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

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## Abstract
The main objective of this paper is to investigate the effects of monetary regime (countries with inflation targeting monetary policy versus countries with exchange rate anchor) on the extent of exchange rate pass-through over the period of 1999-2010. To achieve this objective, the econometric model has been estimated by Dynamic Panel Data approach and Arrelano- Bond (AB) method. The empirical findings indicate that the interaction effect of monetary regime with exchange rate has a negative and positive impact on the exchange rate pass-through in first and second groups of countries respectively. However, the cross effect of inflationary environment with nominal effective exchange rate has negative and significant effect on domestic price level in the both groups of countries. Hence, overall, the Taylor hypothesis has been confirmed.

**Keywords:** Inflationary Environment, Inflation Targeting and Exchange Rate Anchor Regimes, Dynamic Panel Data Approach.

**JEL Classification:** C23, F14, F31



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## 1. Introduction

After the great depression of 1929-1933, one of the appropriate adjustment mechanisms to the structural imbalance in the international trade has been the nominal exchange rate. However, the effectiveness of this mechanism to a great degree depends on the responsiveness of the domestic prices to exchange rate fluctuations.

The recent development in international finance has led to the formulation of exchange rate pass-through (ERPT) which derived from the law of one price. On the base of law of one price, it is expected that the changes in exchange rate completely absorbed into tradable goods (local currency of import prices). In the beginning, it has been assumed that in the balance of payments model there is a one to-one response of imported prices to exchange rates, which is known as complete exchange rate pass-through.

Krugman (1987) and Dornbusch (1987) were the first economists to express that exchange rate pass-through may be partial, when there is less than one to one response of import prices to the exchange rate movements. This can be attributed to several micro and macroeconomic factors.

Numerous economic studies have examined the exchange rate pass-through to import prices in different countries under various circumstances. These studies estimated sensitivities of traded goods prices with respect to the exchange rate changes alongside with other explanatory variables that influences the import prices like exchange rate volatility and marginal cost in the exporting countries.

Traditional theory of pass-through believes that the process is incomplete due to microeconomics factors, such as demand elasticities, market structure and power pricing of firms rather than monetary policy.

Since 1990s, it has been observed that exchange rate pass-through has declined in many developed and industrialized countries. One explanation for this decline in exchange rate pass-through has been attributed to implementing credible monetary policy regime such as inflation targeting (IT), which proposed by Taylor (2000). He noticed that under imperfect competitive market and high inflationary environment, it is likely that the exporting firms shift the higher cost into imported prices to consumers. The same view is shared by Devereux and Yetman (2002) who discuss that the monetary policy affects the exchange rate pass-through when the monetary policy is loose and frequently affect the prices in the importing countries. So the extend of the ERPT to great degree depends on the monetary regime and inflationary environment. In this framework, ERPT is endogenous with respect to the monetary policy.

After the collapse of the Bretton Woods system in 1973, the world has witnessed the emergence of two groups of countries with different monetary regimes. There is no neat and widely accepted definition of monetary regimes. However, we can classify countries into distinguished monetary regime: exchange rate anchor versus inflation targeting.

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 consist of exchange rate systems with no separate legal tender, currency board arrangements, fixed pegs with or without bands, and crawling pegs with or without bands. On the other hand, in the inflation targeting regime, monetary policy decisions are guided by the deviation of forecasts for future inflation from the announced inflation target, with the inflation forecast acting (implicitly or explicitly) as the intermediate target of monetary policy. These regimes cover the managed floating with no pre-determined path for the exchange rate and independently floating regime.

Empirical evidence by Taylor (2000), Gagnon and Ihrig (2001), Bailliu and Fujii (2004), , Karoro (2007), Sowah (2009), Coulibaly and Kempf (2010) and Winkelreid (2011) indicates those countries which followed inflation targeting monetary regime have experienced a decline in exchange rate pass-through.

By review of theoretical and empirical studies on exchange rate pass-through it is revealed that none of the previous studies have examined the effects of monetary regime and inflationary environment on the exchange rate pass-through simultaneously. Hence, the main aim of this paper is to investigate the impact of monetary regime and inflationary environment on the exchange rate pass-through using dynamic panel data approach which embodies countries with inflation targeting monetary regime versus exchange rate anchor over the period of 1999-2010.

The rest of this paper is organized as follows. Section 2, briefly reviews the current literature on the ERPT issue. Section 3 presents the model specification and data source. In Section 4, econometric results of study are analyzed. The final section is concerned with conclusion and

policy implications.

## 2. Review of Literature

The effects of exchange rate fluctuations on the domestic prices can be decomposed into direct and indirect channels. The direct channel arises mainly from the "law of one price (LOOP)" theory.

The law of one price considers that the exchange rate pass-through into import prices would be complete. According to LOOP, under the assumption of costless arbitrage, identical products would sell for same common currency price in different countries. If LOOP holds, then changes in exchange rate would thus completely pass through to import prices. This means that a one percent change in exchange rate will lead to a one percent change in price of imported goods.

The indirect channel of exchange rate pass-through comes from the impact on aggregate demand. An appreciation of exchange rate makes domestic products relatively cheaper for foreign consumers and as a result exports and aggregate demand will rise relative to potential output, inducing an increase in domestic price level.

The literature of exchange rate pass-through suggests that its extension is essentially determined by microeconomic as well as macroeconomic factors. However, in this paper our immediate concern is on the macroeconomics aspects of the pass-through such as monetary regime, inflationary environment and monetary policy.

From a theoretical standpoint, one of the main determinants of ERPT is inflationary environment. According to Taylor (2000), declines in the pass-through to aggregate prices are a consequence of low inflationary environment. Taylor explains the link between inflation and pass-through in terms of a model of firm behavior based on the flexible price setting and monopolistic competition. In this model, if prices are set for several years in advance, then the lower persistence of inflation will result in smaller pass-through, which is characteristic of weakening market power of firms. This is true whether the cost increase is a product of changes in imported prices due to an appreciation of the exchange rate or to a change in commodity prices or wages. Taylor argues that in a low and more stable inflation environment, the firms has a lower price setting power to shift the cost changes into domestic prices. The recent evidence in US confirms that in the period of relatively low inflation, ERPT has been weakening. With respect to Taylor's view, it can be concluded that the ERPT depends on the inflationary environment and monetary regime. It means that in a low inflationary environment, the monetary authorities have more freedom to implement credible monetary regime like inflation targeting to control inflation deviation and consequently the exchange rate pass-through declines. In addition, Choudhri and Hakura (2001) emphasize a channel similar to the Taylor (2000) in the context of a dynamic general equilibrium model based on the new open macroeconomic framework with imperfect competitive market and staggered contracts. In this model, since the pass-through reflect the expected effects of monetary shocks on the current and future costs which in turn, are reduced by having a low-inflation regime, a low inflationary environment will lead to a fall in ERPT. Finally, Devereux and Yetman (2002) by applying a dynamic general equilibrium (DGE) model have investigated the linkage between ERPT and monetary policy. In their model, pass-through is determined by the frequency of price changes for importing firms, and this frequency is a function of monetary policy regime. Firms in countries with credible monetary policy such as inflation targeting, will tend to change their prices relatively less frequently, leading to a lower degree of exchange rate pass-through.

Other determinant of exchange rate pass-through is money supply. On the base of money neutrality, an increase in money supply causes a proportional increase in domestic prices in the long run. Expansionary monetary policy provokes devaluation of home currency, which makes extra pass-through into domestic prices.

On the empirical ground, there are numerous studies on the determinants of exchange rate pass-through. Choudhri and Hakura (2001) examined the impact of inflationary environment on the domestic price in 71 developing and developed countries over the period of 1971-2000. The empirical findings suggest that inflationary environment has a positive and significant effect on the domestic price in the two groups of countries. Gagnon and Ihrig (2001) by applying panel data approach investigated the relationship between CPI pass-through and inflation stabilization for eleven industrial countries during the 1970-2000. Their findings show that the pass-through generally declined in the 1990's and change in the pass-through is significantly related to the variability of inflation. Moreover, the results of this study indicate that there is no systematic relationship between the pass-through and the monetary policy behavior. Devereux and Yetman (2002) analyzed the impact of monetary policy on the consumer price

index in 121 developing as well as industrial countries over the 1990-2000. They concluded that exchange rate pass-through is highly related to the adoption of monetary regime and exchange rate pass-through has declined by switching to the inflation targeting regime. In another study, Bailliu and Fujii (2004) have investigated the effect of inflationary environment on the exchange rate pass-through in 11 developed countries. Their conclusions reveal that ERPT declines when the economy shifts to a low inflationary environment. Using of monthly time series data and panel data approach, Binici and Carrera (2006) have explored the impact of monetary policy on the domestic price in OECD countries during the 1975:1-2002:12. The results of this paper indicate that money supply as a proxy for monetary policy has a positive and significant effect on domestic price in these countries and exchange rate pass-through has declined by adapting the inflation targeting monetary regime.

Karoro (2007) has analyzed the effects of exchange rate variations and inflationary environment on the domestic price in South Africa over the 1980-2005. The results of this paper suggest that exchange rate variations and inflationary environment have positive and significant effect on the exchange rate pass-through. Using the Johansen's co-integration approach, Siklar and Caglarirmak (2007) found out that exchange rate pass-through has declined in Turkey after adopting an inflation targeting monetary regime. Moreover, low exchange rate pass-through provides greater freedom for pursuing credible monetary policy such as inflation targeting. Mishkin (2008) by using a VAR model investigated the impact of monetary policy on the exchange rate pass-through for 13 industrial countries over the 1989:1-2004:4. The results of study show that the degree of exchange rate pass-through has declined with shifting to a low inflationary environment. Sowah (2009a) by applying the dynamic panel data approach explored the effects of monetary regime and inflationary environment in developing and emerging economies over the 1980-2005. The main findings of this study suggest that there is a positive association between monetary regime and exchange rate pass-through. Moreover, countries with the fixed exchange rate regime have experienced a low exchange rate pass-through. Adopting the method of time varying parameter (TVP), Nogueira et al (2010) estimated the exchange rate pass-through model in presence of inflationary environment for 12 developed and emerging economies over the 1980-2007. The empirical results indicate that lower inflationary environment has led to a reduction in ERPR. More recently, Winkelreid (2011) has analyzed the relationship between exchange rate pass-through and inflationary environment for Peru during the 1998-2009. The results of model estimation by SVAR approach suggest that exchange rate pass-through has declined gradually with a switch to low inflation environment. Ivohasina (2012) has studied the effect of exchange rate pass-through to domestic prices and its determinants in sub-Saharan African countries over the period of 1970-2006. They noticed that exchange rate pass-through is lower in countries with more flexible exchange rate regimes and in countries with a higher income. Moreover, a low inflation environment, a credible monetary policy, and a sustainable fiscal policy are associated with a lower pass-through.

In Iranian economy, Shajari et al. (2005) has estimated the exchange rate pass-through over 1959-2001. The results of model estimation reveal that exchange rate pass-through for Iran is incomplete and elasticity of import price with respect to the exchange rate is about of 0.5. In other study, Shajari et al. (2006) by using fuzzy logic have investigated the linkage between monetary policy, trade openness and exchange rate pass-through in Iran over the 1959-2002. The results of this study show that the trade openness and monetary policy have positive and significant effects on the exchange rate pass-through. By applying ARDL technique, Asgharpur et al. (2011) estimated the exchange rate pass-through model over the 1971-2007. The empirical result shows that the elasticity of export price index with respect to the exchange rate in Iran is around 0.78.

The overall conclusion from the above mentioned studies indicates that the credible monetary regime such as inflation targeting regime will retarded the exchange rate pass-through. However, none of these studies have attempted to look at the impact of monetary regime as well as inflationary environment in two different categories of countries with distinguished monetary regimes.

So, the prime objective of this study is to fill out this gap by investigating the effects of monetary regime and inflationary environment for two groups of countries. The first group consists of the countries with the exchange rate anchor and another group comprise of countries with the inflation targeting monetary regime.

In order to examine the responsiveness of domestic price to the exchange rate pass-through

in presence of the monetary regime and inflationary environment in selected countries, the de-facto exchange rate classification and dynamic panel data approach have been used over the period of 1999-2010.

## 3. The Model

In order to evaluate the effects of monetary regime and inflationary environment on domestic price in the countries with exchange rate anchor versus inflation targeting monetary regime,[1] according to the economic literatures as well as empirical studies by Sowah (2009a), Nogueira et al. (2010) and Ivohasina (2012), the following dynamic model in terms of logarithm has been specified:

$$LCPI_{it} = \beta_i + \beta_1 LCPI_{it-1} + \beta_2 LNEER_{it} + \beta_3 \text{Re}gime * LNEER_{it} + \beta_4 Ei * LNEER_{it} + \beta_5 LMS_{it} + \varepsilon_{it} \quad (1)$$

In the above equation, *CPI* is consumer price index[2]; $CPI_{t-1}$ represents the first lag of consumer price index as a proxy for inflation persistence; *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 *NEER* instead of nominal or real exchange rate allows for some variation in the exchange rate and makes it possible to estimate the degree to which the exchange rate fluctuations get passed through to consumer price index. According to the IMF definition for NEER, this variable is expressed as an index of the foreign currency value per unit of domestic currency. Hence, an *increase* in NEER represents appreciation of domestic currency. *Regime*LNEER* is the interaction effect of monetary regime with nominal effective exchange rate in the two groups of countries. Regime is a dummy variable that takes value one, if a country adopt exchange rate anchor or inflation targeting monetary regime between1999-2010[3] and zero otherwise. $E_i$*LNEER* is the cross effect of inflationary environment with nominal effective exchange rate. *Ei* is a dummy variable which equal to one, if a country has a high inflation rate (more than average inflation) and otherwise zero. MS is nominal money supply as a proxy for monetary policy.

As discussed in review of literature, the expected sign of coefficients are: $\beta_1, \beta_5 > 0, \beta_2, \beta_4 < 0$ and $\beta_3$ for countries with the exchange rate anchor monetary regime should be negative and for the second group is expected to be positive.

To investigate the joint effects of the monetary regime and inflationary environment on the domestic prices in the both groups of countries, the empirical model has been estimated by dynamic panel data approach.

One of the important methods in estimating dynamic panel data models has proposed by Arrelano and Bond (1991) that is suitable and credible for a panel of countries with data available for a short time span. In the AB method, the structural model (Eq. (1)) is first differenced in order to eliminate the country fixed effects.

Arrelano and Bond suggest that the Sargan test of over-identifying restrictions would be applied to test whether the estimating model is identified. The null hypothesis in the Sargan test indicates the model is over-identified. In other words, the additional instruments are uncorrelated with the error terms. Thus, a failure to reject the null hypothesis supports the use of the AB method. Also, the error term in first difference may not have autocorrelation of order two. If this is violated, then the AB estimation is not consistent[4].

The data set for the all variables of 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

In this section, the empirical results of model estimation by AB approach have been tabulated for the two groups of countries. The results for first group of countries have been reported in Table

[1] . Based on 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.

[2] . The base year for CPI is 2005

[3] .The de-facto 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.

[4] . For more discussion of AB approach refer to the Baltagi (2009)

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

| Explanatory Variables | Coefficient | Z-value | Probability Value (PV) |
|---|---|---|---|
| C | -0.57 | -1.97 | 0.049 |
| $LCPT_{t-1}$ | 0.76 | 32.24 | 0.000 |
| *LNEER* | -0.13 | -3.57 | 0.000 |
| *Regime*LNEER* | -0.0029 | -1.71 | 0.088 |
| $E_i$**LNEER* | -0.0034 | -5.19 | 0.000 |
| *LMS* | 0.094 | 12.09 | 0.000 |
| Sargan Statistics : $\chi^2(16) = 12.24$ PV(0.73) , Observations: 119, Countries: 15 | | | |

***Source:*** *Authors*

The results of Table 1 show that the nominal effective exchange rate has negative and significant effect on the domestic price index in the first group of countries. In other words, an increase in the value of domestic currency against foreign currencies is accompanied by decrease of demand for domestic produced goods and consequently domestic price level will decline. The first lag of consumer price index has a positive effect on the domestic price level in current period. This indicates that increase of inflation expectation with a time lag affect the consumer prices. In addition, the interaction effect of monetary regime with nominal effective exchange rate has negative impact on the exchange rate pass-through. Hence, it is expected that the exchange rate pass-through increased with adoption of exchange rate anchor monetary regime in these countries. The inflationary environment has also negative and significant effect on the domestic price level. Therefore, a shift to a higher inflationary environment tends to raise the exchange rate pass-through. The elasticity of consumer price index with respect to money supply is about 0.094, which shows that one percent increase of money supply has resulted to the 0.09 percent increase in domestic price. The estimation results in the countries with exchange rate anchor monetary regime reveals that the degree of exchange rate pass-through in presence of monetary regime and inflationary environment has been intensified to -0.14. Consequently, the adoption of exchange rate anchor monetary regime which is associated with a high inflationary environment has led to higher pass-through in these countries. Moreover, the Sargan statistics ($\chi^2$) is 12.24 which indicate that the instrumental variable of model[1] is valid and uncorrelated with the error terms. In next stage, the order of autocorrelation in first differenced model is tested by AB statistics. The result of this test has 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 | -2.05 | 0.039 |
| 2 | -0.30 | 0.76 |

***Source***: Authors

According to Table 2, we can argue that the order of autocorrelation in first-differenced errors is one. This result supports the use of AB method for elimination of the country fixed effects.

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

[1] . In the empirical model, the second lag of *LCPI* is considered as an instrument variable.

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

| Explanatory Variables | Coefficient | Z-value | Probability Value (PV) |
|---|---|---|---|
| $C$ | -1.63 | -13.90 | 0.000 |
| $LCPT_{t-1}$ | 0.52 | 46.06 | 0.000 |
| $LNEER$ | -0.1 | -29.55 | 0.000 |
| $Regime*LNEER$ | 0.0016 | 5.28 | 0.000 |
| $E_i*LNEER$ | -0.0039 | -20.07 | 0.000 |
| $LMS$ | 0.16 | 27.76 | 0.000 |
| Sargan Statistics : $\chi^2(33) = 41.09$ PV(0.16) , Observations: 119, Countries: 15 | | | |

***Source***: Authors

The empirical results for the countries with inflation targeting regime, indicate that inflation persistence has positive effect on the consumer price index in current period. The coefficient of nominal effective exchange rate is negative, which shows that an increase in value of domestic currency versus foreign currencies will lead to reduction in both demand for domestic goods and also their price level. In addition, cross effects of monetary regime with nominal effective exchange rate in these countries is positive and significant. In other words, a shift to the inflation targeting regime tends to decline the exchange rate pass-through. The interaction effect of inflationary environment with nominal effective exchange rate has negative and significant impact on the exchange rate pass-through. Overall, the degree of exchange rate pass-through under the monetary regime and inflationary environment is -0.1, which its absolute value is less than of that in countries with the exchange rate anchor monetary regime. This conclusion drawn from the second group of countries suggests that, the adoption of inflation targeting monetary regime has led to a lower pass-through effect. Similar to previous case, the money supply in these countries has positive and significant effect on the consumer price index.

The results of Sargan test for this model has confirmed the validity of instrumental variable. In order to examine autocorrelation in the first differenced model, we used the AB test. The result of Arrelano and Bond test has been reported in Table 4.

**Table 4: Arellano-Bond test for order of autocorrelation in first-differenced errors**

| Order | Z-value | Probability Value (PV) |
|---|---|---|
| 1 | -1.36 | 0.17 |
| 2 | 0.49 | 0.62 |

***Source***: Authors

With respect to the results of AB test, it can be said that there is no autocorrelation between differenced error terms and AB is the appropriate technique for model estimation.

## 5. Conclusion

This paper analyzes empirically the effects of monetary regime and inflationary environment on the degree of exchange rate pass-through in countries with the exchange rate anchor versus the countries with inflation targeting monetary regime over the period of 1999-2010.

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

The main findings of this study reveal that nominal effective exchange rates as well as interaction effects of inflationary environment and nominal effective exchange rate have negative and significant impact on the domestic price level in both groups of countries. In addition, the first lags of consumer price index and money supply have positive effects on the consumer price index. Moreover, cross effects of monetary regime with nominal effective exchange rate has negative effect on the price level in first group of countries and positive impact in the second group of countries respectively. The

elasticity of consumer price index with respect to money supply is positive, which is indicate that increase in money supply causes a proportional increase in domestic prices in the two groups of countries.

Overall, the effect of inflationary environment on the domestic price is positive which confirms Taylor hypothesis in these countries. The results of this paper are consistent with theoretical framework of exchange rate pass-through and empirical studies such as Sowah (2009b), Nogueira et al (2010) and Ivohasina (2012).

An important policy implication of this paper suggest in formulating monetary policy rules, the dependency of the exchange rate pass-through on the inflationary environment and monetary regime should be taken into consideration. Moreover, in the countries with exchange rate anchor monetary regime and high inflation rate, policy makers and monetary authorities should adopt credible monetary policies such as inflation targeting to control the effect of exchange rate fluctuations on the domestic price level.

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