Do Inflation Targeting Really Reduced Exchange Rate Pass-through?

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ABSTRACT

Implementation of inflation targeting framework (ITF) on the behavior of exchange rate pass-though (ERPT) has been an important role in the last decade. A lot of countries have changed their exchange rate regimes and monetary policy framework. As the ITF being adopted, the role of exchange rate in influencing the inflation rate has decreased. The purpose of this research is to analyze the dynamics of ERPT before and after the implementation of ITF using data from countries. We also compare the results between high income countries and middle income countries. Using autoregressive distributed lag model for 19 countries (8 high income countries; 11 middle income countries), the finding showed mixed results regarding there is a reduction of ERPT after the adoption of ITF. On average, loss of pass-through happened both for high income and middle income countries. However, there was a significant difference on the average long-run ERPT - before and after ITF implementation - in middle income countries compared to high income countries. Thus, the adoption of ITF right after crises brought greater effect to price stability in middle income countries. New empirical findings were found, particularly from middle income countries, where there is a decrease in ERPT after the adoption of ITF in Indonesia and Thailand both in the short-run and in the long-run.

Keywords: Exchange Rate Pass-through, Inflation Targeting Framework, Loss of Pass-through
JEL Classifications: C22, E31, E52

1. INTRODUCTION

Exchange rate pass-through (ERPT) is defined as the change in local currency prices (domestic, import or export) resulting from 1% change in the exchange rate. The degree of ERPT is used to identify the role of exchange rate in influencing the domestic price. Many studies have been carried out concerning the ERPT, among others Taylor (2000), Choudhri and Hakura (2006), Otani et al. (2003), Baillu and Fujii (2004), Gagnon and Ihrig (2004), Karim (2005), Ihrig et al. (2006), Sekine (2006), Nogueira et al. (2010), Mumtaz et al. (2011), Winkelried (2011). Taken together, all agreed that the increased of macroeconomic stability (low inflation environment), which was brought about by more credible monetary policies, has successfully reduced the degree of ERPT to domestic prices.

ERPT becoming more and more interesting after the introduction of the so-called inflation targeting framework (ITF). ITF were chosen as the new monetary policy framework in many countries - both in developed countries and emerging countries - especially after the hyperinflation in 1980's era, in order to achieve low and stable inflation rate. Based on Batini and Laxton (2006), ITF is one of the operational frameworks for monetary policy aimed at attaining price stability. According to Roger and Stone (2005) inflation targeting is founded on a clear commitment to a quantitative inflation target as the primary objectives of monetary policy. By adopting ITF, the role of exchange rate in influencing the inflation rate has decreased which also known as loss of pass-through phenomenon. According to Mukherjee (2010), Taguchi and Sohn (2014), countries who adopt ITF will automatically have a decrease on the degree of ERPT. Therefore, the credibility gains from the adoption of ITF were responsible for keeping low inflation expectations and consequently reduces ERPT (Mishkin and Savastano (2001), Eichengreen (2002) and Schmidt-Hebbel and Werner (2002) Schmidt-Hebbel and Tapia (2002).

Studies concerning ERPT in the perspective of inflation targeting have been done for the past few years. Baillu and Fujii (2004),

Gagnon and Ihrig (2004), Campa and Goldberg (2004), Nogueira (2007), and Coulibaly and Kempf (2010) agreed that the implementation of ITF has successfully decrease the degree of ERPT in most of countries especially developed countries. Taguchi and Sohn (2014) and Syafri (2013) found that there wasn't a decrease of ERPT after implementing ITF in developing countries such as Indonesia, Thailand and the Philippines. These findings have shown that ERPT is higher for emerging than developed countries. According to Eichengreen (2002), the main reason for a higher ERPT in emerging markets lies on the lack of credibility of their monetary authority. Therefore, it implies a greater difficulty to focus on the inflation targets.

Overall, previous research concerning the reduction of ERPT in terms of ITF adoption found mixed results and have not found any clear conclusion. Thus, the objectives of the paper is to give further explore and re-estimate the ERPT in the perspective of ITF by widen the scope of countries and longer the period of study. We analyze the dynamics of ERPT from countries that adopted ITF, both in high income countries (New Zealand, Canada, Sweden, Australia, Poland, Switzerland, South Korea and Norway) as well as in middle income countries (India, Brazil, South Africa, Thailand, Mexico, Hungary, Peru, the Philippines, Indonesia, Romania and Turkey). We are interested in testing the hypothesis whether there's a decrease in ERPT after the adoption of ITF both in the short-run and in the long-run. To answer the questions, we use an autoregressive distributed-lag model (ARDL) to estimate the short-run and the long-run ERPT before and after the adoption of ITF.

Our results give new empirical findings, particularly from middle income countries, where there is a decrease in ERPT after the adoption of ITF in Indonesia and Thailand both in the short-run and in the long-run. Moreover, the Philippines also has experienced loss of pass-through even only in the long run. Regarding there is a reduction of ERPT after the adoption of ITF, we found mixed results. On average, loss of pass-through happened both for high income and middle income countries. The result of the paper will beneficial, not only for researchers but also for the policy makers.

The rest of the paper will be organized as follows: In section 2 will provide the data and research methodology, followed by estimation result on section 3. Summary of the results, the policy implications and suggestions for future research will be provided in section 4.

2. DATA AND METHODOLOGY

This research is carried out using secondary data from nineteen countries who adopt ITF and that may be divided into two groups: The first one comprises high income countries (New Zealand, Canada, Sweden, Australia, Poland, Switzerland, South Korea and Norway) and the second one comprises middle income countries (India, Brazil, South Africa, Thailand, Mexico, Hungary, Peru, the Philippines, Indonesia, Romania and Turkey). To compare the role of ERPT in influencing inflation between the period of before and after adopting ITF, the period of estimation is divided into 8 years before and after implementing ITF. So then each country would have a different period of estimation depends on the commencement of ITF implementation (Appendix Table 1).

The data consist of four variables which are consumer price index as a proxy of domestic price, industrial production index, manufacturing production index and output gap (calculated using Hodrick-Prescott Filter (Hodrick and Prescott, 1997) as a proxy of output growth, nominal exchange rate as a proxy of the exchange rate and value of import as a proxy of the import price. Several countries have limitation on the availability of the monthly data. To solve this we used quarterly data and then convert them into monthly data using Qubic Splines method. The data were collected from International Financial Statistic, CEIC database, Central Bank of Australia and Central Bank of New Zealand. Calculation process was done using statistical package Microfit 4.1 (Pesaran and Pesaran (1997)) and Eviews 6.

To estimate the ERPT coefficient for each country this paper used ARDL model which was introduced by Pesaran and Shin (1997). To provide robust analysis of the relationship between inflation and exchange rate, we start applying some Granger causality tests. Most of the countries have unidirectional causality from exchange rate changes to inflation. Therefore, in order to have a comparable ERPT measurement we decided to use ARDL model. Moreover, the use of ARDL is based upon the fact that it makes possible to estimates both for short-run and long-run ERPT (Campa and Goldberg (2004), Chami et al. (2007) and Nogueira (2007). Gagnon and Ihrig (2004), Campa and Goldberg (2004), Choudhri and Hakura (2006), and Chami et al. (2007), have also suggested to use a single equation model (ARDL) to estimates ERPT, where they found no evidence of endogenity between inflation and exchange rate. As Pesaran and Shin (1997), another advantage of this specification is that ARDL model provides robust results where it has consistent estimates of the coefficients irrespective of whether the underlying regressors are I (1) or I (0).

According to Gujarati (2007), time series data are stationary if its mean and variance do not vary systematically over time. Lag optimum is set based on maximum SBC. The ARDL model specification to identify the ERPT coefficient in each country is adopted from Nogueira (2007) as follow:

$$\Delta p_t = \alpha + \sum_{k=1}^{p} \gamma_k \Delta p_{t-k} + \sum_{k=0}^{q} \varnothing_k \Delta y_{t-k} + \sum_{k=0}^{r} \lambda_k \Delta e_{t-k}$$
$$+ \sum_{k=0}^{s} \beta_k \ \Delta p_{t-k}^* + \varepsilon_t \tag{1}$$

Where:
Δp = change in domestic price
Δy = change in output growth
Δe = change in nominal exchange rate
Δp^* = change in import price
ε = stochastic error term

To differentiate the calculation of the ERPT degree in the short run and long run we adopt the previous research Chami et al. (2007) and by Syafri (2013) where the λ_0 coefficient is interpreted as the short run pass-through coefficient which shows the direct effect of the exchange rate depreciation towards the domestic inflation that happened in no more than one lagged month. While for the long run pass-through coefficient is formulated as follow:

$$\lambda = \frac{\sum_{k=0}^{r} \lambda_k \Delta e_{t-k}}{1 - \sum_{k=1}^{p} \gamma_k \Delta p_{t-k}} \tag{2}$$

Where λ is interpreted as the long run impact from 1% depreciation against the domestic inflation. The long-run effect corresponds to the expected value after all the dynamic adjustment has taken place. Furthermore the identification of loss of pass-through is defined by comparing the estimation result of ERPT degree in the period of before and after implementing ITF. If the ERPT degree in the period of before implementing ITF is higher than in the period of after implementing ITF it can be conclude that the loss of pass-through phenomenon happened.

3. EMPIRICAL RESULTS

As discussed in the methodology, we estimated the ERPT degree - before and after ITF implementation - for each country by using ARDL model. We use data from 19 countries that adopt ITF and divide them into high income countries and middle income countries. Before we estimated, pre-tests were done to provide robust analysis. We have checked the stationarity of the data using PP unit root tests, and concluded that most of the data for all countries are stationary in I (1), except for Brazil where this country occurred hyperinflation era in the period before implementing ITF. We also checked whether the variables in levels were cointegrated using Bound Testing Cointegration test (Pesaran et al., 2001) and found no such evidence. The results of the estimates of the short and long-run ERPT from 19 countries are shown in Table 1.

As we've mentioned before, countries who adopt ITF will have a low and stable inflation rate (Campa and Goldberg (2004), Roger

and Stone (2005), Batini and Laxton (2006), and others). Low inflation environment caused by more credible monetary policy brings the Central Banks to focus on price stability rather than exchange rate movements. The difference both for inflation and exchange rate movement before-after the adoption of ITF were tested using plot data (Appendix Figures 1 and 2) and Paired Sample t-test and Sign Test (Appendix Table 2) to see the difference both for inflation and exchange rate movement before-after the adoption of ITF. The results were similar both for high income and middle income countries where there were found significant difference in inflation and exchange rate after adopting ITF for all countries except Switzerland (Appendix Table 2). The implementation of ITF theoretically should be able to lower the degree of ERPT or commonly known as loss of pass-through phenomenon, both in short term and long term. If a country is proved to experience loss of pass-through phenomenon after implementing ITF then, the coefficient of change in pass-through will be negative.

Table 1 the ERPT estimation results in high income countries showed a significant difference compared to middle income countries. In general, most of countries in high income group were found to have loss of pass-through phenomenon both in the short run and long run. These findings proved by the negative coefficient in change in pass-through coefficient which can be seen in Table 1. Thus, the Central Banks in high income countries are credible enough to focus on reaching the inflation target. These findings in line with Baillu and Fujii (2004), Colibaly and Kempf (2010) and also Campa and Goldberg (2004).

Except for Norway there wasn't found loss of pass-through phenomenon after implementing ITF. This is presumably caused by the long term adoption of exchange rate targeting in Norway. According to Soikkeli (2002), Norway was one of the main

Table 1: Exchange rate pass-through estimation results in high income countries and middle income countries (Period: 8 years before and after ITF implementation)

High income countries	Before ITF		After ITF		Change in pass-through	
	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run
New Zealand	0.006*	0.078*	−0.002	−0.030*	−0.008	−0.108
Canada	0.038	0.028*	−0.036	−0.036	−0.074	−0.064
Sweden	0.026*	0.286*	−0.007	−0.007	−0.033	−0.293
Australia	0.004	0.117*	0.001	0.007*	−0.003	−0.110
Poland	0.043	0.105*	−0.004	−0.009*	−0.047	−0.114
Switzerland	0.002	0.002	−0.010	−0.005*	−0.012	−0.007
South Korea	0.041*	0.099*	0.022	0.035*	−0.019	−0.064
Norway	−0.023	−0.023	−0.006	−0.006	0.017	0.017
Middle income countries	**Before ITF**		**After ITF**		**Change in pass-through**	
	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run
India	0.010*	0.028*	0.014*	0.032*	0.004	0.004
Brazil	0.302*	0.985*	−0.023*	0.082*	−0.325	−0.903
South Africa	0.021	0.028*	−0.006	0.039*	−0.027	0.011
Thailand	0.009	0.037*	0.003	0.004*	−0.006	−0.033
Mexico	0.044*	0.475*	0.021	0.030*	−0.023	−0.445
Hungary	−0.347	−0.714*	0.018	−0.024*	0.365	0.690
Peru	−0.076*	0.021*	0.032	0.052*	0.108	0.031
Philippines	0.019	0.019	0.031	−0.038*	0.012	−0.057
Indonesia	0.028*	0.286*	0.006	0.012*	−0.022	−0.274
Romania	0.044	0.126*	−0.0001	−0.0001*	−0.044	−0.126
Turkey	0.112*	0.386*	0.003	0.004*	−0.109	−0.382

Source: Data processed with Microfit 4.1*=significant in 10%, ITF: Inflation targeting framework

exporting crude oil and natural gas in the world which contributes 57% from the total export in 2001. So then even Norway has adopted ITF since 2001, exchange rate stability still plays an important role to control the export stability. But in general we can conclude that for high income countries, ITF implementation was successfully reducing the pass-through coefficient.

Different findings were found in the middle income countries group where only in Brazil, Thailand, Mexico, Indonesia, Romania and Turkey were found to have loss of pass-through both in the short run and long run. According to Hebbel and Werner (2002), Brazil has been successful in meeting inflation targets after implementing ITF. South Africa only has loss of pass-through in the short run but not in the long run. This finding caused by the use of estimation period which was coincides with the global crisis. Klein (2012) argued that South African Reserve Bank has become more tolerant toward higher levels of inflation to better support economic activity in the face of an extremely challenging global environment.

The Philippines only have loss of pass-through in the long run but not in the short run. Debelle and Lim (1998) argued that the Philippines faced some problems mostly on the ability to respond the fluctuation of capital flow which then became a dilemma to implement inflation targeting or exchange rate targeting. Whereas for Peru, India and Hungary there weren't found a decrease in both short run and long run ERPT after implementing ITF. According to Céspedes et al. (2012), Peru still highly sensitive by the fluctuation of capital flows, where in 2006, Peru experienced overheating that caused to a sharp increase in the inflation rate.

Freedman and Robe (2009) mentioned the ineffective ITF implementation in Hungary is caused by inconsistency where the pre-conditions that must be done before implementing ITF have not mattered yet. Jha (2006) mentioned that the important issue relating to the ITF implementation in India was the high degree of fiscal deficits in the last few years, for about 10% over GDP, which bought to a weak transmission from interest rate to the real sector. Mohandas (2012) argued that Reserve Bank of India would be more efficient in controlling output gap rather than controlling inflation rate or in the other words RBI is better to implement output gap targeting than inflation targeting.

The findings in middle income countries have shown that the ERPT degree after adopting ITF is still relatively higher compare to high income countries. In line with Calvo and Reinhart (2000), and Goldfajn and Werlang (2000), middle income countries have tendencies to have a higher ERPT than high income countries. These facts showed that exchange rate still has an important role in affecting the change in domestic price, which means that the Central Banks in middle income countries were not fully commit on the inflation target but still trapped in controlling the exchange rate. Emerging countries formally adopted a floating exchange rate, but in reality most of them will not allow the exchange rates to freely move (Dilla, Achsani and Anggraeni (2016)). This phenomenon is commonly known as fear of floating. (Mishra and Mishra, 2010), Francia and Garcia (2005), Torres and Saridakis (2007). The strong linkage between exchange rate movements to domestic price will

make difficulties for the monetary authority to focus on the inflation target. But in the other hand, the increase of market openness among countries have made the inflation movement cannot be separated from the exchange rate movement itself.

In general the findings of this study are in line with Nogueira (2007) which also found loss of pass-through phenomenon both in short run and long run in developed countries such as Sweden and some developing countries such as Brazil and Mexico. But there's also a difference where Nogueira (2007) found that in South Korea, loss of pass-through only happened in the long run but not in the short run. This might be caused by the different time periods of estimation where Noguiera used a shorter period (5 years before and after ITF).

This study gives new empirical findings, particularly from middle income countries, where there is a decrease in ERPT after the adoption of ITF in Indonesia and Thailand both in the short-run and in the long-run. Moreover, the Philippines also has experienced loss of pass-through even only in the long run. These facts are opposite with Taguchi and Sohn (2014) who found that among South Korea, Thailand, Indonesia and the Philippines, only South Korea was found to have loss of pass-through after implementing ITF. The different results of the study related to the different period of estimation where Taguchi and Sohn (2014) generalize the estimation period into 1990's and 2000's without taking account about the commencement period of ITF in each country.

To simplify the analysis, the average change in pass-through both in high income and middle income countries in the period of before and after implementing ITF will be shown in Figure 1. Both for high income and middle income countries, the average change in pass-through coefficients are negative or they experienced loss of pass-through phenomenon. The values of average change in pass-through were relatively greater in the long-term for both country groups. In the long-run, where all the dynamic adjustment has taken place, the Central Banks can be more focus on keeping low inflation.

In addition, in the long-run, the values of average change in pass-through in middle income countries are relatively greater than high income countries. As we know that when ITF was started

Figure 1: The average of change in pass-through in high income countries and middle income countries

	Short-run	Long-run
■ High Income Countries	-0.022	-0.093
□ Middle Income Countries	-0.006	-0.135

to adopt, the structural macroeconomic condition in developing countries is not as good as in developed countries. Middle income countries mostly started to adopt ITF right after the exchange rate crisis in 1997/1998.

4. CONCLUSIONS, POLICY RECOMMENDATIONS AND FUTURE RESEARCH

The implementations of ITF have proven to lower the average pass-through both in high income and middle income countries. The values of average change in pass-through were relatively greater in the long-term for both country groups where all the dynamic adjustment has taken place, thus can enhance the credibility and accountability of the Central Banks on reaching the inflation target. In terms of the ITF implementation in middle income countries, which were mostly right after crisis, there was significant difference in the long-run ERPT degree before and after ITF implementation compared to high income countries.

This study gives new empirical findings, particularly from middle income countries, where there is a decrease in ERPT after the adoption of ITF in Indonesia and Thailand both in the short-run and in the long-run. Moreover, the Philippines also has experienced loss of pass-through even only in the long run. Regarding there is a reduction of ERPT after the adoption of ITF, we found mixed results. Most of countries in high income group were found to have loss of pass-through phenomenon both in the short run and long run. But, in middle countries e.g., India, Hungary and Peru there were no evidence. For some countries that have not experienced loss of pass-through after ITF implementation, exchange rate still plays an important role in affecting the domestic price.

Some evaluations about the implementation of ITF particularly in middle income countries who have not experienced loss of pass-through after adopting ITF will be crucial especially concerning the pre-condition that has to be done such as transparency, independency, accountability, no fiscal domination and financial market stability. Otherwise, it would be better for middle income countries to focus on exchange rate targeting rather than inflation targeting. The next interesting area for further research would be to widen the scope of the study by doing a comparative analysis between ITF countries and non-ITF countries.

5. ACKNOWLEDGMENT

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APPENDIX

Appendix Table 1: Estimation period of inflation targeting

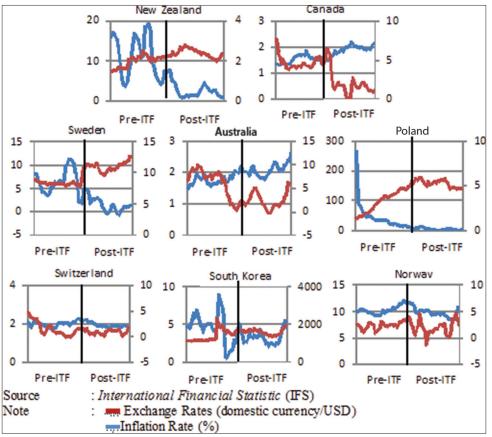| Countries	Year of adoption	Pre-ITF	Post ITF
High income countries			
New Zealand	1990:M1	1982:M1-1989:M12	1990:M1-1997:M12
Canada	1991:M2	1983:M2-1991:M1	1991:M2-1999:M1
Sweden	1993:M1	1985:M1-1992:M12	1993:M1-2000:M12
Australia	1993:M4	1985:M4-1993:M3	1993:M4-2001:M3
Poland	1998:M10	1990:M10-1998:M9	1998:M10-2006:M9
Switzerland	2000:M1	1992:M1-1999:M12	2000:M1:2007:M12
South Korea	2001:M1	1993:M1-2000:M12	2001:M1-2008:M12
Norway	2001:M3	1993:M3-2001:M2	2001:M3-2009:M2
Middle income countries			
India	1990:M12	1982:M12-1990:M11	1990:M12-1998:M11
Brazil	1999:M6	1991:M6-1999:M5	1999:M6-2007:M5
South Africa	2000:M2	1992:M2-2000:M1	2000:M2-2008:M1
Thailand	2000:M5	1992:M5-2000:M4	2000:M5-2008:M4
Mexico	2001:M1	1993:M1-2000:M12	2001:M1-2008:M12
Hungary	2001:M6	1993:M6:2001:M5	2001:M6-2009:M5
Peru	2002:M1	1994:M1-2001:M12	2002:M1-2009:M12
Philippines	2002:M1	1994:M1-2001:M12	2002:M1-2009:M12
Indonesia	2005:M7	1997:M7-2005:M6	2005:M7-2013:M6
Romania	2005:M8	1997:M8-2005:M7	2005:M8-2013:M7
Turkey	2006:M1	1998:M1-2005:M12	2006:M1-2013:M12

Source: World Bank (2012) %, ITF: Inflation targeting framework

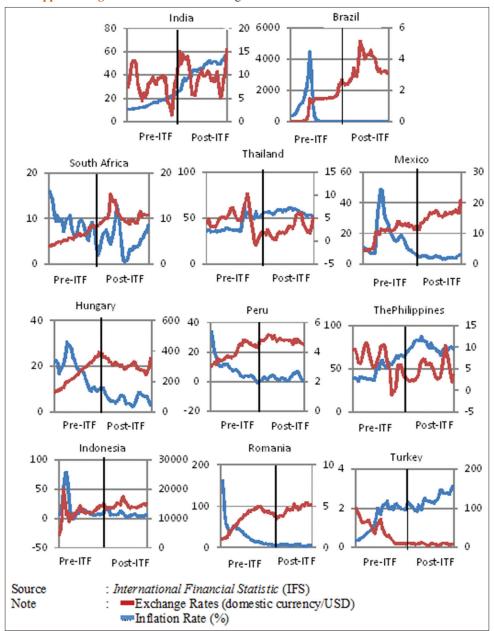**Appendix Table 2: Paired sample test - before and after ITF**

High income countries	Mean of inflation	Mean of exchange rate
New Zealand	0.000**	0.003**
Canada	0.000**	0.000**
Sweden	0.000**	0.000**
Australia	0.000**	0.001**
Poland	0.000**	0.000**
Switzerland	0.596	0.596
South Korea	0.022**	0.022**
Norway	0.049**	0.080*
Middle income countries	**Mean of inflation**	**Mean of exchange rate**
India	0.000**	0.000**
Brazil	0.008**	0.022**
South Africa	0.001**	0.000**
Thailand	0.000**	0.000**
Mexico	0.000**	0.000**
Hungary	0.000**	0.008**
Peru	0.008**	0.000**
Philippines	0.000**	0.022**
Indonesia	0.000**	0.000**
Romania	0.000**	0.000**
Turkey	0.000**	0.000**

**=Significant in 5%; *=significant in 10%, ITF: Inflation targeting framework

Appendix Figure 1: Inflation and exchange rate movements in high income countries

Source: International Financial Statistic. Exchange rates (domestic currency/USD) inflation rate (%)

Appendix Figure 2: Inflation and exchange rate movements in middle income countries

Source: International Financial Statistic. Exchange rates (domestic currency/USD) inflation rate (%)