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Exchange Rate Dynamics, Inflation and Economic Growth: Empirical Evidence from Turkish Economy

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Abstract: This study investigates the close link between real effective exchange rate and economic growth for Turkey spanning period 1970-2015 using time series data. The study uses autoregression distributed lag model (ARDL) and Toda–Yamamoto (TY) Granger non-causality tests to achieve the research objective. All the variables were found stationary after first differencing with drift except GDP growth which is stationary at level. The empirical result demonstrates that real effective exchange rate negatively affects economic growth in the short run; however, it exerts significant positive impact on growth in the long-run. We also found a uni-directional causality running from real exchange rate to GDP growth rate. The value of the error correction parameter turns out to be negative (-1.34) and statistically significant at 0.0 level as expected. This is supported by bound test of long-run relationship. The overall conclusion is that based on the substantial dependence of Turkish economy on import of critical factor inputs for domestic production, maintaining a comparatively strong exchange would possibly exert positive impact on economic growth in the long-run.

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I. SECTION ONE: INTRODUCTION

The link between real exchange rate (RER) and economic growth has been a subject matter of immense debate in economic literature. Theoretical perspectives differ ranging from nonexistence of any relationship connecting these variables, to a positive relationship, and even to an inverse one. Similarly, econometric investigations up to present have supplied indefinite outcomes. This affects advancing of a generalised conclusion and complete support for any of the three standpoints. In the midst of all these, the issue has of late resurrected to the forefront of intellectual and scholarly discuss following Rodrik's (2008) presentation of new transmission mechanism involving changes in the exchange rate policy and output growth. Since then, series of empirical works stimulated by the disparity between growth paths of developing economies in South Eastern Asia, Africa, especially Sub-Saharan Africa and Latin American economies have grown the world over.

The movement of RER around its equilibrium level can cause negative or positive effects on GDP. In most emerging economies, significant interest has been shifted into the field of foreign exchange management to appreciate the role competitive exchange rate in accelerating economic performance (Eichengreen, 2007; Rodrik, 2008; Razmi, Rapetti & Skott (2009). Rodrik (2008) particularly maintains that the connections between undervalued RER and growth are largely positive in developing economies. To investigate the role of equilibrium exchange rate that permits a sound and sustainable growth, scholars have used diverse concepts to define the RER variations, such as exchange rate misalignment, exchange rate uncertainty and exchange rate dynamics. In all these, existing studies suggest that a highly unpredictable exchange rate has negative impacts and reasonably high exchange rate has positive impacts on growth path of an economy. Note that in practice, the currencies in transition and emerging economies are generally undervalued or overvalued.

Ma & McCauley, (2011) contend that intermediate exchange rate regime is positively linked with growth in emerging economies, although it is severely affected by flexibility. Comparatively, floating exchange rate regimes do not show any considerable impact on the developed economies. Therefore, finding the appropriate equilibrium exchange (whether undervalued or overvalued) is largely a problem of less developed and emerging countries like Turkey. Exchange rate undervaluation indicates that the currency is lower than it should be or seriously depreciated, while exchange rate overvaluation means that the exchange rate of one currency is higher than it ought to be (Tang, 2015).

From the above, it is apparent to recognize at least three different perspectives establishing relationship between growth and RER. In the first instance, it reveals that an undervalued RER encourages resource reallocation and restructuring from the non-tradable to the tradable sector. Eichengree (2007) points out that it is essential to the process of learning-by-doing, poistive externalities and technological spillovers. The second stance accentuates the function of competitive RER in soothing the foreign exchange limitation on economic growth. The studies that emphasize the centrality of competitive exchange rate in easing foreign exchange underscores the position that a competitive level of the real exchange rate spurs investment via structural change, which correspondingly, eases the balance-of-payments restrictions. Therefore, exchange rate policy can influence growth not only by enhancing short run competitiveness but also by rising inducements to invest and to promote technological expansion.

However, the third channel through which exchange appreciation could positively impact growth is based on the structure of domestic production. This implies that if domestic production is structurally depend on import of factor inputs, RER appreciation maybe be necessary. This perspective maintains that a positive shock to the exchange rate (an unanticipated appreciation or overvaluation) decreases the cost of imported intermediate goods, increasing domestic output and decreasing the cost of production.

The objective of this paper is to throw more light on this subject and add to existing literature given the dynamism of exchange rate in the Turkish Lira. In essence, the main contribution of this work is to present further substantiation, using autoregression distributed lag econometric model (ARDL).The experience of Turkey is interesting for the analysis of exchange rate on the external sector. Turkey earlier underwent major structural reforms and moved to a flexible exchange rate system with an objective of enhancing competitiveness and stimulates export growth. However, given the enormous dependence of the economy on imports of critical factor inputs for economic production, a careful re-evaluation of foreign exchange policy stands is necessary. We focus on the effects of real effective exchange rate on growth in both short and long time periods

It is well established that a country specific study such as ours often accounts for country specific problem. Therefore, doubts concerning strength and validity of research outcomes that are often related with cross-sectional are avoided. This paper specifically investigates the linkage between real effective exchange rate, inflation and growth which is rarely studied in the context of Turkish economy.

The structure of this article is as follows: the next section presents review of both the theoretical and empirical literature. Section three covers model specification and estimation. The final section concludes and gives possible policy implications of the research.

II. REVIEW OF RELATED LITERATURE

The key purpose of this research is to investigate the short-run and long-run effects of the real exchange rate on overall economic growth. As shown earlier, real effective exchange rate can influence long run economic growth via its endogenous effects on income elasticities of exports and imports, as well as through changes in short run price sensitivities. Based on an empirical stance, studies that run standard growth regressions using some measures of real exchange rate misalignment largely employed two basic perspectives: The first assumes real exchange rate as the purchasing power parity level corrected for the effect of Balassa–Samuelson (PPP-based). The second significantly relies on either single model or general equilibrium models, where the computed equilibrium exchange rate is a function of economic fundamentals. This study follows the PPP-based stance and supplies a comprehensive empirical estimation of the relationship between real exchange rate changes and economic growth.

Earlier, Koccat (2008) investigates the relationship between economic growth, exchange rate movements and exports using quarterly data time series and reported that there is no long-run equilibrium relationship between the variables for Turkey based on the Johansen methodology. This outcome is at variance with so many researches on this area and needs to be re evaluated using some contemporary and robust techniques. Contrary to the above, Gülay, Vedat & Pazarlioğluour (2016) carry out a research on the long run relationship between GDP, exchange rate and oil prices to reveal that there exists a long run relationship between economic growth and the real exchange as well as price of crude oil. This research was done by incorporating the underlying effects of for structural breaks for the Turkish economy. Similarly, Çiftci (2014) examines the relationship among economic growth, real exchange rate and current account deficit using co-integration methodology and show that there is long run relationship between the variables. Missio, Jayme, Britto & Oreiro (2015) empirically analyse the relationship between real exchange rate (RER) and growth rate of output by first estimating the effect of the index of RER undervaluation on the rate of output growth in two samples of countries from 1978 to 2007. They presented new finding the link between the variables is non-linear. They conclude that maintaining a competitive level of RER has positive effects on growth rate.

Unlike previous literature Habib., Mileva., & Stracca (2017) employ a model that incorporates external instruments ((i) global capital flows that interact with individual countries' financial openness and (ii) the growth rate of official reserves) to argue that there is a reverse causality running from growth to the real exchange rate. These authors where able to establish that a real appreciation (depreciation) reduces (raises) significantly annual real GDP growth, more than in previous estimates in economic literature. However, this effect specifically affects developing countries and for pegs exchange rate regimes.

Arize (1995) uses error correction, ARCH, and linear moment methodologies on monthly US data spanning 1971 and 1999 and found that a long-run equilibrium relationship exists between real exports, log real effective exchange rate and log real foreign income.

Njong (2008) carries out a study on the Cameroonian economy using annual series from 1980 to 2003 found that real effective exchange rate, real GDP including some selected instruments found a significant relationship among the variables.

Likewise, Duasa (2009) applies TAR and M-TAR methodology on annual data spanning 1999 to 2006 found that real effective exchange rate and trade balance discover a long-run asymmetric cointegration between real effective exchange rate and exports, which underpins growth for the Malaysian economy.

Babatunde (2009) carries out a panel-fixed effect and random effect analysis on Sub-Saharan African countries using annual data on Merchandise exports, REER, average tariff rate, exchange rate, and imports of raw material show that REER stimulates growth through exports.

In the words of Stiglitz (2006:8) "in a global economic system, not all countries can devalue or increase their exchange rates simultaneously. When one currency devalues, another must be appreciating against others currencies". This perspective accentuates the negative effects of unbalanced foreign trade system that explains global inequalities and regional development disparities.

Lopez and Cruz (2000) refute the far reaching conclusion in Thirlwall's balance of payment constrained growth that relative exchange rates are constant and do not play any role in the long-run. Through a cointegration analysis, the authors confirm a critical adjustment role of exchange rate in the determination of long-run growth equilibrium.

On misalignment and instability, Cottani et al. (1990) identify a strong negative correlation between economic growth and RER misalignment index as well as measure of RER instability. The study showed that while misalignment index affects growth through its correlation with investment capital-output ratio (ICOR), exchange rate volatility influences growth through its correlation with investment and trade openness. From a different perspective, Dincera & Kandilb (2011) were able to show that exchange rate fluctuations had a positive net effect on export growth before 2003; the net effect is negative for the post-2002 period for Turkey. The implication of this is that anticipated movement in the exchange rate guides export plans, signalling the importance of managing fundamentals to anchor rational forecasts. Moreover, less unpredictability of the exchange rate is likely to enhance sectoral export growth in Turkey over time Using Nigerian data, Aliyu (2009) shows that changing exchange rate by 10 percent will promote GNP by 0.35 percent. Theory predicts that the effects of movements in the exchange rate on producers could vary with expectation. Anticipated changes in the exchange rate trigger adjustments on the supply-side that could have long-lasting effects on the dependent variable. In contrast, unanticipated changes capture transitory movements that trigger short-term adjustments on the supply and demand sides of the economy. In practice, anticipated movements in the exchange rate vary with agents' observations of macroeconomic fundamentals that influence developments in forecasts under a flexible exchange rate system to which Turkey subscribes. In contrast, unanticipated movements in the exchange rate are the domain of random shocks that could develop unexpectedly with respect to domestic or external development.

From the above, real exchange rate generally expresses one currency's value to another and measures the competitiveness and perhaps the stability of a country. External and internal shocks cause deviations from the real exchange rate's long-run value. These deviations can reach large magnitudes in serious crisis situations. Volatilities in exchange rates affect economic stabilization. From the point of view of economic stabilization, the persistence of exchange rate volatility is an indicator of economic destabilization. Jin (2008) establishes that real exchange rate appreciation leads to positive economic growth for the Russia economy and a negative economic growth for the Japanese and Chinese economies. Gosh et al. (2009) find out that there is a minute or insignificant relationship between real exchange rate and economic development. To this present date, the impact of exchange, inflation and rate on economic growth remains controversial and or inconclusive[1]. The determination of optimal level economic stability is critical to growth. We hence, study the selected measures singly

We turn to our second regressor. Inflation has been substantially identified as an important barometer of economic stability. The mainstream economics has established a negative relationship between inflation and growth. Similarly, the emergence of new growth theorists in 1990s who concentrated more on long run relationships among economic variables also found an inverse link between the variables. This has led to several studies confirming a negative relationship (Fischer, 1993; Barro 1995; Sarel, 1996; Ghosh and Philips, 1998). High inflation has come to signal that fiscal and monetary authorities are not performing their duties accordingly. Accordingly, Erbaykal and Okuyan (2008) examine the nature and relationship between inflation and economic growth in Turkey by applying the Bound test methodology and found a negative and statistically significant short term relationship. Indeed, Turkish economy has been plagued by high and persistent inflation in the last two decades. On the hand, some studies have discovered that relative inflation may spur growth especially in the short run. Researches that demonstrate positive links could be found in (Bruno and Easterly, 1995; Mallik and Chowdhury, 2011). In conclusion, inflation is thus a variable that is of concern not in its own right, but as an easy-to-see indicator of economic mal-performance which need to be examined alongside some direct indicators like unemployment and welfare. The conclusion on the inflation-growth nexus is that there is an inverse relationship between the variables based on broad spectrum of available literature.

III. THE MODEL AND DATA

Cointegration theory is undeniably a significant improvement in theoretical econometrics that has attracted most interest among economists in the last few decades. It basically assumes that cointegrated series will be adjusted to their long-run equilibrium position. Therefore, if the linear combination of non-stationary series does not have any unit root problems, cointegrating relationship exists among them. In order to ascertain whether there is cointegrating relationship between real effective exchange rate, inflation and economic growth on the Turkish economy, the following variables were necessary. a) GDP (GDP); b) Real effective Exchange rate *(EXR)* calculated as $\left(\frac{Pf*E}{Pd}\right)$ where P_f is the foreign price, E is the prevailing exchange rate and P_d is the domestic price level. c) and GDP deflator to measure inflation (DFL). The data was collected from World Bank Development Indicators (WDI) and Federal Reserve of Saint Louis. The yearly series covers the period 1970-2015. The variables were transformed into natural logarithms to permit interpretation of the coefficients in elasticity. To test data stationarity, we carried out two widely used unit root tests; Augmented Dickey Fuller test (ADF) and Phillips-Perron (PP) tests. The econometric methodology used is the auto distributed lag model (ARDL) and TY-granger non-causality test. We confirm the validity of our estimates by carrying several diagnostic checks on our residuals by testing for heteroscedasticity, serial correlation and normality test.

Determination of statistical properties and underlying structure of the variables

The first stage necessitates determining the order of integration for the model variables using ADF and compare with Philips-Perron tests. The major merit of using ADF is that it corrects the possible autocorrelation of errors by adding lagged differences of observed variables (i.e., Y_t), as expressed in the specification below:

[1] Certainly high inflation (especially when unanticipated) creates instability. But there are other factors which may cause instability such as volatile asset prices, volatile levels of growth, volatile bank lending, even labour market unrest, exchange rate volatility, balance of payment imbalances etc (IMF,2015 and Tejvan Pettinger, August 31, 2009)

i. $\Delta LogY_t = \alpha_0 + \alpha_1 logY_t + \sum_{1=i}^{k} \alpha_2 \Delta logY_{t-i} + \varepsilon_t$ (3.1)

The results of the Augmented Dickey Fuller (ADF) test with intercept as recommended by Engle and Granger (1987) and the Phillips and Perron (1988) are presented in Table 2.

Table 2: Unit Root Test

Augmented Dickey Fuller				Philps-Perron
Variable	**t-statistics**	**probability**	**t-statistics**	**probability**
LNGDP				
Level	**-7.19**	**0.000*****	**-7.203**	**0.000**
LNEXR				
Level	**1.288**	**0.99**	**-0.645**	**0.97**
First Diff	**-3.42**	**0.06***	**-2.66**	**0.08***
LDFL				
Level	**-1.475**	**0.530**	**-1.449**	**0.549**
First Diff	**-7.041**	**0.000*****	**-7.085**	**0.000*****

Notes: * indicates statistical significance at the 1% level
*** indicates statistical significance at the 10% level

Autoregression Distributive Lag (ARDL) Model

ARDL model is essentially used to estimate the growth model. One benefit of this methodology is that it offers reliable parameter estimates irrespective of the order integration with no effect on the asymptotic outcome. The idea of the unit root determination as conducted above is to certify that none of the variables incorporated in the model are I (2), as this would nullify the methodology. The ARDL model is preferred to the erstwhile cointegration methodology like the Johansen system-based reduced rank regression technique or the Engle-Granger residual based method because they are limited to only I(1) variables. Another benefit of ARDL is its capacity of being efficient in small sample and uses single equation which makes explanation comparatively easy and straightforward. Moreover, it is feasible to examine cointegration by means of the bound testing process.

A general ARDL (p, q) is specified as follows:

$\Delta y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^{p} \emptyset_i y_{t-1} + \beta' x_t + \sum_{i=1}^{j} \beta y \Delta y_{t-i} + \sum_{i=0}^{q=1} \beta_i * \text{'}q + \psi_t + \mu_t$ (3.2)

$\Delta x_t = P_1 \Delta x_{t-1} + P_2 \Delta x_{t-2} + \cdots + Ps \Delta x_{t-s} + \varepsilon_t$ (3.3)

Here, the core series are *I(1)* though the model offers dependable results even when adapted to comprise a combination of *I(1)* and *I(0)* variables or just *I(0)* variables. The regressand y_t is regressed on its lagged values y_{t-1}, a set of dependent *I(1)* x_t, variables that donot share long run equilibrium amongst themselves, and the integrated lagged series of x_t. Note that x_t is the *k*-dimensional *I(1)* variables. μ_t and ε_t, are serially uncorrelated errors with mean of *0* and constant variance and covariance, such that ε_t the residuals ~ *N[0,1]*. Correlation involving μ_t and ε_t is reducible by adding an sufficient amount of lagged variations in the independent variables. *Pi,* are the *k x k* coefficient matrices such that the *VAR* process in Δx_t, is stationary. The simultaneous dependence between u_t, and ε_t, is unambiguously modelled in order to obtain the short run effects. Pesaran and Shin (1998) have shown that the *ARDL* approach to estimation and inference is asymptotically well established. Re-specifying the ARDL model specified in equation (3.2) in order to obtain the long run and form and error correction form of the as follows:

$\Delta y_t = c_0 + \gamma y_{t-1} + \vartheta' x_{t-1} + \sum_{i=1}^{p} a_i \Delta y_{t-i} + \sum_{i=0}^{n-1} \beta i' \Delta x_{t-i} + u_t$-------------------------------------(3.4)

Where, $\gamma = -a(1)$, $\vartheta = a(1)\beta = -\gamma\beta$

The above equation (3.4) include only intercept, however it can be modelled to include trend as having both intercept and trend or neither of them.

The application of the *ARDL* model requires a careful selection of the most suitable lag order necessary for valid inferences. The right lag order will be chosen based on the Schwarz Bayesian Criterion *(SBC)* as according to Pesaran and Shin (1998), the *ARDL* model using the SBC performed to some extent superior relative to the *ARDL* model using the Akaike Information Criterion *(AIC).*

From the estimated model in Equation (*3.4)* (i.e. the error correction model), we have the choice of performing Wald or F statistic to verify the joint hypothesis that there is no level connection linking the level variables y_t and x_t, i.e. H0: $\gamma = 0$ and $\vartheta = 0$'.

Pesaran et al (2001), offer two sets of critical value bounds capturing the entire possible categorizations of the forcing series *(x_t)*, into *I(0)* which presents the lower bound, *I(1)* associated with the upper bound and jointly integrated process. An overriding conclusion concerning cointegration of the series can be affirmed when the estimated *F* statistic greater that or fall to the right of the critical value bounds. Putting it differently, if the *F* statistic is larger than the upper bound critical value, then the null proposition is rejected. On the other hand, if the estimated Wald or *F* statistic falls below the lower bound critical value, we accept the null proposition of no long-run level relationship between the series. An inconclusive situation arises when the computed *F* statistic falls within the bounds. Hence, r, of the forcing variables (x_t), would need to be determined in order to proceed. y_t= is a set of (lnGDPg) and its lags. While, x_t comprises of (*lnEXR,* ln*DFL* plus *dummy variable)* and their *lags.*

$\pi\Delta$lnGDPg = log difference of annual growth of real GDP
$\psi\Delta$*lnEXR*= log difference of real effective exchange rate
$\pi\Delta$ln*DFL* = log difference of GDP deflator,

Dum = dummy variable that captures structural break in the dependent variable. ε_t = Stochastic term

The expression above puts *D = 0* and always corresponds to the first period and *D* = 1 to the second. We add 'zeros' (*0s*) up to the second and afterwards 'ones' *(1s)* will be added till the end period. Note that tests for parameter instability and structural change in regression models have been an essential component of applied econometric since the early research of Chow (1960), who tested for regime change at a priori known dates using an F-statistic. More lately, Bai (1997) and Bai and Perron (1998, 2003a) offer theoretical and empirical estimates that further extend Quandt-Andrews framework augmented Chow (1960) by permitting for multiple unidentified breakpoints in the data. The major advantage of these methodologies is that they do not require the apriori knowledge of structural break dates. The existence of structural breaks in a series produces ambiguity concerning the stationarity of the data. Therefore, we test our model in the presence of structural breaks

Descriptive Statistics

The variables under study are found to be normally distributed (Table 2). The mean-to-median ratio of each variable is single digits. The standard deviation is also low compared to the mean, showing a small coefficient of variation. The range of variation between maximum and minimum is also reasonable. The numeric of skewness of each variable is low and is mildly negatively and positively skewed. The Jarque-Bera test statistics also accept the null hypothesis of normal distribution of each variable. Thus, the normality of the distribution is ensured in the study

Table 2: Descriptive Statistics

	LDFL	LGDPG	LER
Mean	3.301116	2.275108	2.559652
Median	3.440961	2.451970	2.517464
Maximum	4.926999	2.842503	2.715237
Minimum	1.666639	0.000000	2.516744
Std. Dev.	0.955290	0.598768	0.059014
Skewness	-0.260547	-2.163932	0.939793
Kurtosis	1.739568	7.545703	2.422133
Jarque-Bera	3.565440	75.50483	7.411319
Probability	0.168180	0.000000	0.024584
Sum	151.8514	104.6550	117.7440
Sum Sq. Dev.	41.06605	16.13354	0.156718
Observations	46	46	46

Table 3: Estimated ARDL Cointegrating and Long Run Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDPG(-1))	0.273925	0.128687	2.128619	0.0406**
D(LNEXR)	-51.756986	14.415014	-3.590491	0.0010***
D(LNEXR(-1))	-31.429860	19.248454	-1.632851	0.1117
D(LNDFL)	-0.276791	0.132090	-2.095479	0.0436**
D(DUM)	-1.682033	0.627320	-2.681298	0.0112**
D(DUM(-1))	3.540984	1.212160	2.921219	0.0062***
CointEq(-1)	-1.346776	0.209735	-6.421309	0.0000***
Cointeq = LNGDPG - (29.2309*LNEXR -0.2055*LNDFL -3.4944*DUM -70.4496)				
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNEXR	29.230903	9.436063	3.097786	0.0039***
LNDFL	-0.205521	0.098167	-2.093599	0.0438**
DUM	-3.494441	1.052635	-3.319707	0.0022***
C	-70.449644	23.744741	-2.966958	0.0055***

Table (3) above, presents both the short and long form of the ARDL error correction model. Our parameter estimates generally demonstrate strong significance at 0.01 and 0.0 5 level of significance. Real xchange rate and inflation measured by GDP deflator in the short run influence economic growth negatively as expected. This is in line with the discovery of Gülay, Vedat & Pazarlioğluour (2016). However, Exchange rate in the long run exerts positive influence on growth. Currency appreciation in the Turkish tends to boost economic growth perhaps because of large dependence of the economy on the importation of major inputs for industrial production and consumption. The dummy which captures structural breaks impacts growth negatively. Exogeneous factors that tend affects economic activities such as political uncertainty and stability have been proven to be harmful to growth process. Ultimately, error correction mechanism of (-1.34) is negative and statistically significant at 0.01 percent level. This means that disequilibrium in the short run is corrected, adjusted and tied to the long run equilibrium position with speed of 1.34 annually.

The study clearly establishes a long run relationship between the variables as evidenced by bound test value (F= 11.08) which falls to the right of all the upper bounds of all the critical values. See the table (4) below:

Table 4: ARDL Bounds Test

Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	k
F-statistic	11.08903	3
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

Toda–Yamamoto (TY) Granger non-causality tests

We used *TY* Granger non-causality to determine the direction of causality between the variables. This method is appropriate in spite difference in the order of integration of the variables. The technique employs a newly modified Wald testing methodology to put a limit on the parameters of the vector autoregression *(VAR)(k)* where *k* represents the chosen lag length. The appropriate order of the multivariate equation (k) is augmented by adding the highest order of integration (d_{max}) to estimate *VAR* $(k+d_{max})$ with the estimates of the preceding lagged d_{max} vector ignored by lag selection criterion. The process therefore, permits causality test using a possibly integrated and cointegrated system of any order of integration contrasting the conventional VAR specification in which the long-run information arising from the system equation is habitually sacrificed in the compulsory and fixed procedure of first order differencing as well as pre-whitening investigation. A VAR of order p can be represented by:

$$y_t = \alpha_0 + \alpha_{1t} + \sum_{i=1}^{p} \phi y_{t-1} + \psi w_t + \mu_t \qquad \text{--} 36$$

From the above *VAR* system equation, y_t is a $(n \times 1)$ vector of endogenous series (in our case, LNGDPG, LNEXR and LNDFL), *t* represents the linear time drift, a_0 and a_1 are $(n \times 1)$ vectors, w_t is a $(q \times 1)$ vector of exogenous series are detected by lag criterion while u_t captures $(n \times 1)$ vector of unobserved errors where $u_t \sim N(0, \Omega)$, $t=1, 2$------- Directions of Granger causality can be detected by applying standard Wald tests to the first 'k' VAR coefficient matrix:

Hypotheses

$H_{01}=A_{12,1} = A_{12,2} ....A_{12,k} = 0$, implies that does not *LNEXR*G ranger cause *LNGDPG*

$H_{02}=A_{21,1} = A_{21,2} ....A_{21,k} = 0$, implies that does not *LNGDPG* Granger cause *LNEXR*

$H_{03}=A_{13,1} = A_{,13,2} ....A_{13,k} = 0$, implies that does not *LNDFL* Granger cause *LNGDPG*

$H_{04}=A_{31,1} = A_{,31,2} ....A_{31,k} = 0$, implies that does not *LNGDPG* Granger cause *LNDFL*

Table 5: Toda–Yamamoto (TY) report of Granger non-causality tests

Dependent variable: LNGDPG			
Excluded	Chi-sq	df	Prob.
LNEXR	13.56550	2	0.0011***
LNDFL	4.121829	2	0.1273
All	27.03948	4	0.0000***

Notes: (i) Asterisks (***) denote rejection of the null hypothesis at 1% level of significance.

Table (5) shows that the null hypothesis (H_{01}) can be rejected, meaning that the causal relationship between real exchange rate and GDP growth rate is unidirectional causality running from real exchange rate to GDP growth at 0.01 significant level (0.0011). Though, inflation was not significant, joint test suggests that all independent variables granger cause GDP at 0.01 level of significance (0.0000).

Diagnostic tests

To confirm that our estimated coefficients meet the BLUE properties of Ordinary least squares, we tested for heteroscedasticity, serial correlation LM test and histogram normality test. We test for heteroscedasticity using the white test and our estimate suggests that we donot have econometric problem of variance non convergence (heteroscedasticity) since Chi-Square probability in table (6) is greater the level of significance (0.2514 > 0.05). The test of serial or autocorrelation in the residuals conducted reveals that the errors are with mean zero and serially uncorrelated given that the Chi-Square statistics in table (7) is also greater than the chosen level of significance (0.1987 > 0.05). Lastly, the Jauque –Bera normality test in fig (1) shows that modelled variables are normally distributed with mean zero, bell shaped and symmetrical(9.6 > 0.008).

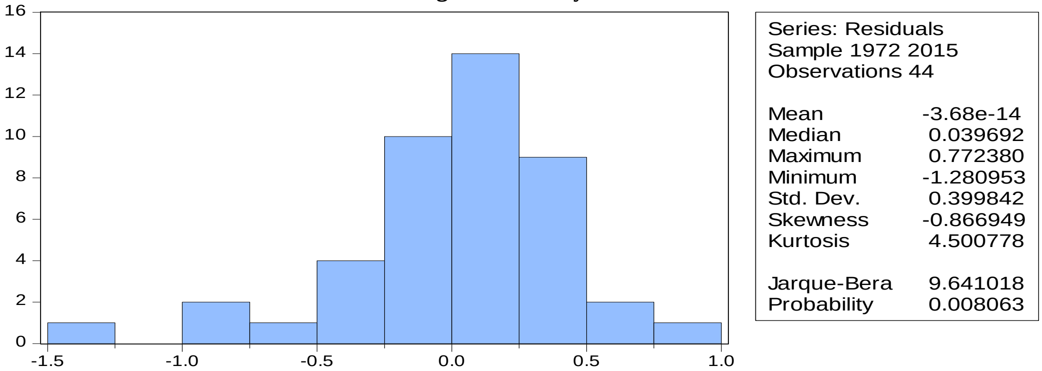
Table 6: Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.315963	Prob. F(9,34)	0.2652
Obs*R-squared	11.36736	Prob. Chi-Square(9)	0.2514
Scaled explained SS	11.88082	Prob. Chi-Square(9)	0.2201

Table 7: Serial correlation LMTest: Breusch-Pagan-Godfrey

F-statistic	1.268332	Prob. F(2,32)	0.2951
Obs*R-squared	3.231731	Prob. Chi-Square(2)	0.1987

Fig 1: Normality test



IV. CONCLUSION

The research investigated the relationship between economic growth measured by log of real gross domestic product (GDP) and real effective exchange rate using annual data spanning 1970 to 2015 on the Turkish economy. Inflation variable was also incorporated into the model as instrument that captures macroeconomic stability. The study employed ARDL and TY-granger non-causality for the empirical investigation in the presence of structural break. It established a long run relationship between economic growth and real effective exchange rate for Turkey. Disequilibrium in the short run is quickly corrected for in the long run with speed of (-1.34). We found a one-way causality running from real exchange rate to economic growth. It therefore, recommended that maintaining a competitive exchange rate may spur growth in only in the short run. In the long run, increase in real effective exchange may positively stimulate growth especially by making the cost of imports of critical inputs cheaper.

Policy Implication

Based on the research findings, the policy implications of this study can be summarized by these points: First, there subsists a long-run connection in the nexus economic growth, exchange rate, price level of Turkey. This relationship shows that the public authorities of Turkey should exploit the above dynamics cautiously on a long-run perspective to take advantage of the benefits of the nexus appropriately. Secondly, policy makers ought to be highly decisive on exchange rate to gain from its constructive and positive impact on economic growth. A reasonable appreciation of the Lira is vital in spurring growth. This is supported by the substantial dependence of Turkish economy on importation of critical factor inputs like petroleum resources.

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Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.315963	Prob. F(9,34)	0.2652
Obs*R-squared	11.36736	Prob. Chi-Square(9)	0.2514
Scaled explained SS	11.88082	Prob. Chi-Square(9)	0.2201

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.268332	Prob. F(2,32)	0.2951
Obs*R-squared	3.231731	Prob. Chi-Square(2)	0.1987

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