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Does the level of capital openness explain "fear of floating" amongst the inflation targeting countries?[1]

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Abstract

Under the assumption of perfect capital mobility, inflation targeting (IT) requires central banks to primarily focus on domestic inflation and to let their exchange rate float freely. This is consistent with the macroeconomic trilemma suggesting monetary independence, perfect capital mobility and a fixed exchange rate regime are mutually incompatible. However, some recent empirical evidence suggests that many developed and developing countries following an IT regime are reacting systematically both to deviations of inflation from its target and to exchange rates. I empirically examine whether the responsiveness of the interest rate to exchange rate fluctuations can be explained in terms of limited capital openness. Applying Arellano-Bond dynamic panel estimation method for 22 IT countries, I find that short-term interest rates do respond to real exchange rate fluctuations. However, the responsiveness of the interest rate to the exchange rate declines significantly as capital market openness increases. The results indicate that capital controls have a significant impact on the exchange rate policy of the IT central banks, as the central banks have relatively less control over the exchange rate movements with greater openness of the capital market.

Keywords: Macroeconomic Trilemma, Inflation Targeting, Interest Rates, Exchange Rate Policy, Capital Market Openness

JEL Classification Numbers: E44, E52, E58, F41

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[2] My sincere thanks to Professor Carl Walsh and Professor Thomas Wu for their helpful suggestions. All errors are my own. Email Address: sanchitam@gmail.com ; Tel.: +1-831-295-0719.

1. INTRODUCTION

Ever since New Zealand adopted inflation targeting (IT) as a monetary policy framework, IT has attracted significant attention from both developed and developing countries. Under flexible inflation targeting, the monetary authority adjusts the short-term interest rate to stabilize deviations of inflation from target and the real economy, represented by the output-gap (Svensson (2000), Taylor (2001), Giannoni and Woodford (2003), Walsh (2009)). A voluminous literature that focused on developed countries suggests that inflation targeters let their exchange rate float freely (Taylor (2001), Svensson (2002)) with no controls on capital and often no interventions (Rose (2007)). However, recent empirical studies based on both developed and developing countries (Mishkin and Schmidt-Hebbel (2001), Edwards (2006), Lubik and Schorfheide (2007), Aizenman et al. (2008)) suggest that short-term interest rates react significantly to both inflation and exchange rates, implying that all of the IT countries do not follow a freely floating exchange rate regime.

The idea of flexible inflation targeting regime is consistent with Mundell's Macroeconomic Trilemma suggesting that the monetary authority has to choose any two of following three choices:

- Autonomous monetary policy[3]
- Fixed exchange rate
- Perfect capital mobility

Since the primary focus of the central banks in the IT countries is the stabilization of domestic inflation and the output-gap, the domestic short-term interest rate has to be adjusted independent of the foreign interest rate whenever the domestic inflation deviates from its target. As a result, the monetary authority has to choose between a fixed exchange rate and perfect capital mobility. Under the assumption of perfect capital mobility the optimal strategy for the central banks is to follow a flexible exchange rate regime. However, if we look at the average capital openness index for IT developed and developing countries (Chinn-Ito (2008))[4] in Figure 1, we find both sets of countries do not allow for perfectly mobile capital flows across borders. After adoption of IT, countries have given up on the fixed exchange rate regime; yet some of them do not allow for perfect capital mobility. Therefore, in this paper I examine whether IT countries that are claiming to float are actually preventing large fluctuations in their currency value (also known as "fear of floating"); and if they are achieving this objective by imposing capital controls.

(Figure 1 here)

[3] such that domestic interest rate is independent of the foreign interest rate

[4] The index ranges from (-1.83) to 2.50, where higher values indicate a more financially open economy. The data are available for 181 countries from 1970-2008.

Accordingly the purpose of this study is to answer the following questions:

- Does the behavior of monetary policy in the sense of responsiveness of the interest rate to the exchange rate, vary with greater capital openness across developed and developing countries?
- If the IT countries respond more to exchange rate changes in the presence of limited capital openness, are they successful in stabilizing both inflation and the exchange rate simultaneously?

This study is important particularly in the current economic scenario. The advanced economies, for example US and Japan, are adopting quantitative easing, which is lowering the value of dollar and yen. This will make investors rush to other advanced and emerging economies in search of higher yields, which will lead to larger capital inflows in those economies. Instead of letting their exchange rate soar, many governments have intervened to buy foreign currency or imposed taxes on foreign capital flows. Brazil recently doubled a tax on foreign purchases of its domestic debt. Thailand has announced a new 15% withholding tax for foreign investors in its bonds. Therefore, it will be interesting to examine whether the presence of these capital controls might have any impact of the exchange rate policy of the central banks.

In order to answer the aforementioned questions, I empirically examine a linear monetary policy reaction function[5] where the short-term interest rate reacts to expected future inflation deviation, output-gap (deviation of actual output from trend output level) and real exchange rate fluctuations. To investigate the effect of capital openness on central bank's exchange rate policy, I incorporate an interaction term between exchange rate and capital market openness and control for capital market openness to avoid omitted variables problem.

The empirical results suggest that short-term interest rates in both advanced and developing IT countries react to real exchange rate fluctuations. However, the responsiveness of interest rate to exchange rate declines significantly as the capital openness increases. The results indicate that capital controls have a significant impact on the exchange rate policy in IT countries, suggesting that with liberalization of the capital account, a central bank with monetary independence loses its control over exchange rate fluctuations.

The paper proceeds as follows. Section 2 discusses the existing literature on inflation targeting and exchange rate considerations. Section 3 presents the data, empirical methodology and discusses the findings. Section 4 assesses whether the IT countries have managed to stabilize inflation over the IT period, and section 5 concludes.

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[5] Derived from the minimization of a central bank's quadratic loss function.

2. LITERATURE REVIEW: INFLATION TARGETING AND EXCHANGE RATE CONSIDERATIONS

Empirical evidence by Calvo and Reinhart (2002), Edwards (2006), Lubik and Schorfheide (2007), Mishkin and Schmidt-Hebbel (2007), Aizenman et al. (2008) suggest that in some of the IT countries, monetary policy is responding systematically to both the inflation and exchange rates. Using a theoretical model, Parrado (2004) analyzes the impact of monetary policy in an inflation targeting small open economy characterized by imperfect competition and short-run price rigidity. He finds that depending on the shock that the economy faces, the effects of monetary policy on output and inflation volatility depend on the exchange rate regime and the inflation index being targeted. If the economy is hit by a real shock then the welfare loss associated with a flexible exchange rate is less than that under a managed exchange rate, and therefore, a flexible exchange rate is preferable. However, when the economy is hit by a nominal interest shock, the reverse is true.

Further, in a structural general equilibrium model of a small economy using Bayesian method, Lubik and Schorfheide (2007) find that Australia and New Zealand do not include nominal exchange rate in their policy rule, whereas Canada and UK do. Calvo and Reinhart (2002) empirically test the data for 39 countries in Africa, Asia, Europe, Latin America and the Western Hemisphere from 1970 – 1999 and find that the countries claiming to allow for their exchange rates to float, mostly do not. They argue that the pass-through from exchange rate swings to inflation is far higher in emerging markets compared to developed economies. Therefore, the exchange rate has a greater potential to affect domestic inflation, which can impede the pursuit of an inflation target. This is one of the reasons why there is a tendency among emerging countries to cap exchange rate swings. Aizenman et al. (2008) suggest that among the IT countries, the commodity exporters are more vulnerable to terms of trade and real exchange rate disturbances. As a result, they react more to exchange rate changes compared to non-commodity exporters. Amato and Gerlach (2002) argue that financial markets are not well developed in the emerging markets and because of the lack of depth in the domestic capital market, firms, households and governments in these economies borrow in foreign currency. As a result, the exchange rate movements have severe impact on the borrower's balance sheet. Therefore, the central bank may be required to increase the short-term interest rate sharply in response to a depreciation, which violates the precondition of exchange rate subordination under inflation targeting. They also argue that with the lack of track record of monetary stability, the exchange rate serves as a focal point for inflationary expectations.

Xafa (2008) points out that IT countries have imposed capital controls to discourage capital flows and reduce appreciation pressure (Chile in 1991, Thailand in 2006, Colombia in 2007). However, there is little empirical evidence that controls are effective in stemming capital flows, especially over the longer term, as markets find ways around them. However, using high frequency data for Chile from 1991-1998, Edwards and Rigobon (2009) found that a tightening of capital controls resulted in a depreciation of the domestic currency in Chile.

The literature on the impact of capital controls on the exchange rates is contradictory and lacks a panel data based approach. Further, although the literature to date offers explanations why the inflation targeting countries, especially the emerging markets react to exchange rate changes, the impact of capital market openness on the responsiveness of the interest rate to exchange rate movements is still relatively unexplored. Therefore, in this paper, I examine whether the inflation targeting countries are imposing capital controls to manage exchange rate movements while maintaining an independent monetary policy.

3. DATA AND EMPIRICAL METHODOLOGY

3.1 ESTIMATING EQUATION:

In the inflation targeting countries, the short-term nominal interest rate is chosen as the monetary policy instrument. Here I assume a linear monetary policy reaction function where the target interest rate responds to expected future inflation deviation, output-gap and exchange rate deviations.

$$\bar{\imath}_{j,t} = \kappa + \beta_\pi \left(E_t\, \pi_{j,t+1} - \pi^*\right) + \beta_y \left(y_{j,t} - \bar{y}_{j,t}\right) + \beta_e \left(e_{j,t} - \bar{e}_{j,t}\right) \qquad (1)$$

where π is the CPI inflation rate, π^* is the inflation target, y is the output, $\bar{y}$ is the trend level of output, e is the real exchange rate and $\bar{e}$ is the trend level of real exchange rate.[6]

Subsequently, following the conventional wisdom and the strong empirical evidence that the current interest rate (i_t) depends not only on the target interest rate $\bar{\imath}$, but also on the lagged interest rate (Goodfriend (1991), Clarida et al. (1998, 2000) and Woodford (1999)), i_t is assumed to be determined as follows:

$$i_{j,t} = \rho\, i_{j,t-1} + (1-\rho)\, \bar{\imath}_{j,t} + \varepsilon_{j,t} \qquad (2)$$

where parameter $0 \leq \rho \leq 1$, represents the degree of interest rate smoothing, ε is an exogenous random shock to the interest rate and it is assumed to be independently and identically distributed (i.i.d).

It should be noted that this view is notably challenged by Rudebusch (2002) who argues that the large and significant coefficient on the lagged interest rate is a result of some serially correlated variables that are incorrectly omitted from the reaction function. At the same time, most of the studies (Castelnuovo (2006), English et al. (2002), Gerlach-Kristen (2004)) investigating the relative importance of policy inertia and the omitted variables conclude that both mechanisms are at play.

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[6] The trend level of output and the trend level of exchange rate are assumed to be the implicit targets for actual output and exchange rate.

Therefore, substituting (2) into (1) the monetary policy reaction function is specified as

$$i_{j,t} = \kappa\,(1-\rho) + \rho\, i_{j,t-1} + \gamma_\pi\,(E_t\,\pi_{j,t+1} - \pi^*) + \gamma_y\,(y_{j,t} - \bar{y}_{j,t}) + \gamma_e\,(e_{j,t} - \bar{e}_{j,t}) + \epsilon_{j,t} \quad (3)$$

To examine whether the central banks explicitly considers exchange rate in their policy rule, and to assess the effect of capital openness on the responsiveness of the interest rate to exchange rate fluctuations, I incorporate an interaction term between exchange rate deviations and capital openness and also control for foreign interest rate. To avoid omitted variable bias, I control for $ko_{j,t}$ as well:

$$i_{j,t} = \kappa\,(1-\rho) + \rho\, i_{j,t-1} + \gamma_\pi\,(E_t\,\pi_{j,t+1} - \pi^*) + \gamma_y\,(y_{j,t} - \bar{y}_{j,t}) + \gamma_e\,(e_{j,t} - \bar{e}_{j,t}) + \gamma_{eko}\,(e_{j,t} - \bar{e}_{j,t}) * ko_{j,t} + \gamma_{ko}\,ko_{j,t} + \gamma_{i^*}\,i_t^* + \epsilon_{j,t} \quad (4)$$

where $ko_{j,t}$ represents the capital openness of country j at time t, i_t^* represents the foreign interest rate, and $\epsilon_{j,t}$ denotes the disturbance term.

3.2 DATA

The macroeconomic data set used in this paper has been taken from IMF's International Financial Statistics database and World Economic Outlook (WEO). The data set ranges from a time when a particular country started targeting inflation through 2009 at an annual frequency.[7] Data on the money market rate has been used as a proxy for short-term nominal interest rate (policy instrument of the central banks). The WEO one year ahead forecast of CPI inflation has been used as a proxy for expected future inflation for developing IT countries. However, since the forecast values for CPI inflation were unavailable for the advanced countries, an average of current and past CPI inflation has been used as a proxy for one-period-ahead expected inflation under the assumption of rational expectations. The output-gap is constructed by subtracting the trend level of real-GDP from actual real GDP where the trend real GDP is calculated using Hodrick-Prescott filter (smoothing parameter 100). Similarly, the data for real exchange rate deviation is constructed by subtracting the trend real exchange rate (calculated using Hodrick-Prescott filter with smoothing parameter 100), from the actual real effective exchange rate. Here, an increase in the exchange rate is considered as a real depreciation of the domestic exchange rate. Further, I have used the normalized values (lies between 0 and 1)[8] of Chinn-Ito (2008) index of capital openness as a measure of capital market openness, where the original index ranges from (-1.83) to 2.50, where higher values indicate a more financially open economy.

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[7] Chinn-Ito capital openness index for both developed and developing countries and the data on real GDP for developing countries are available only at annual frequency.

[8] Subtract the minimum value from the actual and divide by the range to get the normalized values to transform negative values.

Moreover, the federal funds rate (interest rate of the United States) has been used as a proxy for the foreign interest rate. Table 1 reports the summary statistics of the variables.

(Table 1 here)

Before estimating the equations I test for stationarity in the variables. For this I use Augmented Dickey Fuller (ADF) tests with a lag term, where the optimal lag length for each variable was selected using the Schwarz Criterion (SC). The null hypothesis (H_0) for the stationarity tests is that the variable is non-stationary (has a unit root), and the alternative hypothesis (H_A) suggests that the variable is stationary (with no unit root). The ADF test results are summarized in Table 2 and reject the null hypothesis of a unit root for all of the variables, suggesting that they are all stationary.

(Table 2 here)

3.3 EMPIRICAL ESTIMATION TECHNIQUE

There are several challenges with the estimation of equation (3). First, since the focus of the study is on the period in which these countries have followed inflation targeting, the duration of study is not very long, giving a small number of observations for each country, which may lead to biased estimates. To address this shortcoming, I have used panel data set.[9] Second, the equation suffers from endogeneity problem as some of the explanatory variables, $(E_t\, \pi_{t+1} - \pi^*)$, $(y_t - \bar{y}_t)$, $(e_t - \bar{e}_t)$ and ko_t depend on the dependent variable, i_t. Third, the presence of the lagged dependent variable on the right hand side of the estimating equation makes it a dynamic panel model. The second problem of endogeneity can be addressed by applying lagged endogenous variables as instruments. However, complications then arise as the lagged dependent variable would be correlated with the disturbance term. As a result, ordinary least squares, fixed effects and random effects models would generate biased estimates.

To overcome this problem, I use a dynamic GMM panel data estimation model developed by Arellano and Bond (1991)[10] based on Anderson and Hsiao (1981), and Holtz-Eakin et al. (1988). This approach involves taking the first difference of equation (3) to remove the individual effects. Moreover, the number of instrumental variables and hence the orthogonality conditions used to address the endogeneity problem, can be exceeding the number of regressors. Arellano and Bond's dynamic panel data GMM estimator is appealing because it allows for more moment conditions than the number of parameters to estimate. They suggest combining all available lagged values of the dependent variable with current and lagged values of the differences of the exogenous variables into a large instrument matrix, making use of the moment conditions that

[9] The country details are summarized in Appendix 1, Table A1 and A2.

[10] Difference GMM estimator.

these instruments will be orthogonal to the disturbance term. The validity of the instrument matrix can be tested by a Sargan test. [11]

3.4 RESULTS FROM PANEL ESTIMATION

In this section, I present the results from the Pooled OLS, fixed effects and Arellano Bond panel GMM estimations. The coefficient estimates of the panel regressions are summarized in Table 3. The coefficient estimates from the Pooled OLS and fixed effects suffer from endogeneity bias. The estimates from Arellano and Bond dynamic panel GMM estimation are more efficient for two reasons. This technique uses first difference of the estimating equation such that the presence of lagged dependent variable as an explanatory variable does not generate coefficient estimates biased from an autocorrelation problem. Moreover, it creates an instrument matrix to address the problem of endogeneity. To examine the validity of the instruments, I apply Sargan test. The p-value of the Sargan test statistic (0.19) fails to reject the null hypothesis that “the instruments as a group are exogenous”, implying that the instruments are valid.

(Table 3 here)

The coefficient on the lagged nominal interest rate (ρ) is significantly positive and greater than 0.3, suggesting moderate persistence in the interest rate for both advanced and developing economies. There are several plausible explanations in the literature for the positive and significant (but less than one) value of the coefficient attached to the lagged interest rate. The traditional explanation is that it reflects an “interest rate smoothing” or “monetary policy inertia” behavior by the central banks. Clarida et.al (1998, 2000) rationalize this slow adjustment on the ground that central banks seek to “smooth” interest rates, in the sense that they seek to minimize the variability of interest rate changes. Moreover, Goodfriend (1991) and Woodford (1999) interpret it in terms of policy “inertia” that helps the central banks to focus on the expectations of the agents in the economy on its stabilization goals (inflation and output-gap) when its actions affect the longer term interest rates as output and prices respond to variations in the long-term rates, and not to the fluctuations in the overnight rate. However, the long-term rates are to be determined by the market expectations of the future short rates, and therefore, a credible way to make an effective response to the inflationary pressures is committing to a changed future path of short rates. One way to do this is in terms of maintaining interest rates at a higher level for a period once they are raised or following initial small interest rate changes by further changes in the same direction. However, this argument is challenged by Rudebusch (2002) who argues that the large and statistically significant coefficient on the lagged interest rate is a result of mis-specified representation of the monetary policy. He explains that the reason behind interest rate smoothing is that it reacts to some serially correlated variable(s) that is incorrectly omitted from the reaction function. However, Castelnuovo (2006), English et al. (2002), Gerlach-Kristen

[11] The Sargan test has a null hypothesis of “the instruments as a group are exogenous”.

(2004) investigate the relative importance of policy inertia and the omitted variables and conclude there are both mechanisms at play.

The coefficient on expected future inflation (γ_π) is also positive and significant, suggesting that in response to a rise in inflation, the central banks raise the nominal interest rate. The long run inflation coefficient is β_π, which is $\frac{\gamma_\pi}{(1-\rho)}$ = 1.04, implying that as the inflationary expectations increase by 1% over the target, the IT central bank raises the interest rate by more than 1%, such that the real interest rate rises. Further, as the actual output rises above the trend output level (making the output-gap > 0), the central bank increases nominal interest rate.

Another interesting finding is that the interest rate responds positively and significantly to real exchange rate changes along with inflation and output-gap in IT countries. However, this responsiveness of the interest rate to exchange rate varies significantly with the degree of capital market openness. Here the responsiveness of the interest rate to real exchange rate is determined by the coefficient ($\gamma_e + \gamma_{eko} * ko$). When the capital market is completely closed or $ko = 0$, 1% rise (depreciation) in the real exchange rate leads to 0.12% rise in the nominal interest rate. However, as the capital market opens up gradually, the reaction of the interest rate to exchange rate deviations declines significantly. Figure 2 displays the marginal effect of real exchange rate deviations on nominal interest rate along with the normalized capital market openness. The solid line in the middle denotes the effect of real exchange rate on the interest rate ($\gamma_e + \gamma_{eko} * ko$), and the two dotted lines on both sides denote the 95% confidence interval. It shows that as the capital market openness increases the responsiveness of nominal interest rate to real exchange rate declines, but remains positive and significant until $ko = 0.89$. As the capital market openness rises above 0.89, the dotted line below, crosses the 0 line, indicating that as capital market openness rises above 0.89, the responsiveness of the interest rate to exchange rate fluctuations becomes insignificant. This is in line with the trilemma suggesting that when the capital market openness is large enough, the central bank that has monetary independence, loses its control over the exchange rate fluctuations.

(Figure 2 here)

The coefficient on capital openness is negative and significantly different from zero, suggesting that greater capital openness, by itself, leads to lower interest rate. Further, the coefficient estimate on the foreign interest rate (γ_{i^*}) is positive and statistically significant for both developed and developing countries. A positive γ_{i^*} does not imply lack of monetary independence. It is possible that the countries are adjusting their policy instrument in the same direction in the face of similar macroeconomic shocks.

4. STABILIZATION OF INFLATION UNDER INFLATION TARGETING

In this section, I examine whether the IT countries are able to stabilize inflation and real exchange rate during their IT period. To examine this, I calculate the mean and volatility (reflected by standard deviation) of CPI inflation and real exchange rate of the IT advanced and IT developing countries and compare them with a set of non-IT developed and a set of non-IT developing countries respectively. For IT countries the data spans from the year of adoption of IT through 2009. For the developed countries the median year for adoption of IT is 1993, and for the developing countries the median year of adoption of IT is 2000. Therefore, for non-IT countries, the data ranges from the median year through 2009, that is for developed non-IT countries, the data spans from 1993 – 2009, and for the developing countries the data runs from 2000 – 2009. The mean and the standard deviations of CPI inflation and the standard deviations of the exchange rates for the advanced IT and non-IT countries are summarized in Table 4. The mean and standard deviations of CPI inflation and the standard deviations of the exchange rates for the developing IT and non-IT countries are summarized in Table 5. The objective of the inflation targeting countries is to keep the inflation rate below 3%. Table 4 suggests that except for Iceland and Israel, the other IT advanced economies managed to keep their CPI inflation rate below 3% during their respective IT period. Further, the non-IT advanced economies managed to keep their inflation below 3% over the specified time period as well. The volatility of exchange rate is marginally greater in the IT advanced economies (8.4 on average) compared to the non-IT advanced economies (6.8 on average), suggesting relatively greater flexibility of exchange rates in IT advanced countries compared to the non-IT advanced countries.

(Table 4 and Table 5 here)

Table 5 presents the mean and the standard deviations of CPI inflation and the standard deviations of the exchange rates for the developing IT countries. The mean (around 5.5% on average) and volatility of the inflation in IT developing economies are very similar to non-IT developing economies except for Argentina and Ukraine.[12] However, the volatility of exchange rates in IT developing countries (8.79 on average) is significantly greater than that in the non-IT developing countries (4.98 on average). This suggests that IT developing countries managed to stabilize inflation to around 5.5% level with greater flexibility of real exchange rates compared to non-IT developing countries.

Therefore, to summarize this section, both IT developed and developing economies managed to stabilize inflation with greater flexibility of the real exchange rate compared to the Non-IT countries.

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[12] Both mean and volatility of inflation are greater in Argentina and Ukraine compared to other IT and non-IT developing countries.

4. CONCLUSIONS

Over time a growing number of emerging and developing economies are adopting inflation targeting, which requires the countries to primarily focus on domestic inflation stabilization and to let the exchange rate float freely. However, the recent empirical literature argues that some of these countries systematically react to both inflation and exchange rate deviations. Given this scenario, this paper sheds light on the question of whether these inflation targeting countries are using capital controls to systematically respond to exchange rate changes while targeting inflation applying Arellano Bond dynamic panel estimation methodology for 22 IT countries from the time of adoption of IT through 2009.

There are three main findings of this paper. First, the empirical results suggest that the responsiveness of the short-term nominal interest rate to real exchange rate varies significantly with the degree of capital market openness. When the capital markets are completely closed, 1% real depreciation leads to a 0.12% rise in the interest rate. However, this responsiveness declines significantly with greater openness of the capital market. Second, when the capital market openness rises above 0.89 (as measured on a 0 and 1 scale by the Chinn-Ito index), the reaction of the interest rate to real exchange rate fluctuations becomes insignificant. Therefore, these findings support the macroeconomic trilemma, suggesting that when the capital market openness is large enough, the central bank that has monetary independence, loses its control over exchange rate fluctuations. However, with limited capital openness the central bank can achieve monetary independence and a managed float at the same time.

Third, both IT developed and developing countries managed to stabilize inflation with greater flexibility of real exchange rate over their respective inflation targeting periods compared to non-IT developed and developing economies respectively. Further, during their IT periods, both developed and developing IT countries experienced real exchange rate volatility of similar magnitude, which was greater than the exchange rate volatility in non-IT countries.

For future research, one interesting extension would be to look separately at the effects of controls on capital inflows and outflows on the exchange rate policies of the IT central banks. Some recent literature (Edwards and Rigibon (2009), Ostry et al. (2010), Coelho and Gallaher (2010)) has suggested that controls on capital inflows versus capital outflows may have very different impact on real exchange rate volatility. It will be interesting to examine the implications of controls on capital inflows versus outflows on the inflation targeting countries' exchange rate policies as well.

References

Aizenman, J., Hutchison, M. and Noy, I. (2008), "Inflation targeting and real exchange rates in emerging markets", *World Development, Forthcoming*.

Amato, J. D. and Gerlach, S. (2002), "Inflation targeting in emerging market and transition economies", *European Economic Review*, Vol. 46, pp. 781-790.

Anderson, T. and Hsiao, C. (1981), "Estimation of dynamic models with error components", *Journal of the American Statistical Association*, Vol. 76, pp. 598-606.

Arellano, M. and Bond, S. (1991), "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations", *The Review of Economic Studies*, Vol. 58, pp. 277-297.

Calvo, G. and Reinhart, C. M. (2002), "Fear of floating", *The Quarterly Journal of Economics*, Vol. 117, pp. 379-408.

Castelnuovo, E. (2006), "Describing the Fed's conduct with Taylor rules: Is interest rate smoothing important?", *The IUP Journal of Monetary Economics* Vol. 0, pp. 57-77.

Chinn, M. and Ito, H. (2008), "A new measure of financial openness", *Journal of Comparative Policy Analysis*, Vol. 3, pp. 309-322.

Clarida, R., Gali, J. and Gertler, M. (1998), "Monetary policy rules in practice: Some international evidence", *European Economic Review*, Vol. 42, pp. 1033-1067.

Clarida, R., Gali, J. and Gertler, M. (2000), "Monetary policy rules and macroeconomic stability: Evidence and some theory", *Quarterly Journal of Economics*, Vol. 115, pp. 147-180.

Coelho, B., and Gallagher, K. (2010), "Capital controls and 21st century financial crises: Evidence from Colombia and Thailand", *Political Economy Research Institute*, University of Massachusetts at Amherst Working Paper 213.

Edwards, S. (2006), "The relationship between exchange rates and inflation targeting revisited", *National Bureau of Economic Research (NBER)* Working Paper 12163.

Edwards, S. and Rigobon, R. (2009), "Capital controls on inflows, exchange rate volatility and external vulnerability", *Journal of International Economics*, Vol. 78, pp. 256-67.

English, W., Nelson, W. and Sack, B. (2003), "Interpreting the significance of the lagged interest rate in estimated monetary policy rules", *The B.E. Journal of Macroeconomics*, Vol. 3, Article 5.

Gerlach-Kristen, P. (2004), "Interest rate smoothing: Monetary policy inertia or unobserved variables?", *The B.E. Journals in Macroeconomics*, Vol. 4, Article 3.

Giannoni, M. and Woodford, M. (2003), "Optimal inflation targeting rules", *NBER* Working Paper 9939.

Goodfriend, M. (1991), “Interest rate smoothing in the conduct of monetary policy”, Carnegie-*RochesterConference Series on Public Policy*, pp. 7-30.

Holtz-Eakin, D., Newey, W. and Rosen, H. (1988), “Estimating vector autoregressions with panel data”, *Econometrica*. Vol. 56, pp. 1371-1395.

Lubik, T. and Schorfheide, F. (2007), “ Do central banks respond to exchange rate movements? A structural investigation”, *Journal of Monetary Economics*, Vol. 54, pp. 1069-1087.

Mishkin, F. and Schmidt-Hebbel, K. (2001), “One deacde of inflation targeting in the world: What do we know and what do we need to know?”, *NBER* Working Paper 8397.

Ostry, J. D., Ghosh, A. R., Habermeier, K., Chaon, M., Qureshi, M. S., and Reinhardt. D. B. S. (2010), “Capital inflows: The role of controls”, *International Monetary Fund Staff Position Note* SPN/10/04.

Parrado, E. (2004), “Inflation targeting and exchange rate rules in an open economy”, IMF Working Paper 04/21, pp. 1-37.

Rose, A. (2007), “A stable international monetary system emerges: Inflation targeting is Bretton Woods reversed”, *Journal of International Money and Finance*, Vol. 26, pp. 663-681.

Rudebusch. G. D. (2002), “”Term structure evidence on interest rate smoothing and monetary policy inertia”, *Journal of Monetary Economics*, Vol. 49, pp. 1161-1187.

Svensson, L. E. (2000), “Open economy inflation targeting”, *Journal of International Economics*, Vol. 50, pp. 155-183.

Svensson, L. E. (2002), “Inflation targeting: Should it be modeled as an instrument rule or a targeting rule?”, *European Economic Review*, Vol. 46, pp. 771-780.

Taylor, J. B. (2001), “The role of exchange rate in monetary policy rules”, *The American Economic Review*, Vol. 91, pp. 263-267.

Walsh, C. E, (2009), “Inflation Targeting: What have we learned?”, *International Finance*, Vol. 12, pp. 195-233.

Woodford, M. (1999), “Optimal monetary policy inertia”, *NBER* Working Paper 7261.

Xafa, M. (2008), “Monetary stability, exchange rate regimes, and capital controls: What have we learned?”, *Cato Journal*, Vol. 28.

Table 1: Summary Statistics

Variable	Observations	Mean	Standard Deviation	Min	Max
Nominal interest rate	248	0.062	0.040	0.001	0.233
Expected future CPI inflation	248	0.034	0.018	0.0015	0.123
Output Gap	236	-2.57e-11	0.020	-0.075	0.057
Real effective exchange rate	245	-0.002	0.071	-0.499	0.211
Normalized capital openness	228	0.792	0.291	0	1
Federal Funds Rate	248	0.032	0.019	0.002	0.08

Table 2: Stationarity Test Results

Variable	ADF test statistic[13] (# of lag selected by SC)
Nominal interest rate (i_t)	-5.66*** (1)
Expected future inflation deviation $(E_t\, \pi_{t+1} - \pi^*)$	-5.56*** (1)
Output-gap $(y_t - \bar{y}_t)$	-12.18*** (1)
Real effective exchange rate (REER) deviation $(e_t - \bar{e}_t)$	-11.78*** (1)
REER*Capital openness $(e_t - \bar{e}_t) * ko_t$	-10.08*** (2)
Capital Openness ko_t	-6.53*** (1)
Federal funds rate i_t^*	-13.78*** (1)

[13] *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level.

Table 3: Estimation results: All IT countries

Dependent Variable: Nominal interest rate at time t, ($i_{j,t}$)

Variable	Coefficient	Pooled OLS	Fixed Effects	Arellano-Bond Dynamic Panel
Lagged nominal interest rate	ρ	0.669*** (0.058)	0.339*** (0.073)	0.313*** (0.048)
Expected future inflation deviation	γ_π	0.436*** (0.133)	0.723*** (0.139)	0.711*** (0.118)
Output-gap	γ_y	0.271*** (0.086)	0.161** (0.081)	0.065* (0.039)
Real effective exchange rate (REER)	γ_e	0.109*** (0.075)	0.122*** (0.047)	0.116*** (0.035)
REER*Capital openness	γ_{eko}	-0.102** (0.052)	-0.113** (0.055)	-0.098** (0.046)
Normalized Capital Openness	γ_{ko}	-0.003 (0.008)	-0.012 (0.009)	-0.017*** (0.006)
Federal funds rate	γ_{i^*}	0.196*** (0.072)	0.274*** (0.062)	0.280*** (0.052)
Constant	$\kappa\,(1-\rho)$	-0.001 (0.009)	0.017* (0.010)	0.023*** (0.008)
Number of observations (N)		210	210	170
Number of countries		22	22	22
R^2		0.84	0.80	
Wald χ^2				298.27
χ^2 p-value for Sargan Statistic				0.19

Robust Standard Errors in the parenthesis. *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level.

Table 2: Mean and standard deviations of Inflation and exchange rate in Advanced Economies

IT Developed Countries[14]	Inflation		Real Exchange rate	Non-IT Developed Countries	Inflation		Exchange rate
	Mean	Standard Deviation	Standard Deviation		Mean	Standard Deviation	Standard Deviation
Australia	2.65	1.29	9.11	France	1.6	0.67	4.17
Canada	2.02	1.12	10.51	Germany	1.74	0.94	6.01
Iceland	6.36	3.70	11.93	Italy	2.71	1.15	4.51
Israel	5.35	4.47	10.59	Japan	0.09	0.84	15.08
Korea	3.29	1.65	10.75	Netherlands	2.17	0.77	3.96
New Zealand	2.40	1.31	8.42	United States	2.53	0.96	7.21
Norway	1.98	1.07	2.58				
Sweden	1.52	1.34	7.49				
Switzerland	0.95	0.74	2.87				
United Kingdom	2.56	0.94	9.28				

[14] For IT countries the data spans from the year of adoption of IT through 2009 and for developed non-IT countries, the data spans from 1993 – 2009, where 1993 is the median year of IT adoption in developed IT countries.

Table 5: Mean and standard deviations of Inflation and exchange rate in Developing Economies

IT Developing Countries[15]	Inflation		Exchange rate	Non-IT Developing Countries	Inflation		Exchange rate
	Mean	Standard Deviation	Standard Deviation		Mean	Standard Deviation	Standard Deviation
Brazil	6.70	3.01	16.39	Argentina	8.59	7.71	4.50
Chile	3.47	2.00	6.01	China	3.46	2.00	6.08
Colombia	6.68	2.06	10.51	Croatia	3.17	1.38	5.42
Czech Republic	3.79	3.05	16.07	India	5.53	2.40	2.87
Indonesia	9.27	2.91	6.49	Malaysia	2.19	1.45	3.71
Mexico	4.74	0.84	7.88	Ukraine	13.17	8.38	7.34
Peru	2.53	1.66	3.24				
Philippines	5.21	2.45	11.93				
Poland	4.56	3.51	9.08				
Romania	6.77	1.68	6.50				
South Africa	6.12	2.85	8.79				
Thailand	2.45	1.95	6.59				
Turkey	8.99	1.99	4.80				

[15] For IT countries the data spans from the year of adoption of IT through 2009 and for developing non-IT countries, the data spans from 2000 – 2009, where 2000 is the median year of IT adoption in developing IT countries.

Figure 1: Average capital openness in advanced and developing IT countries

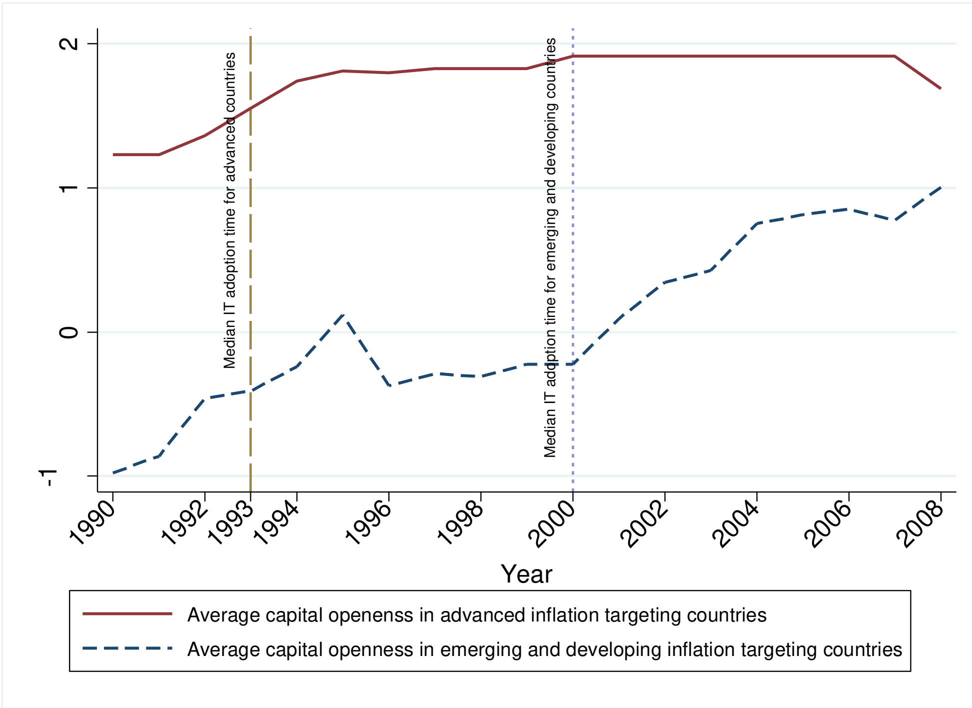
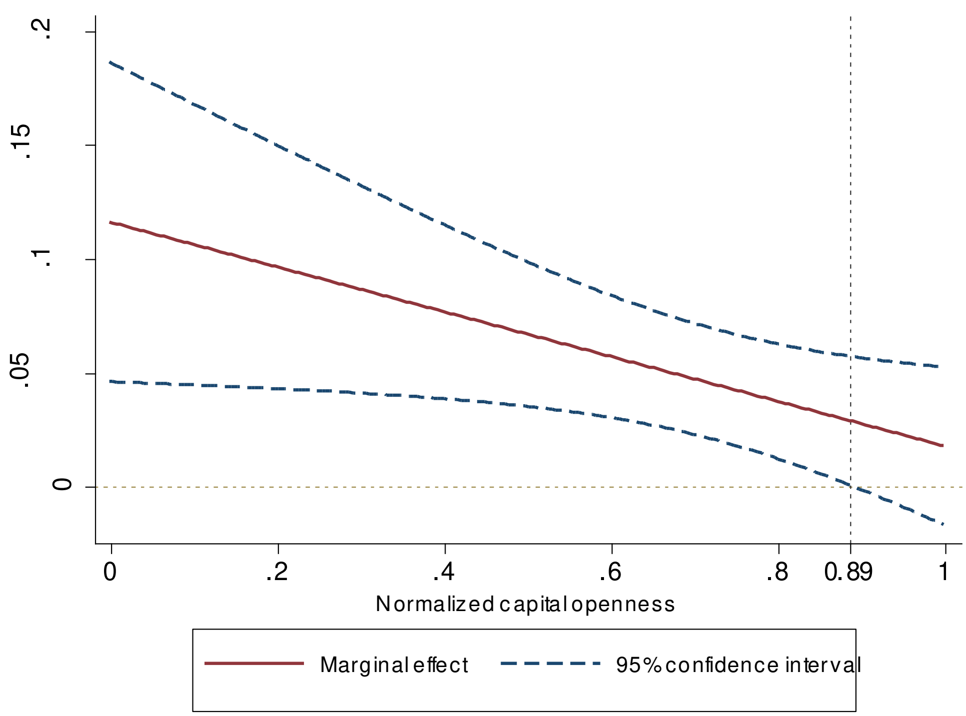


Figure 2: The Marginal Effect of Real Exchange Rate on Nominal Interest Rate and the Normalized Capital Market Openness



APPENDIX 1: IT COUNTRIES INCLUDED IN THE STUDY

Table A1: Advanced Economies

Country	Year of IT adoption	Period of estimation
Australia	1993	1993-2009
Canada	1991	1991-2009
Iceland	2001	2001-2009
Israel	1992	1992-2009
Korea	1998	1998-2009
New Zealand	1990	1990-2009
Norway	2001	2001-2009
Sweden	1993	1993-2009
Switzerland	2000	2000-2009
United Kingdom	1992	1992-2009

Source: Central Banks' websites.

Table A2: Developing Economies:

Country	Year of IT adoption	Period of estimation
Brazil	1999	1999-2009
Chile	1999	1999-2009
Colombia	1999	1999-2009
Czech Republic	1997	1997-2009
Indonesia	2005	2005-2009
Mexico	2001	2001-2009
Peru	2002	2002-2009
Philippines	2002	2002-2009
Poland	1998	1998-2009
Romania	2005	2005-2009
South Africa	2000	2000-2009
Thailand	2000	2000-2009
Turkey	2006	2006-2009

Source: Central Banks' websites.