NBER WORKING PAPER SERIES

THE FEDERAL RESERVE, EMERGING MARKETS, AND CAPITAL CONTROLS: A HIGH FREQUENCY EMPIRICAL INVESTIGATION

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Working Paper 18557
http://www.nber.org/papers/w18557

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 2012

This is a revised version of a paper presented at the conference on monetary policy that celebrated the 20th Anniversary of the Studienzentrum Gerzensee, October, 2011. I am grateful to Juan Marcos Wlasiuk for excellent assistance, to José De Gregorio and Vittorio Corbo for discussions on the policies of the Banco Central de Chile during their tenure as governors, and, especially, to my discussant Frank Shorfheide for excellent comments and suggestions. I also thank the participants at the conference for helpful comments. I thank two anonymous reviewers for very helpful and detailed comments and suggestions. The views expressed herein are those of the author and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 18557
November 2012
JEL No. F30,F32

ABSTRACT

In this paper I use weekly data from seven emerging nations – four in Latin America and three in Asia – to investigate the extent to which changes in Fed policy interest rates have been transmitted into domestic short term interest rates during the 2000s. The results suggest that there is indeed an interest rates "pass through" from the Fed to emerging markets. However, the extent of transmission of interest rate shocks is different – in terms of impact, steady state effect, and dynamics – in Latin America and Asia. The results also indicate that capital controls are not an effective tool for isolating emerging countries from global interest rate disturbances. Changes in the slope of the U.S. yield curve, including changes generated by a "twist" policy, affect domestic interest rates in emerging countries. I also provide a detailed case study for Chile.

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1. Introduction

A fundamental principle of open economy macroeconomics is that under fixed exchange rates and free capital mobility it is not possible for a central bank to conduct an independent monetary policy. This idea is generally known as the "Impossibility of the Holy Trinity." A corollary of this "impossibility" is that under floating exchange rates it is possible for a country to have "monetary independence." Whether these principles are strictly true, or whether they hold partially and only in the long run has, for a long time, concerned central bankers and policy makers. Indeed, in my own work with different central banks, this is one of the first questions that is raised when discussing policy. Moreover, in a course for central bankers from the emerging markets that I have taught at the *Studienzentrum Gerzensee* since 1995, the students – all of them mid-level officials with extensive experience--, invariably end up asking whether the adoption of flexible exchange rates (either "clean" or "dirty" floats) truly grants central banks policy autonomy.

Traditional empirical studies on the degree of monetary independence under alternative exchange rate regimes centered on the extent to which changes in domestic credit were "offset" by changes in international reserves. Under fixed exchange rates, and with free capital mobility, it is expected that the "offset coefficient" would be equal to -1. That is, the central bank is unable to alter the supply of base money; this is demand-determined. On the other hand, under (some degree of) exchange rate flexibility the offset coefficient is expected to be negative but smaller (in absolute terms) than one. In the extreme case of absolute and clean floating, this coefficient would be equal to zero. The reason for this is that under a strict float there would be no changes in the central bank holdings of international reserves.

Early empirical studies that focused on the "offset coefficient" were undertaken at a time when central banks followed "money targeting" strategies. During the last few years, however, most central banks have moved in two directions: first, money targeting has been replaced, either implicitly or explicitly, by "inflation targeting" and, second, central banks have replaced traditional policy tools by the manipulation of a (very) short run policy interest rate. The following process describes, in a simplified way, how modern central banks conduct monetary policy: if inflationary pressures are perceived to be increasing, the central bank raises the policy rate in an effort to directly affect short term interest rates – that is, interest rates on short term government securities and/or short term CDs. Higher short term rates are expected, in turn, to be transmitted along the yield curve, affecting, in particular, medium to long-term interest rates (say 10 year government bonds rates). In many central banks policy rates are also adjusted as a reaction to other economic developments, including changes in unemployment, changes in the currency value, or external shocks. In this world where monetary policy is conducted through interest rates adjustments, the question of monetary policy independence may be posed as follows: to what extent are changes in policy interest rates in the advanced nations – for example, changes in the Federal Reserve Federal Funds' rate—transmitted into short term interest rates in the domestic country. At an analytical level, the answer to this question will depend on a number of factors, including the degree of substitutability of domestic and international securities, the degree of risk aversion, and the extent of capital mobility.

In this paper I use weekly data from seven emerging nations -- four in Latin America and three in Asia -- to investigate the extent to which changes in Fed policy interest rates have been transmitted into domestic short term interest rates during the 2000s. All countries in the sample – Brazil, Chile, Colombia, Mexico, Indonesia, Korea, and the Philippines – had flexible exchange rates during the period under study, and followed some kind of inflation targeting. Also, these countries had different degrees of capital mobility during the first decade of the 2000s. In an index from 1 to 10, where 10 denotes absolute free mobility of capital, capital mobility ranged from a high 8.4 in Chile in early 2008, to a low of 2.9 in Colombia in 2002 – see Section 4 below.

Previous work on this general topic include, among others, Hausmann, Gavin, Pages-Serra, and Stein (2000), Frankel, Schmukler, and Serven (2002), Shambaugh (2004), Miniane and Rogers (2007), Edwards and Rigobón (2009), and Aizenman, Chinn, and Ito (2011). Many of these authors have investigated the transmission of interest rate shocks under alternative exchange rate regimes. This paper differs from previous work in a number of respects: First, and as noted, I use weekly data, while most previous analyses have relied on either monthly or quarterly data. Second, I concentrate exclusively on countries with flexible exchange rates, the exchange rate regime that has become increasingly common among emerging economies. Third, I use a new index on capital mobility to analyze whether controls on financial flows affect the transmission of interest rates shocks. Fourth, I pay particular attention to the short run dynamics of interest rate adjustments to global financial disturbances. Fifth, I explicitly concentrate on the role of the steepness of the U.S. yield curve in explaining the international transmission of interest rates. In particular, I investigate how a policy aimed at "twisting" the yield curve – as announced by the Fed's FOMC on September 21, 2011 – may affect local interest rates in the two regions. Sixth, I investigate in some detail the channels through which advanced countries interest rates shocks are transmitted into changes in domestic interest rates. Seventh, I use high frequency data for one of the countries (Chile) to investigate whether monetary policy in that nation has been influenced by actions undertaken by the Federal Reserve. And eighth, while most previous work has relied on VAR analyses, I use a GGM regression approach. However, and as I point out in Section 6 on extensions and robustness, the results obtained using these two methodologies are very similar.[1]

The topic of this paper may seem, to some readers, somewhat extemporaneous. After all, for some time now the Federal Reserve has conducted monetary policy in the old fashioned way: it has engaged in massive open market operations that have greatly affected its balance sheet – the so-called "quantitative easing" policy. Moreover, the Fed's Chairman announced that short term policy rates will be maintained at a very low level (virtually zero) until mid 2014, at the least. In spite of current monetary conditions in the in the U.S., and more generally in the advanced nations, the analysis pursued in this paper continues to be relevant for at least four reasons. First, this paper goes beyond the Federal Funds rates and analyzes how various external shocks impact on short term interest rates in Latin America and Asia. Second, and as noted, I also analyze how other policy actions by the Fed, including attempts at altering the steepness of the yield curve, affect domestic interest rates in emerging nations. Third, issues related to the effectiveness of capital controls continue to be of paramount policy importance. This is particularly the case after recent actions geared at controlling capital inflows by countries such as Brazil and Korea. And fourth, the vast majority of experts expect that at some point in the future the Fed will resume its normal monetary policy procedures, and will once again use the Federal Funds rates as its main policy tool.

The rest of the paper is organized as follows: In Section 2 I provide a first look at the data on Federal Funds rates and short term interest rates for the seven emerging countries in the sample. More specifically, I use weekly data from January 2000 through September 2008 to analyze the unconditional reaction of domestic short term interest rates in Asia and Latin America to changes in the Federal Funds rates. In Section 3 I provide the theoretical

[1] I thank my discussant at the conference, Frank Schorfheide, for suggesting me to make this comparison.

underpinnings for the analysis, and I present the basic econometric results from the panel estimation of an error correction model on deposit interest rates for the seven Latin American and the Asian countries. Here I analyze the impact and long term effects, and the dynamics of adjustment, to an interest rate shocks stemming from abroad. I consider shocks to the Federal Funds rate, as well as shocks to the long term interest rate in the U.S. In Section 4 I deal with capital controls and the international transmission of interest rate disturbances. In particular, I ask whether a higher degree of capital mobility helps "isolate" domestic interest rates from external financial shocks. In Section 5 I focus on one of the countries in the sample, Chile, and I ask whether Fed actions have systematically affected decisions by the Banco Central de Chile. In Section 6 I deal with robustness and extensions. In particular, I analyze whether allowing for changes in other covariates affect the results; I discuss alternative estimation techniques, including multivariate VARs; and I deal with other robustness issues, including alternative measures of capital mobility. And, finally, in Section 7 I offer brief concluding remarks.

2. Federal Reserve policy and short term interest rates in Latin America and Asia: A first look at the data

In this paper I use weekly data from the first week of January 1, 2000 through the second week of September 2008.[2] The analysis focuses on this period for two reasons: First, during this time span all emerging countries in the sample had a flexible exchange rate regime. To be sure, all seven of them intervened from time to time in the currency market, but, by and large, nominal exchange rates were determined by market forces. And second, I am interested in analyzing a relatively tranquil period. For this reason I excluded the turbulence that followed the collapse of Lehman Brothers in mid September 2008. In Section 6 on extensions I briefly discuss the results for different time periods; in particular, I ask whether the Argentine default of early 2002 affected the transmission mechanism for interest rate shocks.

2.1 Basic interest rate data

In Figure 1 I present data on short term interest rates for the United States. Two rates are displayed: (i) the Federal Funds policy rate; and (ii), the 3 months certificate of deposits rate. As may be seen, both rates move closely together. Indeed, the null hypothesis that these two series

[2] The exception is Korea, which only has weekly data (in Data Stream) on 90-day deposit rates from 2004 onwards.

are not cointegrated is strongly rejected.[3] In addition, the data in Figure 1 suggest that changes in the Fed's policy rate are rapidly reflected in changes in short term deposit rates – for details, see Table 1 below.

During the period under consideration – January 2000-September 2008 -- there were 40 changes in the Federal Funds policy rate. Twenty were increases, and in 19 of them the rate hike was 25 basis points; on one occasion it was increased by 50 basis points (on the week of May 19th, 2000). The other 20 policy actions correspond to cuts in the Fed Funds rate. In seven cases it was cut by 25 basis points; in 11 cases it was cut by 50 basis points; and on 2 occasions it was reduced by 75 basis points (both of them in early 2008: the week of January, 25th and the week of March 21st.)

Figure 2 I present the weekly evolution of short term (90 days) deposit rates for the seven emerging counties in this study.[4] For each of them I also present the Federal Funds policy rate. Several aspects of these data deserve attention: (a) there is significant variation in deposit interest rates in the countries in the sample during this period. (b) Deposit rates in many of the emerging countries – and in particular in Brazil – were quite volatile during this period. (c) In most cases there is no obvious relationship between domestic interest rates and the Fed policy rate. And (c), towards the end of the sample, when the Fed embarked on aggressive interest rate cutting, in many of the countries there seems to be a divergence between Fed policy rates and short term deposit rates.

2.2 *Changes in the Federal Funds interest rates and short term rates in Latin America and Asia*

In Table 1 and Table 2 I present data on the change in the short term (3-month) deposit rate in Latin America and Asia the week in which the Federal Reserve changed the Federal Funds policy rate. I also provide the accumulated change in short term deposit rates 1, 2, 3 and 6 weeks after the Fed's action. I also include data on changes in the U.S. 3-month CD rate during the same periods. Table 1 deals with increases in the Federal Funds rate, while Table 2 contains the results for cuts in the Federal Funds rates. The average increase in the Fed Policy rate was 26.2 basis points across all 20 hike episodes; the average cut was 43.8 basis points.

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[3] Results available on request.

[4] These countries were included in the analysis due to data availability, and because they satisfied two important considerations: having flexible regimes and following some variant of inflation targeting.

The following aspects of these results are noteworthy: First, there are some important differences in interest rates' behavior in Asia and Latin America. Changes in short term rates in Latin America are higher (in absolute terms) than in Asia, on average. This is particularly the case for Fed Funds hikes. Interestingly, however, none of these short term deposit rates changes – either after Fed Funds' hikes or cuts – are statistically significant. Second, after 6 weeks there appears to be a one-to-one transmission of the Fed's action into U.S. deposit rates. This is the case for both Fed Funds increases and Fed Funds' cuts. And third, in the immediate aftermath of cuts in the Fed Funds' rate, short term interest rates in both Asia and Latin America are somewhat erratic, and exhibit both increases and declines. After 6 weeks, however, in both regions there is an accumulated decline in short terms rates. These declines average 12 basis points in Latin America, and only 6 basis points in Asia. In contrast, the 6 week accumulated change in short term deposit rates in the U.S. is -54 basis points (remember that the average cut in the Federal Funds interest rate during this period was almost 44 basis points.)

To summarize, the unconditional results presented in Table 1 and Table 2 suggest that after 6 weeks Federal Funds policy rates changes have been transmitted fully into changes in short term deposit rates in the United States. There is no such evidence in Latin America or Asia: in these two regions the changes in short term deposit rates are very small – indeed, in the two regions they are not significantly different from zero. In Sections 3 and 4 of this paper I use a dynamic model to analyze whether these results are maintained under conditional estimation that incorporates the role of other covariates.

2.3 Capital controls in Asia and Latin America in the 2000s

During the 2000s the seven emerging countries included in this study relied, to different degrees, on capital controls. An important question is whether the international transmission of interest rate shocks depends on the degree of capital mobility. In a number of emerging markets – Brazil, Colombia and Korea being premier examples – policy makers have recently (that is, during 2011) argued that controlling capital mobility, and, in particular, controlling so-called "speculative" capital flows will increase the degree of policy independence.[5]

In order to analyze this issue I constructed a new measure of capital controls. The basis of this indicator is the index on "International Capital Markets Controls" published by the Fraser

[5] The main reason given for imposing capital controls is to avoid "excessive" currency appreciation. In most countries, however, it has also been argued that capital controls will protect the local economy from external financial shocks, including shocks to interest rates.

Institute. This index goes from 0 to 10, with higher values denoting an economy that is more open to international financial movements, and is available yearly from 2000 through 2008. In an effort to improve this index, I used information obtained from the World Bank, the Interamerican Development Bank, and national sources for the seven countries to modify (and improve) the Fraser index. More specifically, I made an effort to adjust its value and to record changes in the degree of capital mobility at the time they actually took place, and not only once a year. [6] In Section 6 I discuss alternative indexes of capital mobility, and their merits and limitations.

In Figure 4 I present the distribution and basic statistics on the "International Capital Markets Controls" index for 2000-2008. The means for the index are significantly different across both regions: 5.3 for the four Latin American countries and 4.2 for the three East Asian nations. That is, during the period under study the Latin American nations were, on average, more open to international capital movements than the Asian countries. For the Latin American sample the country with the highest degree of capital mobility is Chile with an index value of 8.2 in 2008; the Asian nation with the highest index value is Korea with 5.3, also in 2008. In Section 4 I present a number of results that explicitly incorporate the (possible) role of capital controls in the international transmission of interest rate shocks.

3. The international transmission of interest rate shocks: Basic results and "twist" policies

In this Section I present the basic results on the transmission of Federal Reserve policy changes into short term deposit interest rates in two groups of emerging nations in Asia and Latin America. I begin by discussing the theoretical underpinnings for the analysis. I then present the base-run results using both GLS and GMM techniques. Then, in Sub Section 3.2 I analyze the way in which changes in the U.S. yield curve affect short term interest rates in these two groups of countries.

3.1 Theoretical underpinnings

A number of authors have recently constructed open economy DSGE models to analyze different aspects of monetary policy. For example, in an influential paper Monacelli (2005)

[6] The bases of the Fraser Index are data compiled by the International Monetary Fund. Individual country studies, of course, lend themselves for using more detailed measures of capital mobility that may change week to week. This is what Roberto Rigobón and I do in our study of Chile's control with controls on capital inflows. See (Edwards and Rigobón (2009). For a recent overall assessment of alternative indexes of capital mobility see, for example, Quinn, Schindler, and Toyoda (2011).

developed a model of a small open economy with monopolistic competitive firms, short run deviations to the law of one price for importables (but not for exportables), and complete international markets for state-contingent securities.[7] As is customary, he assumed that the central bank minimizes a quadratic loss function on the deviations of inflation and output from target values. He then used this model to investigate how different variables are affected by a series of shocks, including productivity shocks. As in most DSGE models of open economies, the optimization of Monacelli's framework yields an interest parity condition of the following form (this assumes risk neutrality):

$$(1) \qquad r_t - r_t^* = E_t\{\Delta e_{t+1}\},$$

Where r_t and r_t^* are nominal interest rates at home and abroad, and e is the log of the nominal exchange rate.

Another important contribution in this field is Lubik and Schorfheide (2006), who developed a two country DSGE empirical model that lends itself for empirical estimation. The authors assume symmetry in technology and consumers' preferences, asymmetric nominal rigidities in the two countries, currency pricing by domestic and foreign firms, incomplete exchange rate pass through, central banks that minimize a quadratic loss function, and a series of country-specific and world-wide shocks. As in Monacelli (2005), and under the assumption of integrated capital markets and perfect risk sharing, they generate an equilibrium condition identical to (1). Models by De Paoli (2009) and Justiniano and Preston (2010), among many others, also generate equations such as (1).

Equation (1), as noted, assumes that there are no impediments for moving capital across borders. For most emerging countries, however, this is a simplification. As may be seen in Figure 3, all the countries considered in this paper controlled capital mobility in one way or another during the period under analysis (2000-2008). It is easy to show that if the home country levies a tax of rate t on capital outflows, equation (1) becomes (assuming risk neutrality): [8]

[7] Monacelli (2005) shows that if the pass through from the exchange rate to prices is incomplete in the short run, the closed and open economy versions of the "canonical" New Keynesian models are not isomorphic. The deviation of the law of one price for imports stems from the assumption that imports are sold to the public by monopolistic competitive retailers. In the long run, however, the law of one price holds for imports.

[8] Different countries use different mechanisms for controlling capital mobility, including taxes, licenses, quotas, and other. The analysis that follows assumes that country nationals have to pay a tax t if they take funds out of the

$$(2) \qquad r_t - r_t^*(1-t) + t = E_t\{\Delta e_{t+1}\},$$

That is, under capital controls the wedge between domestic and foreign interest rates will tend to be higher than when there is free capital mobility. Also, equation (2) indicates that the extent of interest rate "pass through" from foreign to domestic interest rates will depend on the magnitude of the capital controls. The higher is the tax on capital movement t the lower will be the pass through. The above, of course, assumes that capital controls are fully enforceable. There is substantial evidence, however, that firms and individuals find ways of evading these controls, and that de facto impediments are much weaker than the jure capital controls – see Edwards (1999), and Eichengreen (2002). In the final analysis, whether capital controls are an effective mechanism for isolating countries from external interest rate shocks is an empirical question, and one that I address in the pages that follow, where I report results from the estimation of a series of dynamic interest rate equations based on (1) and (2).

Two additional remarks are in order: First, the models that yield equations (1) and (2) assume that domestic and international securities are perfect substitutes, and that investors are risk neutral. If, however, these securities are imperfect substitutes the pass through will be less than complete even in the absence of capital controls. In this case, equation (2) becomes:

$$(2') \qquad r_t - \beta\, r_t^* + \gamma = E_t\{\Delta e_{t+1}\},$$

Where, β is a combination of parameters that capture the extent of capital controls and the degree substitutability across securities -- $0 \leq \beta \leq 1$, The value of β in empirical analyses will capture the magnitude of the interest rate pass through. Second, after a change in foreign interest rates, and during the transition, the expected rate of depreciation $E_t\{\Delta e_{t+1}\}$ will change, affecting the dynamic path of domestic interest rates. The actual behavior of $E_t\{\Delta e_{t+1}\}$ during the transition will depend on a number of factors, including the degree of price stickiness, the speed at which different markets clear, and whether the law of one price holds for importables and/or exportables. If the spot exchange rate overshoots its final equilibrium, as in the celebrated

country. The results are very similar, however, for cases where capital controls take different forms. For a discussion on different forms of capital controls see, for example, Edwards (1999).

Dornbusch model, an increase in foreign interest rates will result in an expected appreciation of the local currency. At the end of the road, then, the extent to which changes in foreign interest rates – say, changes in the Fed's policy interest rates – affect domestic short term rates is an empirical question. The purpose of the analysis that follows is to use a number of variants of equations (1) through (2') to analyze this issue using historical weekly data for the countries discussed above.

3.2 Basic empirical equations and data

At a very general level the dynamics of interest rates in an open economy may be described by the following error correction model:

(3) $$\Delta r_t = \theta(\tilde{r}_t - r_{t-1}) + \sum_{i=1}^{k} \gamma_i \, y_t + \lambda \Delta r_{t-1} + \varepsilon_t$$

Where r_t is the domestic interest rate for securities of a certain maturity in period *t*, $\tilde{r}_t$ is the "equilibrium" domestic interest rate in period *t*, the y_t are other variables that possibly affect the change in interest rates, including changes in international economic conditions captured by terms of trade shocks and global perceptions about risk; ε_t is an error term with the usual characteristics.[9] If λ is equal to zero, the dynamic structure becomes very simple, and is characterized by a partial adjustment process, where the speed of convergence is given by θ. If, however, λ is different from zero, the adjustment process will be more complex, and may be characterized by oscillations. In the empirical analysis that follows I investigate this issue empirically, and I allow the data to tell whether $\lambda = 0$. An important question, and one that I address in the section that follows, is whether the estimated coefficients depend on the extent of capital controls.[10] As pointed out above, most modern macroeconomic open economy models with fully integrated capital markets yield an "equilibrium" (non-arbitrage) condition for domestic interest rates similar to equation (2'). Further assuming that there is a nonzero probability of a country defaulting on its obligations, it is possible to rewrite (2') as follows:

(4) $$\tilde{r}_t = \alpha_0 + \alpha_1 \, r_t^* + \alpha_2 \, \delta_t + \alpha_3 \, \rho_t + \omega_t.$$

[9] Whether the equilibrium rate should be dated contemporaneously at *t*, or with a one period lag at period *t-1* is a matter of debate. I discuss this issue below, in light of the results.

[10] Miniane and Rogers (2007) address this issue using a panel of countries and monthly data. They define a U.S. monetary shock in a different way, however.

r_t^* is "a" foreign or international interest rate, δ_t is the expected rate of devaluation of the domestic currency, ρ_t is a country risk premium, and ω_t is an error term. Under full international capital markets integration (that is, no capital controls) α_0 is expected to be equal to 0, and α_1 through α_3 are expected to be equal to 1. Whether this is the case is, of course, an empirical issue. As may be seen, equation (1) is a special case of equation (4).

The following definitions for the key variables in equations (3) and (4) were used in the estimations reported below: r_t is the nominal interest rate on 3-months CDs in the local banking sector in each of the seven emerging nations in the sample. r_t^* is the Federal Funds rate (in some regressions alternative definitions for r_t^* were used; see the discussion below). δ_t is the expected rate of depreciation calculated as the difference between the natural logarithm of the 3 months non-deliverable forward exchange rate, and the natural logarithm of the spot exchange rate. Both the forward and spot rates are with respect to the U.S. dollar. I annualized the expected depreciation by multiplying the logarithmic differential by 4. Finally, for all countries in the sample, with the exception of Korea, ρ_t is given by the EMBI Global spread for sovereign bonds. For Korea I constructed a data series on country risk premium by combining the EMBI Global spreads and Credit Default Swap (CDS) spreads. The reason for doing this is that Korea was removed from the EMBI Global index by the end of April of 2004.[11] All data were obtained from *Data Stream*.

An important question refers to the timing of the observations. The reason for being concerned about this issue is that when the FOMC of the Federal Reserve announces its interest rate decisions, Asian financial markets are likely to be closed for that calendar day. That is, if there is any reaction to the Fed's action, it is likely to be on the *next* calendar day. In this study, however, each data point corresponds to that week's Friday data. FOMC meetings are never on Fridays, however. They are usually on Tuesdays. Two days meetings usually span a Tuesday and a Wednesday. This means that using contemporaneous -- that is, same week -- data for

[11] The Korean sovereign risk spread was constructed by the following procedure: a regression was run of the EMBI spread on the CDS spread for the period where both data were available. Then, fitted values from this regression were used as a country risk indicator for the period after April 2004.

analyzing the transmission issue does not pose a timing problem. It would be problematic, however, in studies that rely on daily data.[12]

3.2 Preliminary Tests

In Table 3 I present data on unit root tests for short term interest rates in the seven countries, both for levels and first differences. As may be seen, the null hypothesis of a unit root cannot be rejected in levels. This is the case both when a common process is assumed, and when individual unit root processes are considered. On the other hand, the null of unit root is rejected for the differenced series. Tests for the Fed Funds rate, the log of the Embi and the expected rate of devaluation, not reported here due to space considerations, indicate that these series are non-stationary in levels and stationary in first differences.[13]

In Table 4 I present the results from the Pedroni panel cointegration tests for domestic interest rates, the Fed Funds rate, the log of the Embi index, and expected devaluation. As may be seen, the null hypothesis of no integration is strongly rejected, indicating that, as posited in equation (4), there is indeed a long run equilibrium relationship between these variables. The estimated cointegtrating vector for Latin America is (t-statistics in parentheses): 1, -0.88 (-4.32), -0.55 (-1.84), -1.2 (-11.92). The cointegrating vector for Asia is: 1, -1.23 (-7.13), -0.40 (-0.94), -1.027 (-11.53). When Kao and Fisher tests were used the results were similar, and the null hypothesis was strongly rejected, as in Table 4.

3.3 An Error Correction Model: Results

After combining equations (3) and (4) I estimated the following dynamic panel equation for the Latin American and the Asian countries (see Section 6 for a discussion on alternative estimation techniques):

$$(5)\quad \Delta r_{it} = c_{i0} - \theta\, r_{it-1} + \theta\, \alpha_1 r^*_{it} + \theta\, \alpha_2 \log Embi_{it} + \theta\, \alpha_3 \delta_{it} + \sum_{i=1}^{k} \gamma_i\, y_{it} + \lambda \Delta r_{it-1} + \varepsilon'_{it}.$$

In this equation c_{i0} is a country-specific fixed effect.

Table 5 contains the base-run results using pooled data sets for the four Latin American countries and the three Asian nations in the sample. Two y_{it} shocks were included in the base

[12] For that actual dates of FOMC meetings since 1967, see the Fed's web site. The URL is: http://www.federalreserve.gov/monetarypolicy/fomc_historical.htm

[13] The expected rate of devaluation is borderline stationary. The null hypothesis cannot be rejected when a common unit root process is assumed; it is rejected under the assumption of individual processes.

regressions: the percentage change in the price of WTI crude oil, and the percentage change in JP Morgan's agricultural commodities index (both of these indexes are available at weekly frequencies). The first two equations in Table 5– equations (5.1) and (5.2) -- were estimated using GLS with White corrected covariances. Equations (5.3) and (5.4), on the other hand, were estimated using a dynamic panel GMM method that takes into account the fact that both Embi and expected devaluation are endogenous. Three groups of instruments were used: commodity indexes that instrument for expected devaluation; global financial indicators that capture the degree of global and regional risk; and lagged values of some regressors in equation (5). More specifically, the following instruments were used: the contemporaneous and lagged 3-month Libor rate, the log of the country risk premium for neighboring countries, the Ted spread in levels and first differences, the percentage change in commodity price indexes for oil, agricultural commodities, energy and metals, and lagged values of the different covariates. Unless otherwise stated, all the equations reported in this paper include fixed country effects.

As may be seen from Table 5, there are both similarities and differences in the estimates for the two regions. The main results may be summarized as follows:

- For both regions the estimated coefficient of r_{t-1} is negative and significant, as expected. It is also small in absolute terms, with its point estimate ranging from -0.05 to -0.13. It should be noted, however, that these coefficients correspond to weekly data; when transformed into quarterly equivalents the numbers are significantly higher, indicating that in 3 months between 45% and 82% of the adjustment process is completed.
- In both regions the coefficient of the Federal Funds policy interest rates is *significantly positive*, indicating that during the period under analysis Federal Reserve actions were indeed transmitted into changes in domestic interest rates in Latin America and Asia.
- Two points related to the previous conclusion deserve particular attention. First, the estimated coefficient for the Federal Funds is significantly higher in the Asian region than in Latin America. Second, the GMM estimation generates smaller coefficients in both regions than the GLS estimates. The GMM estimates suggest that 50 basis points Fed Funds rate hike is transmitted, ***on impact***, into a 6 basis

points interest rate increase in Asia; in Latin America the ***impact*** effect is merely 1.5 basis points. Both of these impact effects are statistically different from zero.

- While the coefficient of Δr_{t-1} is significantly negative in Latin America (with a point estimate of -0.387 in the GMM estimate), it is not significantly different from zero in the Asian estimation. This means that the adjustment is slower in Latin America than in Asia (See Figure 4, below).
- The *long run* estimated coefficient for the Federal Funds rate is 0.60 in Latin America and 1.20 in Asia (both of these estimates are obtained from the GMM results).[14] This means that while Federal Reserve interest rate shocks have been transmitted only partially to Latin America, they have been fully transmitted to the Asian nations (this long run coefficient is not significantly different from one in Asia).
- In every regression the coefficients of the Embi and expected devaluation are positive. In three of the four regressions they are significant at conventional levels. This suggests that, as expected in open economies, domestic interest rates are affected by country risk and expectations of devaluation.
- The coefficients of the terms of trade shocks are not significant in the Asia regressions, and only one of them is marginally significant for Latin America.

In Figure 4 I present the path followed by domestic interest rates as a result of a hypothetical permanent hike in the Federal Reserve Federal Funds rate of 50 basis points. For illustrative purposes I assume that short term deposit rates are initially equal to 5% in both regions, and that before the hike the Federal Funds' rate was 3%. I also assume that the Fed hikes its policy rate in week 11, and that everything else remains constant. In these simulations, for the Asian region I set the coefficient of Δr_{t-1} equal to zero (recall, from Table 5, that it is not significantly different from zero). As may be seen, 4 weeks after the Fed action, short term deposit rates in Asia will be 5.19%, while they will only be 5.05% in Latin America. After 3 months deposit rates will be 5.4% in Asia and 5.11% in Latin America, and after 6 months they will be 5.47% in Asia and 5.22% in Latin America. Although the adjustment process is much faster in Asia, in both regions it is smooth and is virtually finished after one year.

[14] These are approximations due to rounding. The actual long run coefficients are 0.56 and 1.16.

It is important to notice that equation (5) does not include as a covariate the emerging countries' monetary policy interest rate. That is, when interpreting the coefficient of the Federal Funds interest rate r_{it}^{*} presented in Table 5 the "with other things given" does not include the domestic country's policy interest rate. That is, this interest rate "pass through" could be the result of the local central bank adjusting its policy stance in response to the Fed's action, or to a direct market response in the country in question to changing international financial conditions. In Section 5 I deal with this issue in greater detail for the case of Chile.

3.4 "Twist" policies and the U.S. yield curve

An interesting question is how changes in the steepness of the yield curve in the United States affects short term interest rates in the emerging markets. This has become particularly important in light of the September 2011 decision by the Federal Reserve to "twist" the yield curve by buying long term securities, while simultaneously selling short term securities. The goal of this policy is to flatten the yield curve, without affecting the overall stock of base money. At a more general level an important issue is whether changes in the steepness in the U.S. yield curve – independently of whether they are triggered by "twist" policies or by market forces – affect short term interest rates in the emerging markets. In order to deal with this issue I estimated a number of equations similar to (5), where I included the yield of the 10-year Treasury note as an additional regressor. The GMM results obtained for both regions are reported in Table 6 – see equations (6.1) and (6.2).

As may be seen, for the Asian countries the estimated coefficient for the ten year note is not significantly different from zero, and the point estimates of the other coefficients – including the coefficient for the Fed Funds rate -- are very similar to those obtained in the base case estimation reported in Table 5. For Latin America, on the other hand, the coefficient of the 10-year Treasury note is significantly *negative* with a point estimate of -0.105. The point estimate of the coefficient of the Fed Funds policy rate is still significant, but its point estimate is now 0.062, twice as large as the one reported in Table 5. This indicates that changes in the slope of the U.S. yield curve will tend to have significant effects on interest rates in Latin America. It is useful to distinguish four cases:

- Consider first a Fed Funds hike of 50 basis points that doesn't affect the 10 year yield. This will flatten the yield curve, and will result in an immediate (same week) increase in Latin American deposit rates of 3 basis points. The long run effect will be an increase in Latin American deposit rates of 50 basis points. That is, under these circumstances there is full transmission of the Fed Policy hike.

- Consider now the case where the U.S. yield curve becomes flatter due to a reduction in the ten year note yield, with no change in the Federal Funds rate. In this case, on impact, short term deposit rates in Latin America will increase by 5 basis points.
- A Fed Funds 50 basis points hike that results in a parallel shift of the yield curve (that is, in a simultaneous 50 points increase in the ten year yield), will generate a long run decline in short term interest rates in Latin America of 36 basis points.
- Finally, under current circumstances the most interesting case is that of a “twist” policy like the one announced by the FOMC on September 2011. Assume that such policy results in a Fed Funds hike of 50 bps and a simultaneous decline of 50 basis points in the 10 year note. According to equation 6.1 this Fed policy will put significant upward pressure on short term rates in Latin America. In the long run this “twist” approach will result, on average and with everything else given, in an increase in 90 days deposit rates of 133 basis points.

In an effort to gain further insights on this issue I also estimated an equation that included the yield on the 30 year Treasury note (detailed results are available on request). When this is done the coefficient of the 10 year note becomes insignificant; that of the 30 year note is significantly negative, indicating that, as reported above, the steepness of the yield curve affects deposit rates in this group of Latin American nations.

4. Capital controls and the international transmission of interest rate disturbances

During the period under study the vast majority of emerging markets – including the seven countries in the current sample -- relied on some kind of controls on capital mobility. According to the “capital mobility” index reported in Figure 4 Asian nations controlled cross border capital movements more tightly than the Latin American countries: in a scale that goes from 1 to 10, where a higher number represents a higher degree of capital mobility, the Latin American nations have an average of 5.3, while the Asian nations have an average of 4.1. There are, however, important differences within regions: Colombia, as noted, had one of the lowest degrees of capital mobility during this period; Korea, on the other hand, had a fairly high (that is, above the sample's median) degree of capital mobility during most (but not all) of the years considered in this paper. For the sample as a whole the average value of the index for the seven countries is 4.8; the median is 4.6. The average (and median) values of the capital mobility index for the individual emerging markets in this study are:

- Brazil: 5.3 (5.5)
- Chile: 7.2 (7.7)
- Colombia: 3.7 (3.8)
- Mexico: 4.7 (4.8)
- Indonesia: 4.4 (4.8)
- Korea: 4.3 (4.1)
- The Philippines: 3.6 (3.4)

An important question is whether the international transmission of interest rate shocks depends on the degree of openness of the capital account. From a policy point of view this issue has become central in global policy discussions. A number of political leaders in the emerging markets have argued that recent monetary largesse in the advanced nations, and in particular in the United States (QE1, QE2 and a possible QE3), has impacted their country's macroeconomic performance. Indeed, in a number of countries – including in Brazil and South Korea --, the response to this perceived problem has been the strengthening of controls on capital mobility. This effectiveness of capital controls has been addressed by De Gregorio, Edwards, and Valdés (2000), Edwards (1999) and (2010), Eichengreen (2002), Miniane and Rogers (2007), Edwards and Rigobón (2009), and Aizenman, Chinn, and Ito (2011), among others.[15] These papers have used different techniques and have covered different groups of countries: some have focused on panel estimation, while others have analyzed in great detail specific countries' experiences. These works, as the vast majority of other analyses on this subject, have used either quarterly or monthly data, and most of them have relied on VAR estimation techniques. By and large these papers have found that there is no robust evidence suggesting that countries with a higher degree

[15] See, also, Chinn and Ito (2002)

of capital controls are less vulnerable to monetary shocks from abroad. Miniane and Rogers (2007, p. 20) summarize the state of this debate aptly: “We find essentially no evidence that capital controls are effective in this sense [of isolating countries from external shocks.]”

In principle, capital controls could affect the transmission of interest rates shocks in three ways: they could affect the impact effect, the long run effect, and/or they could alter the dynamic process of convergence towards the steady state. In this Section I analyze the potential role of capital controls in the transmission process by interacting the capital mobility index discussed in Section 2 with different regressors of interest.

In Table 7 I present the GMM regressions obtained when the capital controls index is interacted with a number of variables for the Latin American and Asian countries. The results pertaining to the variables of interest may be summarized as follows:

- For the Latin American countries the coefficient for the interaction between capital controls and the Fed policy rate is negative and significant at the 10 percent level. The interactive coefficient for r_{t-1} is significantly negative, as is that of Δr_{t-1}.
- For the Asian region the coefficient for the interaction between capital controls and the Fed policy rate is not significantly different from zero (its point estimate is -0.004). The coefficient of r_{t-1} is negative and imprecisely estimated. The coefficient of Δr_{t-1} is significantly negative with a point estimate of -0.08.

Taken literally, these estimates suggest that capital controls are not a very effective tool for reducing a country’s exposure to global interest shocks. Indeed, for both regions the regressions in Table 7 indicate that countries with a high degree of capital mobility – say, countries with an index value of 6 – will be affected mildly by Fed policy actions. On the other hand, this is not the case for countries with a low level of mobility. For example, in a Latin American country with a mobility index of 3, a 50 basis points Fed Funds rate hike will be translated, in the long run, into an increase in deposit rates of 40 basis points. These estimates also indicate that the speed of adjustment to different shocks is faster in countries with low mobility than in countries with high mobility. In order to analyze this issue further I estimated a number of regressions for countries with “very high” mobility – where “very high” is defined as having a value of the index in excess of 5.2 --, and countries with an index lower than 4, or a "very low" degree of capital mobility. When GMM are used the coefficient of the Federal Funds policy rate for the "very high mobility" countries is insignificantly different from zero (with a point estimate of 0.014). On the other hand, the coefficient for the "very low" mobility countries is 0.05 with a t-statistic of 3.7. When GLS are used, the coefficient for the Fed Funds policy rate turns out to be significant for both groups of nations. However, the point estimate for the high mobility countries is lower than that for the very low mobility countries; 0.06 vs. 0.075.

The results that capital controls don't help countries to effectively isolate themselves from monetary shocks stemming from abroad confirm findings from other authors that have used lower frequency data for shorter periods and a smaller set of countries.[16] Interestingly, however, the results in this paper go a step further and indicate that nations with lower capital mobility have tended to experience a slightly higher "interest rate pass through" than countries with higher mobility of capital. A plausible explanation is that countries with lower mobility tend to have a higher rate of inflation, and are thus more sensitive to different shocks, including Fed policy actions. Indeed, the average yearly inflation in the "low mobility" countries is 6.2%; in the "high mobility" countries it is 4.7%. At this stage, however, this is only a conjecture and a more definitive conclusion would require more refined and textured measures of the degree of capital mobility. It is important to emphasize that the analysis reported in this Section relies on an imprecise measure of capital restrictions. More conclusive results – including a more precise estimation of the coefficients of interest – will require refining the capital controls index. I discuss possible directions for this research in Section 6. Also, see the discussion in Habermeier, Kokenyne, and Baba (2011).

5. The Federal Reserve and policy rates in emerging countries: A case study

The analysis presented in the preceding Sections analyzed the way in which market interest rates in seven emerging markets have reacted to changes in Federal Reserve's policy. An interesting and related question is whether central bankers in emerging nations react directly to Fed actions by adjusting their own policy rates. In this Section I investigate this issue for the case of one of the countries in the original sample: Chile.

[16] Miniane and Rogers (2007), Edwards and Rigobón (2009).

In Figure 5 I present the weekly evolution of Chile's policy interest rate, known as the *Tasa de Política Monetaria* (TPM), from January 2000 through mid September 2008. I also depict the Federal Funds rate. During this period the Banco Central de Chile changed its policy rate 42 times: there were 26 interest rate hikes and 16 cuts. The average (median) TPM increase was 39 (25) bps, while the average (median) cut was 44 (50) bps.

A preliminary inspection of the data in Figure 5 suggests that there are periods of synchronicity and periods of divergence between the two policy rates. Indeed, the Figure suggests that there may have been a break in the relationship between these two policy rates in mid 2007, when the Fed embarked in an aggressive process of rate cuts, while the Banco Central de Chile entered a period of concerted tightening. For this reason, most (but not all) of the results reported below concentrate on the 2000 through June 2007 period. During 2000-mid-2007, on average, the TPM is almost 60 bps higher than the Federal Funds policy rate. If the longer 2000-2008 period is taken, the average differential is 90 bps. Interestingly, however, the TPM is not always higher than the Federal Funds rate. Indeed, and as may be seen from Figure 5, there are periods when the Fed's policy rate exceeded Chile's rate.

As a first step in the analysis I performed Granger causality tests. As may be seen from Table 8, the results indicate that the hypothesis that Fed policy *doesn't* cause Chile's policy is strongly rejected. Of course, the other half of the result is uninteresting, as no one would seriously believe that Chile's policy actions would influence the FOMC. What is possible, however, is that in an open economy Central Banks from both large and small countries react to similar and common signals and information on global inflationary pressures.

In an effort to further understand the way in which Fed policy influenced monetary policy in Chile I estimated a number of error correction equations similar to (5), with the change in the TPM as the dependent variable. In addition to the Federal Funds policy rate, in the basic specification I included the following covariates: (a) the log of the Embi for Latin America, excluding Chile, lagged one period. (b) The one year change in the price of copper (Chile's main export), lagged one period. (c) Expected inflation in the U.S. measured as the difference between the yield on the 10 year Treasury note and the 10 year TIPS, also lagged one period. (d) Expected annualized devaluation of the peso, lagged one period. (e) Actual 12 month rate of devaluation of the peso, lagged one period. (f) The one year change in an index of agricultural commodities prices, lagged one period. And, (g) the one year change in an index of global energy prices, lagged one period.

In Table 9 I present the basic least squares regressions from this analysis.[17] The main results may be summarized as follows: (a) as expected, the TPM exhibits significant persistence. (b) In all estimates the coefficient of the Federal Funds rate is positive and significant. However, the point estimate of this short run coefficient is rather small. (c) In the longer run, changes in the Fed Funds policy rate tend to be fully incorporated into changes in the TPM. (d) The coefficient of expected inflation in the U.S. is significantly positive. (e) The coefficient of the 12 months change in the price of copper is negative and marginally significant. (f) The coefficient of the expected rate of devaluation is positive and significant at marginal levels. And, (g) the Embi index, and changes in global agriculture and energy prices are not significant. This is also the case for the estimated coefficients of the actual rate of devaluation during the past year (when alternative periods were used for the actual rate of devaluation the results were similar).

The fact that the coefficient of the Federal Funds rate is significant even when the U.S. expected devaluation is included suggests that central bankers in Chile believe that decisions made by the Federal Reserve contain information that goes beyond the information captured by the market and reflected in the TIPS breakeven expected inflation. With respect to the other covariates, a few comments are in order: the negative coefficient for the price of copper suggests that the Banco Central de Chile has taken into consideration the evolution of the real exchange rate when making policy decisions. A higher price of copper will exercise upward pressure on the currency value; this pressure may be (partially) relieved by reducing domestic interest rates. Interestingly, the fact that the *expected* rate of devaluation also enters positively in the regression indicates that the Banco Central de Chile has a forward looking attitude and takes into account other determinants of currency values, in addition to the price of copper, when making policy decisions.[18]

[17] Results from other specifications and other estimation procedures are available on request.

[18] The results in Table 9 were obtained when the Fed Fund's policy rate was introduced as a covariate. As I point out in Section 6 below, it may be argued that what really matters is the effective (as opposed to policy) Federal Funds rate. However, when the effective rate is used the results are almost identical to those in Table 9.

6. Robustness, extensions and future work

In this section I briefly deal with some extensions and robustness checks. I also discuss some directions for future research.

6.1 Which Fed Funds rate?

The results reported in the preceding sections focused on how changes in the Fed Funds policy rate affect deposit rates in seven emerging markets. It may be argued, however, that what matters are changes in the *effective* Fed Funds rate. The reason for this is that the market for Federal Funds tends to anticipate changes in Federal Reserve actions. Indeed consider the following information: the overall mean differential between the effective and policy Federal Funds rates was merely one basis point during 2000-2008. However, the mean differential the week before a Fed Funds rate increase was 12 bps (with a standard deviation of 6 bps); the mean differential the week before a Fed Funds cut was -17 bps (standard deviation of 20 bps).

In order to address this issue I estimated a number of regressions with the effective Fed Funds rate instead of the policy rate. I also used the differential between the two rates as a covariate. When the Fed Funds effective rate was used the results were virtually identical to those reported in the Tables above. When the differential between effective and policy rate was included its coefficient was insignificant, however.

6.2 Allowing for expected devaluation and country risk premia to adjust

The results presented above, including the simulations in Figure 4, assume that the country risk premium and expected devaluation remain constant when the Fed Funds policy rate changes. In reality, however, it is unlikely that this will be the case. Indeed, work by Uribe and Yue (2006) and Edwards (2010) indicate that increases in the Federal Reserve's policy rate will have a small but significant effect on perceived country risk in the emerging markets. Also, changes in interest rates in the U.S. will tend to affect currency values in the short run through the carry trade. An interesting question, then, is what will be the reaction of domestic interest rates if the Embi spread and the expected devaluation are allowed to adjust. I deal with this issue by excluding these variables from the short run interest rate regression. In this way, the "all other things given" will not refer to either the country risk premia or the expected rate of devaluation.

The results obtained when excluding these variables are in Table 10. As may be seen the coefficients of the Fed Funds rate are still significantly positive, but their point estimates are somewhat smaller than in Table 6. This indicates that even when other key determinants of domestic interest rates are allowed to adjust, Fed policy has an effect on short term interest rates in these emerging nations.

6.3 Volatility in global financial markets and contagion

The analysis reported above concentrated on how changes in U.S. interest rates (both policy as well as market rates) affect financial markets in the developing countries. A related question is the way in which perceived risk in the advanced economies impact on interest rates in Asia and Latin America. In order to address this issue I incorporated as an additional covariate the *Ted spread* (defined as the spread between the 3-month Libor rate and the effective Fed Funds rate). The results obtained – available on request – are quite interesting: for Latin America the coefficient of the Ted spread is significantly positive, with a point estimate (t-statistic) equal to 0.19 (2.03). For Asia, on the other hand, the coefficient of the Ted spread is not significantly different from zero. This suggests that, as one would expect, with other things given an increase in perceived risk in the advanced economies is translated into higher domestic interest rates in the emerging economies.

During the early 2000s the main source of global financial volatility was the Argentine crisis that eventually resulted in the abandonment of that country's fixed exchange rate and currency board. It is possible that this situation, which was reflected in a significant increase in the EMBI index for Argentina and, thus, for Latin America, affected the transmission mechanism of interest rate shocks across countries. Indeed, the EMBI for Latin America more than doubled between December 1999 and September 2002: from 596 to 1,349 basis points in. By early May 2003, however, the EMBI spread for the Latin American region had declined to 649 basis points. The EMBI for Asia, in contrast, increased by less than 100 basis points between December 1999 and September 2002 (from 190 to 282). In order to investigate the possible impact of the Argentine crisis I included in the GMM estimates a variable that interacted the Fed Funds rate with a dummy variable that takes the value of 1 during September 2001 and April 2003, and zero otherwise (this is the period of heightened Argentine instability).[19] The results obtained – available on request – show that the interacted variable is insignificant in both Asia and Latin America, indicating that the Argentine crisis didn't alter the transmission mechanism for the countries in the sample. It is still the case global (that is Fed originated) interest rate shocks are

[19] April 2003 is an important date, since at that time the freeze on bank deposits that had been implemented in December 2001 was lifted. For details see Edwards and Rigobón (2009).

more completely transmitted to the Asian than to the Latin American countries. As a way of further analyzing this issue I re estimated the GMM equations for a shorter period (2003-2008) that excluded the Argentine crisis. The results for Asia were virtually unchanged, with a point estimate for the Federal Funds rate of 0.099 (3.21). In Latin America, the new point estimate for the Federal Funds rate is higher than when the complete sample is used (0.064 vs 0.026). It is still the case, however, that the pass through is faster and stronger in Asia than in Latin America.

6.4 Alternative estimation techniques: Using multivariate VARs

The results reported in the preceding Sections were obtained by estimating different versions of an error correction equation – equation (3) – with GMM for dynamic panels. It is possible, however, to use alternative methodologies for addressing the question at hand. A popular option – and one that has been used in a number of empirical applications of DSGE models – is to estimate a multivariate VAR, and analyze the impulse response functions. This has been done, for instance, by Lubik and Schorfheide (2006) in their analysis of the U.S. and the Euro Zone; see, also, Monacelli (2005), and Justiniano and Preston (2010) for discussions on these issues.

In order to investigate whether the econometric strategy affects the results in a significant way I estimated a number of multivariate VARs for individual countries in the sample.[20] The results obtained for the effect of a Fed Fund's policy action were quite similar to those from the GMM estimations reported above. In order to illustrate this, in Figure 6 I show the impulse response function for short term interest rates in Mexico. As in the exercises reported above the shock is a 50 basis points permanent increase in the Federal Funds policy rate. As may be seen, the impact effect is an increase in Mexico's short term deposit rates of 13 basis points; the long run effect is an increase in deposit interest rates of 27 basis points. This long run effect is almost identical to the one obtained using GMM for Latin America and reported in Table 5.

6.5 Other extensions

Other extensions and robustness tests included checking whether different time periods affected the results in a significant way. Also, I used interest rates other than the Fed Funds rate as a measure of "foreign interest rates." More specifically, I included the 3-month Libor and the

[20] I thank Frank Schorfheide for suggesting me to undertake this exercise. In the estimation of the multivariate VARs the following variables were included: domestic interest rates, log of the EMBI for Mexico, expected devaluation, change in commodity price index for oil, and Fed Funds policy rate. As is customary, several orderings were considered when computing the impulse response function. In the results depicted in Figure 6 the Fed Policy rate was considered first.

3-month CD rate in the U.S. In addition, I considered different timing for the different covariates included in the different versions of equation (5). None of these changes affected the main conclusions captured in the results reported above. As a further robustness check I estimated the ECM model when the Fed's policy rate enters lagged one period, rather than contemporaneously. The results obtained were very similar to those reported in Table 5. For example, for Asia the coefficient of the lagged Fed Funds rate was 0.097 (t-statistic, 3.30); when it is entered without a lag the estimated coefficient is 0.106 (3.49). For Latin America the coefficient of the lagged Fed Funds rate is 0.030 (2.05); when it enters without a lag it is 0.029 (1.98).[21]

The results reported in this paper were obtained using pooled data for two groups of countries for Latin American and Asia. Further work on this area should look in greater detail at individual countries. Efforts to analyze individual country experiences could either rely on ECM estimation (as in the analysis of Chile's case in Section 5), or use VAR analyses, as in the Mexican analyses in Sub Section 6.4. A challenge for pursuing this type of country-specific analysis is that in most countries there is limited time series variability of the capital controls index.

6.6 Alternative measures of capital controls and future work

There are a number of possible directions for future work. Perhaps one of the most promising -- and challenging – one has to do with the formulation of a multiple equation system for analyzing this transmission issue. Ideally, this system would include equations for domestic interest rates in the emerging markets, exchange rate expectations, and country risk premia. This type of analysis would allow researchers -- as well as policy makers -- to understand better the channels through which the Fed's (or other advanced central banks' for that matter) actions affect domestic interest rates and interest rate differentials.

For a long time researchers have struggled to define an appropriate index of capital mobility. Initial measures were very crude, and considered a binary situation: the capital account was either "open" (the index got a value of 1), or it was "closed" (zero). The underlying data for constructing these indexes were taken from actual regulations and were obtained from the IMF's *Exchange Arrangements and Exchange Restrictions Yearbook*. In an attempt to use a finer measure with different shades of grey, some authors used data on the capital markets to make an

[21] I am grateful to a reviewer for suggesting this robustness check.

inference on the actual extent of capital mobility.[22] Quinn (1997) provided one of the first comprehensive indexes of capital mobility. This index covered 20 advanced countries and 45 emerging economies. In the last 15 years or so, a number of authors (and institutions) have made additional efforts to improve on these indexes. Some of these attempts include Edison and Warnock (2003), Chinn and Ito (2002), Quinn, Inclan and Toyoda (2001), Miniane (2004), Edwards (2007), Binici, Hutchison and Schindler (2010), Quinn, Schindler and Toyoda (2011), and Habermeier, Kokenyne, and Baba (2011). Some of these indexes have attempted to make a distinction between type of flows (equities vs debt), and whether they are inflows or outflows. In spite of significant progress in this area, most indexes continue to be subject to limitations, including the fact that most of them are only available at low yearly frequencies. Future work in this field will require refining the measures of capital mobility along the lines of the work done by some of the authors mentioned above. In order to check for the robustness of the results reported in this paper, I re estimated the ECM models using an alternative measure of capital controls constructed by extending the indexes by Quinn (2003). The results obtained were similar to those reported above, and indicate that during the period under consideration, and for the nations in this sample, controls on capital mobility were not very effective in isolating these countries from interest rate shocks. This means that, until improved indexes become available, the (tentative) conclusion that emerges from this study is that countries with higher controls have not been overly successful in isolating themselves in the medium to long run from interest rate shocks.

Further work should also tackle the issue of (potential) omitted variables. These come in two flavors: those variables that are not usually available at the weekly (or higher) frequency, and those variables pertaining to a country’s policy stance. Among these, an effort should be made to incorporate the potential role of prudential regulations. Although constructing an index that captures the nuances in this area will not be easy, it is possible to learn from past efforts to construct encompassing measures of capital mobility (see Habermeier, Kokenyne, and Baba (2011)).

7. Concluding Remarks

In this paper I used high frequency (weekly) data from seven emerging nations -- four in Latin America and three in Asia -- to investigate the extent to which changes in Fed policy

[22] Dooley (1995), Edwards & Khan (1986).

interest rates have been transmitted into domestic short term interest rates during the 2000s. The results suggest that there is, indeed, interest rates "pass through" from the Fed to emerging markets. However, the extent of transmission of interest rate shocks is different – in terms of impact, steady state effect, and dynamics – in Latin America and Asia.

Fed actions tend to be fully transmitted into interest rates in the three Asian countries in the sample. In Latin America, on the other hand, the final effect is approximately equal to one half. Also, as shown in Figure 4 the adjustment process is significantly faster in Asia than in Latin America. The results reported in this paper also suggest that changes in the steepness of the yield curve have important consequences for interest rates in the Latin American countries. This is not the case, however, in the Asian nations. These are important results for evaluating the possible effects of the Fed's "twist" policy announced in September 2011.

The results reported here are in line with results in other studies, including Shambaugh (2004), Miniane and Rogers (2007), Edwards and Rigobón (2009), Aizenman, Chinn, and Ito (2011), Binici, Hutchison, and Schindler (2010), and Quinn, Schindler and Toyoda (2011). The estimations presented above suggest that capital controls are not an effective tool for isolating emerging countries, in the medium and longer run, from global interest rate disturbances. Indeed, the econometric analysis indicates that domestic interest rates in countries with a lower degree of international mobility of capital have been somewhat more sensitive to Fed policy shocks than in nations that are more integrated to the world capital market. However, as I point out in Section 6, these results are not fully conclusive, and are subject to the limitations of the indexed of capital mobility used in the analysis. Moreover, some of the estimated coefficients are marginally significant. More definitive results require improving the measures of capital mobility, including the frequency with which they are available.

Before closing, a few words on some of the limitations of this study are in order. As is always the case with studies that use high frequency data, the analysis suffers from a "missing variables" problem. This is because much of the data on macroeconomic conditions and policies – including inflation rates and different measures of economic activity – are only available at a monthly (or lower) frequency. In spite of this, however, the results presented here provide useful information for understanding the influence of the Fed on emerging nations.

Table 1 - **Average accumulated changes in short term deposit interest rates weeks following a Fed Funds policy rate hike, weekly data 2000-2008 (in basis points; standard deviation in parentheses)***

	Impact	**1 week**	**2 weeks**	**3 weeks**	**6 weeks**
Latin America	14 (111)	14 (99)	14 (100)	12 (115)	15 (150)
Asia	2 (29)	5 (33)	7 (39)	5 (54)	9 (78)
U.S.	3 (2)	6 (3)	9 (4)	12 (6)	25 (12)

*Average Fed Funds hike is 26 basis points.

Table 2 - **Average accumulated changes in short term interest rates weeks following a Fed Funds policy rate cut, weekly data 2000-2008 (in basis points; standard deviation in parentheses)**

	Impact	**1 week**	**2 weeks**	**3 weeks**	**6 weeks**
Latin America	17 (82)	5 (89)	15 (115)	9 (145)	-12 (161)
Asia	-1 (84)	8 (121)	4 (93)	-15 (72)	-6 (113)
U.S.	-20 (22)	-21 (26)	-24 (28)	-30 (29)	-54 (29)

*Average Fed Funds cut is 44 basis points.

Table 3 - **Unit Root Tests for Short Term Interest Rates in Asia and Latin America, weekly data 2000-2008**

a. Levels

Exogenous variables: Individual effects
User-specified lags: 4
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	0.15942	0.5633	7	2817
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.28892	0.6137	7	2817
ADF - Fisher Chi-square	15.3446	0.3550	7	2817
PP - Fisher Chi-square	26.2916	0.0238	7	2829

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

b. First differences

Exogenous variables: Individual effects
User-specified lags: 4
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.73717	0.0001	7	2814
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-20.6321	0.0000	7	2814
ADF - Fisher Chi-square	408.668	0.0000	7	2814
PP - Fisher Chi-square	838.939	0.0000	7	2826

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 4 - **Cointegration Tests: Panel for Seven Emerging Markets, weekly data 2000-2008**

Pedroni Residual Cointegration Test
Included observations: 3192
Cross-sections included: 7
Null Hypothesis: No cointegration
Trend assumption: Deterministic intercept and trend
User-specified lag length: 4
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	4.348856	0.0000	2.361670	0.0091
Panel rho-Statistic	-60.42462	0.0000	-42.80862	0.0000
Panel PP-Statistic	-26.11857	0.0000	-20.77056	0.0000
Panel ADF-Statistic	-1.520729	0.0642	-1.673731	0.0471

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	-38.58590	0.0000
Group PP-Statistic	-20.22773	0.0000
Group ADF-Statistic	-1.663894	0.0481

Cross section specific results

Phillips-Peron results (non-parametric)

Cross ID	AR(1)	Variance	HAC	Bandwidth	Obs
BRA	0.640	3.019182	5.948539	14.00	439
CHL	0.600	0.243076	0.396258	11.00	353
COL	0.734	0.497780	0.667721	11.00	455
INDO	0.597	0.684649	0.871621	7.00	225
KOR	0.953	0.001478	0.003783	8.00	213
MEX	0.648	0.822551	1.213694	10.00	455
PHL	0.797	0.393689	0.328063	4.00	369

Augmented Dickey-Fuller results (parametric)

Cross ID	AR(1)	Variance	Lag	Max lag	Obs
BRA	0.871	2.389361	4	--	435
CHL	0.822	0.197131	4	--	349
COL	0.869	0.442208	4	--	451
INDO	0.819	0.599421	4	--	221
KOR	0.934	0.001004	4	--	209
MEX	0.826	0.716708	4	--	451
PHL	0.866	0.370034	4	--	365

Table 5 - **Dynamic Panel Estimates: Short Term Interest Rates in Latin America and Asia, weekly data 2000-2008**

	Eq. 5.1 Latin America GLS	Eq. 5.2 Asia GLS	Eq. 5.3 Latin America GMM	Eq. 5.4 Asia GMM
FF_POLICY	0.06 (4.33)	0.13 (7.09)	0.03 (1.98)	0.11 (3.49)
C	0.24 (3.43)	0.10 (1.02)	0.20 (2.76)	-0.06 (-0.40)
EMBI	0.08 (6.91)	0.07 (2.80)		
LOG(EMBI)			0.17 (2.51)	0.36 (2.81)
EXP_DEV_AN	0.03 (4.22)	0.07 (8.43)	0.01 (0.80)	0.03 (2.33)
R_90D(-1)	-0.09 (-7.93)	-0.13 (-9.82)	-0.05 (-4.14)	-0.09 (-4.79)
D(R_90D(-1))	-0.37 (-16.73)	0.02 (0.48)	-0.39 (-17.09)	0.03 (0.88)
DLOG(WTI_SPOT)	0.02 (0.04)	0.33 (0.99)	0.44 (0.33)	1.34 (1.29)
DLOG(COMM_AGRIC)	-0.64 (-0.77)	-0.08 (-0.13)	-0.64 (-1.62)	-0.62 (-0.83)
Periods included:	452	367	452	366
Cross-sections included:	4	3	4	3
Total panel (unbalanced) obs.:	1688	799	1688	798
Cross-section fixed (dummy variables)	x	x	x	x
R-squared	0.2	0.1	0.2	0.1
F-statistic	42.1	12.2		
Prob(F-statistic)	0	0		
Mean dependent var	-0.011	-0.002	-0.011	-0.002
Durbin-Watson stat	2.16	1.91	2.17	1.99
Instrument Rank			26	25
J-statistic			22.6	18.0

Note: t-statistics in parenthesis.

Table 6 - **"Twist" Policies by the Fed and Short Term Interest Rates in Latin America and Asia, weekly data 2000-2008***

	Eq. 6.1 Latin America	Eq.6.2 Asia
FF_POLICY	0.06 (2.90)	0.11 (3.49)
C	0.54 (3.09)	-0.06 (-0.25)
LOG(EMBI)	0.23 (3.17)	0.36 (2.63)
EXP_DEV_AN	0.01 (1.43)	0.03 (2.32)
R_90D(-1)	-0.06 (-4.57)	-0.09 (-4.71)
D(R_90D(-1))	-0.39 (-17.06)	0.03 (0.88)
UST_10YR	-0.10 (-2.13)	0.002 (0.04)
DLOG(WTI_SPOT(-1))	0.83 (0.63)	1.34 (1.29)
DLOG(COMM_AGRIC(-1))	-1.76 (-1.79)	-0.61 (-0.82)
Method: Panel GMM	Yes	Yes
Total panel (unbalanced) obs.:	1688	798
Cross-section fixed (dummy variables)	Yes	Yes
R-squared	0.19	0.09
Mean dependent var	-0.011	-0.002
Durbin-Watson stat	2.17	1.99
Instrument Rank	26	25
J-statistic	18.12	18.00

Note: t-statistics in parenthesis.

* The data used in these estimates correspond to end-of-week interest rates. See the text for a discussion on timing.

Table 7 - **Capital Controls and the Transmission of Fed Poly Action to Latin America and Asia, weekly data 2000-2008**

	Eq. 7.1 Latin America GMM	Eq. 7.2 Latin America GLS	Eq. 7.3 Asia GMM	Eq. 7.4 Asia GLS
FF_POLICY	.88 (1.66)	0.13 (1.80)	0.41 (1.78)	0.27 (2.83)
C	3.17 (1.38)	-0.003 (-0.006)	-1.03 (-1.00)	1.23 (2.85)
LOG(EMBI)	1.28 (1.21)	0.22 (1.02)	2.45 (-3.97)	0.99 (4.05)
EXP_DEV_AN	0.94 (1.87)	0.14 (2.63)	-0.31 (-3.49)	0.04 (0.95)
R_90D(-1)	-1.17 (-1.75)	-0.19 (-2.46)	-0.19 (-1.49)	-0.50 (-6.31)
D(R_90D(-1))	0.56 (2.10)	0.47 (2.59)	0.32 (1.73)	0.14 (0.84)
FF_POLICY*CAP_CONTROLS	-0.15 (-1.57)	-0.01 (-1.12)	-0.07 (-1.28)	-0.04 (-1.57)
LOG(EMBI)*CAP_CONTROLS	-0.19 (-0.95)	0.02 (0.42)	-0.52 (-3.53)	-0.16 (-2.78)
EXP_DEV_AN*CAP_CONTROLS	-0.17 (-1.86)	-0.02 (-2.37)	0.10 (4.54)	0.01 (1.01)
R_90D(-1)*CAP_CONTROLS	-0.20 (1.64)	0.02 (1.47)	-0.00 (-0.14)	0.08 (4.15)
D(R_90D(-1))*CAP_CONTROLS	-0.17 (-3.54)	-0.15 (-4.70)	-0.08 (-1.74)	-0.04 (-0.81)
CAP_CONTROLS	-0.56 (-1.25)	0.04 (0.38)	0.37 (1.51)	-0.20 (-1.95)
Total panel (unbalanced) obs.:	1545	1687	799	799
Cross-section fixed (dummy variables)	Yes	Yes	Yes	Yes
R-squared	0.10	0.20	0.05	0.18
F-statistic		30.43		13.22
Prob(F-statistic)		0		0
Mean dependent var	-0.01	-0.01	-0.00	-0.00
Durbin-Watson stat	2.08	2.17	1.73	1.88
Instrument Rank	32		31	
J-statistic	17.9		18.54	

Note: t-statistics in parenthesis.

Table 8 - **Granger Causality Tests: Weekly Data for Fed Funds and Chile's TPM rate, weekly data**

A: 2000-2007

Pairwise Granger Causality Tests
Sample: 12/31/1999 6/15/2007 IF CHILE=1
Lags: 12

Null Hypothesis:	Obs	F-Statistic	Prob.
FF_POLICY does not Granger Cause TPM_1D	390	3.38462	0.0001
TPM_1D does not Granger Cause FF_POLICY		3.33618	0.0001

B: 2000-2008

Pairwise Granger Causality Tests
Sample: 12/31/1999 9/19/2008 IF CHILE=1
Lags: 12

Null Hypothesis:	Obs	F-Statistic	Prob.
FF_POLICY does not Granger Cause TPM_1D	456	1.99616	0.0232
TPM_1D does not Granger Cause FF_POLICY		2.53588	0.0031

Table 9 - **An error correction model for the Fed's influence on Chile's monetary policy, weekly data 2000-2008**

Dependent Variable: D(TPM_1D) (Chile) – Sample : 12/31/1999 6/15/2007

	Eq. 9.1	Eq. 9.2	Eq. 9.3	Eq. 9.4
FF_POLICY	0.03 (3.00)	0.03 (2.49)	0.02 (2.24)	0.02 (2.01)
C	-0.25 (-1.34)	-0.27 (-1.41)	-0.24 (-1.20)	-0.20 (-0.94)
TPM_1D(-1)	-0.03 (-2.69)	-0.02 (-2.05)	-0.03 (-2.23)	-0.03 (-2.26)
TIPS_EXP_INF_USA(-1)	0.10 (1.98)	0.11 (2.02)	0.11 (1.95)	0.10 (1.80)
LOG(EMBI_LATAM(-1))	0.03 (0.96)	0.03 (0.91)	0.02 (0.51)	0.01 (0.25)
ANN_CH_COPPER(-1)	-0.08 (-1.40)	-0.09 (-1.52)	-0.09 (-1.47)	-0.08 (-1.11)
ANN_CH_OIL(-1)		0.02 (0.49)	0.02 (0.50)	0.03 (0.58)
ANN_CH_AG(-1)		0.04 (0.42)	0.05 (0.59)	0.05 (0.59)
EXP_DEV_AN(-1)			0.01 (1.23)	0.01 (1.24)
DEV_12_MONTH(-1)				0.09 (0.50)
Periods included.:	389	389	389	389
R-squared	0.03	0.03	0.04	0.04
F-statistic	2.50	1.83	1.79	1.62
Prob(F-statistic)	0.03	0.08	0.08	0.11
Mean dependent var	0.00	0.00	0.00	0.00
Durbin-Watson stat	2.00	2.02	2.00	2.00

Note: t-statistics in parenthesis.

Table 10 - **Allowing for Embi and expected devaluation adjustments, weekly data 2000-2008**

	Eq. 10.1 Latin America GMM	Eq. 10.2 Latin America GMM	Eq. 10.3 Asia GMM	Eq. 10.4 Asia GMM
FF_POLICY	0.05 (2.55)	0.02 (1.24)	0.08 (2.86)	0.03 (2.78)
LOG(EMBI)	0.21 (2.99)		0.41 (2.88)	
EXP_DEV_AN		0.01 (0.91)		0.02 (3.30)
C	0.48 (2.82)	0.37 (2.22)	-0.16 (-0.64)	0.09 (0.79)
R_90D(-1)	-0.05 (-4.85)	-0.03 (-3.28)	-0.06 (-4.49)	-0.04 (-4.07)
D(R_90D(-1))	-0.39 (-17.38)	-0.40 (-17.61)	0.04 (1.04)	0.02 (0.73)
UST_10YR	-0.08 (-1.79)	-0.04 (-0.91)	0.01 (0.25)	0.01 (0.21)
DLOG(WTI_SPOT(-1))	0.67 (0.52)	0.27 (0.21)	1.37 (1.29)	0.70 (0.88)
DLOG(COMM_AGRIC(-1))	-1.75 (-1.78)	-1.64 (-1.66)	-0.67 (-0.87)	-0.47 (-0.79)
Total panel (unbalanced) obs.:	1688	1688	798	1026
Cross-section fixed (dummy variables)	x	x	X	X
R-squared	0.19	0.18	0.03	0.05
Mean dependent var	-0.01	-0.01	-0.00	-0.01
Durbin-Watson stat	2.18	2.17	1.98	1.99
Instrument Rank	26	26	25	25
J-statistic	20.02	27.80	20.48	25.28

Note: t-statistics in parenthesis.

Figure 1 - **Federal Funds policy rate and 3thre-month certificate of deposit rate in the US: Weekly data, 2000-2008**

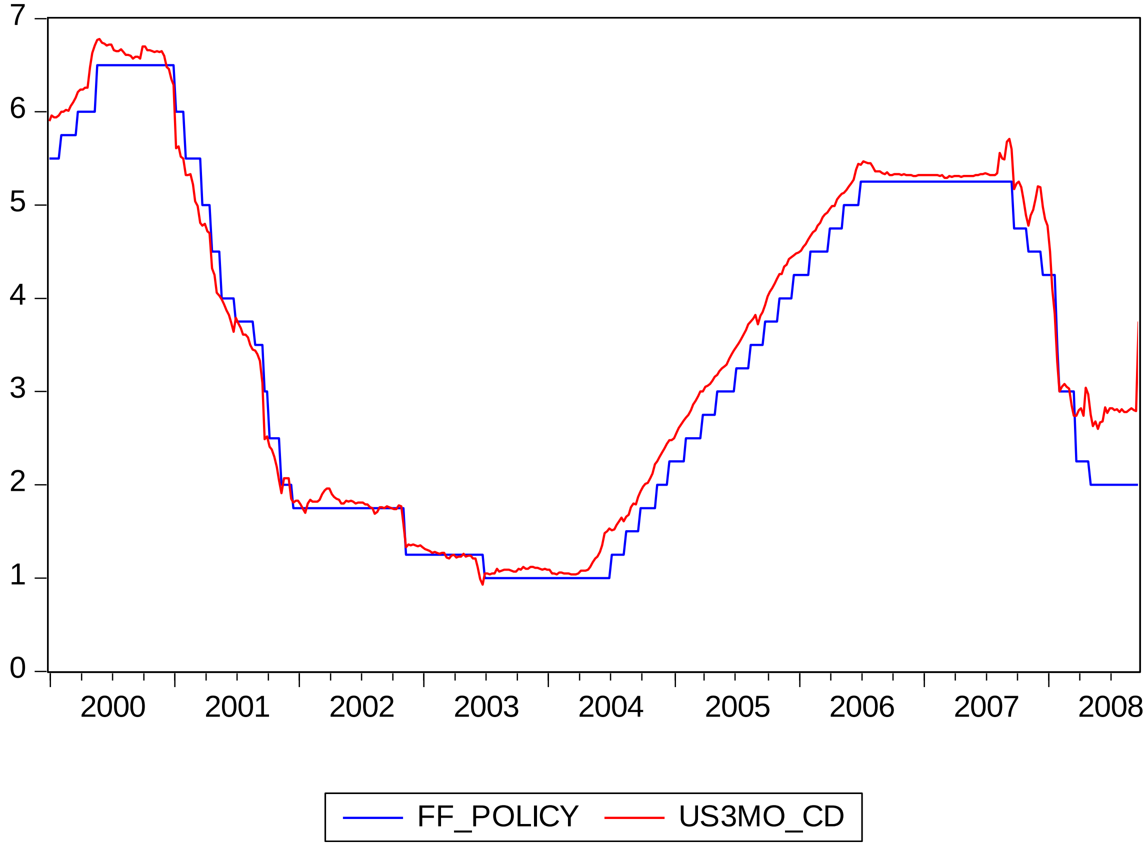


Figure 2 - **<u>Short term deposit rates in seven emerging markets and Federal Funds' policy rates: Weekly data, 2000-2008</u>**

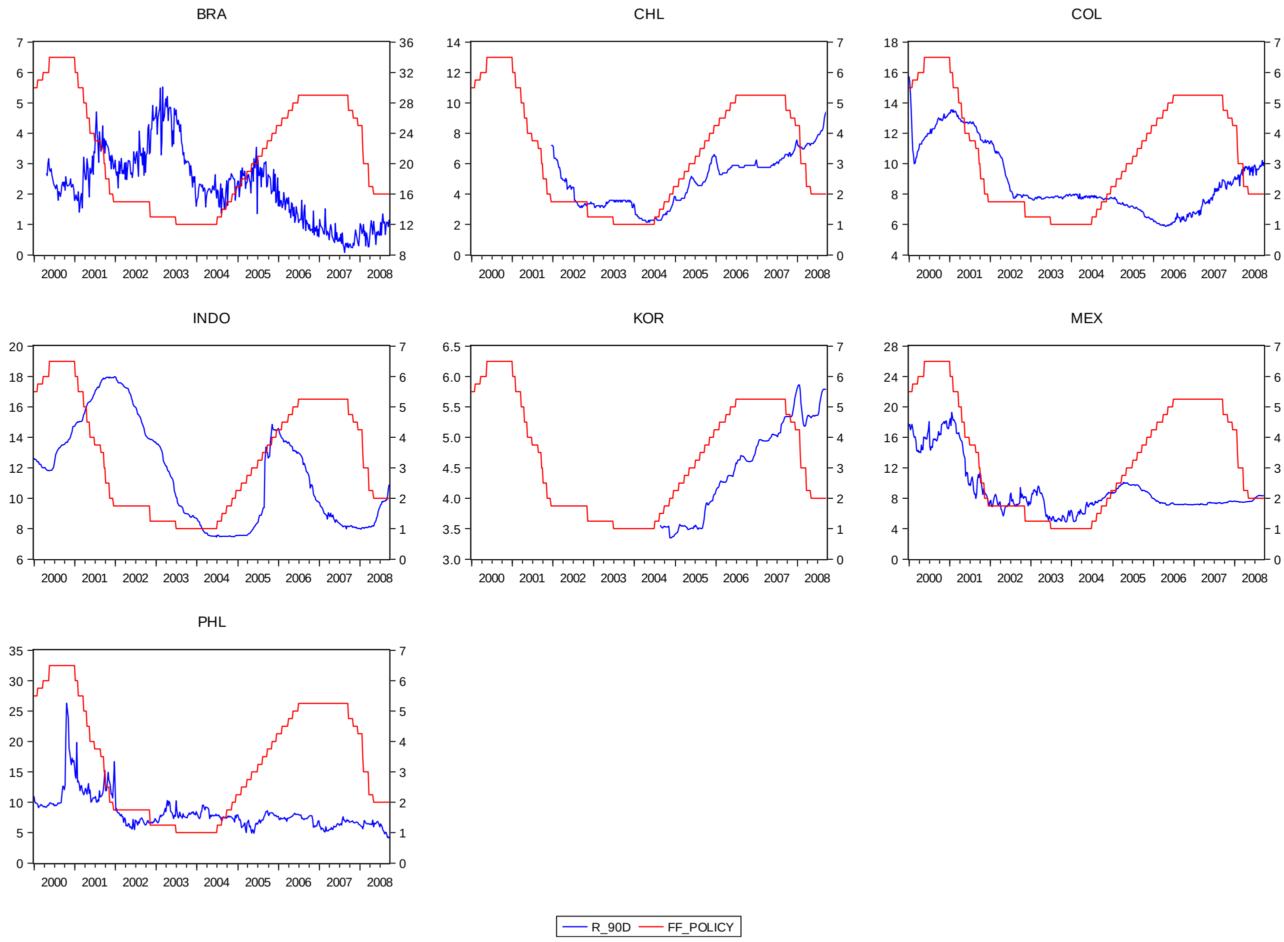
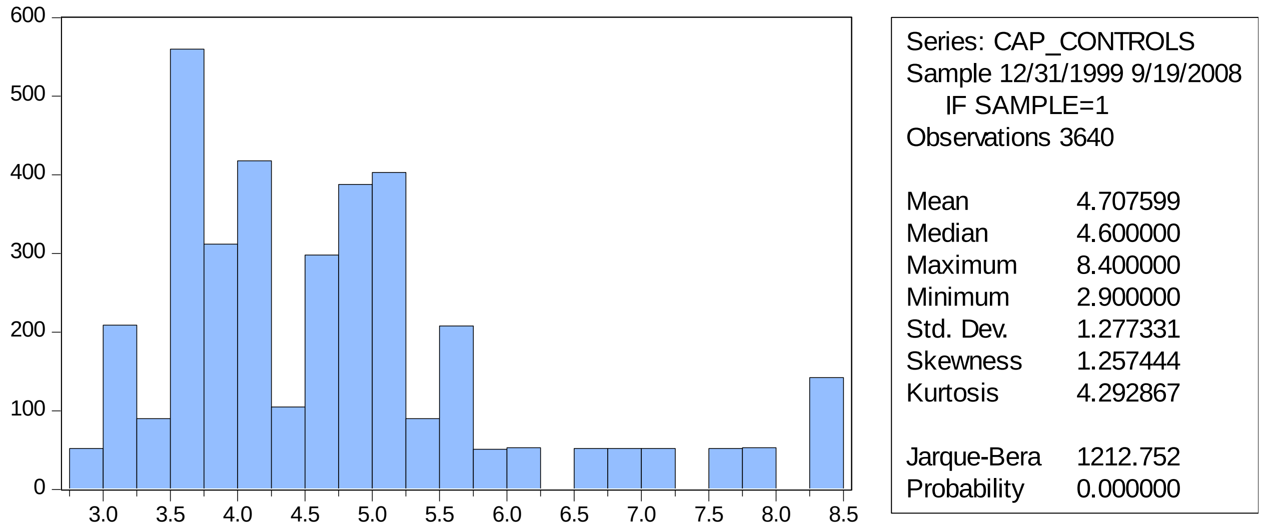
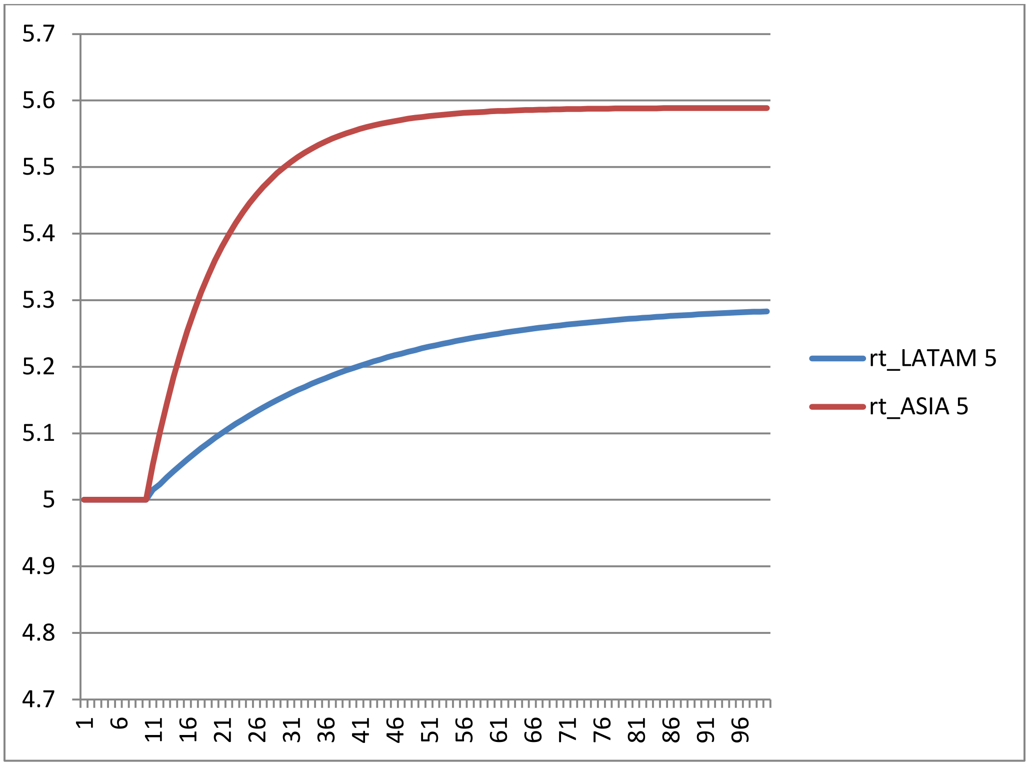


Figure 3: Capital Controls Data for Seven Emerging Markets, 2000-2008



Source: These data were constructed by making some adjustments and corrections to the Fraser Institute's index on capital mobility. See the text for details.

Figure 4 - **Simulated response of deposit interest rates to a 50 basis points Fed Funds hike in Asia and Latin America**



<u>Figure 5 - **Monetary policy interest rates for the U.S. and Chile: Weekly data, 2000-2008**</u>

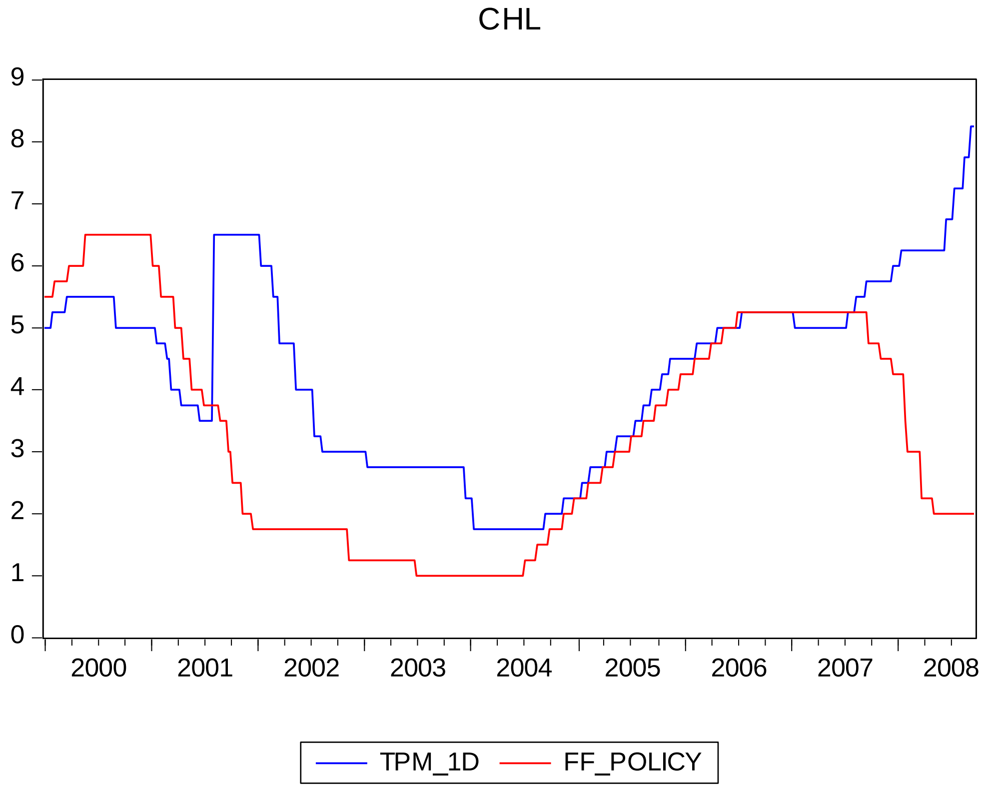
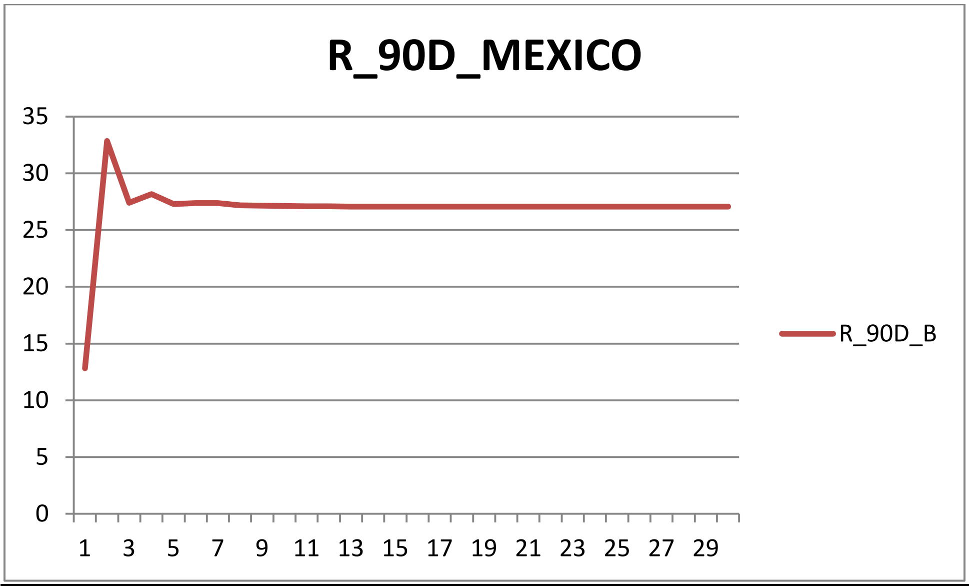


Figure 6 - **Impulse response function for Mexico's deposit rates (Shock: Hike in Fed Policy rate by 50 basis points)**



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