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THE ROLE OF EXCHANGE RATES IN MONETARY POLICY RULE: THE CASE OF INFLATION TARGETING COUNTRIES

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─Abstract ─

This paper examines two main issues for the case of inflation targeting countries. The first is to investigate whether monetary authorities react to the exchange rate movements, in addition to inflation and output gap, as in simple monetary policy rule. The second is to investigate whether reactions to the exchange rates have any implications for the inflation targeting performance. The main result of the analysis indicates that some inflation targeting countries react to the exchange rate movements. The policy to stabilize the exchange rate movements helps achieve the inflation target; however, this is not robust across different specifications. In contrast, the real exchange rate variability worsens the inflation targeting performance. The other main finding from the panel data model is that the deviation of the inflation from the target rate exhibits a high and systematic persistence. Additionally, central banks with constant inflation targeting are more successful controlling inflation in the target path compared to banks with a non-constant inflation target. Finally, restriction on capital controls helps the inflation targeting performance.

JEL classification: C22; E52; F41

Keywords: Monetary policy rules; Exchange rates; Inflation targeting; GMM; Panel data

1. INTRODUCTION

The monetary policy regimes after the 1990s have been characterized by the adoption of inflation targeting (IT) and floating exchange rates. Currently eight industrial countries and over fifteen emerging market countries are implementing

an inflation targeting regime. The IT countries use the inflation rate as a target for monetary policy rather than the exchange rate or money growth rate. Accordingly, they let their exchange rates float quite freely. Even though the inflation target is the main nominal anchor for monetary authorities, the movement in the exchange rates, however, is another major indicator for the stance of the monetary policy. As reviewed by Taylor (2002) for several models, the exchange rates have important implications for the transmission of monetary policy through their effect on the aggregate demand. Therefore, particularly in the case of small open economies with inflation targeting, any shock to the exchange rate may have important impacts on the inflation. Although, recent studies document low-pass through effect, changes in exchange rates can still have an important impact on the inflation rates through import prices and the demand for exports. Furthermore, there might be different dynamics in the interaction between interest rates and inflation due to additional channels introduced by exchange rates in the transmission of monetary policy. In this context, Svensson (2000) argues that by inducing exchange rate movements, monetary policy can affect inflation with a shorter lag.

The optimal monetary policy design can be quite different in cases where the exchange rate is an important element in open economies. Most theoretical studies, as discussed later in detail, show that the optimal monetary policy rules, including the exchange rate, have better outcomes in terms of macroeconomic stability, and lower welfare loss. However, whether monetary authorities include the exchange rate in their policy rule is an empirical question, and needs to be investigated with country specific conditions. The first objective of this paper is to document whether inflation targeting countries react to the exchange rate movements. The second objective is to investigate whether adding the exchange rate to the monetary policy rule helps achieve the inflation target rate. Therefore, the paper analyzes the role of exchange rate in the monetary policy rule and its implications for the inflation targeting performance.

When estimating monetary policy reaction functions, the analysis found that most IT countries react to the real exchange rate changes significantly. These results are robust across different specifications and can be justified on different grounds. First, one can argue that central banks with IT regimes do, in fact, stabilize inflation, output and exchange rates with short term interest rates. This may also imply that they have a target exchange rate along with the inflation rate. Second one could argue that central banks do not target their exchange rate, or any other

asset prices, but use them in their information set to construct the expected inflation and output behavior. Therefore, adding the exchange rate to the monetary policy reaction function may not necessarily imply that central banks target both the level of exchange rate and the inflation rate at the same time.

In the case of the inflation targeting countries, the second question investigated in this paper is that if central banks do add exchange rate in the policy rule, does it help to achieve the inflation target? This investigation is carried in a panel data framework after estimating the rolling regression Taylor rules for each country, and constructing a panel accordingly. After controlling for the domestic, and the external factors such as oil prices, output gap and foreign interest rates, the main finding is that the reaction to the exchange rates helps achieve the inflation target. However this is not robust and significant across different specifications. On the other hand, other control variables in the panel data model provide striking policy implications. First, the deviation of the inflation from the target rate exhibits a high and systematic persistence. Second, the real exchange rate variability worsens the inflation targeting performance. Third, central banks with constant inflation targeting are more successful in controlling inflation in the target path compared to banks with a non-constant inflation target. Therefore, some benefits of inflation targeting may arise if central banks announce a constant rate over medium to long run. And finally, restriction on capital controls may help the inflation targeting performance.

The rest of paper is organized as follows. Section 2 describes the data and methodology. Section 3 provides the estimation results of the reaction function, and describes the panel setting and accordingly the panel estimation results. Section 4 concludes.

2. DATA AND METHODOLOGY

We use monthly interest rates, inflation, output gap, and real exchange rate in the reaction function estimation. Overnight money market rates were used as a proxy for the actual interest rates that central banks set. The inflation rates are year over year changes in the consumer price index for each country. Since the monthly output measure is not available, the industrial production index is used as a proxy for the output. The output gap is then generated using the HP filtering. The real exchange rate is a bilateral nominal exchange rate (national currency per US Dollar, i.e. increase in the exchange rate is depreciation) adjusted with relative aggregate prices. The sample period in analysis starts with the adoption of the inflation targeting regime for each country, and ends at 2010:09. The country

sample includes five developed countries (with IT adoption year) and nine emerging market countries which are Canada(1991), Norway(2001), Sweden(1995), Switzerland(2000), United Kingdom(1992), Chile(1991), Colombia(1999), Czech Republic(1998), Hungary(2001), Israel(1992), Korea(1998), Mexico(1999), Poland(1998), South Africa(2000). In fact there are more countries, such as Australia, New Zealand, that implements inflation targeting regime, however they are not included in the analysis because the monthly industrial production indices were not available. Most of the data series are drawn from International Monetary Fund's International Financial Statistics database, and for some countries the interest rates series are obtained from the database provided by Global Financial Data.

The second part of the data includes the variables to test the hypothesis for the impact of the reaction to the exchange rates on the inflation targeting. First, to obtain the deviation of the actual inflation form the target level, the target rate of inflation for each individual country since the starting date of the regime from central bank web sites were used in the analysis. Accordingly, the inflation targeting performance is the absolute deviation of the actual inflation from the target for each month in the sample period. The reason of taking the absolute deviation rather than simple deviation of actual inflation from target is because the deviation in either direction is considered a failure for central banks. Some central banks such as Bank of England make this explicit in their monetary policy framework: "Inflation below the target of 2% is judged to be just as bad as inflation above the target. The inflation target is therefore symmetrical."

The variables in the panel frameworks are classified into the domestic and the external factors that may account for the deviation of the inflation for the target. The domestic factors are considered to be the lagged output gap, the previous period inflation targeting performance, the reaction to real exchange rate, the changes in real exchange rates, real exchange rate variability, and capital controls. The reaction to exchange rate is the standardized parameter of the exchange rate from rolling regression monetary policy rule which is described in more detail later. Real exchange rate variability is the twelve-month moving average standard deviation of the real exchange rate. The capital control measure is *de jure* index from IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The data is obtained from the IMF World Economic Outlook, October 2007.

Additionally, an indicator variable called constant inflation targeting as in Sheridan (2003) is included in the analysis. The constant inflation targeting (CIT) means that central banks have an unchanging target or target range. For these countries the target is always constant; however, for others there is a transitional period before reaching a stable and constant target level. Additionally, in some cases even inflation is at some lower rate, still central banks might be changing the target rate from year to year. Ball and Sheridan (2003) argue that some benefits of inflation targeting may not arise if central banks change the target rate rather than announcing a constant rate over medium or long run. The external factors are considered to be the US interest rates, and changes in oil prices which might be considered as the exogenous shocks to the domestic economy.

The methodology of this analysis was to use the extended Taylor rule in forward-looking specification as in Clarida et al. (1998) to investigate the role of exchange rate. Therefore, the target rate of nominal interest rate is set according to

$$i_t = ri_{t-1} + (1-r)\left[a + bp_{t+12} + gy_t + d\Delta q_t\right] + u_t \quad (1)$$

where i_t is money market rate, p_{t+12} is twelve months ahead inflation rate, y_t is output gap, and Δq_t is change in bilateral (home versus the US) real exchange rate (RER) changes. Following Clarida et al. (1998) general methods of moments were used to estimate the equation (1), where the instrument set includes the lag of the interest rate, inflation and output gap up to twelve months.

The model to be estimated for the inflation targeting performance has the following panel specification:

$$ITP_{i,t} = fITP_{i,t-1} + gCIT_{i,t} + X_{i,t}^{'}b + Y_{i,t}^{'}q + h_i + e_{i,t}, \quad (2)$$

Where i denotes country, t time, ITP is the inflation targeting performance which is the absolute deviation of actual inflation from the target rate, therefore $ITP_{i,t} = |p_{i,t} - p_{i,t}^{*}|$. CIT is the indicator variables for constant inflation targeting which is equal to one if a central bank has constant, non-changing target rate, zero otherwise if the target rate is changing which is often the case at the early stage of adopting the inflation targeting regime. The variables in category X include the standardized parameter of the real exchange rate (RER) variable from the estimated rolling regression monetary policy rule. This variable is called as reaction to RER, which is obtained from the baseline specification of the equation (1) for the five years fixed period rolling regression. Additionally, X includes RER variability which is twelve-month moving average standard

deviation of the RER, and monthly changes in the real exchange rate. The capital controls and output gap is also included in variable category of X , therefore it is called as domestic factors that may account for deviation of the inflation from the target rate. The external factors are included in Y which are the absolute change in oil prices, and foreign interest rates. h is the country fixed effect, and e is the random disturbance term.

As in reaction function estimation, I use monthly data to estimate the equation (2). The model is estimated using an unbalanced panel sample of 15 countries. The period covered for each country is presented in Table 1. The beginning and the end of period are equivalent to the period for which the rolling regression policy rule is estimated. The equation (2) has the dynamic panel form by including the lagged ITP in the right hand side. The dynamic panel model accounts for two factors. First, it accommodates the persistent deviations of the inflation from the target level. Second, it takes the credibility that central banks build into consideration. When agents form their expectation for the future inflation, they might systematically deviate from the inflation target depending on how success central banks have reached the target. Therefore, the degree to which inflation may deviate from the target might be due to this inertia, and the discredibility in anchoring expectation. This might be the case for the constant inflation targeting countries even when there is no major shock to the inflation.

The model in equation (2) has endogeneity problem due to the lagged dependent variable in the right hand side, and also other variables such as real exchange rate volatility, reaction to the exchange rate and the output gap. To control for the endogeneity problem, panel data instrumental variable estimation was used. The instrument set includes the lagged value of dependent variable, and the other right hand side variables that introduce possibly endogeneity.

3. EMPIRICAL RESULTS

The empirical results consist of two parts. First, the baseline specification of equation (1) was estimated. To conserve space, only panel model estimation results are presented here, and the policy rule estimation results are available with author upon request. The objective in panel estimation is to investigate whether the reaction to the exchange rates has any implication for the inflation targeting performance. The estimation results for the country fixed effect are presented in the Table 2 with mainly domestic factors, and in Table 3 by extending to include the external factors along with domestic ones. One of the main results of the hypothesis testing is that after controlling for the domestic and external factors,

the reaction to the RER does help to achieve inflation target. Under different specifications in Table 2 and 3, the parameters of the reaction to the RER is negative, which is in the favor of the hypothesis that reaction to the exchange rate help for the inflation targeting performance. However, the reaction to RER variable has a very marginal contribution to the inflation targeting performance, and is not statistically significant.

On the other hand, the panel data model provides couple of striking results. First of all, the deviation of inflation form the target rate is quite persistent. In other words, the *t* period deviation from the target depends on the past deviation quite significantly. As shown in Table 2 and 3, the parameter for lagged ITP is positive, statistically significant and being close to 0.8 in all specifications. This implies that once economic agents perceive that central banks are not successful in keeping inflation at the target, then at period *t* the inflation may deviate from the target. This might be due to the pricing decision of the firms or the expectation formation which are not consistent with inflation target.

Second, the other exchange rate indicators have some impact on the inflation targeting performance even though the reaction to the RER is does not matter. One of the exchange rate indicators is the variability in the RER which is measured by a twelve month moving average standard deviation. Under different specifications, the RER variability parameter is positive and statistically significant mostly at the conventional level. This implies that the higher the RER variability, the more deviation of the inflation from the target rate. Therefore, the exchange rate variability has important implications for the inflation dynamics.

The third important finding is that in the case of constant inflation targeting, there is less deviation of the actual inflation from the target rate compared to the non-constant targeting. In Table 2 and 3, under all specifications the indicator variable constant IT is negative and significant. In fact, this finding is has a very strong policy implication. The argument is that once a central bank has a clear commitment to the steady state, constant inflation rate over medium to long run, and form credibility in their policy, the inflation stays more in the target path. Therefore, as argued by Ball and Sheridan (2003) some benefits of inflation targeting may not arise if central banks change the target rate from annually rather than announcing a constant rate over some period of time.

Another control variable used in the panel data model is the restrictions on capital inflows. In general, the macroeconomic policies in open economies face a trilemma. In this framework, there are three objectives for the policy makers

where the first is stabilize the exchange rates, secondly to have international capital mobility, and lastly to implement a monetary policy independently toward domestic goals . Therefore, the capital control variable included in the model to test whether it contributes to achieve one of the domestic goals which is the inflation being in the target path. The estimation results from Table 2 and 3 provide some evidence that the higher restrictions on the capital inflow, the less deviation of the inflation from the target rate. In other words, the capital controls contributes to the monetary policy independence. This finding is reasonable since the most of countries in the analysis are emerging market countries with inflation targeting regimes that have some level of restrictions on capital inflows.

4. CONCLUSIONS

This paper examines two main issues for the inflation targeting countries. First, the monetary policy reaction function was estimated to investigate whether monetary authorities react to the exchange rate movements. The main result is that most inflation targeting countries react to the real exchange rate movements in addition to control inflation, and output gap as in simple monetary policy rule. Compared to the pre-inflation targeting regime, the reaction to the exchange rate is the case for most of the countries. In addition, these results are robust once different measure of the exchange rates are used in the reaction function estimation. For instance, the reaction to trade weighted exchange rate has quite similar results with the bilateral real exchange rates. Further more, there is asymmetric behavior in the reaction to the depreciation versus appreciation events.

The second objective of this paper is to investigate whether the reaction to the exchange rates has any implication for the inflation targeting performance. The main result is that the reaction to stabilize the exchange rate movements helps achieve the inflation target; however, it is not significant and robust across different specifications. The other control variables in the panel data model provide striking policy implications. First, the deviation of the inflation from the target rate exhibits a high and systematic persistence. Second, the real exchange rate variability worsens the inflation targeting performance. Third, central banks with constant inflation targeting are more successful in controlling inflation in the target path compared to the one with non-constant inflation target. Therefore, some benefits of inflation targeting may arise if central banks announce a constant

rate over medium to long run. And finally, restriction on capital controls may help the inflation targeting performance.

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Table 1: Inflation Targeting Adoption Dates, Panel Data Starting Period

Country Name	IT Adoption Date	Constant IT Adoption Date	Starting Period of the Panel Data
Canada	1991	1994	1994m1
United Kingdom	1992	1993	1995m10
Sweden	1995	1995	1998m1
Switzerland	2000	2000	2003m1
Norway	2001	2001	2004m3
Chile	1991	2001	1994m1
Colombia	1999		2002m9
Check Republic	1998	2003	1999m1
Hungary	2001		1999m1
Israel	1992	2003	1995m1
Korea	1998	2001	2001m4
Mexico	1999	2003	2004m1
Peru	2001	2002	2004m1
Poland	1998	2004	2001m9
South Africa	2000	2000	2003m2

Source: Mishkin and Schmidt-Hebbel (2007), and Ball and Sheridan (2003), and author.

Table 2: Panel with Country Fixed Effect

	(1)	(2)	(3)	(4)
$\|Dev.fromTarget_{t-1}\|$	0.777***	0.772***	0.775***	0.775***
	(0.019)	(0.018)	(0.018)	(0.019)
Reaction to RER	-0.012			-0.0129
	(0.010)			(0.010)
Variability of RER		0.004**		0.003*
		(0.002)		(0.002)
|Change in RER|			0.004	
			(0.011)	
Capital Controls	-0.387**	-0.172	-0.214	-0.338**
	(0.170)	(0.160)	(0.160)	(0.170)
$\|Output\text{-}Gap_{t-1}\|$	0.009	0.01	0.01	0.009
	(0.009)	(0.009)	(0.009)	(0.009)
Constant IT Dummy	-0.155***	-0.156***	-0.147**	-0.161***
	(0.058)	(0.058)	(0.058)	(0.058)
Constant	0.474***	0.376***	0.408***	0.439***
	(0.089)	(0.090)	(0.091)	(0.091)
Observations	1039	1078	1078	1041
R-squared	0.733	0.742	0.741	0.736

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Panel with Country Fixed Effect

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
|Dev.fromTarget$_{t-1}$|	0.776***	0.772***	0.774***	0.764***	0.759***	0.761***	0.762***
	(0.019)	(0.018)	(0.018)	(0.020)	(0.018)	(0.018)	(0.020)
Reaction to RER	-0.012			-0.011			-0.012
	(0.010)			(0.010)			(0.010)
Variability of RER		0.004**			0.004**		0.003*
		(0.002)			(0.002)		(0.002)
|Change in RER|			0.004			0.002	
			(0.011)			(0.011)	
Capital Control	-0.388**	-0.172	-0.214	-0.298*	-0.0757	-0.124	-0.252
	(0.170)	(0.160)	(0.160)	(0.170)	(0.170)	(0.170)	(0.170)
|Output-Gap$_{t-1}$|	0.009	0.01	0.01	0.011	0.012	0.012	0.011
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Constant IT Dummy	-0.153***	-0.154***	-0.145**	-0.190***	-0.196***	-0.185***	-0.196***
	(0.058)	(0.058)	(0.058)	(0.060)	(0.060)	(0.060)	(0.060)
|Change in Oil Price|	0.522	0.416	0.533	0.379	0.26	0.392	0.273
	(1.040)	(1.040)	(1.040)	(1.050)	(1.040)	(1.040)	(1.050)
US Interest Rates				-0.027***	-0.030***	-0.029***	-0.027***
				(0.010)	(0.009)	(0.010)	(0.010)
Constant	0.463***	0.367***	0.397***	0.569***	0.486***	0.520***	0.534***
	(0.092)	(0.092)	(0.093)	(0.100)	(0.100)	(0.100)	(0.100)
Observations	1039	1078	1078	1039	1080	1080	1041
R-squared	0.733	0.742	0.741	0.733	0.744	0.743	0.736

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.