Measuring Monetary Policy Independence Across Regions*

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Abstract

The existence and nature of inter-linkages between sovereign nations are always of interest in economics. In monetary economics an interesting question is that of monetary policy independence; in Europe prior to the introduction of the euro, many central banks were characterised as being Bundesbank-watchers: if the German central bank changed interest rates, within the hour they too would mimic the German move. Many Latin American and East Asian nations have explicit or implicit relationships with the US dollar, and as such may be expected to move in line with US interest rate movements, else find their targetted exchange rate level threatened. It has been proposed that an "impossible trinity" exists: a country is unable to maintain open capital markets, a fixed exchange rate *and* an independent monetary policy simultaneously. In this paper we attempt to measure to what extent monetary policy independence exists in a number of different regions. Cointegration analysis is used to distinguish whether a country belongs to a steady-state relationship involving interest rates of other countries, and whether a country adjusts to that relationship or not. Regional poles of influence other than simply the US are considered, and in general, little independence is discovered in the data for smaller nations; 'big' countries, such as Japan, the US and the Euro area, do exhibit considerable independence, as might be expected.

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1 Introduction

A perennial topic of interest in economics is the nature of inter-linkages between sovereign nations; in particular whether some countries dependent upon others, and the nature of that dependence. In monetary economics an interesting question has been that of monetary policy independence; in Europe prior to the introduction of the euro, many central banks were characterised as being Bundesbank-watchers: if the German central bank changed interest rates, within the hour they too would mimic the German move. Many Latin American and East Asian nations have explicit or implicit relationships with the US dollar, and as such may be expected to move in line with US interest rate movements, else find their targetted exchange rate level threatened. Moreover, in the literature, there has been much talk about how nations have an "impossible trinity": a country is unable to maintain open capital markets, a fixed exchange rate *and* an independent monetary policy simultaneously. A "possible duality" is purported to exist: any two of the three can be maintained at the same time. It is into this debate that this paper enters: we attempt to measure to what extent monetary policy independence exists in a number of different regions. By monetary policy independence we mean the ability of a nation to set its own interest rate, and not follow the rates that are being set elsewhere.

The degree of monetary policy independence that countries enjoy (or lack) has great implications for the discussion about the costs and benefits of monetary integration. The conventional wisdom is that the benefits of monetary integration lie in microeconomic efficiency, whereas the main costs of monetary integration are to be seen in the loss of independent monetary policy. This, however, holds only true if countries enjoy monetary policy independence to begin with. In the case of Western Europe, it is arguable that the member countries of the European Monetary System (except Germany) had already abandoned monetary and exchange rate autonomy long before entering the European Monetary Union (EMU) and that Germany has, in fact, been the only country that has actually lost its ability to independently set its monetary policy through its EMU membership (Volz 2006). Indeed, virtually all other euro countries have regained a voice in monetary policy decisions through their membership in the common monetary union. Thus, for economies with a low degree of policy independence the purported costs of monetary integration might in some cases turn into a benefit.

The remainder of this paper is structured as follows. Section 2 gives an overview of the literature on monetary policy independence. We then present our econometric methodology and the data that we use in Sections 3 and 4. In Section 5 we describe the results we obtain for the different regions analysed - East Asia, Latin America and South Asia. Section 6 concludes.

2 Monetary Policy Independence in the Literature

This important and interesting topic has been investigated by a number of authors. Edison and MacDonald (2000) considered how much independence European countries that entered the exchange rate mechanism (ERM) as part of the European Monetary System (EMS) had during the 1980s and 1990s, and to some extent find that the "impossible trinity" is possible, at least over certain time horizons. They found that, for example, the Netherlands had over a year in which it could deviate from German interest rates. Edison and MacDonald use cointegration analysis to address the question of monetary policy independence, and Fratzscher (2002) augments this with a GARCH model to account for possible conditional heteroskedasticity in interest rate data at the daily frequency. Fratzscher appears to find little evidence for monetary autonomy in various regions of the world: European countries did not within the ERM his results suggest, while East Asian and Latin American countries that loosened exchange rate linkages with the US over the last twenty years similarly failed to display any less interest rate dependence on the US. Frankel, Schmukler and Serven (2004) similarly find little monetary policy independence, and concur with Fratzscher (2002) that for European nations prior to the introduction of the euro, Germany interest rates and not US interest rates became a focal point. This last point to some extent contradicts the findings of Edison and MacDonald (2000), who suggest that without US interest rates cointegration cannot be uncovered between European rates.

Shambaugh (2004) and Obstfeld, Shambaugh and Taylor (2005) comment on the impossible trinity, with both finding that fixed exchange rate systems do force the country to follow the base country more closely than floating system.

3 Econometric Strategy

As Shambaugh (2004) notes, interest rates cannot be unit root processes theoretically; their variance is not exploding over time, and they will always be bounded below and above.[1] Nonetheless, Juselius (2007) has argued the merits of treating ambiguous time series as non-stationary, in order to exploit potential co-movements between them and other possibly non-stationary time series. This approach is adopted here. The possibility of co-movement between interest rates discussed in Section 2 is strongly suggestive of cointegration: two time series that are individually non-stationary may be cointegrated if they move together. Formally, if two series that are individually integrated of order one, are described as cointegrating if a linear combination of the two, is stationary. Two such series may form a multi-variate (or bi-variate if $p = 2$) system of p equations:

$$X_t = \Pi_0 + \sum_{i=1}^{K} \Pi_i X_{t-i} + \varepsilon_t,\ \varepsilon \sim \mathsf{N}\left(0, \sigma^2\right). \tag{1}$$

Here, X_t is a $p \times T$ data matrix, while Π_i are $p \times p$ coefficient matrices. If the data are non-stationary, so $X_t \sim I(1)$, then in order for (1) to be balanced, it must be rearranged into equilibrium correction form:

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{K-1} \Gamma_i \Delta X_{t-i} + \varepsilon_t. \tag{2}$$

Here, $\Pi = \sum_{i=1}^{K} \Pi_i - I$, and $\Gamma_i = -\sum_{j=i+1}^{K} \Pi_j$. Further, if $X_t \sim I(1)$, then given that $\varepsilon_t \sim I(0)$ and $\Delta X_t \sim I(0)$ then Π must be of reduced rank for (2) to be balanced. If Π is of

[1] Above is more an approximation than below; interest rates in Argentina in the early part of this decade exceeded 100%, but such explosive situation are extremely rate.

reduced rank then there exist $p \times r$ matrices α and β such that $\Pi = \alpha\beta'$, and (2) becomes:

$$\Delta X_t = \alpha\beta' X_{t-1} + \sum_{i=1}^{K-1} \Gamma_i \Delta X_{t-i} + \varepsilon_t. \tag{3}$$

The $\beta' X_{t-1}$ terms are cointegrating vectors, the stationary relationships between non-stationary variables. From the discussion in Edison and MacDonald (2000), these could be seen as combinations of interest rates that individually are non-stationary, but together are stationary. The cointegrated vector autoregressive model in (3) allows a rich analysis of monetary independence: firstly, $\beta' X_{t-1}$ combinations can be tested to see if the data support them; furthermore, the α coefficients will determine how much each interest rate series responds to disequilibrium in the stationary relationship described in $\beta' X_{t-1}$: if $\beta' X_{t-1} \neq 0$ then there exists disequilibrium.

To illustrate, assume a big country, a, and a small country, b. Then:

$$X_t = \begin{pmatrix} r_a \\ r_b \end{pmatrix}_t . \tag{4}$$

If testing suggests that $r = 1$, there is one cointegrating vector in this system. It is possible to then carry out likelihood-ratio tests to test for the form of the cointegrating vector. Suppose the restrictions required for the following system are accepted:

$$r_{a,t} = \beta_0 + r_{b,t} + \varepsilon_t. \tag{5}$$

The two countries respond one-for-one in interest rates; if the country b interest rate rises by 25 basis points, so does the country a rate. This can be written the cointegrated vector-autoregressive model of (3):

$$\begin{pmatrix} \Delta r_a \\ \Delta r_b \end{pmatrix}_t = \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} \begin{pmatrix} \beta_0 & \beta_1 & \beta_2 \end{pmatrix} \begin{pmatrix} 1 \\ r_a \\ r_b \end{pmatrix}_{t-1} + \sum_{k=1}^{K-1} \Gamma_k \Delta X_{t-k} + \varepsilon_t. \tag{6}$$

With the restriction $\beta_1 = -\beta_2 = 1$, then:

$$\begin{pmatrix} \Delta r_a \\ \Delta r_b \end{pmatrix}_t = \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} \begin{pmatrix} r_a - r_b - \beta_0 \end{pmatrix}_{t-1} + \sum_{k=1}^{K-1} \Gamma_k \Delta X_{t-k} + \varepsilon_t. \tag{7}$$

It may be expected that country a would not adjust to this cointegrating vector, as it is a large country and so might be expected to exert monetary policy independence; so $\alpha_1 = 0$. Country b may be expected to adjust, as it is a small country, so $\alpha_2 \neq 0$. Furthermore, α_2 describes how much of any disequilibrium is corrected each period, as $\alpha = \Delta X_t / (\beta' X_{t-1})$, hence (ceteris paribus) a speed of adjustment can be calculated; the smaller is this coefficient, the more independent is a country's monetary policy, as it devotes less of its attention to correcting to what other interest rates are doing. As such, the α matrix is very informative about the nature of monetary policy independence. A country not adjusting to a cointegrating vector in which it appears is said to 'drive' the system: the level that the country's interest rate is at is not constrained by the cointegrating relationship, but in fact dictates what level that cointegrating relationship takes.

The cointegrated vector-autoregressive model framework allows the modelling of partial systems: provided all the assumptions placed upon the residuals ε_t are satisfied, then the rank test outcome is valid, and any cointegrating vectors found in that system should be found in any enlarged system (Ericsson, Hendry and Tran 1994, Juselius 2007) (the sectoral-specific-to-general property). It is proposed here that a system involving X_t in (4) should be sufficient for modelling interest rate movements. It is sought that all possible influences on monetary policy are captured in the model however, and so r_a will not represent one country, but depending on the region under analysis, will include the US interest rate alongside some other regionally dominant nation; for East Asia China is used, for South Asia India, and for Latin America Brazil. At this stage, no other variables, such as exchange rates, or inflation differentials, or the output gap, will be used. This is not to argue that these variables are unimportant, nor that they are constant; simply in the partial system of international interest rate movements, and monetary policy independence, they are not necessarily important. Future research will consider augmenting the information set with these and other variables.

In this paper, panel cointegration methods, such as those outlined in Pesaran *et al* (2004) will not be used, as the authors are of the opinion that it is very hard to find a good model for one country individually, and that country will require many nuances to an econometric model; as such, the more labour-intensive search for an acceptable model for each country will be carried out.

Following Johansen (1995), a likelihood-based estimation framework will be employed, and so the Normality assumption in (1) must hold. Thus regressors, lag length, and the inclusion of dummy variables for outliers and possible structural breaks, will be altered in order that an econometric model passing all misspecification tests relating to the Normality of the residuals is found. The important tests in this regard are the autocorrelation test and Normality test (Doornik and Hansen 1994). If these tests are passed, then the rank test has the designed statistical size and power properties, and its outcome can be relied upon. Minor failures of these tests may allow still for reasonably accurate rank test outcomes; for example, Nielsen and Rahbek (2000) have shown that failures of heteroskedasticity and ARCH tests are less important than autocorrelation and Normality.[2]

A growing literature is investigating the effects of adding impulse, or dummy, variables to regression models. The benefit of adding impulse variables to account for outlying observations has frequently been espoused (for a review see Hendry and Santos 2005); the systematic relationships existent in the data can better be picked up if outliers are removed. There is a concern that by adding too many impulse variables spurious results might be generated; yet Hendry and Santos show that adding impulse variables adventitiously based on statistically testing is harmless in a single-equation context. Based on this, in the empirical work in this paper, impulse variables will be added for observations identified statistically as outliers, in order that a well-specified econometric model can be presented.

[2]Even within this, because it is a symmetric distribution of errors that is required, failures of the Normality test due to excess kurtosis can be tolerated, but not those due to skewness. Also, with negatively correlated errors, intuitively the rank test suggests more cointegration than actually exists, as the residuals move around the mean more due to negative correlation with previous observations. By the same logic, positively correlated errors will cause the rank test to suggest less cointegration than actually exists.

Having determined rank, the cointegrating space β must be identified; for a given rank of r, $r-1$ restrictions must be imposed upon the system. A variety of identification strategies have been proposed, and a number of these will be used; there is little theory to guide which countries should form particular steady-state relationships, but ideally one relationship will involve the "small" country b, and any additional relationships may be more macro or global interest rate relationships. Once a system has been identified along the lines described, likelihood ratio test statistics can be calculated to check that further restrictions imposed reflect what the data supports. In the systems reported in this paper, restrictions suggested by insignificant coefficients in the α and β matrices will be imposed until either there are no possible restrictions, or one previous restriction is rejected by the likelihood-ratio test.

A vector-autoregressive system is preferable to any single-equation approach for a number of reasons. Not least, Banerjee, Dolado, Galbraith and Hendry (1993) showed that the Engle and Granger (1987) single-equation estimation method for cointegrated data induces bias. Additionally, more than one cointegrating vector can be tested, and secondly the co-existence of a number of such vectors established.[3] Furthermore, the possibility of endogeneity is averted, because each variable in the system is modelled. The cointegration framework is used because many of the facets of monetary policy independence can be analysed without adding prior restrictions (other than that of the information set). A criticism of a number of previous econometric studies in this area has been the imposition of particular forms of cointegrating vectors without testing (e.g. Cheung, Tam and Yiu (2007) who comment on the strange results found but not on the test output).

An information set containing simply interest rates is a restrictive information set, and moreover an untested restriction. Nonetheless, if a well specified model can be found for a restricted information set, then one can be confident that one has successfully conditioned on these other factors; the sectoral-specific-to-general property of cointegrated vector-autoregressive models discussed above is appealed to - if the other important variables were added, the cointegrating vectors found in the simple system would be found again in the extended model.[4] Future research will look into including inflation differentials, and expected exchange rate changes, in accordance with standard economic theories such as uncovered interest parity. For now, as the main objective is to analyse interest movements, simple interest rate formulations, like those in Edison and MacDonald (2000), will be used.

4 Data

The data are taken from a number of sources. The interest rate taken for each country is the three-month interbank interest rate, and whichever source provided the longest time series was taken. The sources were the IMF's International Financial Statistics service, Datastream, and the Global Financial Database.

[3]The existence of two distinct cointegrating vectors in isolation does not necessarily imply they will exist together in a rank two system.

[4]For successful applications of this property, see Juselius and MacDonald (2000) alongside Juselius and MacDonald (2004), as well as Tuxen (2007) for Eurozone inflation, and Reade and Stehn (2007) for the interactions of monetary and fiscal policies in the US.

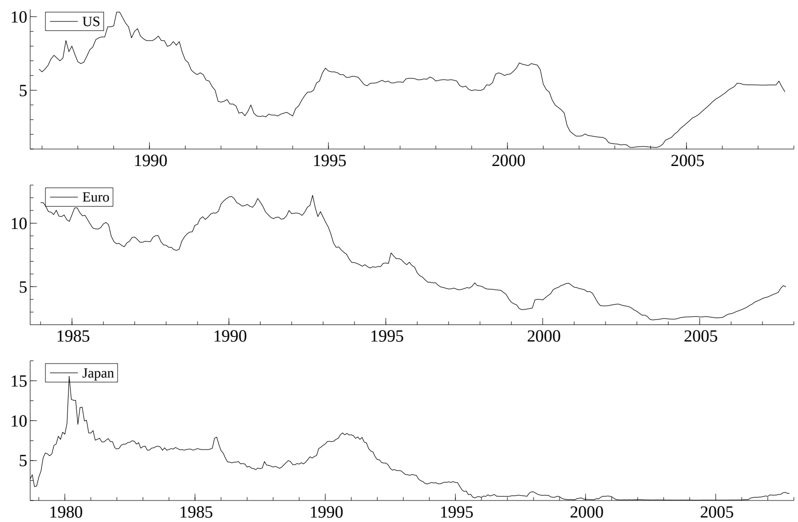

Figure 1: Plots of the three-month interbank interest rates for the the three 'a' countries; the US, Europe and Japan.

4.1 The 'a' List Countries

Section 3 set out the econometric methodology, and the countries expected to dominate in monetary policy terms were denotes with an a; these countries are the US, Japan and Europe. The US and Japan have long time series available for 3-month interbank interest rates, but for Europe the picture is slightly less clear. The rate chosen is that provided by average of the EU 15 3-month interbank rates, and this series runs back to 1984:1. The three interest rate series are plotted in Figure 1

4.2 The 'b' List Countries

The smaller countries considered in each model were labelled 'b' countries in Section 3. The eventual aim of this research project is to consider as many regions as possible. Thus far East Asia, South Asia and Latin America have been modelled; Central Asia, Southern Africa, North Africa, East Africa, West Africa, Europe (and various subsections thereof), North America, and the Caribbean is a non-exhaustive list of the kinds of regions it is hoped will be investigated. In the next two subsections, East Asia and Latin America will be introduced.

4.2.1 East Asia

For East Asia, there are many country b's. The "small" countries under consideration are: China, Hong Kong, Macau, Taiwan, South Korea, Thailand, Indonesia, Malaysia,

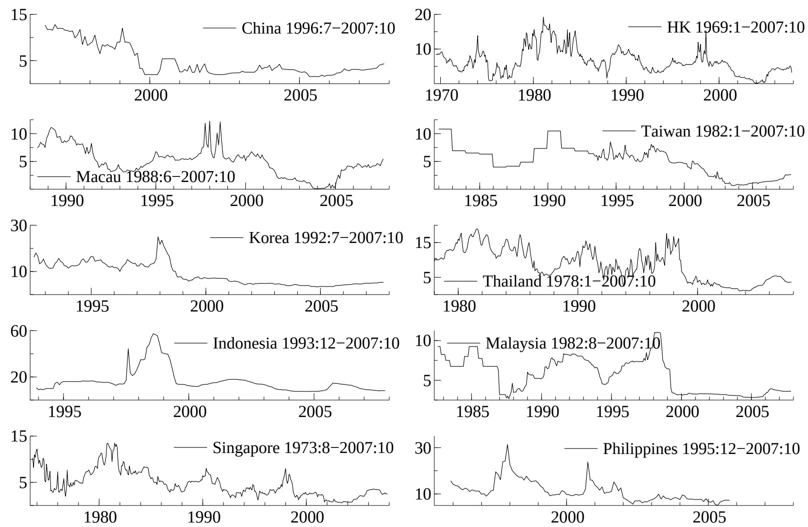

Figure 2: Plots of the three-month interbank interest rates for the East Asian countries modelled.

Singapore, and the Philippines. China takes on the role as the regional pole of influence, and so also joins the list of 'a' countries. Figure 2 plots all ten of these countries and lists the sample length afforded for each country. All series could plausibly have a negative trend fitted to them over the period, as presumably risk premia have fallen. Nonetheless, different dynamics of downward progression have affected each series; Indonesia's series is very flat both before and after the effects of the Asian crisis, which appear to have affected the country from mid-1997 until mid-1999. Korea, Thailand and Malaysia appear to have moved into a very different interest rate regime since the Asian crisis, perhaps reflecting their decreased linkage to the US dollar after this time. Singapore doesn't appear to have entered quite so smooth a regime in the last decade, and compared to earlier interest-rate spikes, the Asian crisis does not appear to have had too large an impact on interest rates. Thus far, due to the paucity of pre-crisis data for a number of the Asian countries, only post-crisis data have been used. Attempting to include the crisis in the model proved problematic. A further research topic will be to conduct a pre- and post-crisis investigation of monetary policy independence in East Asia.

4.2.2 South Asia

Four South Asian countries have data readily available on the Global Financial Database, and they are plotted in Figure 3: India, Pakistan, Sri Lanka and Nepal. From Figure 3 potential causes of modelling difficulties can be identified; first for Pakistan a period between mid 2002 and early 2005, where the interbank interest rate was held constant at 8.925%, and second Nepal, whose series bares little resemblance to any of the other Asian series or

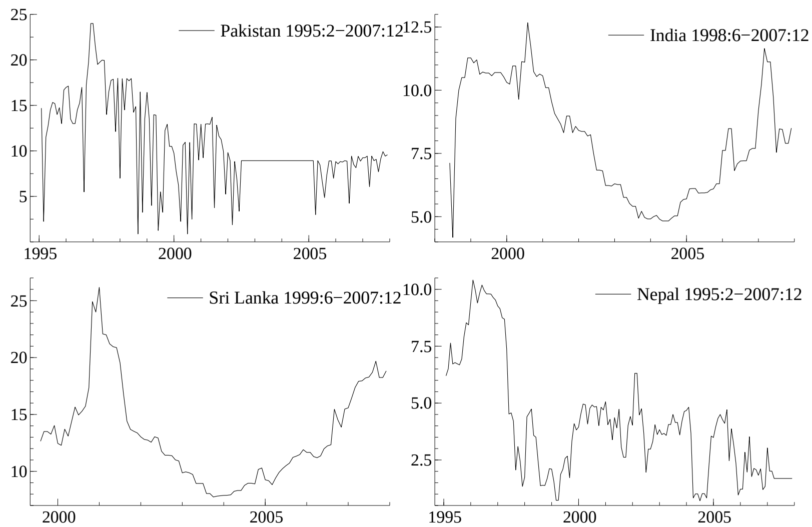

Figure 3: Plots of the three-month interbank interest rates for the South Asian countries modelled.

any of the 'a' country series.

4.2.3 Latin America

In Latin America, Brazil takes on the role as the regional pole of influence, and the remaining countries considered are: Brazil, Argentina, Chile, Peru and Columbia.

Ecuador is not modelled because since 2000:10 it has used the US dollar as its official currency, and so while data is available on the interbank rate, it has remained constant at 4.3 since then. Only for Brazil and Argentina were 3-month interbank rates available from the Global Financial Database; for the remaining countries average interbank rates were available. Despite being unsatisfactory, in the interim these rates have been used. These five interest rate series are plotted in Figure 4. The Argentinian series displays the financial crisis around 2002 that affected the country, while Brazilian rates peak at over 25% in mid-2003. The Chilean, Columbian and Peruvian rates look quite similar, with periods of more volatility turning into more stable series some time around mid-2002.

5 Results

The results for East Asian, South Asia and Latin America will be reported in the next two sections. In each Section a Table collects the main results pertaining to that region, while the main regional pole of influence is considered in isolation first. It is impractical to report each country's regression in full, nor the important misspecification tests related to each

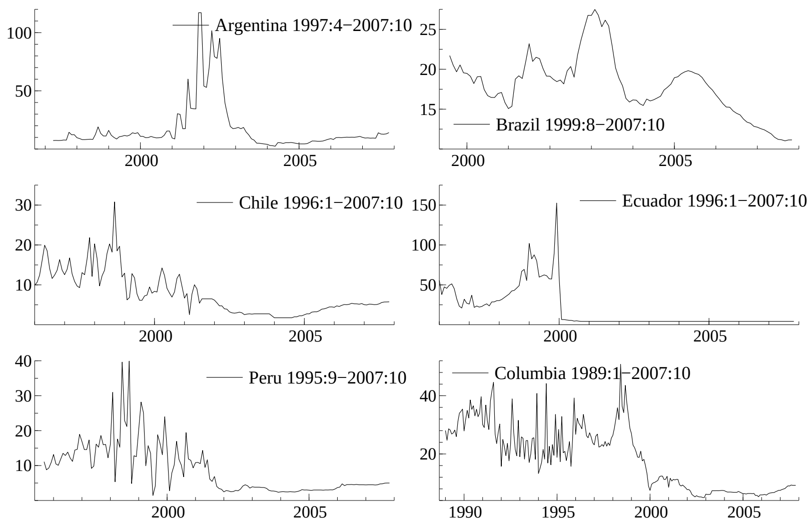

Figure 4: Plots of the three-month interbank interest rates for the Latin American countries modelled.

model; instead, in the Table for each region, any test failures are noted.[5]

5.1 East Asia

5.1.1 The 'a' Countries

It makes sense to consider our four base countries on their own first, because a property of the cointegrated vector-autoregressive model is that cointegrating relations found in a model are invariant to additions to the information set (i.e. additions of more variables). Furthermore, Cheung *et al.* (2007) model Chinese interest rates and find some puzzling output. A model with ten lags and six impulse variables is required for a congruent model. The resulting rank is two, and the identified model is:

$$\begin{pmatrix} r_{Japan} \\ r_{Eurozone} \\ r_{China} \\ r_{US} \end{pmatrix}_t = \begin{pmatrix} 0 & 0 \\ \underset{(0.038)}{-0.089} & \underset{(0.017)}{-0.093} \\ \underset{(0.334)}{1.585} & \underset{(0.168)}{-0.304} \\ 0 & \underset{(0.032)}{-0.141} \end{pmatrix} \begin{pmatrix} r_{Japan} - \underset{(0.009)}{0.088} \left(r_{China} + r_{US}\right) - \underset{(0.079)}{0.398} \\ r_{Eurozone} - \underset{(0.035)}{0.314} r_{US} - \underset{(0.146)}{2.311} \end{pmatrix}_{t-1}. \tag{8}$$

The first cointegrating vector involves China, and suggests that Chinese interest rates move in a relationship with both US and Japanese interest rates. Firstly, for a percentage point

[5]See footnote 2 on important model misspecifications.

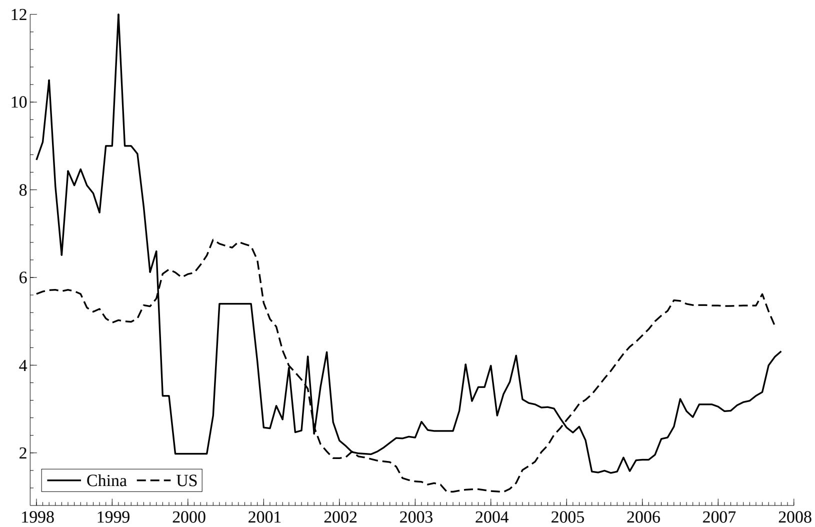

Figure 5: 3-month interest rates for China and the US.

move in Japanese rates, Chinese rates move by a rather small 0.09 percentage points. The same relationship appears to hold for Japanese and US interest rates, leaving Chinese and US interest rates moving in opposite directions to each other with equal magnitude. At first this movements appears odd and unintuitive, yet Figure 5 suggests that the two interest rates have moved in opposite directions over the sample period, potentially why Cheung *et al.* (2007) also find this puzzling result when looking at 1-month rates rates. Japan and the US do not adjust to this cointegrating vector, as their corresponding α coefficients are insignificant. Chinese rates adjust in a substantial way to this relationship, moving to correct more than 150% of any disequilibrium each period, suggesting some over-shooting type behaviour.

5.1.2 Each 'b' Country

Table 1 reports the results from East Asia; along each row are the results relating to each country. In brackets after each country name is the rank of the system found, and under the $\widehat{\alpha}_i$ for $i = 1, 2, 3$ are the estimated speed of adjustment coefficients, followed by the estimated cointegrating vectors, under $\widehat{\beta}_i$. Underneath each estimated coefficient is its standard error, and a bold typeface figure denotes that that interest rate corrects significantly to that particular cointegrating vector. All cointegrating vectors relating to each country b are reported first, as $\widehat{\beta}_1$, and show that in each system, there was a cointegrating vector relating to that country. Generally there is one steady-state relationship relating to the small country, and a wider cointegrating relationship. Ideally these wider relationships would look similar, but this is not vital.

Country	$\widehat{\alpha}_1$	$\widehat{\beta}_1$ r_{Ja}	r_a	r_{Eu}	r_{Ch}	r_{US}	int	$\widehat{\alpha}_2$	$\widehat{\beta}_2$ r_{Ja}	r_a	r_{Eu}	r_{Ch}	r_{US}	int
China	1.58 (0.04)	1	n/a		−0.09 (0.01)	−0.09 (0.01)	−0.4 (0.08)	−0.09 (0.02)		n/a	**1**		**−0.31 (0.04)**	−2.31 (0.15)
Hong Kong	−0.45 (0.04)		**1**			−1.17 (0.06)	1.06 (0.27)	0.40 (0.12)			1	−0.08 (0.03)	−0.30 (0.05)	2.19 (0.18)
Macau	−0.26 (0.07)		**1**			−1.5 (0.17)	2.3 (0.71)	0.94 (0.25)	1		0.6 (0.12)	0.08 (0.02)	−0.28 (0.05)	−1.01 (0.3)
Taiwan	0.09 (0.03)	−0.34 (0.05)	**−1.47 (0.10)**		**1**		−0.11 (0.02)	0		−1.51 (0.10)		1	−0.03 (0.01)	
Korea	0.83 (0.16)	−0.54 (0.02)	**−0.54 (0.02)**	**1**			−1.84 (0.27)	−0.67 (0.21)		**−0.42 (0.13)**	**1**	**−0.42 (0.13)**		−0.34 (0.22)
Thailand	0.12 (0.02)		**−1**		**−1.36 (0.18)**	**1**		−0.12 (0.05)		−0.4 (0.04)	1			2.37 (0.20)
Indonesia	0.16 (0.03)		**−0.24 (0.04)**		**−1**	**1**	2.54 (0.81)	0			−1.54 (0.33)	1		2.67 (1.19)
Malaysia	0.07 (0.05)		**1**		−0.84 (0.03)	**−0.16 (0.03)**		0.08 (0.05)	0.47 (0.25)	1	0.4 (0.08)	−0.81 (0.05)		0.8 (0.19)
Singapore	0.24 (0.08)		**−1.80 (0.24)**		**−0.47 (0.15)**	1	1.43 (0.61)	0	−3.91 (1.13)		−0.70 (0.11)	1		
Philippines	5.01 (0.65)	1	**−0.09 (0.01)**				0.59 (0.06)	0		−0.28 (0.03)		1		

	$\widehat{\alpha}_3$	$\widehat{\beta}_3$ r_{Ja}	r_a	r_{Eu}	r_{Ch}	r_{US}	int	Sample	Lags	Impulse	Rank	Normality
China								1998:1–2007:10	10	6	2	
Hong Kong								1998:1–2007:10	6	16	2	K(1)
Macau								1998:1–2007:10	7	13	2	K(3)
Taiwan	−0.27 (0.12)	1		−0.65 (0.07)			2.03 (0.19)	1998:1–2007:10	8	9	3	
Korea	−0.19 (0.09)				1	−0.26 (0.04)	−1.84 (0.27)	1998:1–2007:10	7	16	3	K(3)
Thailand	−0.46 (0.10)	1			0.28 (0.04)		0.54 (0.15)	1998:1–2007:10	3	21	3	K(4)
Indonesia								1998:1–2007:10	3	12	2	K(4)
Malaysia								1998:1–2007:10	2	16	2	K(5)
Singapore								1998:1–2007:10	2	8	2	K(5)
Philippines	0	−1		1		−0.35 (0.03)	−2.29 (0.14)	1998:1–2007:10	6	8	3	K(1),AC(1)

Table 1: Table of cointegrating vectors and adjustments for East Asia; β_1 is the first cointegrating vector, α_1 the adjustment of East Asian country b to that vector, β_2 the second cointegrating vector, etc. The final column of the bottom panel reports any misspecification issues with the model; K(n) signifies n equations in that model had an excess kurtosis problem, while AC(n) denotes that n equations had problems with autocorrelation.

Considering the rest of the primary cointegrating relations involving "small" countries, Europe does not appear to influence interest rate movements in the region; the European rate enters in only one cointegrating relationship, for Korea, and Europe adjusts to that relationship, suggesting it does not have any driving role in policy determination. The US figures in a number of these relationships, appearing in five steady-state relationships (six including China), and adjusts significantly to only three of these relationships. This is something like what would be expected: the US is widely seen as the policy leader in this area, and so it would be expected that it would not adjust to any of these steady-state relationships, but would dictate whether they are. China appears in many of the relationships, but in all bar one it is adjusting, suggesting that China, along with the country b, does not show any monetary independence. Japan appears in four country cointegrating vectors, and adjusts to none of these, suggesting that Japan has considerable monetary independence within East Asia. Nonetheless, regardless of the adjustment or not of the US, the fact that each country, with the exception of Malaysia, adjusts to a cointegrating vector suggests that to some extent all countries in the region lack monetary independence, even in the period since 1997 when many adopted simpler exchange rate regimes in relation to the US dollar.

5.2 South Asia

5.2.1 The 'a' Countries

India is the country in South Asia deemed dominant, and hence joins the US, Japan and Europe in the 'a' list of countries. The model involving these four countries requires four lags and eight impulse dummies to be well specified. The rank test implies a rank of one or two, but a more coherent and economically sensible system is found when a rank of two is taken; the second cointegrating vector has a sufficiently high eigenvalue (suggesting stationarity), and at a 5% significance level would be accepted. The resulting system is:

$$\begin{pmatrix} r_{Japan} \\ r_{India} \\ r_{Europe} \\ r_{US} \end{pmatrix}_t = \begin{pmatrix} \underset{(0.005)}{0.014} & \underset{(0.013)}{0.032} \\ \underset{(0.041)}{0.158} & 0 \\ 0 & \underset{(0.032)}{-0.123} \\ 0 & \underset{(0.028)}{-0.099} \end{pmatrix} \begin{pmatrix} r_{US} - r_{India} + \underset{(0.229)}{4.17} \\ r_{Europe} - \underset{(0.045)}{0.298} r_{US} - \underset{(0.183)}{2.103} \end{pmatrix}_{t-1} . \tag{9}$$

5.2.2 The 'b' Countries

Table 2 contains the output from models for India (also shown above in (9)), Pakistan, Sri Lanka and Nepal. When modelling Pakistan, a shift dummy taking the value 1 for all observations when the interbank rate was fixed at 8.925% is added to the system, and restricted so that it can enter the cointegrating relationships, allowing for this slightly strange period to represent a different equilibrium level. The system is nonetheless slightly strange and seemingly unstable; adding impulse variables does not solve the Normality issues, and while all the test failures are caused by harmless excess kurtosis, it would be preferable to have a model that did not fail so many tests. Four lags and four impulse variables are included, and the rank test suggests a rank of two. The first cointegrating vector contains

Pakistan, Japan and the US, with Japan and Pakistan sharing a (1,-1) relationship, and the US coefficient being smaller at -0.59. Japan and Pakistan react to disequilibrium in this relationship, although Japan adjusts in a destabilising manner. The US does not adjust at all to the relationship, and hence Pakistan can be seen to be the country exhibiting monetary dependence in this relationship. It overreacts also, moving each month to correct 139% of any disequilibrium. This is evidence for a lack of monetary independence for Pakistan. The second cointegrating vector does not involve Pakistan, and instead is a bivariate relationship between India and Europe, a slightly perplexing outcome given that in the India model in (9) no such relationship was found. Such discrepancies are the subject of future research.

The model including Sri Lanka requires nine impulses and four lags, and still a number of kurtosis driven Normality test failures remain. The rank of the system is three, and all three vectors involve Sri Lanka, although it only reacts to one of the three. The relationship is reacts to involves Sri Lanka, Japan and the US, somewhat mirroring that found for Pakistan. However, the coefficient values for Japan and the US are very different in this vector, with Sri Lanka's interest rate having to move a about seven times as much as Japan's to reinstate equilibrium, and nearly twice as much as the US interest rate. Japan does not adjust to this cointegrating vector, and although the US does adjust, Sri Lanka moves to correct considerably more of any disequilibrium: the US corrects just 3.7%, while Sri Lanka moves to close 14.1%. Still, 14.1% is a relatively small number, and given that this is the only vector which Sri Lanka corrects to, the tentative implication is that Sri Lanka exhibits some level of monetary independence. The system for Nepal required 13 impulse variables and four lags, and the resulting rank-two model probably reflects that their interbank rate looks little like any other series being modelled, from Figure 3. This may be due to capital controls in the country. Nepal doesn't adjust to either of the two cointegrating vectors, and is only marginally significant in the first vector, a relationship between Nepal, Europe, India and Japan. India and Japan do adjust to this relationship, and hence Europe can be seen to be driving the relationship, given Nepal's borderline significance. The second cointegrating vector in the Nepal model can be seen to be some kind of combination of the two cointegrating vectors in the Indian model (9).

Country	$\widehat{\alpha}_1$	$\widehat{\beta}_1$ r_{Ja}	r_{Ind}	r_a	r_{Eu}	r_{US}	int	$\widehat{\alpha}_2$	$\widehat{\beta}_2$ r_{Ja}	r_{Ind}	r_a	r_{Eu}	r_{US}	int
India	0.158 (0.041)		**−1**	n/a		1	4.17 (0.229)	0			n/a	**1**	**−0.298 (0.045)**	−2.103 (0.183)
Pakistan	−1.39 (0.22)	**−1**		**1**		−0.59 (0.14)	$-\underset{(0.49)}{1.46}\,D_{Pk} - \underset{(0.65)}{5.96}$	0		−0.19 (0.03)		**1**		1.65 (0.22)
Sri Lanka	−0.14 (0.05)	6.9 (1.62)		**1**		−1.70 (0.21)	−5.69 (0.79)	0		**−0.54 (0.05)**	−0.54 (0.05)		1	7.09 (1.06)
Nepal	0	**−0.69 (0.46)**	**−0.36 (0.03)**	−0.10 (0.05)	1			0		−0.16 (0.05)		1	−0.23 (0.06)	1.13 (0.25)

	$\widehat{\alpha}_3$	$\widehat{\beta}_3$ r_{Ja}	r_{Ind}	r_a	r_{Eu}	r_{US}	int	Sample	Lags	Impulses	Rank	Normality
India								1998:10–2007:12	4	8	2	K(1)
Pakistan								1998:10–2007:12	4	4	2	K(4)
Sri Lanka	0			−0.46 (0.10)	**−2.17 (0.44)**	**1**	8.84 (1.22)	1999:10–2007:12	4	9	3	K(2)
Nepal								1998:10–2007:12	4	13	2	K(5)

Table 2: Table of cointegrating vectors and adjustments for South Asia; β_1 is the first cointegrating vector, α_1 the adjustment of South Asian country b to that vector, β_2 the second cointegrating vector, etc. The final column of the bottom panel reports any misspecification issues with the model; K(n) signifies n equations in that model had an excess kurtosis problem, while AC(n) denotes that n equations had problems with autocorrelation.

5.3 Latin America

5.3.1 The 'a' Countries

Focussing now on Latin America, again the intention is to consider whether or not the countries here are concerned about other interest rates, and so the Japanese and European rates will be modelled alongside the more conventionally expected US rate. Brazil will be considered to be the additional regional pole of influence, akin to China's role in East Asia. Interbank interest rates are used for Latin America. A rather large number of lags (twelve) were required to ensure the distributions of residuals in all equations appeared normal, and one impulse dummy was additionally required to provide a well specified econometric model. Such a struggle to find a well-specified model is indicative of the possibility of omitted variables; one dimension of this will be explored in Section 5.4. The identified system is:

$$\begin{pmatrix} r_{Japan} \\ r_{Brazil} \\ r_{euro} \\ r_{US} \end{pmatrix}_t = \begin{pmatrix} \underset{(0.012)}{-0.057} & \underset{(0.024)}{-0.105} \\ \underset{(0.240)}{1.435} & \underset{(0.469)}{3.132} \\ 0 & \underset{(0.013)}{-0.058} \\ 0 & \underset{(0.036)}{-0.080} \end{pmatrix} \begin{pmatrix} r_{US} - \underset{(0.010)}{0.226} r_{Brazil} \\ r_{EU} - \underset{(0.031)}{0.748} r_{US} - \underset{(0.313)}{1.567} r_{Japan} - \underset{(0.161)}{0.266} \end{pmatrix}_{t-1} \tag{10}$$

So Brazil's interest rates move in the same direction as US interest rates, although not with a $(1, -1)$ relationship; for a unit rise in US interest rates, Brazilian rates will rise by 0.23 units. But US interest rates do not correct to this relationship - they drive it, while Brazilian rates even over-correct for disequilibrium, moving to correct 144% of any disequilibrium each month, indicative of a low level of monetary independence for Brazil from the US.

5.4 Each 'b' Country

Table 3 provides information on the different 'b' countries in Latin America, and how they move in line with the 'a' countries (the US, Japan, Europe and Brazil). The adjustment coefficients for each 'b' country are reported, followed by the cointegrating vector, and information on the number of lags and impulse variables required for a congruent model, along with any minor test failures, is reported.

Country	$\widehat{\alpha}_1$	$\widehat{\beta}_1$ r_{Ja}	r_{Br}	r_a	r_{Eu}	r_{US}	int	$\widehat{\alpha}_2$	$\widehat{\beta}_2$ r_{Ja}	r_{Br}	r_a	r_{Eu}	r_{US}	int
Brazil	1.44 (0.24)		**−0.23 (0.01)**	n/a		1		3.13 (0.47)	**−1.57 (0.31)**		n/a	**1**	**0.75 (0.03)**	−0.27 (0.16)
Argentina	−0.35 (0.06)		**−1**	**1**		**−1**	9.79 (0.74)	0.25 (0.11)	−7.89 (1.33)	**−0.69 (0.08)**			**1**	
Chile	−0.24 (0.06)		**−0.31 (0.06)**	**1**		−1.48 (0.18)	5.92 (1.38)	0			1	−5.00 (1.03)	**−1.50 (0.38)**	15.67 (2.84)
Peru	−0.99 (0.040)		**−1**	**1**		−2.16 (0.51)	20.62 (1.75)	0.48 (0.14)	**1**		**0.31 (0.05)**			1.12 (0.30)
Columbia	−0.02 (0.02)		**−1**	1		−1	12.62 (0.89)	0	−6.21 (1.76)		−0.59 (0.16)		1	2.59 (1.32)

	$\widehat{\alpha}_3$	$\widehat{\beta}_3$ r_{Ja}	r_{Br}	r_a	r_{Eu}	r_{US}	int	Sample	Lags	Impulse	Rank	Normality
Brazil								2000:8–2007:10	12	2	2	K(1)
Argentina	6.29 (1.40)	−2.21 (0.14)			**1**	**0.09 (0.01)**		2002:10–2007:10	3	5	3	K(2)
Chile	−0.45 (0.26)	−2.36 (0.30)		**−0.33 (0.03)**	**1**		1.16 (0.15)	2000:2–2007:10	6	8	3	
Peru	0	**1**			−0.13 (0.09)	−0.13 (0.03)	0.59 (0.21)	2000:2–2007:10	6	7	3	K(1)
Columbia	0				1	**0.16 (0.08)**	2.62 (1.32)	2000:1–2007:10	5	5	3	K(3)

Table 3: Table of cointegrating vectors and adjustments for Latin America; β_1 is the first cointegrating vector, α_1 the adjustment of Latin American country b to that vector, β_2 the second cointegrating vector, etc. The final column of the bottom panel reports any misspecification issues with the model; K(n) signifies n equations in that model had an excess kurtosis problem, while AC(n) denotes that n equations had problems with autocorrelation.

Because of the economic and political crisis in Argentina around 2002, a sample from 2002:10 is taken, when it is deemed that the crisis had settled down. This leaves a small number of observations, but nonetheless, with three lags and five impulse variables, a reasonably well specified model is found. Rank three is selected. Japan is weakly exogenous, which doesn't really matter here; Brazil and Argentina both adjust to all vectors, but so does the Eurozone and the US - although the US is not a stabilising influence on the first two cointegrating vectors. The first cointegrating vector involves the US, Brazil and Japan, and is mildly concerning, as the Brazil coefficient is much larger than in the Brazilian system above, while Japan creeps in. This can probably be attributed to the sample size. The second vector relates to Argentina, and suggests it moves one-for-one with the US rate, and with the Brazilian rate, with a difference between the Argentinian and US rates of almost 10 - which is reflected in the data, and could perhaps be seen as some crude measure of the risk premium. Brazil and Argentina both correct to this relationship in the right way, stabilising it - Argentina reacts the most, correcting 35% of any gap each month. This suggests some monetary independence.

Chile's system required six lags and eight impulse variables for a well-specified model. Chile is involved in all three cointegrating vectors, but only corrects in a stabilising fashion to the first one, where it moves alongside the US interest rate and Brazilian rate. It corrects in a destabilising way to the third cointegrating vector, and cannot be restricted out of any of the cointegrating vectors. The first cointegrating vector is nice, but the reactions and nature of the second and third are slightly less pleasing. The first relation seems nice because both Brazil and Chile respond in a corrective manner to it, while the US drives where it is at.

Peru appears quite similar to Chile, in that a rank of three is found. Six lags were required, with seven impulse variables. Peru enters the characteristic relationship with the US and Brazilian rates, with the Brazil coefficient restricted to 1, and the US coefficient restrictable to 2. Further, only Brazil and Peru correct to this relation, with the US driving where it is. The second cointegrating vector, perhaps slightly oddly, pits Peru in a relationship with Japan, to which both Japan and Peru adjust - however Japan adjusts in a destabilising manner, whereas Peru in a stabilising manner, suggesting that actually Japan does drive this relationship. The third vector is the now reasonably standard Europe-Japan-US cointegrating vector, which the US dominates in. It's perhaps also notable that Peru moves to close 99% of the gap each month, suggesting a total lack of monetary policy independence. It also moves to correct roughly half of the disequilibrium generated by Japan in the other steady-state relationship.

On the face of it, Columbia provides a nice looking system; however, regardless of what one tries, Columbia does not really respond to the steady-state relationships. The data seem to suggest that whatever it is that Columbia is doing, it isn't responding to cointegrating vectors. So the adjustment coefficient on Columbia, while having the right sign, is insignificant by any measure. It seems throwing Columbia in there does odd things across the board though, as the usual Europe, US, Japan relationship is reduced to a Europe, US one, while Brazil stops adjusting to things as well.

6 Conclusions

Our results show that full monetary policy independence seems to be the exception rather than the rule. Most countries analysed in this study so far show a high degree of dependence on the monetary policies of other, larger economies. As mentioned before, this is a very preliminary draft and we are planning to make substantial additions to future versions of the paper. Firstly, we intend to extend the analysis to other regions, especially various subregions of Europe, Southern Africa (potentially also West, East and Northern Africa if data allow), North America, the Middle East and the Caribbean. We shall also seek to refine the research insofar as we intend to investigate the distinct pre-/post-crisis periods in East Asia, and pre-/post-EMU periods in Europe.

And while we are confident that the results we obtain by solely using interest rate data are provide an accurate picture, our methodology also allows us to include other variables such as exchange rate regime and capital account openness. Including these in our model may improve a number of the less satisfactory country models, particularly those in South Asia.

A Model Details

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