure profits and therefore cannot exist in a rational equilibrium[8].

[7]When interest rates are annualized, the forward premium may be multiplied by a scaling factor (12 for one-month data, 4 for 3-month data, etc) to get the CIP deviation in percent per annum terms. This approach is used here as the deviations for different maturities are directly comparable with this method.

[8]Rubinstein(2000)

However, in a world with oligopolistic players, underdeveloped money markets, exchange or capital controls or risk of such controls, differential taxation, limited supply of capital, sovereign immunities, transaction costs and other inconveniences, forward rate may differ from current spot rate by more than the interest differential, even with rational markets. The arbitrage conditions are then modified in the manner discussed below. I start with some well known treatment of transactions costs (Frenkel and Levich, 1975; Rhee and Chang, 1992; Balke and Wohar, 1998) and then move on to a discussion of capital controls.

I.1. Transactions Costs and CIP

Assume that there are transactions costs in the foreign exchange market, encapsulated in a positive bid-ask spreads on exchange rates. Denote by F_b the one-period forward bid rate for a foreign currency, say the Chilean peso (CHP), expressed as USD per CHP. It is the number of units of USD the investor gets when she sells forward one peso to a foreign exchange dealer. Denote by F_a the forward ask rate for the peso[9]. S_a and S_b are the spot ask and bit rates. All exchange rates are expressed as USD per unit of that currency and US is assumed to be the 'home' country. Let i be the US interest rate of one period maturity, i^* the foreign onshore interest rate of the same maturity. A covered arbitrage that involves borrowing dollars to invest in pesos in this world will be profitable if and only if:

$$\delta_p = \frac{F_b - S_a}{S_a} - \frac{i - i^*}{1 + i^*} > 0 \tag{2}$$

[9]Note that the bid rate for a currency is precisely equal to the inverse of the ask rate for USD in terms of that currency. This last identity is used often in the succeeding analysis.

An outflow from Chile and into US similarly is profitable if the following holds:

$$\delta_n = \frac{F_a - S_b}{S_b} - (i - i^*) < 0 \tag{3}$$

Since $\delta_p \neq \delta_n$, Covered Interest Parity now requires that the following hold:

$$\delta_p \leq 0 \qquad and \qquad \delta_n \geq 0 \tag{4}$$

When CIP deviations are measured using the average of the bid and ask rates in the spot and forward markets, as is often the case in emirical studies, the above condition modifies to the measured differential ($\hat{\delta}$) satisfying:

$$\hat{\delta} = \frac{F - S}{S} - \frac{i - i^*}{1 + i^*} \leq \frac{F}{S} - \frac{F_b}{S_a} \tag{5}$$

$$\Rightarrow \hat{\delta} \leq \frac{F}{S}(1 - \Omega_o) \tag{6}$$

and

$$\hat{\delta} = \frac{F - S}{S} - \frac{i - i^*}{1 + i^*} \geq \frac{F}{S} - \frac{F_a}{S_b} \tag{7}$$

$$\Rightarrow \hat{\delta} \geq \frac{F}{S}(1 - \frac{1}{\Omega_i}) \tag{8}$$

giving the neutral band:

$$\frac{F}{S}(1 - \frac{1}{\Omega_i}) \leq \hat{\delta} \leq \frac{F}{S}(1 - \Omega_o) \tag{9}$$

where $\Omega_o = \frac{F_b}{S_a}\frac{S}{F}$ and $\Omega_i = \frac{S_b}{F_a}\frac{F}{S}$ express transactions costs as a fraction of forward and spot rates, as in Frenkel and Levich (1975). The latter assume $\Omega_o = \Omega_i$ but as the definitions imply, this not generally true. The right hand side of (6) is always positive as ask rates are higher than corresponding bid rates and the right hand side of (8) is always negative. It is also possible to show that the absolute value of κ_n is greater than κ_p, implying threshold asymmetry, when measured forward and spot rates are simple average of corresponding bid and ask rates. Also, the bandwidth turns out to be $\frac{F_a}{S_b} - \frac{F_b}{S_a}$ which is wider than the wider of the two spreads, that on forwards $(F_a - F_b)$. Often, transaction costs in securities markets are more important than those in foreign exchange markets (Rhee and Chang, 1992). Defining these to be symmetric as in Frenkel and Levich (1975), and equal to t percent of transaction size in US and t^* percent of transaction size in Chile, and assuming that the foreign investor already holds foreign securities that yield i, the CIP condition modifies to:

$$\frac{F}{S}\left(1 - \frac{1}{\Omega_i \Phi}\right) \leq \hat{\delta} \leq \frac{F}{S}\left(1 - \Omega_o \Phi\right) \tag{10}$$

where $\Phi = (1-t)(1-t^*) < 1$, so that the neutral band is wider with transactions costs in securities markets than without.

I.2. Capital Controls in Emerging Markets

The analysis above assumes that all distortions and costs are fully reflected in the bid-ask spreads. In practice, this is not true. Countries often tax earnings from foreign investments at different rates, impose taxes or reserve requirements on foreign capital flows for the explicit purpose of encouraging or discouraging such flows and impose outright limits on transaction volumes, among other measures. For example, Brazil increased tax payable by foreigners on fixed interest investments from 5 per cent to 9 per cent between October 1994 and March 1995. Chile imposed a stamp tax of 1.2 per cent per year on foreign loans, applicable on all credits in their first year, except trade loans in 1991. In this section, I look at the implications of capital controls for the CIP relationship, and how this relates it to my model.

I.2.1. Tax on Inflows

Suppose there exists a tax τ on foreign inflows into Chile (the analysis is analogous for a tax on outflows). Now, a foreigner investing X dollars in Chile can make a profit iff:

$$X(1+i*)(1-\tau)\Phi\frac{F_b}{S_a} \geq X(1+i)$$

The CIP condition then modifies to:

$$\frac{F}{S}\left(1-\frac{1}{\Omega_i\Phi}\right) \leq \hat{\delta} \leq \frac{F}{S}\left[1-\Omega_o(1-\tau)\Phi\right] \tag{11}$$

thus increasing the positive threshold. Moreover, if the Chilean investors take into account the fact that their earnings abroad are taxed when they are repatriated back to Chile, they would require the (absolute) differential to be larger before they take money out of Chile. In this way, the tax on inflows could push down the negative threshold (or reduce the supply of arbitrage capital, or both), widening the neutral band[10]. A tax on outflows would similarly widen the no-arbitrage band.

I.2.2. Reserve Requirements

Suppose, as in Chile between 1994 and 1998, there exists a requirement to keep as unremunerated reserves, u per cent of every USD of inflow into the country. This amount is paid back at time h, which let's assume is greater than or equal to 1, the maturity period of our short term speculative investment. Assume also that the return from investment is repatriated at the time the investment matures and that interest rates are constant throughout (not realistic, but dropping this assumption will only reinforce our results). At time 0, the choice being faced is between investing

[10] My thanks to Sergio Schmukler for this insight.

a USD for h periods at the interest rate i or to invest $\frac{1-u}{S_a}$ at interest rate i^* for one period and re-invest this in USD for $h-1$ periods at interest rate i. Now, CIP requires that the following hold[11]:

$$\frac{F}{S}\left(1-\frac{1}{\Omega_i}\right) \leq \hat{\delta} \leq \frac{F}{S}\left[1-\Omega_o(1-u)-\frac{\Omega_o u}{(1+i)^{k-1}(1+i^*)}\right] \tag{12}$$

when there are no transactions costs in securities markets and

$$\frac{F}{S}\left(1-\frac{1}{\Omega_i}\right) \leq \hat{\delta} \leq \frac{F}{S}\left[1-\Omega_o(1-u)\Phi(1-t)-\frac{\Omega_o u(1-t)}{(1+i)^{k-1}(1+i^*)}\right] \tag{13}$$

when there are transactions costs in securities market. The upper threshold in (12) is unambiguously greater than that without reserve requirements $(1-\Omega_o)$ and increases with the duration of reserve requirement relative to the horizon of investment. With transactions costs in securities markets, assuming the investor has to sell home securities to invest in Chile and then again to buy them after period 1, incurring a transaction cost each time, the positive threshold on CIP differential will be higher with reserve requirements than without, as long as the transactions costs in the foreign securities market are not too large and the reserve requirement isn't too low[12]. In either case, the threshold increases with the duration of the reserve requirement. Similarly, a reserve requirement on capital outflows can be shown to push down the negative threshold. Other kinds of restrictions, like regulatory and 'exposure requirements'[13] will not only increase bandwidth (as

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[11] This is in terms of USD at time h.

[12] This may seem counter intuitive but with transactions costs that are prohibitively high and interest rates that are not too high, any inflow into Chile would exploit the forward spot differential and in this case a high reserve requirement simply reduces the transactions costs incurred while allowing you to take a position on the currency, thus narrowing the band.

[13] India currently imposes currency exposure requirements for access to onshore forward market for Indian rupee, and requires all foreign investors to register with the SEBI.

any quantitative restriction can be converted into an equivalent tax) but also throw ‘sands in the wheel’ of international capital. The latter can be interpreted as a reduction in elasticity of supply of capital, thereby reducing the speed with which any deviation outside threshold reverts back. One can summarize the testable implications derived from the above discussion as follows:

1. The no-arbitrage band $[\kappa_n, \kappa_p]$ is larger than the largest spread. This also implies that the bands are wider during crisis periods when spreads are wider.

2. The thresholds are likely to be asymmetric around zero, with larger negative thresholds than positive ones.

3. Taxes and quantitative controls on capital inflows increase the positive threshold, and controls or taxes on outflows increase the absolute value of the negative threshold; and both types of controls increase the bandwidth. This effect is more pronounced for shorter maturities. Controls are also likely to reduce the elasticity of supply of arbitrage capital.

When supply of capital is less than perfectly elastic, CIP could be said to hold as long as any deviation outside the band reverts back to the band. In the absence of market rationality, the differentials could follow a non-stationary process even outside the bands. This leads us to the SETAR model as a natural choice for testing integration: The wider the estimated thresholds and the longer the time to correct a deviation outside the band, the lower the level of integration. I describe this model and data in the next two subsections.

I.3. Empirical Model

The Asymmetric Self-Exciting Threshold Autoregressive model (SETAR) is called 'self-exciting' because AR regime that is applicable this period depends on the value of the dependent variable last period and 'asymmetric' because the negative threshold is allowed to differ from the positive threshold. It takes the form:

$$\delta_t = \rho_i \delta_{t-1} + \epsilon_{it} \qquad \text{for} \quad \kappa_n < \delta_{t-1} < \kappa_p \tag{14}$$

$$\delta_t - \kappa_n = \rho_n(\delta_{t-1} - \kappa_n) + \epsilon_{nt} \quad \text{for} \quad \delta_{t-1} \leq \kappa_n \tag{15}$$

$$\delta_t - \kappa_p = \rho_p(\delta_{t-1} - \kappa_p) + \epsilon_{pt} \quad \text{for} \quad \delta_{t-1} \geq \kappa_p \tag{16}$$

where $\epsilon_{jt} \sim N(0, \sigma_j^2)$, $j = i, n, p$ and κ_n and κ_p are the negative and positive thresholds respectively. Note that this model assumes that speculative activity will push the deviations to the edges of the band, rather than to its center. The AR(1) process within the band is allowed to be a random walk, but the hypothesis of rational markets states that the AR(1) process outside the bands be stationary. If the thresholds were known, the model could be estimated by ordinary least squares applied separately to the inner regime and outer regime observations. But since the thresholds aren't known, they are estimated using a grid search over possible threshold combinations. All the percentiles between the 5^{th} and 95^{th} percentiles are taken and separated into sets of negative thresholds candidates and positive threshold candidates. The model then chooses the combination of negative and positive threshold values that minimize the residual sum of squares. This estimation method is called the constrained least squares. Another way to estimate the thresholds is by choosing the combination of positive and negative threshold that maximizes a log-likelihood function, but this assumes that residuals are normally distributed, an assumption that was violated for most countries in my sample. The constrained least squares estimates are consistent and I also use Tsay (1989) test to test for nonlinearity in the data[14].

I.4. Integration Index

To construct the Integration Index, I take into account five different measures that derive from the model. The first is the bandwidth, which measures the size of the no-arbitrage band, and is expected to be wider the greater the transactions costs of effective controls in an economy. I also use percentage of observations lying in the outer regimes($OutObs$), the median positive and negative deviation outside the measured band ($MedDevNeg$ and $MedDevPos$ respectively) and the third quartile of continuous runs outside the band ($3rdQuartile$). These measures capture how frequent are profitable deviations from intrest parity, and how fast they revert back to the band. The more elastic the supply of capital, and the less effective the controls, the fewer the deviations outside the band[15] and the faster the reversion speed. One could also use the AR coefficients in outer regimes or the half lives, but the results should be similar. Medians and quartiles are preferable to average deviations as they are immune to outliers.

I first normalize each of the indicators mentioned above by subtracting from them their inter-country mean and dividing by the standard deviation. The normalizations are done separately for

[14]Chan and Ng (2004) compare various tests for SETAR type nonlinearity and find that between Tsay(1989) and Hansen(1996) tests, neither scores over the other in all situations. Both tests lose power and have inflated empirical sizes in the presence of outliers. Given that Hansen(1996) requires substantially more involved computation and doesn't allow for regime dependent heteroskedasticity as in my model, I chose to use the Tsay test.

[15]Note that the paper uses daily data, so measured deviations are those that were present at the end of the day.

the two maturities, one and three months. For Chile, Malaysia, Thailand and Mexico, for which data on one of the maturities is not available, I use the available maturity's data to approximate for the missing maturity model[16]. Also, I only use non-crisis period observations in computing the index. The Integration Index is:

$$I_j = -\frac{Bandwidth_j n + OutObs_j n + MedDevNeg_j n + MedDevPos_j n + 3rdQuartile_j n}{5} \qquad (17)$$

where subscript j refers to the country and n to the fact that the variable has been normalized. The negative sign allows larger values of the index to be interpreted as greater integration. Note that this index is centered at zero and gives only an ordinal ranking. I compare this index with three other available indices of financial integration/openness. The first one is constructed by Chinn and Ito (2006) and is a de-jure measure of openness constructed using Principal Component Analysis. The second is the updated index in Edwards (2005) and uses detailed information on de-facto controls. The third is the quantitative measure of de-facto integration defined as the ratio of total foreign assets and liabilities to GDP constructed by Lane and Milesi-Ferretti (2006). Note that the last index measures the stock of foreign investments and therefore incorporates historical openness as well as that in the last decade. Each of these indices is available yearly, up to 2004. I average these for each of the countries over my sample period (1995-2004 for all the developed countries and shorter for EMEs) to arrive at a single number which I then compare with my index.

[16]The analysis was repeated after dropping these four countries and the ranking of the rest of the countries are identical relative to each other in the smaller sample.

II. The Data

The US is treated as the home country in each equation. Interbank interest rates and onshore forward exchange rates of one and three month maturities are used to construct the covered interest deviations. The interbank rate used for the US is the US dollar LIBOR, from online database of the Board of Governers of the Federal Reserve System. Forward rates and interest and exchange rates of developed markets (excluding Hong Kong) are from Datastream and the rest are from Global Financial Database. Data used is of daily frequency. Data from IMF's International Financial Statistics was used for generating Kaminsky and Reinhart (1999) index of currency market turbulence, to identify crisis months. Crisis periods are defined as 6 months before and after the crisis months. If two or more crisis months lie within 6 months of each other, then the entire period from 6 month before the first crisis month to 6 months after the last crisis month is deemed the crisis period. Crisis periods so identified are successful in isolating periods of sharply increased deviations from CIP, as seen in figures (1) and (2) below. Only countries for which at least 2 years of data was available were used in the analysis. The period of analysis is from the late 1990's to 2006 for most countries, except for Hungry, whose daily data series stops in 2002 and Poland, Chile and Brazil whose data begins in or after 2002. For developed economies and Singapore, longer data series were available but were truncated to post-1995 period, to facilitate comparison with other EMEs. The analysis admittedly excludes some important emergine economies, including Russia and China, but the lack of data on them is itself a statement on their level of financial integration with the rest of the world.

Tables 1 and 2 contain the summary statistics on CIP differentials for 1- and 3-month maturity instruments respectively. The mean deviations for both maturities are significantly different from zero, except for UK (1-month) and perhaps Malaysia (1-month, non-crisis period). This is consistent with CIP in a less than perfect world, as seen above and in Cheung et. al. (2003). Also, the mean, variance and range of deviations do not move in the same direction, so that a more formal evaluation of the parity condition is needed. The results of the Tsay (1989) test are presented in last columns in the tables. The F-statistic tests the null hypothesis of no non-linearity in the data. The 10 percent critical value is 2.3 and almost all data series show strong evidence of non-linearity. CIP deviations for all countries and maturities satisfied stationarity (Malaysia was a borderline case) and the results are available on request.

III. The Results

Details of the estimated models are presented in Tables (3) to (6). On the whole, developed markets have narrower bandwidths, fewer observations in outer regimes and smaller average deviations outside thresholds. All of these are consistent with fewer controls and more elastic supply of capital in these market. They also have closer estimates for the two maturities, which may again reflect their deeper and more liquid markets for both maturities and less ad-hoc restrictions.

Consistent with the predictions in the theoretical section above and with the larger deviations seen in crisis periods in figures (1) and (2) below, crisis period bands are wider than tranquil period bands with the exception of Malaysia's 1-month differentials[17]. Malaysia's highly effective capital controls introduced on September 1, 1998 complicate estimation. The controls managed to push

[17]Norway's crisis period model could not be estimated because there were only four positive observations in the entire period.

the CIP differential to below 100 per cent per annum on October 28, 1998 and keep it at three specific values all the way to August 1999, as clearly seen in figure (1.A). This means a lack of variability in the data for one third of the crisis period, precluding precise estimation.

Among emerging markets, Chile, Mexico and Singapore (3-month) have the narrowest bands and Philippines and Malaysia (both 1-month) the widest. Most EMEs have bands that are highly asymmetric about zero, with larger negative thresholds than positive ones. The model therefore, is able to capture the higher costs to borrowing in local currencies and lending in dollars imposed by capital controls. Although we discussed only two types of capital controls in Section I above, this prediction of enlarged bands when capital controls are imposed is true more generally. Given that even well-enforced capital restrictions rarely involve a complete moratorium on foreign lending, they only serve to make such transactions more expensive and harder (but not impossible) to undertake. These can thus be translated into an effective tax, akin to the tax discussed in Section I, which any CIP differential must additionally cover, to be profitable.

Often, the controls seek to (and are successful in[18]) changing the composition of capital flows to longer maturities and therefore impose a higher effective tax on shorter term transactions, while reducing the supply of speculative capital. This reduction in the supply of capital means that the differentials would take longer to converge to the band edge. To see whether this happens here, one can look at continuous runs (number of successive days for which the differential was outside the same threshold) shown in columns (8) and (9) of Tables 3 and 4. The third quartiles of consecutive runs for all countries are less than 4 (except for Malaysia (1-month)). This suggests that most deviations, when they do occur tend to be corrected within a business week. All countries,

[18]Magud et. al. (2005)

however, have seen at least one run that lasted a considerable period of time, the longest being for Malaysia and Norway, with continuous runs of over a year. There seems to be a fair bit of democracy here, with no clear difference between developed and emerging markets. The difference seems to be in how large are the shocks to the differentials (given by the median deviations outside thresholds), not how fast they are arbitraged away.

Furthur confirmation of this is in Tables (5) and (6), which contain the estimated AR(1) coefficients and their standard errors for each of the three regimes. All coefficients in outer regimes are significantly less than unity in absolute value, at 1 percent level of significance. Some of these are not significantly different from zero. This implies that any deviations outside thresholds in all markets considered here reverts back to the band, and that markets are rational.

My index of financial integration is presented in Table (7) below. What is immediately clear is that all the developed countries rank higher than all the emerging markets in my sample. Among emerging markets, Philippines, Chile and Mexico and India are the highest ranked, and South Africa, Malaysia and Brazil the lowest ranked. Singapore's low rank is contrary to its popular image as a vibrant financial center, but not to the lesser known fact that trades in the Singapore dollar remain tightly regulated and activity in the domestic interbank market is dominated by a few banks. India's fourth rank amongst the emerging markets would be a surprise for the Indian regulators, but confirms the widely held belief among practitioners that capital is actually quite fluid in that market. The other indices of integration rank India below Brazil in terms of openness, whereas my Index puts India on top. Figure 3 makes clear why. While the estimated thresholds for Brazil are narrower, perhaps because of fewer de-jure restrictions [19] there are nevertheless larger

[19]Note that there was furthur loosening of controls in Brazil in 2005, which is not reflected in the de-jure indices

and more persistent deviations outside the band for Brazil than for India. These may be caused by the same country and counterparty risks that also account for the existence of the offshore non-deliverable market in Brazilian real. Furthurmore, access to onshore futures market in Brazil requires traders to post local government bonds as collateral for their positions, multiplying their exposure to onshore risk ((Lipscomb 2005)). My index is relatively highly correlated with the de-jure indices of Chinn and Ito (2006) and Edwards (2005) with the correlations exceeding 0.7. It is not so highly correlated with the quantitative measure of Lane and Milesi-Ferretti (2006), which as I argued earlier, would be because one can expect quantity and price indices to be imperfectly correlated and because the Lane and Milesi-Ferretti (2006) measure captures historical openness as well as current openess. It is defined as the sum of external financial assets and liabilities over GDP.

IV. Conclusions

The research presented here proposes a price-based index of financial openness that allows one to rank different economies based on their de-facto integration with the world markets. It reveals a much more rational global financial market than has been allowed for in previous studies. Although all the emerging economies in my sample seem less integrated than the developed economies, in none of them are deviations from CIP such as to reject efficient arbitrage, in the sense that any profitable deviations are arbitraged away. The estimated coefficients on outer regimes are all significantly less than one in absolute value. Among the emerging markets, Philippines and Chile show high degree

because their data ends in 2004. For a summary of de-jure restrictions and changes therein, see (Goldfajn and Minella 2005) and (Garcia 2006).

of openness while Malaysia and Brazil are bottom ranked among the conomies for which data is available.

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Table 1. Summary Statistics: 1-Month CIP Deviations

Currency of	N	Mean	Std. Error	Variance	Min	Max	Tsay F-Stat
Emerging Markets							
Brazil	658	-1.53	0.27	47.80	-37.59	46.88	0.23
Hungary	1293	-2.13	0.11	15.02	-17.72	20.55	0.45
India	1900	-1.36	0.05	4.00	-12.89	7.91	49.05
Malaysia							27.91
Non-Crisis Period	1809	-0.07	0.04	3.38	-11.46	3.68	126.19
Crisis Period	682	-82.66	5.13	17921.67	-361.71	46.65	8.04
Philippines							20.11
Non-Crisis Period	1851	-2.46	0.06	7.03	-49.78	31.96	48.61
Crisis Period	269	-8.90	0.78	162.63	-117.76	33.93	13.12
Poland	1203	-1.65	0.11	13.26	-14.06	21.93	3.31
Singapore							15.57
Non-Crisis Period	2605	-0.31	0.05	6.23	-11.28	13.40	2.28
Crisis Period	377	-2.15	0.22	18.83	-25.51	12.13	6.10
Thailand							169.23
Non-Crisis Period	1995	-2.54	0.07	10.68	-37.97	14.73	43.75
Crisis Period	368	-16.00	1.12	462.94	-147.76	52.90	4.67
South Africa	2413	-3.40	0.11	29.36	-33.00	38.92	12.82
Developed Markets							
Australia	3051	0.05	0.02	1.85	-16.69	17.14	4.75
Canada	3051	0.11	0.02	0.77	-10.93	7.80	7.56
Denmark	3051	0.09	0.03	2.45	-25.50	15.03	10.36
Euro Area	2021	0.08	0.03	1.66	-11.45	20.48	5.80
Hong Kong	2910	-0.08	0.01	0.53	-11.16	2.25	19.11
Japan	3051	0.35	0.05	6.51	-37.58	52.40	1.11
Norway							127.15
Non-Crisis Period	2772	0.16	0.05	7.60	-24.08	96.32	114.32
Crisis Period	279	0.44	0.04	0.49	-0.59	7.47	0.38
Sweden	3051	0.10	0.03	2.18	-24.03	20.79	21.78
Switzerland	3051	0.27	0.02	1.37	-12.40	10.90	19.58
United Kingdom	3051	-0.01	0.02	0.82	-17.06	10.13	11.09

Note. — USA is assumed to be home country and the deviations are on a per cent per annum basis. Crisis periods excluded refer to 6 month windows around crisis months identified using Kaminsky and Reinhart(1999) criteria. F-Statistic computed using arranged regressions as described in Tsay (1989). The null hypothesis is of no non-linearity in the data. The 10 per cent critical value for degrees of freedom (2, inf) is 2.31.

Table 2. Summary Statistics: 3- Month CIP Deviations

Currency of	N	Mean	Std. Error	Variance	Min	Max	Tsay F-Stat
Emerging Markets							
Brazil	659	-0.71	0.11	7.46	-12.82	14.58	5.08
Chile	667	-0.56	0.05	1.68	-4.92	4.36	2.26
Hungary	1301	-1.09	0.04	1.86	-7.88	6.43	0.2
India	1920	0.13	0.03	1.93	-9.15	5.54	74.67
Mexico	1380	-0.91	0.07	5.89	-23.05	9.30	11.27
Philippines							43.33
Non-Crisis Period	1878	-0.81	0.02	0.90	-14.55	11.13	51.64
Crisis Period	271	-2.98	0.27	20.04	-38.18	10.89	10.07
Poland	1203	-0.67	0.04	1.49	-4.71	7.26	3.3
Singapore							68.57
Non-Crisis Period	2611	-0.12	0.02	0.74	-5.21	4.47	0.59
Crisis Period	380	-1.33	0.09	3.01	-9.46	3.36	4.03
South Africa	2547	-1.37	0.04	3.31	-11.38	12.34	14.67
Developed Markets							
Australia	3051	0.06	0.01	0.53	-20.51	11.84	32.48
Canada	3051	0.08	0.01	0.10	-3.54	5.51	34.62
Denmark	3051	0.11	0.01	0.29	-8.48	5.11	14.3
Euro Area	2021	0.07	0.01	0.27	-8.88	6.99	11.63
Hong Kong	2910	-0.03	0.01	0.20	-4.87	13.70	186.92
Japan	3051	0.22	0.01	0.20	-6.07	12.93	34.56
Norway							102.01
Non-Crisis Period	2772	0.10	0.02	0.96	-7.92	32.58	92.66
Crisis Period	279	0.27	0.02	0.07	-0.14	2.58	0.9
Sweden	3051	0.13	0.01	0.31	-7.93	7.00	30.28
Switzerland	3051	-0.03	0.01	0.23	-5.91	7.12	59.71
United Kingdom	3051	0.03	0.01	0.09	-3.24	3.49	34.91

Note. — USA is assumed to be home country and the deviations are on a per cent per annum basis. Crisis periods excluded refer to 6 month windows around crisis months identified using Kaminsky and Reinhart(1999) criteria. F-Statistic computed using arranged regressions as described in Tsay (1989). The null hypothesis is of no non-linearity in the data. The 10 per cent critical value for degrees of freedom (2, inf) is 2.31.

Table 3. TAR Models: 1- Month CIP Deviations

Currency of	Thresholds		Bandwidth	Out Obs.	Median Deviation		Longest	Third	Data Range	
	Negative	Positive		%	Negative (abs)	Positive	Run	Quartile	Begin	End
Emerging Markets										
Brazil	-1.25	0.14	1.39	90	3.7	3.39	14	2	30-Mar-04	15-Dec-06
Hungary	-1.72	0.03	1.75	82	2.27	1.73	12	2	27-Oct-97	3-Oct-02
India	-2.08	0.08	2.16	50	0.79	1.2	69	3	2-Dec-98	29-Dec-06
Malaysia	-3.33	1.69	5.01	29	0.06	0.21	282	34	2-Jan-97	11-Jan-07
Crisis Period	-0.70	1.64	2.35	84	20.57	1.45	211	2	1-Jan-97	31-Aug-99
Philippines	-5.97	0.08	6.05	11	0.89	0.54	8	1	3-Jan-97	3-Oct-05
Crisis Period	-5.55	0.56	6.11	68	4.42	5.93	14	4	1-Jun-97	30-Jun-98
Poland	-1.35	0.02	1.37	84	2.09	1.81	13	2	12-Feb-02	11-Jan-07
Singapore	-0.8	0.06	0.86	90	1.61	1.69	12	3	4-Jan-95	11-Jan-07
Crisis Period	-2.18	0.01	2.19	77	2.66	1.32	11	2	1-Jun-97	30-Nov-98
South Africa	-3.02	0.02	3.04	67	3.11	1.99	17	2	2-Apr-97	29-Dec-06
Thailand	-2.36	0.03	2.39	53	1.7	0.6	63	2	2-Jan-97	29-Dec-06
Crisis Period	-3.88	0.16	4.04	77	15.75	0.94	33	4	1-Jan-97	31-Jul-98
Developed Markets										
Australia	-0.59	0.3	0.89	28	1.31	0.16	9	2	1-Jan-95	25-Jan-07
Canada	-0.001	0.2	0.20	35	0.08	0.09	53	2	1-Jan-95	25-Jan-07
Denmark	-0.004	0.27	0.27	38	0.06	0.09	26	2	1-Jan-95	25-Jan-07
Euro Area	-0.2	0.21	0.41	17	1.67	0.16	8	2	1-Jan-95	25-Jan-07
Hong Kong	-0.03	0.29	0.32	61	0.37	0.21	78	4	1-Jan-95	11-Jan-07
Japan	-0.01	1.48	1.49	22	0.26	2.44	19	2	1-Jan-95	25-Jan-07
Norway	-0.4	0.001	0.40	78	0.29	0.22	276	3	4-Jan-95	25-Jan-07
Crisis Period									1-Jun-97	30-Jun-98
Sweden	-0.02	0.23	0.25	53	0.13	0.09	53	3	1-Jan-95	25-Jan-07
Switzerland	-0.01	0.82	0.83	15	0.09	1.05	26	2	1-Jan-95	25-Jan-07
United Kingdom	-0.16	0.05	0.21	41	0.09	0.04	21	2	1-Jan-95	25-Jan-07

Note. — Observations are for non-crisis periods unless otherwise specified. Out. Obs refers to percentage of observations lying in the outer regimes, longest run is the maximum number of consecutive days that a deviation is in the same outer regime. See text for details of computations.

Table 4. TAR Models: 3- Month CIP Deviations

Currency of	Thresholds		Bandwidth	Out Obs.	Median Deviation		Longest	Third	Data Range	
	Negative	Positive		%	Negative (abs)	Positive	Run	Quartile	Begin	End
Emerging Markets										
Chile	-0.4	0.02	0.42	86	0.76	0.66	11	2	30-Mar-04	28-Dec-06
Brazil	-0.66	0.02	0.68	89	1.52	1.11	36	2	30-Mar-04	15-Dec-06
Hungary	-0.81	0.04	0.85	78	0.87	0.64	21	2	27-Oct-97	3-Oct-02
India	-1.03	1.78	2.81	24	0.42	1.22	115	4	28-Nov-97	29-Dec-06
Mexico	-0.3	0.07	0.37	90	0.95	0.7	15	2	18-Jul-01	29-Dec-06
Philippines	-1.44	0.04	1.48	24	0.45	0.21	21	2	2-Jan-97	30-Nov-06
Crisis Period	-1.79	0.14	1.93	71	1.56	1.27	15	4	1-Jul-97	30-Jun-98
Poland	-0.6	0.002	0.60	79	0.76	0.62	11	2	12-Feb-02	11-Jan-07
Singapore	-0.12	0.02	0.14	95	0.64	0.56	16	3	4-Jan-95	11-Jan-07
Crisis Period	-0.56	0.03	0.59	83	1.19	0.52	30	3	1-Jun-97	30-Nov-98
South Africa	-1.45	0.001	1.45	58	1.11	0.68	15	2	2-Apr-97	17-Jan-07
Developed Markets										
Australia	-0.14	0.18	0.32	22	0.11	0.03	15	2	1-Jan-95	25-Jan-07
Canada	-0.004	0.15	0.15	34	0.04	0.06	39	2	1-Jan-95	25-Jan-07
Denmark	-0.001	0.25	0.25	21	0.07	0.09	19	2	1-Jan-95	25-Jan-07
Euro	-0.01	0.15	0.16	28	0.03	0.07	19	2	1-Jan-95	25-Jan-07
Hong Kong	-0.01	0.12	0.13	66	0.14	0.08	45	3	1-Jan-95	11-Jan-07
Japan	-0.0004	0.4	0.40	17	0.32	0.1	33	1	1-Jan-95	25-Jan-07
Norway	-0.17	0.01	0.18	84	0.12	0.15	236	4	4-Jan-95	25-Jan-07
Sweden	-0.01	0.24	0.25	31	0.08	0.04	59	2	1-Jan-95	25-Jan-07
Switzerland	-0.27	0.08	0.35	26	0.43	0.06	22	2	1-Jan-95	25-Jan-07
United Kingdom	-0.07	0.08	0.15	38	0.05	0.04	20	3	1-Jan-95	25-Jan-07

Note. — Observations are for non-crisis periods unless otherwise specified. Out. Obs refers to percentage of observations lying in the outer regimes, longest run is the maximum number of consecutive days that a deviation is in the same outer regime. See text for details of computations.

Table 5. TAR Coefficients: 1- Month CIP Deviations

Currency of	Inner Regime		Negative Regime		Positive Regime	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Emerging Markets						
Brazil	3.24	0.88	0.12	0.05	-0.10$^{@}$	0.07
Hungary	1.74	0.26	0.06$^{@}$	0.04	-0.39	0.07
India	1.09	0.03	0.51	0.03	0.81	0.04
Malaysia	0.91	0.01	-0.41	0.03	0.36	0.09
Crisis Period	-4.73$^{\#}$	3.31	0.99$^{@}$	0.003	-0.06$^{@}$	0.07
Philippines	0.90	0.01	0.06$^{@}$	0.10	0.60	0.09
Crisis Period	2.38	0.41	0.67	0.04	-0.90	0.14
Poland	2.15	0.29	0.09	0.04	-0.14	0.06
Singapore	0.27$^{@}$	0.30	-0.07	0.03	-0.01$^{@}$	0.03
Crisis Period	1.71	0.31	0.30	0.07	-0.29	0.12
South Africa	1.42	0.08	0.20	0.03	-0.44	0.05
Thailand	1.04$^{\#}$	0.04	0.77	0.02	-0.53	0.08
Crisis Period	4.38	0.66	0.82	0.04	-0.36	0.14
Developed Markets						
Australia	0.03$^{@}$	0.11	-0.14	0.05	-0.06	0.03
Canada	1.13	0.14	-0.09	0.04	-0.09	0.03
Denmark	0.88$^{\#}$	0.18	0.13	0.02	-0.05$^{@}$	0.05
Euro Area	0.63	0.27	-0.002$^{@}$	0.06	0.11	0.05
Hong Kong	0.62	0.07	0.67	0.02	-0.03$^{@}$	0.06
Japan	0.77	0.12	0.14	0.03	0.06$^{@}$	0.05
Norway	1.07$^{\#}$	0.25	-0.19	0.04	0.62	0.02
Sweden	1.39	0.19	0.16	0.02	-0.04	0.04
Switzerland	0.81	0.06	-0.14	0.03	-0.15$^{@}$	0.06
United Kingdom	1.22$^{\#}$	0.26	-0.11	0.02	-0.03$^{@}$	0.04

$^{\#}$Not significantly different from 1 at 10 percent level.

$^{@}$Not significantly different from 0 at 10 percent level. All coefficients in outer regimes are significantly less than 1 in absolute size at 1 percent level, except cirsis period positive regime coefficient in Philippines.

Table 6. TAR Coefficients: 3 - Month CIP Deviations

Currency of	Inner Regime		Negative Regime		Positive Regime	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Emerging Markets						
Brazil	2.93	0.75	0.24	0.05	0.32	0.06
Chile	2.47	0.54	0.07@	0.05	-0.38	0.08
Hungary	2.08	0.17	0.21	0.04	-0.51	0.08
India	0.91	0.02	0.58	0.04	0.93	0.02
Mexico	3.00	0.73	0.20	0.03	-0.38	0.05
Philippines	0.99#	0.02	0.10	0.05	0.62	0.07
Crisis Period	1.74	0.19	0.72	0.05	-0.80	0.26
Poland	1.84	0.18	0.09	0.04	-0.16	0.06
Singapore	-0.61# @	0.94	0.15	0.03	-0.01@	0.03
Crisis Period	2.88	0.58	0.60	0.05	-0.56	0.16
South Africa	1.25	0.06	0.18	0.03	-0.52	0.06
Developed Markets						
Australia	0.86#	0.11	0.001@	0.05	-0.05@	0.03
Canada	1.08#	0.07	-0.13	0.04	-0.10	0.03
Denmark	1.02#	0.07	0.09	0.03	-0.09@	0.05
Euro	1.33	0.14	-0.08	0.03	0.06@	0.06
Hong Kong	0.75	0.07	0.66	0.02	0.04@	0.04
Japan	1.03#	0.04	-0.02@	0.07	-0.01 @	0.02
Norway	0.67#	0.28	-0.03@	0.04	0.63	0.02
Sweden	1.11#	0.06	0.10	0.03	0.001@	0.04
Switzerland	1.12#	0.10	-0.09	0.04	0.01@	0.04
United Kingdom	0.82#	0.12	-0.15	0.03	-0.02@	0.04

Not significantly different from 1 at 10 percent level.

@ Not significantly different from 0 at 10 percent level. All coefficients in outer regimes are significantly less than 1 in absolute size at 1 percent level.

Table 7. Integration Index

Country	Integration Index	Ranking	Chinn-Ito	LMF	Edwards
Denmark	0.67	1	2.62	3.04	100
Canada	0.66	2	2.62	2.07	100
United Kingdom	0.62	3	2.62	5.96	100
Euro Area	0.58	4			
Sweden	0.57	5	2.54	3.79	87.5
Australia	0.54	6	1.66	1.79	75
Switzerland	0.53	7	2.62	8.55	100
Japan	0.35	8	2.49	1.14	75
Hong Kong	0.34	9	2.62	11.93	102.5
Norway	0.19	10	2.35	2.29	100
Philippines	0.08	11	0.20	1.43	75
Chile	-0.24	12	1.52	1.99	62.5
Mexico	-0.27	13	0.72	0.79	62.5
India	-0.31	14	-0.95	0.47	64.3
Singapore	-0.39	15	2.42	8.04	96.4
Poland	-0.45	16	0.20	1.03	50
Thailand	-0.47	17	-0.05	1.43	39.1
Hungary	-0.52	18	1.08	1.50	75
South Africa	-0.68	19	-1.09	1.25	50
Malaysia	-0.95	20	-0.01	2.05	64.1
Brazil	-1.11	21	-0.05	0.89	62.5
Correlation with Integration Index			0.78	0.38	0.72

Note. — The numbers for last three columns are the average of the respective indices over the sample period of the Integration Index for each country. LMF refers to the Lane and Milesi-Ferretti (2006) index.

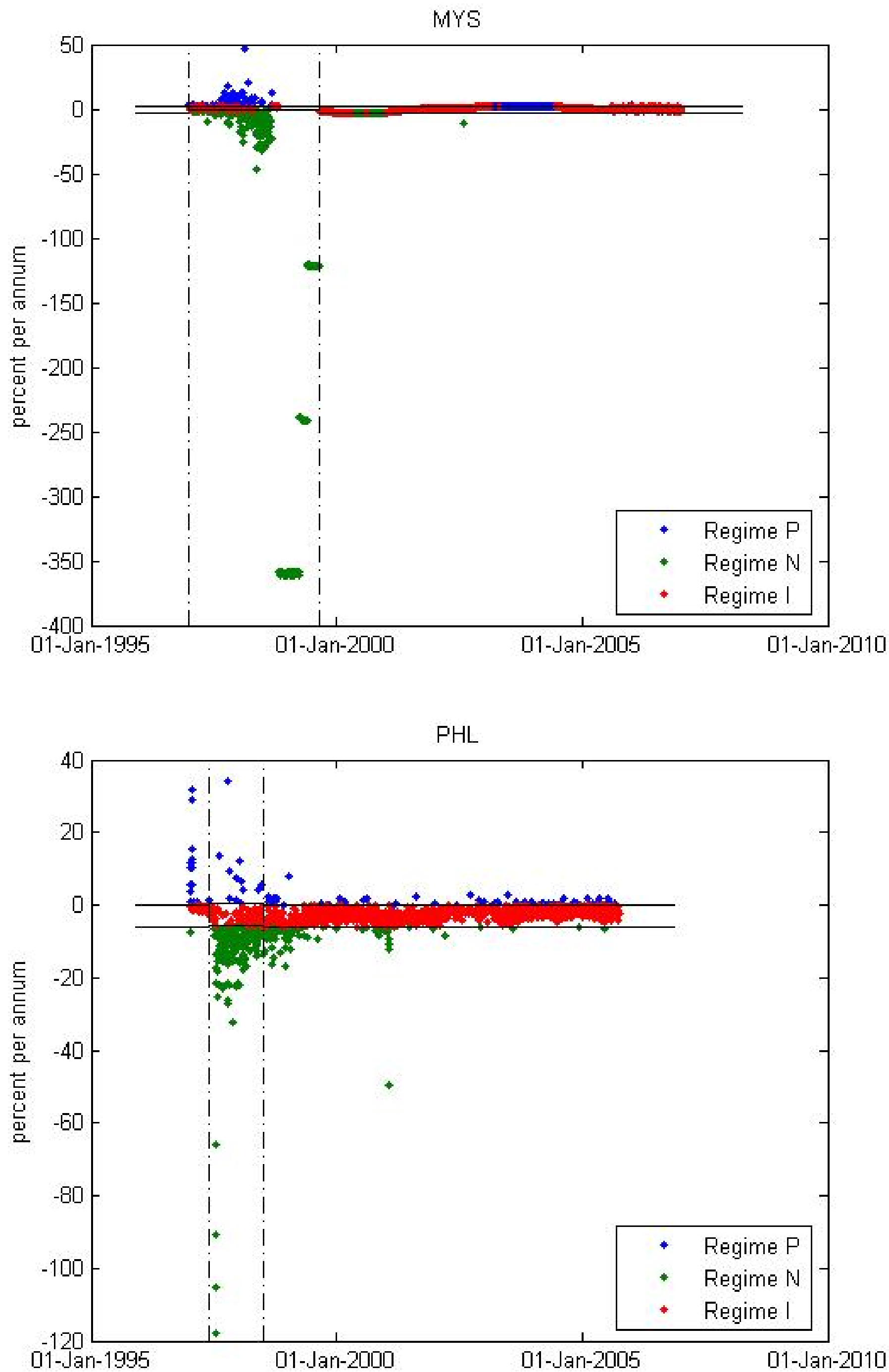

Fig. 1.A.— CIP Differentials, 1-Month Instruments

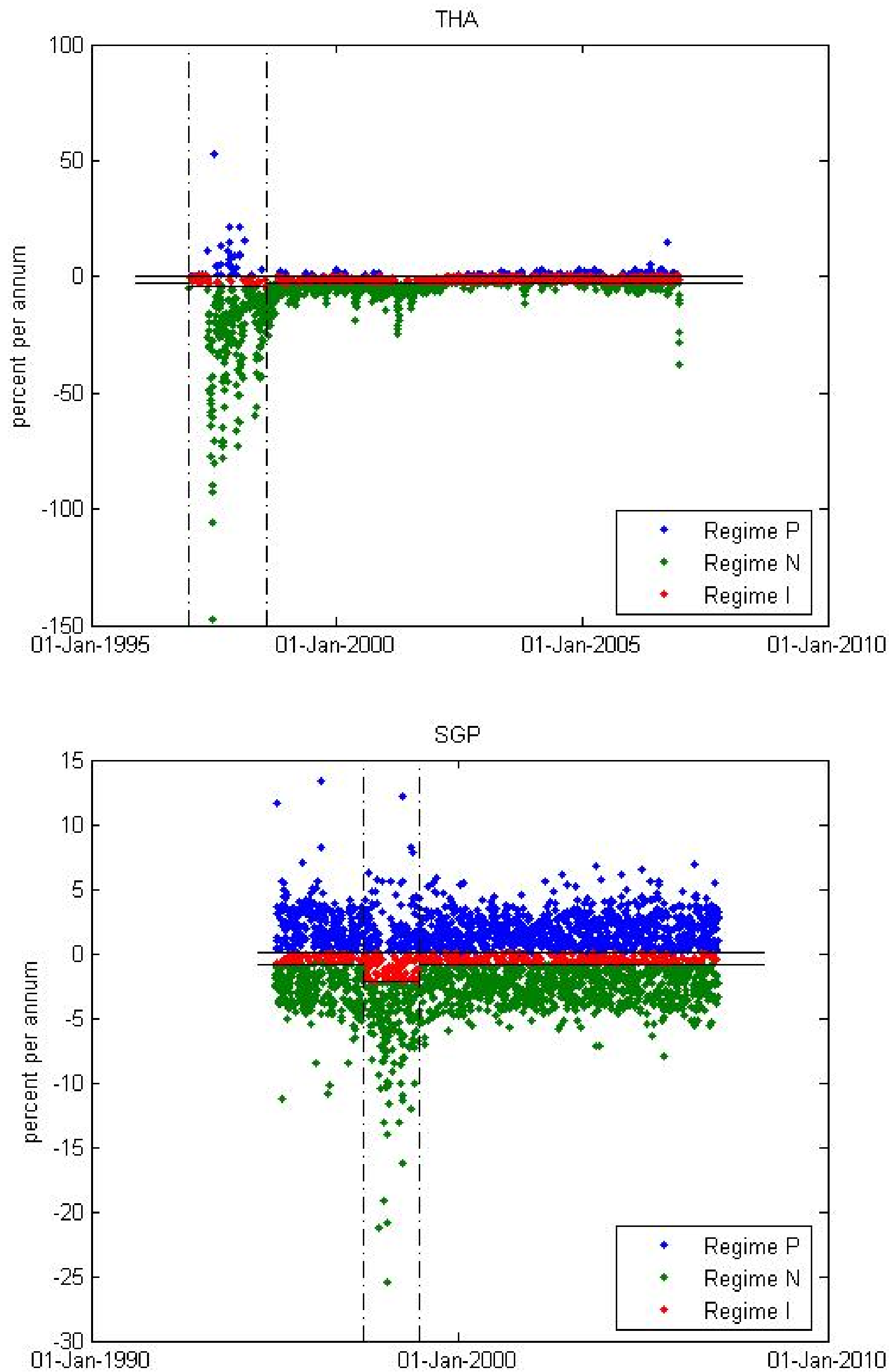

Fig. 1.B.— CIP Differentials, 1-Month Instruments

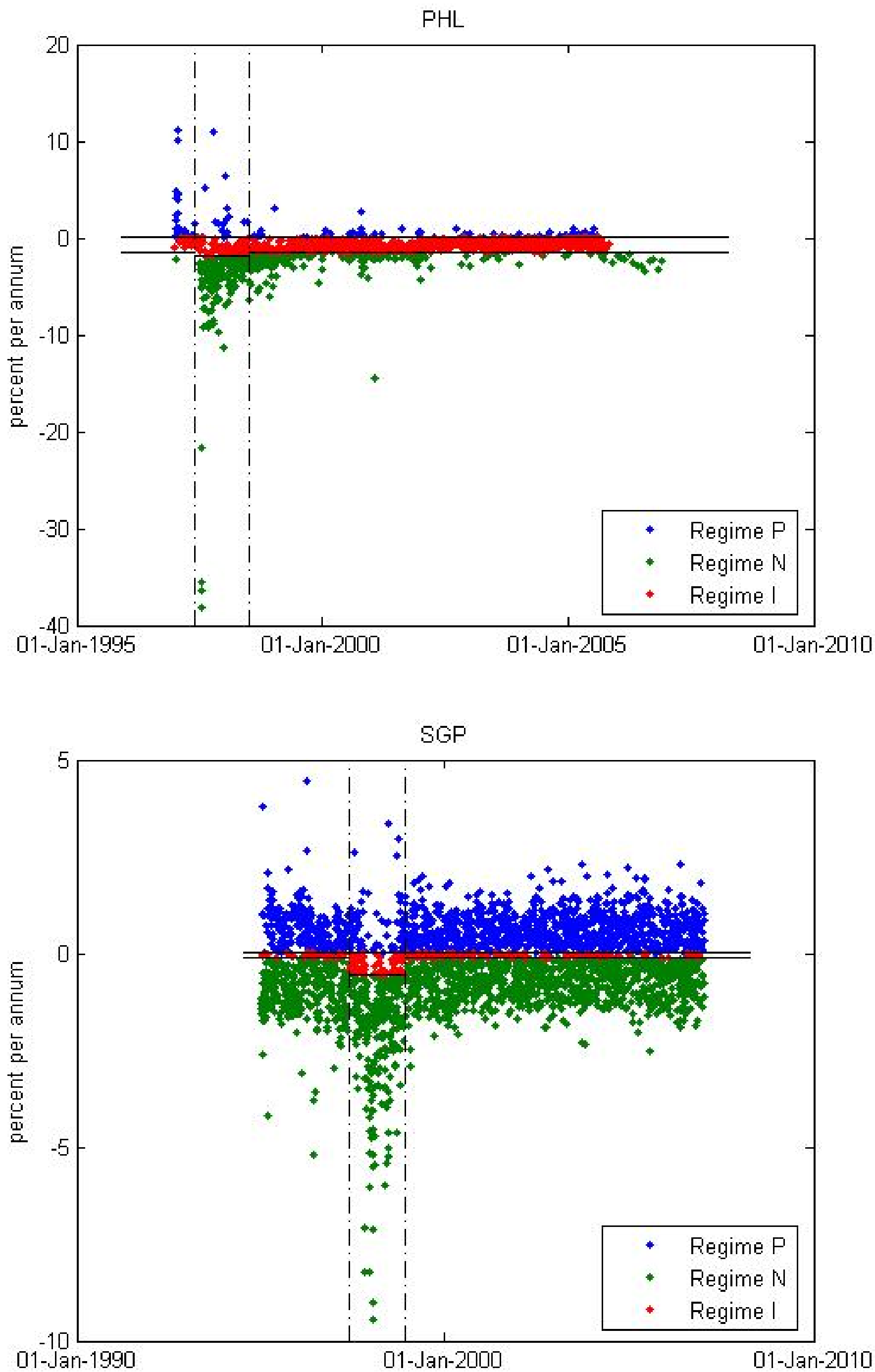

Fig. 2.— CIP Differentials, 3-Month Instruments

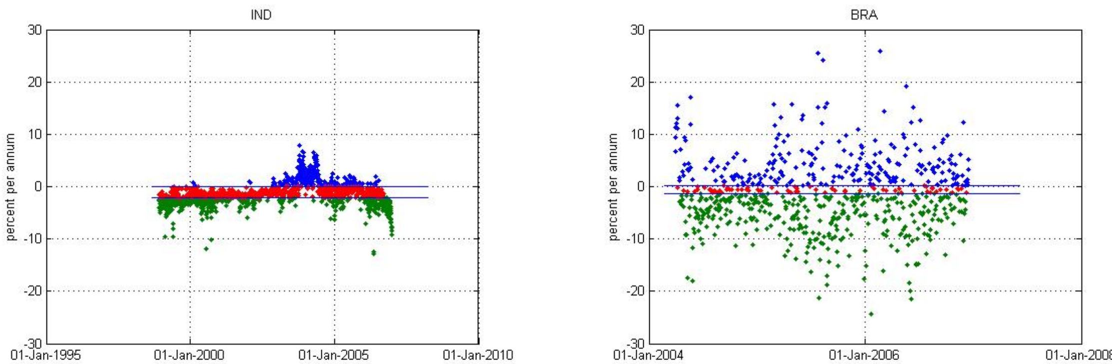

Fig. 3.A.— India and Brazil, CIP Differentials, 1-Month Instruments

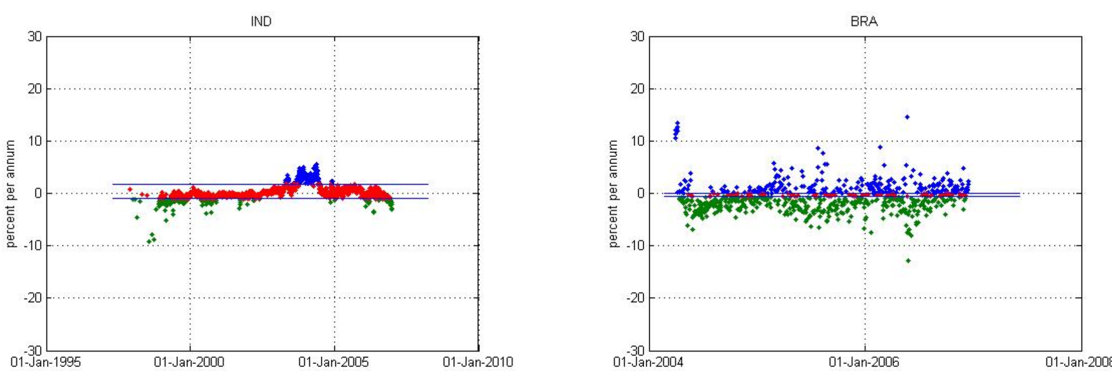

Fig. 3.B.— India and Brazil, CIP Differentials, 3-Month Instruments