

The Impact of Monetary Regime on the Exchange Rate Pass-Through under Exchange Rate Volatility (Dynamic Panel Data Approach)

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Abstract

The main Purpose of this paper is to investigate the impact of monetary regime and exchange rate volatility on the exchange rate pass-through in two subsets of countries with the inflation targeting versus exchange rate as nominal anchor over the period of 1999-2010. To conduct this study, the empirical model has been estimated by dynamic panel data approach and GMM estimator. The main findings of this paper show that exchange rate volatility has positive effect on the import prices in the two groups of countries. In addition, the results of model estimation reveal that the interaction effect of monetary regime with nominal effective exchange rate has positive and negative effects on the import price index in the first and second group of countries respectively. The overall conclusion suggests that the impact of monetary regime on the exchange rate pass-through under exchange rate volatility is higher if it is accompanied with exchange rate anchor in comparing with inflation targeting strategy.

Keywords: Exchange Rate Volatility, Inflation Targeting and Exchange Rate Anchor Regimes, Dynamic Panel Data Approach

1- Introduction

The relationship between exchange rate movements and price adjustments of traded goods, which is called the exchange rate pass-through (ERPT), has long been debated in the field of international economics.

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Exchange rate pass-through is defined as the percentage change in local currency import prices resulting from a one percent change in exchange rate between exporting and importing countries¹. In the exchange-rate pass-through literature, pass-through is considered complete when the response is one-to-one and 1 percentage change in the exchange rate results in a 1 percent change in the import price. If pass through is less than complete, then we have evidence of pricing in the local currency of importers or pricing to market. Incomplete pass through can be attributed to micro factors such as market structure and product differentiation as well as macroeconomic variables like exchange rate movements, trade openness, monetary policy and trading partner's production cost.

According to An (2006), McCarthy (2009) and Sowah (2009), exchange rate volatility is one of the key determinants of exchange rate pass-through. The effect of exchange rate volatility on pass-through depends on whether exchange rate movements are perceived to be transitory or permanent. When exchange rate volatility is high, the cost of price adjustment also rises. If the exchange rate shock is perceived to be transitory, exporters and importers would be more willing to adjust their profit margin rather than to change prices. However, if the shock is expected to persist, then exporters and importers would be more likely to change prices.

In addition, the exchange rate pass-through is affected by monetary regime and inflationary environment. Taylor (2000) argues that in a model with staggered prices and monopolistic competition, low inflationary environment leads to a low exchange rate pass-through to import and domestic prices.

Since the 1980s, there has been a growing attention to examine the linkage between exchange rate pass-through with monetary policy behavior and exchange rate volatility. Several studies have investigated the effect of exchange rate volatility and monetary policy on the exchange rate pass-through in developed and developing countries. Devereux and Engel (2001) shows that low exchange rate variability and stable monetary policy has resulted in a low exchange rate pass-through. Wickremasinghe and Silvapulle (2003) pointed out that there is a positive relationship between

1- Goldberg and Knetter (1997).

exchange rate pass-through and exchange rate volatility for Japan. Kiptui, Ndolo, and Kaminchia (2005) find out that an exchange rate shock leads to a sharp increase of import price index in Kenya. Choudhri and Hakura (2006) provided a relationship between the low inflationary environment and exchange rate pass-through. Kun and Zhanna (2008) concluded that exchange rate volatility has led to a high exchange rate pass-through. Nogueira et al (2010) found that exchange rate pass-through has declined with a shift to a low inflationary environment. Byrne et al (2010) showed that exchange rate volatility has a positive effect on the exchange rate pass-through. Aguerre et al (2012) suggested that exchange rate volatility and monetary policy play a crucial role in exchange rate pass-through.

The review of empirical studies on the exchange rate pass-through shows that there is no study on the effects of exchange rate volatility and monetary regime on the exchange rate pass-through in countries with different monetary regime and exchange rate arrangements. Hence, to close this gap, the main contribution of this paper is to examine the effects of exchange rate volatility and monetary regime on the import price index in countries with the inflation targeting monetary policy versus exchange rate anchor over the period of 1999-2010.

In inflation targeting monetary regime, monetary policy decisions are guided by the deviation of forecasts for future inflation from the announced inflation target, where the inflation forecast acts as the intermediate target of monetary policy. This regime covers the managed floating with no pre-determined path for the exchange rate and its nature solely reflects independently floating exchange rate.

In the exchange rate anchor regime, the objective of monetary authority is to buy or sell foreign exchange at given rates to maintain the exchange rate at the certain range. So, the exchange rate serves as the nominal anchor or intermediate target of monetary policy. This regime consists of exchange rate regimes with no separate legal tender, currency board arrangements, fixed pegs with or without bands, and crawling pegs with or without bands.

It is expected that in the inflation targeting regime, the effects of monetary regime under the exchange rate volatility on exchange rate pass-through to be less than in the countries with nominal exchange rate anchor.

The remainder of the paper is organized as follows: Section 2, briefly reviews the current literature on the ERPT issue. Section 3, presents the

empirical model and data sources. In Section 4, econometric results of study have analyzed. The final section is concerned with conclusions and policy implications of the paper.

2- Review of Literature

The theoretical literature on the linkage between exchange rate volatility and exchange rate pass-through indicate that the direction of this relationship is ambiguous. Higher exchange rate volatility is typically associated with lower ERPT (i.e. negative link) in a highly competitive market because exporters are prepared to let their markup fluctuate, seeking to hold or increase market share (Froot and Klemperer, 1989). On the contrary, if exporters predominantly seek to stabilize their profit margin they will tend to maintain prices in their own currency, i.e. higher ERPT, and so the expected effect is positive (Devereux and Engel, 2002). As pointed out by Gaulier et al. (2008), this mixed nexus reflects a trade-off in the exporter's main strategy, namely, to stabilize export volume or marginal profit.

A related argument is whether the volatility shock is perceived as long-lasting or short-lived by exporters; in the latter case, they are more likely to adjust down their profit margin rather than incur the costs associated with frequent price changing (Froot and Klemperer, 1989).

There are theoretical arguments and evidence in favor of relationship between the import prices and the exchange rate volatility (Kendall, 1989; Parsley and Cai, 1995; Dhalokia and Raveendra, 2000). Consequently, it is reasonable to assume that the profit margin of exporters depends on the exchange rate volatility. In this case, import prices respond to the changes in domestic prices and the exchange rate volatility. By assuming a perfectly competitive condition in the domestic market, exporters consider only the changes in exchange rate volatility and domestic prices in their pricing behavior.

In order to demonstrate the relationship between exchange rate volatility and import prices, we can review the Wickremasinghe and Silvapulle's (2003) model. According to their model, the exporters in foreign countries set their prices (PX) as a function of profit mark-up (π) and production cost (CP). Therefore, the export price has been defined as:

$$P X = \pi C P \quad (1)$$

The import prices in importing country can be obtained by multiplying the export price (PX) in terms of foreign currencies by exchange rate (ER):

$$PM = PX * ER = (\pi CP) * ER \quad (2)$$

In this equation, the profit margin of exporters depends on the exchange rate volatility (H) and profit mark-up which can be extended as:

$$\pi = \left(\frac{PD}{CP * ER} \right)^\alpha H^\beta \quad (3)$$

Where PD is domestic price in the importing country and α , β is constant parameters.

With substituting of equation (3) in equation (2) and taking logarithm of variables, the final equation for import prices in importing country has been derived as follows:

$$p_m = \alpha pd + cp(1 - \alpha) + er(1 - \alpha) + \beta h \quad (4)$$

Based on equation (4), it can be stated that the import price is a function of exchange rate, production cost, domestic prices, and exchange rate volatility which is a core relationship for econometric estimation.

Moreover, the monetary policy also is one of the major determinants in exchange rate pass-through. According to Taylor (2000), Hakura (2001), Baiiliu and Fujii (2004) and Sowah (2009), countries with credible monetary regimes such as inflation targeting or low inflationary environment have experienced a lower degree of exchange rate pass-through. So the countries with inflation targeting monetary regime have managed to reduce their inflation rate and subsequently have entered in to a period of relative price stability. The stability of relative prices in these countries has resulted in more stable inflationary environment and declines in exchange rate pass-through.

The production cost in the exporting countries is another variable that should be included in the empirical model of exchange rate pass-through to import prices. Inclusion of this variable provides support for the notion that

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exporting firms adjust their mark-ups in response to exchange rate fluctuations. The variable of production cost in the exporting countries is used as a proxy for measurement of marginal cost in the trade partner countries. A rise in the marginal costs in foreign currency could also lead to an increase in import prices through the cost channel as the firms would be looking to recover the cost of production by charging higher prices.

On the empirical ground, there exist many studies on the estimation of exchange rate pass-through to import prices. For instance, Mann (1989) by using of quarterly data over the period of 1973:1-1988:2 has estimated the exchange rate pass-through to import prices in United States. The results of this study reveal that exchange rate fluctuations and marginal production costs have positive and significant effects on the import price index. Goldfajn and Werlang (2000) have analyzed the effects of real GDP and exchange rate volatility on the import price index for OECD and non-OECD countries during the 1980-1998. They found that exchange rate volatility and real GDP have positive and significant effect on the import prices. Campa and Goldberg (2001) have investigated the main determinants of exchange rate pass-through for twenty three OECD countries over the 1975-2000. The results of this paper indicate that exchange rate volatility, real GDP and marginal cost in exporting countries have positive effects on the import prices in these countries. Bailliu and Fujii (2004) by using annual data for 11 industrialized countries during the 1977-2001 found that exchange rate pass-through has declined due to a low-inflationary environment as result of a change in monetary policy regime. More specifically, the conclusion suggests that pass-through to import, producer, and consumer price indices has declined following the inflation stabilization that occurred in many industrialized countries in the early of 1990s. Nogueira et al (2010) have estimated the effects of inflationary environment on the import prices for 12 developed and emerging economies during the 1980-2007. They concluded that a shift to low inflationary environment has resulted in declining the exchange rate pass through. Aguerre et al (2012) have explored the effects of exchange rate volatility on the import prices in developed and developing countries over the period of 1997:1-2009:3. The main findings of their study reveal that pass-through has been universally falling in developed markets and that it is higher for emerging countries.

None of the previous studies have attempted to look at the impact of monetary regime and exchange rate volatility on the exchange rate pass-through simultaneously, so the prime objective of this study is to bridge this gap by investigating the effects of monetary regime on the exchange rate pass-through under exchange rate volatility for two sets of countries. The first category consists of the countries with the exchange rate anchor and the second group comprise of countries with the inflation targeting monetary regime. In order to examine the responsiveness of import prices to the exchange rate pass-through in presence of the monetary regime and exchange rate volatility in selected countries the defacto exchange rate classification and dynamic panel data approach have been used over the period of 1999-2010.

3- Empirical Model and Data Collection

To investigate the effects of monetary regime and exchange rate volatility on the import prices in the two groups of countries,¹ according to the economic literature as well as empirical studies by Kim (2007), Kun Sek and Kapsalyamova (2008), Sowah (2009) and Junttila and Korhonen (2012) the following dynamic model in terms of logarithm has been specified as:

$$LIP_{it} = \beta_i + \beta_1 LIP_{it-1} + \beta_2 LNEER_{it} + \beta_3 Regime^* LNEER_{it} + \beta_4 EX_VOL^* LNEER_{it} + \beta_5 LMC_{it} + \varepsilon_{it} \quad (5)$$

In above equation, LIP is unit value of imports (as a proxy for import price index); LIP_{t-1} represent the first lag of unit value of imports; $NEER$ is nominal effective exchange rate. This variable is defined as the trade weighted average of country's exchange rate against other currencies. Using the LNEER instead of nominal or real exchange rate allows for some variation in the exchange rate and makes it possible into estimate the degree to which the exchange rate fluctuations get passed through to import price index. Based on IMF definition for NEER, this variable is expressed as an index of the foreign currency value per unit of domestic currency. Hence, an

1- On the base of IMF monetary regime and exchange rate classification (2009), countries with exchange rate anchor regime consist of 15 countries which Iran is on the fifteen countries in this group. In second group, there are 44 countries with inflation targeting monetary regime and managed float or independently floating exchange rate arrangements.

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increase of NEER represents the appreciation of domestic currency. $Regime * LNEER$ is the cross effects of monetary regime with nominal effective exchange rate in two groups of countries. Monetary Regime can be defined by a dummy variable that takes one if the country adopt exchange rate anchor or inflation targeting monetary regime between 1999-2010¹ and zero otherwise. $EX_VOL * LNEER$ is interaction effects of exchange rate volatility with nominal effective exchange rate in two groups of countries. EX_VOL is exchange rate volatility in terms of standard deviation of nominal effective exchange rate over three years. According to Barhoumi (2005), Kim (2007) and Sowah (2009) exchange rate volatility has been defined as follows:

$$EX_VOL = \sqrt{\frac{1}{T} \sum \left(\frac{NEER_{i,t+3} - NEER_{i,t}}{NEER_{i,t}} \right)^2} \quad (6)$$

In above formula, T and NEER are number of periods and nominal effective exchange rate for country i. MC is marginal cost of the exporting partner's. To measure the production cost, we follow Campa and Goldberg (2001), Sowah (2009) and Ceglowski (2010) methodology and construct a proxy as follows:

$$MC = \left(\frac{NEER_t^j}{REER_t^j} \right) * P_t^j \quad (7)$$

In this equation, NEER and REER are the nominal and real effective exchange rate for importing country j respectively, and P^j is the consumer price index in the importing country.

As mentioned in the review of literature, the expected sign of coefficients are: $\beta_1, \beta_5 > 0, \beta_2, \beta_4 < 0$ and β_3 for countries with the exchange rate anchor monetary regime should be negative and in the second group with inflation targeting is expected to be positive.

1- The defacto exchange rate classification has been reported by IMF after the 1999, for this reason, the period of this study has limited to the period of 1999-2010.

In examining the monetary regime and exchange rate volatility effects on the import prices in both groups of countries, the empirical model has been estimated by dynamic panel data approach¹.

Dynamic panel-data method developed by Arellano and Bond (1991) was based on work by Anderson and Hsiao (1981) and Holtz-Eakin, Newey, and Rosen (1988). Their approach involves taking the first difference of equation (1) to remove the individual effects.

Although the model in first difference form is still characterized by a correlation between the lagged dependent variable and the disturbance term, Anderson and Hsiao demonstrated that, without the individual effects, there is a simple technique of instrumental variable estimation. They thus proposed instrumental variables for the lagged dependent variable which can be appear either in the lag or first difference of dependent variable; both of these instruments are suitable, given that they are uncorrelated with the disturbance term but correlated with the lagged dependent variable.

Their methodology also relies on the assumption that there is no second-order correlation in the first-differenced error terms. Using this instrumental variable matrix, Arellano and Bond (1991) derive a GMM estimator as well as two specification tests for this estimator that can be used to test the validity of instrumental variables (Sargan test of over-identifying restrictions) and test of second-order autocorrelation in the first-differenced residuals.

The data set for all variables of the model has been collected from World Bank indicators (WDI) and international financial statistics (IFS) CD-ROM over the period of 1999-2010.

4- Empirical Results

This section presents the results of model estimation by AB approach for two groups of countries. At first, the results for countries with the exchange rate anchor monetary regime are reported in Table 1.

1- As discussed by Arellano and Bond (1991), the dynamic panel data approach is suitable method for estimation of model when the time dimension of the panel is small.

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Table 1: The Results for the Countries with the Exchange Rate Anchor Monetary Regime

Explanatory Variables	Coefficient	Z-value	Probability Value (PV)
C	0.11	0.11	0.91
LIP_{t-1}	0.59	17.32	0.000
$LNEER$	-0.26	-2.36	0.018
Re gime * $LNEER$	-0.017	-2.93	0.003
$EX_VOL * LNEER$	-0.06	-3.61	0.000
LMC	0.66	5.89	0.000

Sargan Statistics : $\chi^2(28) = 13.05$ PV(0.99) , Observations: 142, Number of Countries: 15

Source: Authors Computations

The results of Table 1 show that nominal effective has negative and significant effect on the domestic price index in first group countries. In other words, an increase of domestic currency against foreign currencies is accompanied with the decrease of demand for domestic produced goods and consequently domestic price level will also decrease. The first lag of unit value of imports has a positive effect on the unit value level in current period. This result indicates that an increase of import prices in previous period, will lead to a higher per unit value of imports in these countries. In addition, the cross effect of monetary regime with nominal effective exchange rate also has a negative effect on the exchange rate pass-through. Hence, with adopting exchange rate anchor monetary regime in these countries, it is expected that the exchange rate pass-through gets intensified. The interaction effects of exchange rate volatility with the nominal effective exchange rate has also negative and significant effect on the per unit value of imports. Therefore, as exchange rate volatility rises, the cost of price adjustment also increases and consequently import price index gets higher. The elasticity of import price index with respect to the marginal cost of exporting countries has been estimated to be 0.66, it means that one percent increase of the marginal cost in the exporting countries has resulted in 0.66 percent increase in import price level. According to the results of model estimation in countries with exchange rate anchor monetary regime, it can be concluded that the degree of exchange rate pass-through in presence of monetary regime and exchange rate volatility has been higher (around - 0.34). Moreover, the value of Sargan statistic with χ^2 distribution is 13.05

which indicate that the instrumental variable of model¹ is valid and uncorrelated with the error term. In next step, the order of autocorrelation in first differenced error term is tested by AB statistic. The results of this test have been presented in Table 2:

Table 2: Arellano-Bond test for Order of Autocorrelation in First-Differenced Errors

Order	Z-value	Probability Value (PV)
1	-2.40	0.016
2	-0.11	0.91

Source: Authors Computations

According to Table 2, we can conclude that the order of autocorrelation in first-differenced errors is one. This result supports the use of AB method to eliminate the fixed effects cross countries.

In next section, the results of model estimation for the countries with inflation targeting monetary regime have been reported in Table 3.

Table 3: The Estimation Results for Countries with Inflation Targeting Monetary Regime

Explanatory Variables	Coefficient	Z-value	Probability Value (PV)
C	-0.31	-5.38	0.000
LIP_{t-1}	0.79	193.86	0.000
<i>LNEER</i>	-0.1	-7.82	0.000
<i>Re gime * LNEER</i>	0.007	20.10	0.000
<i>EX _ VOL * LNEER</i>	-0.07	-27.76	0.000
<i>LMC</i>	0.38	24.03	0.000
Sargan Statistics : $\chi^2(34) = 42.13$ PV(0.16) , Observations: 375, Number of Countries: 43			

Source: Authors Computations

The empirical results for countries with inflation targeting monetary regime indicate that first lag of per unit value of imports has positive effect

1- In empirical model, the second order lag of LIP is considered as an instrument variable.

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on the import price index in current period. The coefficient of nominal effective exchange rate is negative, which shows that an increase of domestic currency value against foreign currencies induce the demand for imported inputs to rise and as result the import price index goes up. In addition, cross effect of monetary regime with nominal effective exchange rate in these countries is positive and significant. Furthermore, with adoption of inflation targeting monetary regime, it is expected that exchange rate pass-through declines. The interaction effect of exchange rate volatility with nominal effective exchange rate has negative and significant effect on the exchange rate pass-through. This result shows that, an increase of exchange rate volatility has led to higher price of imported goods. The marginal cost in exporting countries has a positive and significant effect on the import price index as mentioned before. As overall result, the estimated degree of exchange rate pass-through under the monetary regime and in presence of exchange rate volatility is -0.16, which is less than of exchange rate pass-through in countries with the exchange rate anchor monetary regime. This conclusion suggests that in second groups of countries, the adoption of inflation targeting monetary regime has led to decrease of exchange rate pass-through.

The results of Sargan test for this model has confirmed the validity of instrumental variables. In order to examine autocorrelation in the first differenced error terms, the AB test has been used. The result of Arrelano and Bond test has been shown in the table 4.

Table 4: Arellano-Bond Test for Order of Autocorrelation in First-Differenced Errors

Order	Z-value	Probability Value (PV)
1	-4.54	0.000
2	0.19	0.84

Source: Authors Computations

With respect to the results of AB test, it can be concluded that there is no autocorrelation between differenced error terms and AB approach is the suitable method for the model estimation.

5- Concluding Remarks and Policy Implication

This paper has analyzed empirically the effects of monetary regime and exchange rate volatility on the degree of exchange rate pass-through in two sets of countries, one with exchange rate anchor and other inflation targeting monetary regime over the period of 1999-2010.

For this purpose, by using of IMF defacto exchange rate classification and dynamic panel data approach, empirical model has been estimated for these two subsets of countries.

The main findings of this study indicate that nominal effective exchange rate and cross effect of exchange rate volatility with nominal effective exchange rate have negative and significant impact on the per unit value of imports in two groups of countries. In addition, the first lags of unit value of imports and marginal cost of exporting countries have positive effects on the import price index. Moreover, interaction effect of monetary regime with nominal exchange rate has negative effect in countries with exchange rate anchor regime and positive in the second groups of countries. Cross effect of exchange rate volatility with nominal exchange rate has negative and significant effect on the per unit value of imports in the both subsets of countries. It can be interpreted that any increase in the exchange rate volatility, the adjustment of prices would be unavoidable. The elasticity of import price index due to marginal cost is positive, which indicate that increase in marginal cost of the exporting countries provokes an increase in the import prices of these countries. The results of this paper are consistent with theoretical framework of exchange rate pass-through and previous empirical studies such as Sowah (2009), Nogueira et al (2010) and Ivohasina (2012).

An important policy implication of this paper dictates that the dependency of the exchange rate pass-through on the exchange rate volatility and monetary regime should be taken into consideration in designing monetary policy rules. It means that in the countries with exchange rate anchor monetary regime and high exchange rate volatility like Iran, policy makers and monetary authorities should adopt credible monetary policies such as inflation targeting in order to dampen the effect of exchange rate shocks on the import price level.

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