Exchange Rate Pass-Through in Emerging Countries

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Abstract

Considering external constraints on monetary policy in emerging countries, we propose a vector autoregression (VAR) model to examine the exchange rate pass-through to domestic prices. We estimate the degree of exchange rate pass-through to consumer prices. The empirical results suggest that the exchange rate pass-through is higher in Latin American countries than in the Asian countries. Monetary policy plays an important role in anchoring the inflationary expectations. The exchange rate pass-through has declined after the adoption of an explicit inflation targeting monetary policy.

Jel classification: E31, F31, F41.

Key words: Exchange rate pass-through, emerging countries, VAR.

1. Introduction

Exchange rate pass-through to inflation is generally defined as a change in domestic prices due to a percentage change in the exchange rate. Since the beginning of the nineties, the analysis of exchange rate pass-through into domestic prices in East Asian and Latin American emerging economies has got a lot of importance due to currency crises and subsequent transitions to new policy regimes. The economies are susceptible to exchange rate pass-through because these are highly trade dependent economies.

Taylor (2000) argued that in low exchange rate pass-through in low inflation countries is a result of low inflation environment. If firms set prices for several periods in advance, their prices will respond less to an increase in costs if this increase in costs is perceived to be less persistent. Thus, the lower persistence will result in smaller exchange rate pass-through. Low inflationary environment tends to have less persistent costs. Thus, exchange rate pass-through will be low in countries characterized by low inflationary environment. It implies that the exchange rate pass-through depends on the credibility of monetary policy. A credible monetary policy focusing explicitly on anchoring inflationary expectations will tend to reduce the exchange rate pass-through.

This paper provides empirical evidence on exchange rate pass-through into domestic prices from East Asian (Indonesia, Philippines, South Korea, and Thailand) and Latin American (Brazil, and Mexico) emerging market economies. In order to have more credible monetary policy these countries have introduced inflation targeting policies in the recent years.

Emerging economies have specific characteristics that differ from those of developed countries. Central banks in emerging economies stabilize exchange rates[1]. A flexible exchange rate regime in these economies resembles a de facto peg. Since these economies are characterized by underdeveloped financial markets, their central banks intervene in foreign exchange markets to stabilize exchange rates. This phenomenon is often explained by the hypothesis of ''fear of floating'' (Calvo & Reinhart, 2000). When a central bank stabilizes the exchange rate, its policy rate follows the foreign interest rate, i.e., the policy rate of the anchor currency's country. Hence, a monetary policy analysis in these economies requires a model specification different from those of developed countries.

Previous empirical studies have used simultaneous equation models to examine the exchange rate pass-through in emerging countries. However, these models are often misspecified due to the imposition of wrong restrictions.[2] These studies have treated the oil prices and the world commodity prices as an endogenous variable in the vector autoregression (VAR) model. They identify an oil price shock (or a shock to the world commodity prices) as a supply shock in the VAR model. By restricting the only the contemporaneous effects of exchange rate, prices, output gap on the oil prices, these studies examine the exchange rate pass-through in industrialized and emerging countries. Thus, the domestic variables have no contemporaneous effect on oil prices (and world commodity prices) but they affect the oil prices (and the world commodity prices) with lags. However, an oil price shock (or a shock to

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[1] For more details, see Calvo and Reinhart (2000); Reinhart and Rogoff (2002); Levy and Sturzenegger (2005).

[2] Ashock (2002), Leigh and Rossi (2002), Billmeier and Bonato (2004), Korhonen and Wachtel (2005), Zorzi et al. (2007), Ito and Sato (2008), Sek and Kapsalyamova (2008) have used the vector autoregression (VAR) models to examine the exchange rate pass-through in emerging countries. All these studies are suffered from model misspecification.

world commodity prices) is not affected even in the lagged periods by any variable of a small country.

Considering the above-mentioned flaws, we propose a VAR model to examine the exchange rate pass-through in East Asian and Latin American emerging countries. Among these countries South Korea was the first who adopted the inflation targeting framework. The other countries adopted inflation targeting framework at different dates. We examine whether the exchange rate has declined after the transition to inflation targeting framework.

The paper proceeds as follows. In section 2, we review the previous work on exchange rate pass-through. In section 3, we analyze the monetary policies of emerging countries. In section 4, we propose a benchmark VAR model in order to estimate the exchange rate pass-through in emerging countries. We examine the exchange rate pass-through to domestic prices during different sample periods. We conclude in section 5.

2. Literature review

Menon (1995) surveys the literature on exchange rate pass-through and highlights the importance of choice of data and methodology in the estimation of exchange rate pass-through. By using alternative econometric models, Parsley and Popper (1998) examine the role of monetary policy in determining the degree of exchange rate pass-through and show that the exchange rate pass-through coefficient are more significant after including the monetary policy in the model. Kim (1998) uses vector error correction model to examine the exchange rate pass-through in the United States. He concludes that the dollar exchange rate has a significant negative impact on inflation during 1973-95. Taylor (2000) estimates a microeconomic model of price setting and a macroeconomic model of staggered price setting

to examine the exchange rate pass-through in the United States. He finds a decline in exchange rate pass-through due to a decline the pricing power of firms. Gagnon and Ihrig (2004) develop a theoretical model to explain that the degree of exchange rate pass-through declines in response to an increased emphasis on inflation stabilization. By estimating the model they for 20 industrial countries they attribute a decline in exchange rate pass-through to the observed monetary policy behavior. Barhoumi and Jouini (2008) use structural breaks and cointegration tests to examine the decline in exchange rate pass-through coefficients in some developing countries. They demonstrate that a change in the monetary policy regimes of these countries caused a shift to low inflation environment and a low exchange rate pass-through. Mishkin (2008) surveys the literature on exchange rate pass-through and discusses the implications of exchange rate pass-through on the conduct of monetary policy. Ghosh and Rajan (2009) estimate the long run exchange rate pass-through elasticities in Korea and Thailand. They find a higher exchange rate pass-through in Thailand than in Korea and that the exchange rate pass-through is larger into import prices than CPI for both countries.

Recently, the Vector Autoregression (VAR) models have become a widely used tool for analyzing exchange rate pass-through. McCarthy (2000) estimates a recursive VAR framework by incorporating a distribution of price chain. He finds that exchange rate has modest effect on aggregate domestic prices. Moreover, pass-through was higher in countries with larger import share and more persistent exchange rates and import prices. Bilmeier and Bonato (2004) examine the exchange rate pass-through in Croatia. They find that manufacturing price index responds significantly to an exchange rate shock. The retail price index does not respond significantly to an exchange rate shock. Belaisch (2003) points out that the exchange rate pass-through to wholesale prices was larger and more rapid as compared to consumer prices. Choudhri et al (2005) examine a variety of new open economy macroeconomic models to explain the exchange rate pass-through to domestic prices. They

find that the best-fitting model incorporates sticky goods prices, sticky wages and distribution costs for imports. Zorzi et el. (2007) examine the degree of exchange rate pass-through to prices in emerging and developed countries. They find that in East Asian emerging countries characterized by low inflation environment, the exchange rate pass-through to import and consumer prices is low and similar to developed countries. Ito and Sato (2008) examine the effects of exchange rate changes on inflation in post-crisis Asian economies. They find that the degree of exchange rate pass-through to consumer price index (CPI) was generally low, with an exception of Indonesia. In Indonesia, the response of monetary policy to an exchange rate shock and the response of consumer prices to a monetary policy shock were positive.

3. Monetary policy in emerging countries

In the 1990s, monetary policies in emerging countries under consideration underwent important changes. After suffering from currency and financial crises during the nineties, most of the emerging countries adopted the floating exchange rate regime. Focusing on anchoring inflationary expectations, many emerging countries switched from exchange rate and monetary targeting policies to inflation targeting policy[3]. Among the East Asian countries, South Korea was the first that adopted inflation targeting policy in April 1998, just five months after the devaluation of won, the South Korean currency. The Bank of Thailand implemented the flexible inflation targeting framework in May 2000. Under flexible inflation targeting, the emphasis was given to maintaining core inflation within the target range such that the economy can grow along a sustainable path in the long run. The Philippines Central

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[3] Inflation targeting focuses mainly on achieving price stability as the ultimate objective of monetary policy. This approach involves the announcement of an explicit inflation target that the central bank promises to achieve over a given time period. The target inflation rate is set and announced by the central bank.

Bank (BSP) and the Bank of Indonesia had officially implemented the inflation targeting framework in January 2002 and July 2005, respectively.

The two Latin American countries continued the monetary targeting and exchange rate based stabilization policies until the end of nineties. Mexico adopted the inflation targeting framework in January 1999. In Brazil the exchange rate based stabilization programme reduced the inflation from 2500% in December 1993 to less than 2% in December 1998. In the end of 1998, the Brazilian currency, real came under the speculative attack and in January 1999 real depreciated sharply. In June 1999 the Brazilian government implemented the inflation targeting framework.

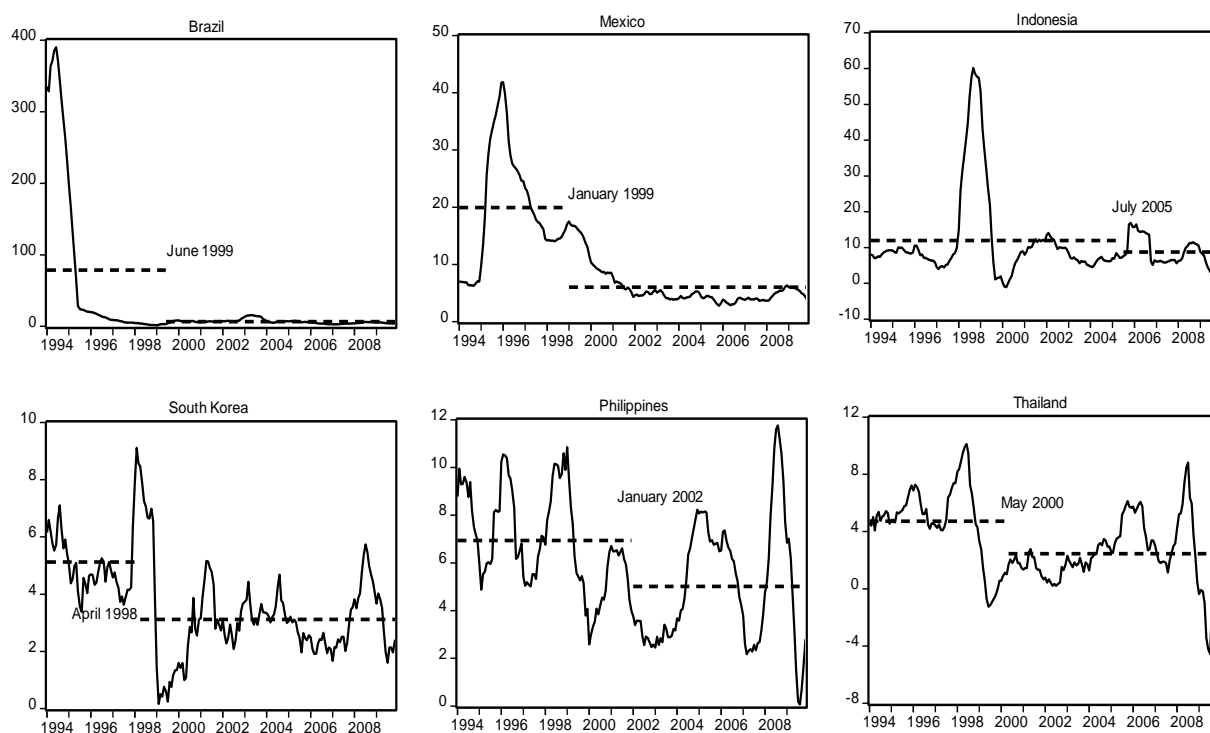Fig. 1: Inflation in emerging countries

Figure 1 depicts the evolution of the rate of inflation in emerging countries from January 1994 to November 2009. The average inflation has declined in all the countries after

Table 1: Overview of the emerging countries

		Brazil	Mexico	Indonesia	Philippines	South Korea	Thailand
GDP growth rate	*Pre-inflation targeting*	2,63%	3,11%	4,44%	2,96%	7,25%	4,62%
GDP growth rate	*Post-inflation targeting*	3,33%	2,95%	5,88%	5,28%	4,03%	4,78%
Inflation variability[4]	*Pre-inflation targeting*	31.21	10.37	12.98	3.42	1.12	2.73
Inflation variability	*Post-inflation targeting*	2.86	3.41	4.16	2.64	1.50	2.23
Currency crisis during nineties		Jan. 1999	Dec. 1994	Aug. 1997	July 1997	Nov. 1997	July 1997
Date of switch to the inflation targeting policy		June 1999	January 1999	July 2005	January 2002	April 1998	May 2000
Official exchange rate regime		Floating	Floating	Floating	Floating	Floating	Floating

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[4] We define the inflation variability as a standard deviation of inflation. The dates of transition to inflation targeting regime are taken from IMF (2005), IMF (2008) and Levin et al. (2004).

the adoption of inflation targeting framework. Table 1 shows an overview of emerging countries since January 1994. The inflation variability declined after the transition to inflation targeting policy. Moreover, the GDP growth rate increased during the inflation targeting regime in all countries except in Mexico.

4. Benchmark VAR model

4.1 Benchmark identification scheme

We employ the VAR approach to examine the effects of an exchange rate shock on domestic prices. The VAR approach takes into account the simultaneity between monetary policy variables and the real sector. This approach is widely used to examine the dynamic impact of unanticipated shock to one variable on other variables in the system. We identify the benchmark *VAR(p)* representation as follows:

$$\sum_{i=0}^{p} \Phi_i Y_{t-i} = \Theta X_t + \varepsilon_t \tag{1}$$

where Y_t is the vector of endogenous domestic variables and X_t is the vector of exogenous foreign variables. Φ and Θ are polynomials. ε_t is the vector of structural innovations. The rationale for including the vector of exogenous foreign variables is to take into account external constraints and to control for international economic events. We assume that the exogenous variables have contemporaneous effects on the endogenous variables and that there is no feedback effect from endogenous variables to exogenous variables[5].

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[5] The VAR methodology is discussed in the appendix.

The vector of endogenous domestic variables consists of output gap, nominal effective exchange rate (NEER), consumer prices (CPI) and an indicator of the monetary policy stance (*i*). The vector of endogenous variables in the benchmark model is as follows:

$$Y_t^{'} = \begin{bmatrix} outputgap & cpi & NEER & i \end{bmatrix}$$

The above ordering reflects a central bank reaction function in an emerging country. This ordering is partially guided by the fact that movements in the policy rates tend to lead changes in output, prices and exchange rate. However, output is not affected contemporaneously by shocks to other variables. Prices are contemporaneously affected by a shock to output gap. The exchange rate responds contemporaneously to shocks to GDP and prices. However, GDP and prices do not respond contemporaneously to exchange rate shocks. Monetary policy is ordered last. Monetary policy responds contemporaneously to shocks to GDP, prices and exchange rate. However, GDP, prices and exchange rate do not respond contemporaneously to a monetary policy shock.

Monetary policies in emerging economies are constrained by the world's major central banks, i.e., the Federal Reserve Bank, European Central Bank and the Bank of Japan. Central banks in emerging economies take into account the foreign variables to set the policy rates. These economies are indebted in a foreign currency, e.g., the US dollar or Euro. Default risks can aggravate if the central banks in these economies let the exchange rates fluctuate freely. Similarly, foreign trade in these economies is primarily invoiced either in US dollar or Euro. Thus, abrupt exchange rate variations in these economies are harmful for foreign trade. For these reasons, the central banks in emerging economies stabilize exchange rates even though they announce that they do not do so. Therefore, we include the federal funds rate in the vector of exogenous variables.

We also include the oil prices and the GDP of the United States in the vector of exogenous variables to control for changes in world inflation and demand. Thus, the vector of exogenous foreign variables consists of the oil price index ($Oilprices$), federal funds rate (i^{us}) and GDP of the United States (y^{us}).

$$X_t^{'} = \begin{bmatrix} Oilprices & i^{us} & y^{us} \end{bmatrix}$$

4.2 Data selection and estimation methodology

We use the monthly data. The whole sample differs for each country. All price series and GDP are seasonally adjusted. We use the central bank policy rates to represent the monetary policy stance.[6]

Table 2: Augmented Dickey-Fuller unit root test

Variables	Brazil	Indonesia	Mexico	Philippines	Korea	Thailand
CPI	-2.94	-1.46	-0.86	-3.87**	-2.23	-2.46
ΔCPI	-4.65***	-6.36***	-4.67***	-8.75***	-10.74***	-7.50***
NEER	-0.711	-1.51	-5.58***	-1.91	-1.87	-2.03
ΔNEER	-10.27***	-9.66***	-10.58***	-10.39***	-10.44***	-10.12***
Output gap	-5.00	-4.35***	-5.23***	-7.87***	-3.83***	-4.27***
Interest rate	-5.58***	-2.93	-4.54**	-7.73***	-1.91*	-1.93*
Δinterest rate	---	-16.59***	---	---	-11.67***	-24.48***

*** significant at 1% ** significant at 5% * significant at 10%. GDP of the United States, Oil prices and federal

funds rate are stationary at first difference.

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[6] We use the short term interest rate if the data for the policy rate was unavailable.

We define an increase in nominal effective exchange rate (NEER) as a depreciation of the currency of the respective country. We examine the responses of domestic prices to a positive unanticipated exchange rate shock. The time series properties of variables are tested by the Augmented Dickey Fuller unit root test.

Table 2 shows the results of the unit root test. In most cases, the variables are stationary in the first differences. The output gap is stationary at levels. Hence, we use the output gap in levels. However, the other variables are estimated either at first difference or at levels depending upon their time series properties. Since all foreign variables are stationary in first differences, the vector of exogenous variables is as follows:

$$X_t^{'} = \left[\Delta oilprices \quad \Delta i^{US} \quad \Delta GDP^{US} \right]$$

We use the sequential modified LR test statistic, final prediction error, Akaike, Schwarz, Hannan-Quinn information criteria to estimate the optimal lag length for each country. The optimal lag length varies not only across countries but also across different samples. We examine the impulse responses of output gap, consumer prices and interest rate to a positive exchange rate shock. Since, all the countries suffered from currency crisis during the nineties. We capture the impact of the currency crisis by using a dummy with a value of 1 for the currency devaluation month and 0 otherwise.

4.3 Results of the benchmark model

Figure 2 depicts the accumulated impulse responses of output gap, prices (CPI), and interest rate to a shock to exchange rate. We have standardized a positive shock to exchange rate to a 1% shock. Thus, the accumulated impulse responses of prices in figure 2 represent

the percentage change in prices to a positive unanticipated 1% shock to exchange rate. The dotted line represents a 2 standard error confidence band around the accumulated impulse responses. The immediate effect of a positive unanticipated exchange rate shock is an increase in prices. The increase in prices is statistically significant in all countries except Thailand. The largest response of prices to a 1% exchange rate shock in Indonesia suggests the largest exchange rate pass-through to domestic prices in Indonesia. A larger response of prices to a 1% exchange rate shock in the two Latin American countries as compared to East Asian countries suggests a higher pass-through in Latin American countries. Output gap responds negatively to a positive exchange rate shock. An increase in the interest rate in response to a positive exchange rate shock represents a monetary tightening in response to currency depreciation.

Fig. 2: Benchmark model: Accumulated impulse responses to an exchange rate shock
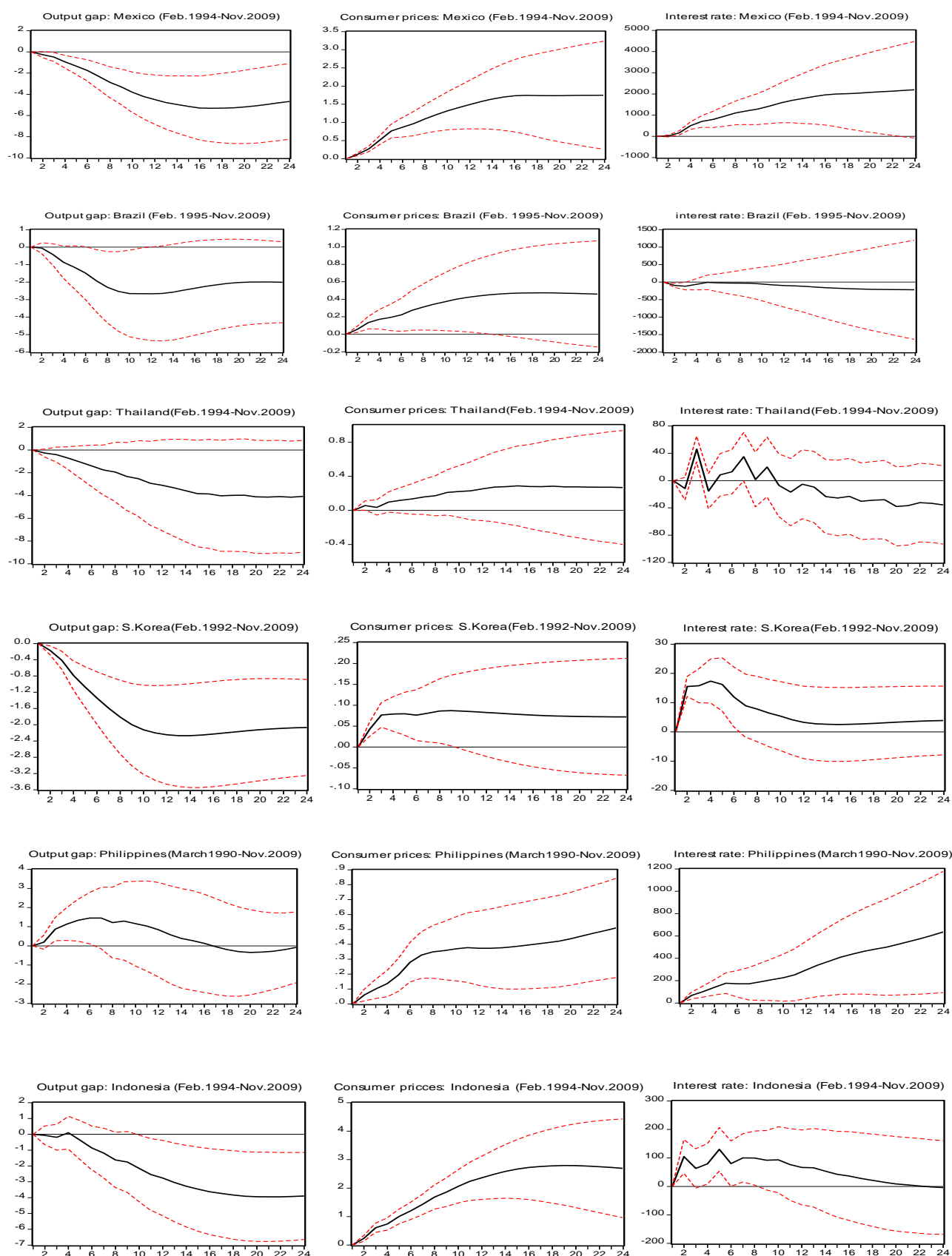
4.4 Effects of inflation targeting monetary policy on exchange rate pass-through

The degree of exchange rate pass-through depends on central bank's credibility to anchor inflation expectations. An increase in Central Bank's credibility to fight inflation reduces the exchange rate pass-through. In order to assess the behavior of exchange rate pass-through after the transition to inflation targeting regime, we estimate the pass-through to domestic price during the pre-inflation targeting and the post-inflation targeting framework.

Table 3: Accumulated impulse responses of prices to an exchange rate shock

	Pre-inflation targeting		Post-inflation targeting	
	12 months	24 months	12 months	24 months
Brazil	0.36	0.49	0.42	0.31
Mexico	1.60	1.44	0.66	0.59
Indonesia	2.34	2.67	1.41	1.41
Philippines	0.50	0.58	0.14	0.25
S. Korea	0.063	0.062	-0.0004	-0.0304
Thailand	0.18	0.20	0.11	0.21
Average	*0,84*	*0.91*	*0.46*	*0.46*

Table 3 shows the percentage accumulated impulse responses of prices to a positive 1% shock to exchange rate. The percentage accumulated responses of prices are higher during the pre-inflation targeting regime than the post-inflation targeting regime. A decline in the

percentage accumulated impulse responses of prices to a positive 1% exchange rate shock during the post-inflation targeting framework suggests a decline in the exchange rate pass-through to domestic prices. If we exclude Indonesia, the Latin American countries are characterized by a higher exchange rate pass-through in the two sub-samples. These results suggest a decline in the exchange rate pass-through after the transition to inflation targeting regime.

When a central adopts an inflation targeting policy, it becomes more vigilant at fighting inflation. Consequently, the average inflation and inflation variability decline. In the countries under consideration, both the average inflation and inflation variability have declined during the post-inflation targeting policy. We examine the relationship between change in exchange rate pass-through to domestic prices versus the change in average inflation and the rate of change in exchange rate pass-through versus change in the inflation variability.

Fig. 4: Exchange rate pass-through to consumer prices versus average inflation
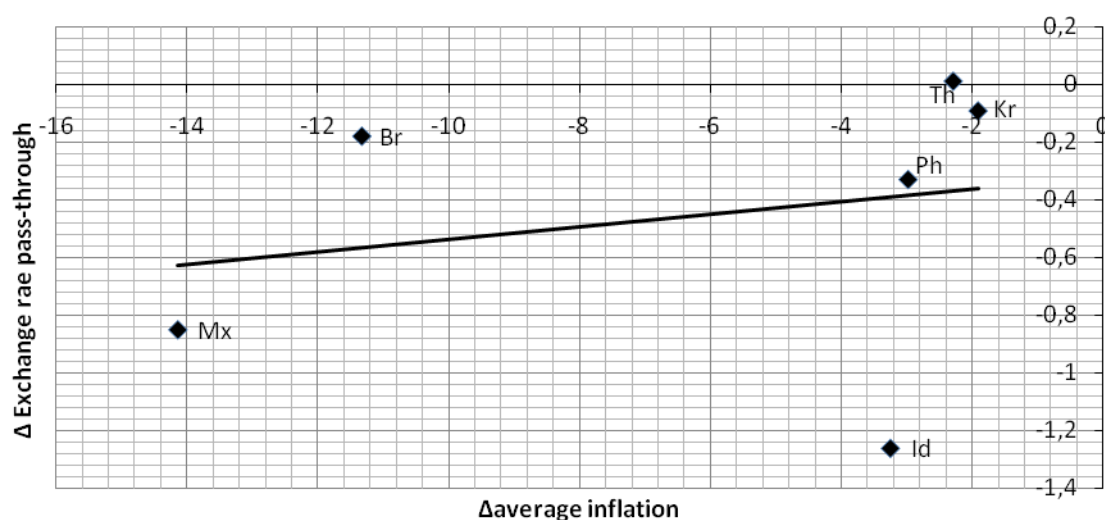
Note: Exchange rate pass-through is represented by an accumulated reponse of consumer prices to a 1% exchange rate shock after two years.

Fig. 5: Exchange rate pass-through to consumer prices versus inflation variability
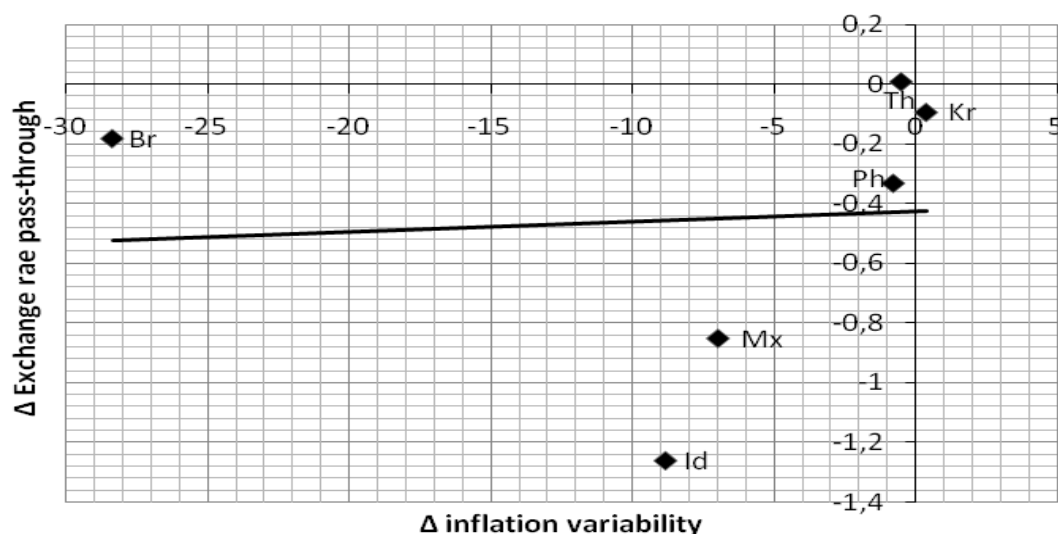
Figures 4 and 5 depict the change in the rate of exchange rate pass-through versus change in the average inflation and change in exchange rate pass-through versus change in the inflation variability, respectively. The vertical axis in figures 4 and 5 represent the change in exchange rate pass-through and the horizontal axis represent the change in average inflation and change in inflation variability, respectively. The diagonal line represents the linear trend. In figure 4, the linear trend shows a positive relationship between the change in exchange rate pass-through and the change in average inflation. In figure 5, we find the same rusults. It suggests that the exchange rate pass-through has declined in all countries after the transition to inflation targeting policy. In Thailand, there was an insignificant increase in the pass-through during the inflation targeting regime. Since Korea adopted the inflation targeting framework immediately after the currency crisis, the inflation targeting regime is characterized by a higher inflation variability than pre-inflation targeting regime.

5. Conclusion

Considering external constraints on monetary policy in emerging countries, we propose a VAR model to examine the exchange rate pass-through to domestic prices. The benchmark VAR model is composed of a vector of endogenous domestic variables and a vector of exogenous foreign variables. We imposed restrictions on the contemporaneous effects of endogenous variables to have an exact identification of the benchmark VAR model. The results of the benchmark VAR model suggest that the Latin American countries are characterized by higher exchange rate pass-through than the East Asian countries. Among the East Asian countries Indonesia has the highest pass-through. In order to assess the behavior of exchange rate pass-through after the transition to inflation targeting regime, we estimate the pass-through to domestic price during the pre-inflation targeting and the post-inflation targeting framework. These results suggest a decline in the exchange rate pass-through after the transition to inflation targeting regime. The Latin American countries are characterized by higher pass-through than the East Asian countries. We examine the link between the change in exchange rate pass-through versus the change in average inflation and versus the change in inflation variability across different sub-samples. We find the evidence that change in exchange rate pass-through is positively related to a change in average inflation and a change in inflation variability. These results further suggest that the exchange rate pass-through is low in less persistent inflation environment.

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Appendix

VAR model:

A VAR model consisting of four endogenous variables: w, x, y and z is written as follows:

$$w_t = b_{10} - b_{12}x_t - b_{13}y_t - b_{14}z_t + \gamma_{11}w_{t-1} + \gamma_{12}x_{t-1} + \gamma_{13}y_{t-1} + \gamma_{14}z_{t-1} + \varepsilon_{wt} \tag{1}$$

$$x_t = b_{20} - b_{21}w_t - b_{23}y_t - b_{24}z_t + \gamma_{21}w_{t-1} + \gamma_{22}x_{t-1} + \gamma_{23}y_{t-1} + \gamma_{24}z_{t-1} + \varepsilon_{xt} \tag{2}$$

$$y_t = b_{30} - b_{31}w_t - b_{32}x_t - b_{34}z_t + \gamma_{31}w_{t-1} + \gamma_{32}x_{t-1} + \gamma_{33}y_{t-1} + \gamma_{34}z_{t-1} + \varepsilon_{yt} \tag{3}$$

$$z_t = b_{40} - b_{41}w_t - b_{42}x_t - b_{43}y_t + \gamma_{41}w_{t-1} + \gamma_{42}x_{t-1} + \gamma_{43}y_{t-1} + \gamma_{44}z_{t-1} + \varepsilon_{zt} \tag{4}$$

In this model, if we restrict the contemporaneous effects of y and z on x, the coefficients b_{12}, b_{13} and b_{14} become zero. Equation 1 can be rewritten as follows:

$$x_t = b_{10} + \gamma_{11}x_{t-1} + \gamma_{12}y_{t-1} + \gamma_{13}z_{t-1} + \varepsilon_{xt} \tag{1'}$$

Thus, even if we restrict the contemporaneous effects of y and z on x, equation 1' shows that the w depends on the lagged values of x, y and z. We propose an alternative VAR model, by treating w as an exogenous variable. Thus,

$$x_t = b_{10} - b_{12}y_t - b_{13}z_t + \gamma_{11}x_{t-1} + \gamma_{12}y_{t-1} + \gamma_{13}z_{t-1} + \gamma_{14}w_{t-1} + \varepsilon_{xt} \tag{5}$$

$$y_t = b_{20} - b_{21}x_t - b_{23}z_t + \gamma_{21}x_{t-1} + \gamma_{22}y_{t-1} + \gamma_{23}z_{t-1} + \gamma_{24}w_{t-1} + \varepsilon_{yt} \tag{6}$$

$$z_t = b_{30} - b_{31}x_t - b_{32}y_t + \gamma_{31}x_{t-1} + \gamma_{32}y_{t-1} + \gamma_{33}z_{t-1} + \gamma_{34}w_{t-1} + \varepsilon_{zt} \tag{7}$$