ARE THERE ASYMMETRIES IN THE NEXUS BETWEEN EXCHANGE RATE AND DOMESTIC PRICES? EVIDENCE FROM TURKEY

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This study examines the presence or otherwise of asymmetries in the relationship between exchange rate and domestic prices (both consumer and producer prices) in Turkey. Monthly series on the study variables were collected for the period from January 2003 to April 2018. The econometric analysis was carried out by employing the Threshold Autoregressive (TAR) and Momentum Threshold Autoregressive (MTAR) models following the approach of Enders and Siklos (2001). The findings of the study suggest the presence of asymmetry in the relationship between exchange rate and both consumer and producer prices in Turkey. It was further discovered that adjustments of both consumer and producer prices following exchange rate depreciation appear to be more sluggish relative to an appreciation of exchange rate. The study emphasized the inappropriateness of adopting a one-size-fits-all approach to managing price level dynamics following exchange rate fluctuations.

Key words: exchange rate, pass-through, inflation, asymmetry, TAR, prices, Turkey, non-linear

INTRODUCTION

The relationship between exchange rate and domestic prices has continued to be a source of discussion among economists and policy makers due to its relevance in monetary policy decisions. Changes in the exchange rate and import prices are among the major factors that determine the level of domestic price inflation (Ozmen and Topaloglu 2017). The case of Turkey is not different. The high level of importation by Turkey makes it domestic prices susceptible to the effect of exchange rate fluctuations. The mechanisms through which exchange rate fluctuation affects domestic prices include the price of imported inputs used for domestic production; similarly, exchange rate fluctuation creates uncertainty about the price of foreign commodities and this can have an influence on domestic price determination, hence producing an effect on the general price level. (Monafred and Akin 2017; Agenor and Montiel 1996).

Although out of the scope of this paper, one of the methods through which the effect of exchange rate on domestic prices can be measured is through the Exchange Rate Pass Through (ERPT). As postulated by Aron et al (2014), the traditional definition of ERPT being the change in import prices (valued in domestic currency) in response to change in exchange rate has now been re-coined to mean the effect of exchange rate movements on consumer or producer prices. Exchange rate pass-through to domestic prices can be in two folds; complete pass-through and incomplete (partial) pass-through, however, most empirical works suggest the presence of incomplete ERPT (Li and Zhang 2018; Comunale and Kunovac 2017; Faruqee 2004). The complete pass-through of exchange rate is the situation where a certain percentage change in exchange rate influences domestic prices to change by a proportionate rate; while an incomplete pass-through is where a certain percentage change in exchange rate influences a less than proportionate change in domestic prices.

Empirical studies examining the relationship between exchange rate and domestic prices have largely been geared towards symmetric modeling of the relationship between the variables with less attention directed towards appraising the asymmetric nature of the relationship. Although theoretical underpinnings such as the Purchasing Power Parity (PPP) theory of exchange rate, McCarthy (1999) and Taylor (2000) models provide a basis for the symmetric relationship between exchange rate and domestic prices; models such as Pollard and Coughlin (2004) provide underpinnings for asymmetries in the relationship between the variables.

The year 2001 saw Turkey's fiscal and currency crises leading to a high inflation rate, massive exchange rate depreciation and an increase in unemployment among other economic challenges. Following this crisis, a new economic framework was adopted by the Turkish authorities aimed at lowering public deficits and decreasing inflation among others (Oral et al, 2011). In the pre-2001 crisis period, Turkey adopted the exchange rate pegging system, this collapsed following the crises. As Sahinbeyoğlu (2007) noted, in a bid to curb inflation, inflation targeting (hereafter IT) was gradually adopted becoming fully implemented in the year 2006. The implementation of IT saw a fall in the inflation rate from 73.11 percent in January 2002; 26.38 percent in January 2003; 16.22 percent in January 2004; down to 9.24 percent in January 2005 (TCMB 2018). To ensure exchange rate stability, the Turkish authorities adopted the floating exchange rate system regime starting in the year 2002 (Görmez and Yılmaz, 2007).

Although studies such as Karahan (2017) and Tunç & Kılınç (2018) investigated the nexus between exchange rate and consumer prices in Turkey; and studies such as Siklar et al (2017), Volkan et al (2007), Leigh and Rossi (2002), Dedeoğlu and Kaya (2014) examined the nexus between exchange rate and both consumer and producer prices. All these studies modelled a symmetric relationship between the variables. We intend to build upon these studies by employing an asymmetric framework to examine the relationship between exchange rate fluctuation and both producer and consumer prices in Turkey for the post reform period.

THEORETICAL CONSIDERATIONS

The nexus between exchange rate and domestic prices are entrenched in theory. The pass-through of exchange rate to domestic prices can be through direct or indirect channels. The direct channel entails the prices of intermediate goods used for further production by firms. Change in exchange rate affects the value of these products when valued in local currency hence pushing up the production cost which has the tendencies to affect prices. Taylor (2000) in his model hypothesized that the altering of prices by firms following the change in cost depends on the inflation environment; high inflationary regime witnesses a higher degree of pass-through to consumer prices. The model puts forward that the existing inflation environment curtails the ability of firms to pass-through cost in their pricing decisions, hence limiting the magnitude of the effect of exchange rate fluctuations on consumer prices.

McCarthy's (1999) model explains the effect of changes in exchange rate and import price fluctuation on the domestic producer and consumer prices by putting inflation at the stages of import, production, and consumption. Inflation is assumed to consist of several components such as the expected inflation from the previous period, the supply and demand shocks, as well as the exchange rate shocks on inflation. Under the McCarthy (1999) model, variation in exchange rate is treated as endogenous hence allowing the pass-through to be tracked at each stage of the distribution chain.

Pollard and Coughlin's (2004) model of exchange rate effect signifies that changes in production costs by firms have a direct bearing on price-cost margins hence providing a framework for understanding how prices respond to changes in exchange rate via cost changes. The model assumes that firms utilize both domestic and imported inputs in production. The model posits that the degree of pass-through depends on the responsiveness of marginal cost to changes in exchange rate and of markup to changes in price. In the Pollard and Coughlin (2004) model, since cost affects profit margin, the changes in exchange rate are reflected in the pricing decisions of firms. The effect of exchange rate on domestic prices depends on the ability of firms to switch between domestic and foreign inputs, this is also determined by the prices of these inputs.

The second component of the direct channel is the prices of imported consumable goods valued in local currency. The Law of One Price (LOP) supports this with its major thrust being that the price of a commodity in a market should equate the price of the same good in another market if measured in the same currency. It puts forward that regardless of where the product is bought, its value should be the same. The Purchasing Power Parity is built upon on the LOP which employs price indices across countries is used as a basis for analyzing the degree of pass-through of exchange rate (Berga 2012).

The indirect channel of exchange rate effect on prices as postulated by Karahan (2017) is where changes in exchange rate influence aggregate demand. A depreciation of the exchange rate makes foreign products more expensive when priced in the local currency hence pushing consumers to look for alternatives among local products. The increase in demand for the local substitute if not accompanied by an increase in supply particularly if some components of the product are imported and their cost more expensive can lead to an increase in prices. The reverse is the case for exchange rate appreciation.

DATA AND METHODS

To achieve the study objective, the Threshold Autoregression (TAR) and Momentum Threshold Autoregression (MTAR) models of Enders and Siklos (2001) were employed. The TAR and MTAR models are threshold regression models that can be used to determine the presence or otherwise of an asymmetric relationship between variables. The TAR and MTAR models are an extension of the conventional Engle and Granger (1987) two-step to cointegration approach. Before commencing the analysis, there is a need for determining the order of integration of the variables via the unit root test. If all variables are found to be integrated of order one, the next step is to determine if the variables have a long run association (cointegration).

For the symmetric cointegration test, we employed the Engle and Granger (E and G) cointegration test. To do this, we start by running a simple regression between the variables say X_t and Y_t as specified in equation 1.

$$Y_t = C_0 + \gamma X_t + e_t \tag{1}$$

Where: C_0 – Intercept Term; γ – slope coefficient and e_t - residual term.

From the estimated equation (1), we get the linear combination of the variables which is represented by the residual (i.e estimated e_t). The estimated residual can be represented by equation 2.

$$\mu_t = \hat{Y}_t - \hat{C}_0 - \hat{\gamma} X_t \qquad (2)$$

To test for cointegration, we subject eq.2 to ADF unit root test by estimating the specification in equation 3.

$$\Delta\mu_t = \rho\mu_{t-1} + \sum_{i=1}^{j} \beta_i \Delta\mu_{t-j} + \varepsilon_t \qquad (3)$$

Where: Δ is the difference operator and ε is iid.

After estimating eq.3, and if we find to be stationary i.e. the null hypothesis of no cointegration (ρ = 0) being rejected, we conclude that there is a long run relationship among the variables. In other words, the variables are linearly (symmetrically) cointegrated.

Having established the presence of linear cointegration between the variables, the next step in the analysis is to determine whether or not asymmetric cointegration exists between the variables (Abubakar, 2019). To do this, we employ the TAR and MTAR model of Enders and Siklos (2001). This model performs two major functions; it determines both the presence or otherwise of asymmetric cointegration as well as if the adjustment patterns of the errors are symmetric or otherwise. The TAR and MTAR model is an extension of the Engle and Granger Two Step to Cointegration Approach. Under the TAR and MTAR model, the lag of the residual in equation (2) which is a linear combination of the variables () is partitioned into two; one to account for deviations above the threshold and the other for deviations below the threshold. The threshold value (τ) is determined following the approach of Chan (1993) where the top and bottom 10% or 15% of the will be excluded and the remaining first lag of the errors will each be treated as a potential threshold value, the endogenously determined model's τ with the lowest Residual

Sum of Squares (RSS) is assumed to be the true threshold value (Aliyu and Tijjani, 2015). Having determined the threshold value, to partition the errors into below and above the threshold, we employ a Heaviside indication function (I_t) which is a dummy variable that takes the form of:

For TAR Model;

$$I_t = \begin{cases} 1, & if\ \mu_{t-1} \geq \tau \\ 0, & if\ \mu_{t-1} < \tau \end{cases} \tag{4}$$

For MTAR Model;

$$I_t = \begin{cases} 1, & if\ \Delta\mu_{t-1} \geq \tau \\ 0, & if\ \Delta\mu_{t-1} < \tau \end{cases} \tag{5}$$

In order to test for asymmetric cointegration, we substitute eq (4) into eq (3) for TAR or eq (5) into eq (3) for MTAR model. The equation for testing foe the presence of asymmetric cointegration is then specified as:

$$\Delta\mu_t = I_t\rho_1\mu_{t-1} + (1 - I_t)\rho_2\mu_{t-1} + \sum_{i=1}^{j} \beta_i \Delta\mu_{t-j} + \varepsilon_t \tag{6}$$

From eq (6), and accounts for adjustments below and above the threshold value respectively. The speed of adjustment is captured by the coefficients of ρ_1 and $\rho_{2.}$ What differs the MTAR specification from TAR specification is that if the adjustment pattern is found to be persistent in one direction say adjustment below threshold is more persistent than adjustment above threshold by a large magnitude, we employ the MTAR model where in the specification will be based on the change in the lagged sequence of the residual (as specified in eq (5). To decide whether to employ TAR or MTAR, we compare the absolute values of ρ_1 and ρ_2, if they are very much apart, we can employ the TAR model, otherwise, we employ the TAR. As a rule, just as in the ADF test, the coefficients must be $-2 < (\rho_1, \rho_2) < 0$.

The null hypothesis of testing for cointegration is specified as $\rho_1= \rho_2=0$ with the alternative hypothesis that at least either ρ_1 or ρ_2 is not zero. If this null hypothesis is rejected, we conclude that there exists asymmetric cointegration among the variables. To determine whether the adjustment pattern is symmetric or asymmetric, we test the null hypothesis of $\rho_1 = \rho_2$ with the alternative hypothesis of asymmetric adjustment specified as $\rho_1 \neq \rho_2$. Should the null hypothesis be rejected, we conclude that the adjustment process is asymmetric hence inferring that the relationship between the variables is non-linear. Both tests have an F-test distribution with critical values available in Enders and Siklos (2001). The TAR and MTAR model allow the inclusion of an exogenous variable into its cointegration equation specification. This is to say you can have two endogenous variables and an exogenous variable in your equation (Enders and Siklos 2001).

Data on all study variables (Exchange rate - Exr; Consumer Prices- CP; Producer Prices- PP; Interest rate- Int) were sourced from the Central Bank of Turkey's online statistical database and collected for the period January 2003 to April 2018.

RESULTS AND DISCUSSION

Stationarity Tests

The study adopted the Augmented Dickey Fuller (ADF) by Dickey and Fuller (1979); Philps-Perron (PP) by Philips and Perron (1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) by (Kwiatkowski et al, 1992) unit root test to determine the order of integration of the variables i.e. the number of times the series need to be differenced in order to become stationary. While the ADF and KPSS test is parametric; the PP test is non-parametric. Both tests were employed in order to have more certainty about the order of integration of the variables. The null hypothesis of both the ADF and PP test is "series has a unit root (i.e. non-stationary)"; on the other hand, the null hypothesis of the KPSS test is "series are stationary". The null hypothesis is rejected if the test statistic is greater than the critical value at the chosen level of significance. Rejecting the null hypothesis in the case of ADF and PP signifies that the series are stationary. However, in the case of KPSS, non-rejection of the null hypothesis indicates that a series is stationary. The result of unit root tests employed is presented in Table 1.

Table 1: *Unit Root Test Result*

Variables	Level		First Difference		Order of Integration
	Intercept	Intercept & Tend	Intercept	Intercept & Tend	Intercept
ADF Unit Root Test Result					
Exr	1.23	-2.18	-9.80**	-	I(1)
CP	0.68	-1.98	-10.02**	-	I(1)
PP	4.24	0.38	-8.65**	-	I(1)
Int	-2.45	-1.87	-4.24**	-	I(1)
Philips-Perron Unit Root Test Result					
Exr	1.09	-2.02	-9.19**	-	I(1)
CP	0.29	-3.12	-11.82**	-	I(1)
PP	0.10	-2.60	-7.77**	-	I(1)
Int	-2.64	-1.80	-9.48**	-	I(1)
KPSS Unit Root Test Result					
Exr	1.47**	0.411**	0.58	0.023	I(1)
CP	1.78**	0.20**	0.14	0.138	I(1)
PP	1.77**	0.13*	0.08	0.079	I(1)
Int	0.91**	0.34**	0.37	0.037	I(1)

Source: Author's computation using Eviews9

** Signifies rejection of the null hypothesis at 5% statistical significance level.

Note: Where Exr- Exchange Rate; CP- Consumer Prices; PP- Producer Prices; Int- Interest Rate.

Table 1 presents the results of both the ADF and PP unit root test. From the result, all series were found to be stationary only after taking their first difference i.e. the variables were not found to be stationary in their level form. We could thus say that all series are integrated of order one. Since all series are found to be non-stationary, the next step in the analysis is to determine the existence or otherwise of long run association (cointegration) among the variables (Abubakar, 2018).

Eagler and Granger (1987) Test Result

The E & G (1987) cointegration test was employed to determine whether or not variables have long run association. Being a bivariate single equation test, it was applied to both the CP and PP models individually. The result is presented in Table 2.

Table 2: *Engle and Granger (1987) Cointegration Test Result*

Model (Variables)	Coint. Coeff (Prob.)	Inference
CP (CPI & EXR)	-3.25 (0.00)**	Presence of cointegration
PP (PPI & EXR)	-2.92 (0.00)**	Presence of cointegration

Source: Author's computation using Eviews9.

** indicates rejection of the null hypothesis at 5% significance level.

Table 2 presents the result of E & G cointegration test. It could be inferred that from the result presented, both the CP and PP models show the presence of cointegration among the variables. It could be concluded that CPI and EXR have long run associations so also are PP and EXR. Since the E and G (1987) test assumes linear relationship among the variables and our major objective is to identify whether or not the relationship between our variables is non-linear, we will employ the TAR Cointegration test which has a non-linear framework.

Asymmetric Cointegration Tests Results

The TAR and MTAR cointegration model was employed to test for the presence of asymmetric cointegration among the variables. The findings of these models will provide us grounds to make an informed decision about the nature of the relationship between the variables, hence answering the question of whether the nexus between the variables is symmetric or asymmetric. The results are presented in Table 3.

Table 3: *TAR and MTAR Model Result*

	CP Model		PP Model	
	TAR	**MTAR**	**TAR**	**MTAR**
ρ_1	-0.035	-0.044	-0.019	-0.014
ρ_2	-0.192	-0.189	-0.166	-0.136
Ψ_f	7.244*	5.230	8.913*	6.930
	(7.164)	(8.359)	(6.058)	(8.105)
Ω_f	7.471*	6.422	8.023*	7.871
	(7.161)	(8.197)	(7.147)	(8.224)
τ	*-0.109*	*-0.029*	*-0.085*	*-0.006*

Source: Author's computation using Eviews9

*signifies statistical significance at 5% level.

In table 3, Ψ_f represents the F-statistic for testing the hypothesis of asymmetric cointegration ($\rho_1 = \rho_2 = 0$); Ω_f represents the F-statistic for testing the hypothesis of asymmetric adjustment ($\rho_1 = \rho_{2)}$, while τ represents the threshold value. The critical values of TAR and MTAR (Ψ_f and Ω_f) were generated by Monte Carlo simulation based on Enders and Siklos (2001) using Eview9 and are presented in parenthesis.

Table 3 presents both the consumer prices (CP) and producer prices (PP) TAR and MTAR model asymmetric cointegration test results. In both the models, an exogenous variable interest rate was included. The negative values of ρ_1 and ρ_2 suggest convergence (Aliyu and Tijjani, 2015; Abubakar, 2019). From the TAR results of the CP model, the F-statistic of asymmetric cointegration ($\Psi_f = 7.244$) was significant, leading to the rejection of the null hypothesis of the absence of cointegration among the variables. The F-statistic for a symmetric adjustment (Ω_f = 7.471) between the variables was significant, leading to the rejection of the hypothesis of symmetric adjustment and the conclusion that the adjustment pattern between the variables is asymmetric. The MTAR result of the CP model identified a threshold value of – 0.029, however, the non-significance of the F-statistic of both symmetric cointegration and symmetric adjustment is an indication that for this model, the adjustment pattern is not persistent in one direction, hence we negate the MTAR model and focus on the TAR model results. We could thus infer from the TAR results that the nexus between exchange rate and consumer prices exhibits an asymmetric nature.

From the TAR results of the PP model, the F-statistic of asymmetric cointegration (Ψ_f = 8.913) was found to significant leading to the inference that asymmetric long run relationship between producer prices and exchange rate exists. The F-statistic for an asymmetric adjustment (Ω_f = 8.023) was also found to be significant leading to the conclusion of the presence of asymmetry in the adjustment pattern between the variables. The results of the MTAR model show the F-statistic of both the symmetric cointegration and adjustment to be insignificant, implying that persistence of adjustment in one direction does not exist hence making inferences to be based upon the TAR model. From the PP results, we could conclude that the nexus between exchange rate and producer prices is also asymmetric in nature. On the overall, exchange rate is found to have an asymmetric relationship with both producer prices and consumer prices in Turkey. Specifically, the speed of adjustment following exchange rate depreciation (ρ_1) of both models appears to be more sluggish than that of exchange rate appreciation (p_2). What this signifies is that producer and consumer prices return to their long run equilibrium levels faster when exchange rate appreciates (decrease in Turkish Lira needed to purchase a unit of foreign currency) than when exchange rate depreciates. Inferences that can be drawn from this finding is that exchange rate depreciation leads to longer time span of deviations of domestic prices from their equilibrium level than exchange rate appreciation, pointing to the notion that exchange rate depreciations exert greater impact than exchange rate appreciations on domestic prices in Turkey.

CONCLUSIONS

The study set out to examine the nature of the relationship between exchange rate and domestic prices (i.e. both consumer and producer prices) for Turkey during the post economic reform period following the year 2001 fiscal and currency crises. In particular, we tested for the presence or otherwise of asymmetry in the relationship between exchange rate and domestic prices. The findings of the study confirmed the presence of asymmetry in the relationship between the variables. This denotes the fact that the behavior of consumer and producer prices following exchange rate depreciation and appreciation exhibit different patterns. This leads to the conclusion that the relationship between the variables is non-linear. Further, it was discovered that adjustments of both consumer and producer prices following exchange rate depreciation appear to be more sluggish relative to exchange rate appreciation.

The findings of the study are important to the monetary authorities and policy makers because it will shed light on designing the right policy framework to tackle the bearing of exchange rate fluctuations on domestic prices. Specifically, the study gives insight into the fact that the behavior of domestic prices following exchange rate appreciation differs from that of exchange rate depreciations, therefore, a one-size-fits-all approach to price level management might be inappropriate. The study suggests the need to tailor specific measures following exchange rate appreciations on one hand and specific measures towards depreciation on the other hand with a view to achieving more effective management of prices by the authorities.

Although the scope of the paper is limited to ascertaining whether or not asymmetries exist in the relationship between exchange rate and domestic prices in Turkey, suggested areas of further research includes the examination of the dynamics of asymmetric pass-through of exchange rate to domestic prices in both short and long run.

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