PressAcademia
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JEFA
ISSN 2148-6697
Journal of Economics, Finance and Accounting YEAR 2018 VOLUME 5 ISSUE 3

CPI, MONEY SUPPLY AND EXCHANGE RATE DYNAMICS IN TURKEY: A VECM APPROACH

DOI: 10.17261/Pressacademia.2018.934
JEFA- V.5-ISS.3-2018(3)-p.249-260

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Date Received: June 26, 2018 **Date Accepted:** September 15, 2018

To cite this document
Sunal, O. (2018). CPI, money supply and exchange rate dynamıcs in Turkey: a VECM approach. Journal of Economics, Finance and Accounting (JEFA), V.5(3), p.249-260.
Permemant link to this document: http://doi.org/10.17261/Pressacademia.2018.934

ABSTRACT

Purpose- The aim of this study is to outline the relationship between The Consumer Price Index (CPI), Money Supply (M3) and The Exchange Rates (EXC) in Turkey.
Methodology- The data were gathered from The Turkish Statistical Instittute and The Central Bank which covers the monthly period between 2005/1 and 2017/12 and were taken on their own levels where an error correction model was utilized to reveal both the long and short run relationships.
Findings- The results revealed that 100 billion TL rise in M3 is accompanied by 19 points increase in the CPI and 1TL depreciation of local currency (appreciation of $) leads to 82.9 points upswing in CPI.
Conclusion- The Cointegrating equation revealed that there was a significant long-run relationship between CPI, Money Supply and Exchange Rates. Moreover changes in M3 and EXC together cause changes in CPI at .10 significance level. Money Supply endogeneity was also observed at the 10 level.

Keywords: Inflation, money supply, exchange rates, error correction model, Turkey.
JEL Codes: E00, C22, E51

1. INTRODUCTION

The rate of inflation or the change in CPI still is and has always been among the most important economic variables which was closely watched and tracked by all economic agents as unanticipated and highly volatile rates of it signals danger as it yields high costs on the economy as a whole. Therefore, measurement, prediction and causes of this important economic variable has always attracted both academic and public interest. As a result there are a couple of variables which are regarded as the most relevant causes of changes in general price levels in the literature. Hence the majority of the studies conducted concerning the causes of inflation with reference to the underlined theoretical models focuses on a few important variables such as the monetary aggregates, the exchange rates, the interest rates and the fiscal deficits. The outlined framework becomes more evident as the literature reveals that more often for the emerging group of countries when compared to their developed counterparts there seems higher levels of significant relationships between the monetary aggreagtes, the exchange rates and the rate of inflation especially in the long-run.

In this framework Turkey can be regarded as a fragile country with highly volatile price levels and exchange rates for a long period of time. There are more than a couple of few factors which might be considered as the cause of this economic outcome. The lack of strong commitment for an explicit inflation target, fiscal dominance, structural constraints, persistent trade and current account deficits, foreign currency dependence and demand as a result of highly debted private sector, a strong exchange rate pass through effect, domestic demand driven growth with slow supply side adjustments, presence of a wage-inflation spiral might all be admitted as the important contibutors to the outlined economic state mentioned above.

There are numerous studies in the relevant economic literature both conducted abroad and domestically which aim to outline the relationships between the price levels, monetary aggregates and the exchange rates. More often the relationships were revelaed by taking the differences or changes in these variables econometrically as the series are usually not stationary. In this study the variables are aimed to be taken on their own levels to show both the long and the short run relationships by adopting an error correction model where monthly CPI, M3 and exchange rates (TL/$) for Turkish economy for the 2005-2017 period will be used.

In the upcoming sections first the relevant literature will be outlined by using both international and domestic studies. Then the data and the methodology (error correction model) of this stıdy will be given in the next section. Findings of this study will be revealed and finally the concluding remarks will be shared in the proceeding sections.

2. LITERATURE REVIEW

In this context Hossain (2010) in his study by using a cointegration and error correction mechanism found a stable money demand function and causality between money supply growth and inflation in Bangladesh. Ratnasiri (2009) showed that money supply growth was a significant cause of inflation both in the short and long-run though the effect of exchange rate depreciation was revelaed to be insignificant in Sri Lanka. Kilindo (1997) likewise proposed a tight monetary policy in Tanzania (where the growth of money supply should be kept at the rate of growth of real output) to control inflation as a strong relationship between these variables were obtained in the study. Siregar and Rajaguru (2005) stated that persistent inflationary pressures during the 1997 crisis were highly related with the loose monetary base policy adopted and the expected depreciation of the local currency in Indonesia. In line with these studies Chaudhary and Ahmad (1995) found that money supply in Pakistan is an endogenous variable and especially fiscal deficits which in turn raises money supply raises inflation. Qayyum (2006) also concluded that there was a strong relationship between money supply growth and inflation in Pakistan during 1960-2005 period. Kemal (2006) detected significant long-run relationship between money supply and price levels in Pakistan where a lag of nine months was observed. Lozano (2008) also revealed a significant long run relationship between money growth and inflation in Colombia. De Grauwe and Polan (2005) in their study used a sample of data for 60 countries over a period of 30 years and especially found strong relationships between money growth rates and price level growth rates for countries with high inflation though they indicate that this relationship becomes weaker as low inflation countries are examined. Narayan, Narayan and Prasad (2006) used 4 different estimators and found significant long-run relationship between monetary growth and inflation in Fiji. Nguyen (2015) utilized data for a composition of asian countries and showed that M2 significantly effects the rate of inflation when PMG estimation method is applied.

Nevertheless the results of some other studies were rather different where either the relationship between the monetary aggragates and the rate of inflation was weaker or other varibales such as the interest rates were believed to be more significant. In that framework Zhang (2009) concludes that money supply and inflation relationship in China becomes weaker as a result of rise in money multiplier and velocity and a more aggressive interest rate response would limit economic fluctuations. Vymyatnina (2006) found Granger causality running from CPI to M2 but not in the opposite direction which was interpreted as a support for the endogeneity of money supply and likewise suggested that interest rate as a policy instrument could produce better inflation outcomes. Staiger, Stock and Watson (1997) analysed the effect of 71 leading indicators of inflation forecasts for two different periods and two different time horizons (a year and two year a head) and M3 ranks the 49th and 30th leading indicator for a year head predictions of two different periods and ranks the 64th and 5th for two years a head predictions though they comment that drawing a conclusion such that the inflation does not respond to the type of monetary policy (tight or loose) might be a misguide. Woodford (1998) revelaed that the equilibrium inflation rate could be analysed without making any specific reference to the money demand and supply conditions if a Wicksellian interest rate rule is adopted as a policy guideline. Senda (2001) shows that unanticipated policy changes such as money supply shocks creates assymetric outcomes especially when the prices are more flexible upwards than downwards. This outcome i suppose might also be interpreted as the importance of the role of monetary policy changes even when they are unanticipated as the real output effect is more limited as a result of more upward flexible prices. Hossain (2005) found a bi-directional causality between money supply growth and inflation where power of relationship from inflation to money growth was observed to be stronger which in turn concluded to be the reason for a self sustaining inflationary process in Indonesia.

The relationship between exchage rates and inflation rates are more often regarded as bi-directional. The theoretical framework such as the PPP (purchasing Power Parity) states that the long-run excahnge rates are determined as a result of relative price changes accross countries. In the reverse direction as clearly underlined by the ERPT (exchange Rate Pass Through) framework the change in exchange rates might effect the domestic price levels via the prices of imported goods. The ERPT effect seems more evident among emerging market economies when the literature is reviewed although the persistence of it becomes weaker as low and stable levels of inflation rates are reached. In that manner Minella et al. (2003) revealed that the ERPT effect was evident and concluded that exchange rate volatiliy contributes to the volatility of inflation in Brazil. De Grauwe and Schnabl (2008) used data for south eastern and central european countries and put forward that as moderate and low inflation levels became dominant the relationship between exchange rate regimes and inflation turned out to be weak and insignificant. Likewise similar results were interpreted in studies (Bailliu and Fujii, 2004; Gagnon and Ihrig, 2004; Choudhri and Hakura, 2006; Winkelreid, 2014) where low rates of average inflation rates were associated with the decline in ERPT effect. Strikingly in their study Bussiere, Chaire and Peltonen (2014) calculated the long-run ERPT coefficients for 40 countries where Turkey had the highest score (0.991) which was even significant at 0.01 level.

When the domestic literature is reviewed different studies found varying results. Kaya and Öz (2016) by using quarterly data showed that there is a long-run positive relationship between money supply and inflation rate where an ARDL bounds testing approach is adopted. Also similar results were obtained both in the short and long run in Altıntaş, Çetintaş and Taban (2008). Nevertheless money supply and inflation were negatively associated in the short run in another study (Korkmaz, 2017). Also no evidence of support for the Quantitiy Theory was observed in Koru and Özmen (2003). In contrast Oktayer (2010) by using co-integration analysis revealed that monetary aggregates, budget deficits and price levels move together in the same direction in the long run. Koyuncu (2014) found one way causality from monetary growth to inflation where money supply can be admitted as exogenous. Though real base money was found to be endogenous in Altınkemer (2004).

The exchange rate and (domestic) price level relationship in Turkey is also investigated in a numerous studies. A rapid and fast ERPT was found in Kara and Öğünç (2008) until 2001 but the effect was obesrved to be less in the following years. Mihaljek and Clau (2001) found the exchange rate elasticity .56 in their study where the ERPT effect regarding several emerging economies was surveyed. Also the ERPT effect was evidenced in Civcir and Akçağlayan (2010).

3. DATA AND METHODOLOGY

In this study CPI, M3 and exchange rate (EXC) monthly time series between years 2005 and 2017 was used to analyse the relationship among them. The stationarity of series in time series analysis is important as spurious regressions with high goodness of fit values might lead to misjudgements and misinterpretations of obtained regression results if series are non-stationary or in other words have unit roots. Therefore to outrule this possibility of a spurious regression, stationarity of series should be tested and verified.

There are a few unit root tests which are generally used for testing stationarity such as the Augmented Dickey and Fuller (1981) unit root test. The ADF unit root test is conducted as follows where the first equation represents the model without trend and constant terms, the second equation with only constant term and third equation with both trend and constant term.

$$\Delta x_t = \psi x_{t-1} + \sum_{i=1}^{p} \beta_i \Delta x_{t-i} + u_t \quad (1)$$

$$\Delta x_t = \beta_0 + \psi x_{t-1} + \sum_{i=1}^{p} \beta_i \Delta x_{t-i} + u_t \quad (2)$$

$$\Delta x_t = \beta_0 + \lambda t + \psi x_{t-1} + \sum_{i=1}^{p} \beta_i \Delta x_{t-i} + u_t \quad (3)$$

Here Δ is the difference operator, β_0 the constant term, λ the trend term, t time, p the lag value and u_t the error term.

The null hypothesis H_0 states that the series are non stationary (or the condition where $\psi = 0$) and is tested by comparing the τ test statistic with the MacKinnon critical value.

The relationship between variables might be examined by using VAR based models if they are I(0) integrated of order zero which means that they are stationary on their on levels. Also Granger causality tests might be conducted as well to determine the direction of relations as well. Nevertheless if variables are not stationary on their levels the first differences of them might become stationary I(1) or integrated of order one. Then if the variables are co-integrated the vector of I(1) variables can be linearly transformed to an I(0). As this outrules the possibility of a spurious regression the relationship between variables can be detected by constructing a vector error correction model (VECM) where both short and long run dynamics might be investigated (Engel and Granger, 1987). Johansen and Jeselius (1990) co-integration procedure is widely applied for this purpose where Maximum Eigenvalue and Trace test statistics are used. Maxium Eigenvalue tests the null htpothesis of r co-integrating equations against more than r where r = 0,1,….n-1. Here n represents the number of variables therefore the number of co-integrating equations at most could be one less than the number of variables. Trace statistic tests r co-integrating equations against r+1. The results provide the rank of the system and when both test statistics reveal the same rank position then the decision can be made fairly easily. The Trace and Max Eigenvalue statistics are as follows:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{g}\ln(1-\hat{\lambda}_i) \quad (4)$$

$$\lambda_{max}(r, r+1) = -T\ln(1-\hat{\lambda}_{r+1}) \quad (5)$$

The VECM can be estimated after the the rank of the co-integration equation is determined using the relevant criteria mentioned just above. The equation below is a general representation of a VECM.

$$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta\, y_{t-1} + \Gamma_2 \Delta\, y_{t-2} \dots\dots\dots\dots + \Gamma_{k-1}\Delta\, y_{t-(k-1)} + u_t \quad (6)$$

$$\Pi = \left(\sum_{i=1}^{k}\beta_i\right) - I_g \quad (7)$$

$$\Gamma_i = \left(\sum_{j=1}^{i}\beta_j\right) - I_g \quad (8)$$

Π is the long–run coefficient matrix and g represents the total number of variables. If 1<rank (Π)<g and there are r co-integrating vectors then:

Π=αβ′ where β′ (rxg) represents the coeficients of the variables in the error correction equation and α (gxr) the adjustment parameters (error correction coefficients). The sign of the adjustment parameter is imortant as a minus sign represents convergence into equilibrium. Also the magnitude of it represents the speed of adjustment.

Also it is important to note that the co-integration system and error correction model estimates are highly sensitive to the lag length chosen. Therefore different types of criteria such as LR (modified Likelihood Ratio Statistic), FPE (Final Prediction Error) AIC (Akaike Information Criterion, SC (Schwarz Information Criterion) and HQ (Hannan-Quinn Information Criterion) for optimum lag lenght selection might be used.

4. FINDINGS

The stationarity of the variables are first tested on their own levels and then on their first differences by using ADF. Then the optimum lag lenghts were determined by using the results of different information criteria. Co-integration rank tests (Trace and Max. Eigenvalue) were applied to find out whether the rank of co-integrating equations. Then vector error correction estimates are found where both long and short run coefficients were revealed. Wald and VECM based Block Exogeneity Test were conducted to find out the causality relationships. At the end Jarque – Bera Test for normality, Breush and Godfrey Test for serial correlation, Breusch and Pagan Test for Heteroskedasticity andn CUSUM Tets for structural stability are used. Also the Impulse Response Funtions (IRF) are graphed.

Table 1: ADF Test Results of Variables on Their Own Levels

	CPI			**M3**			**EXC**		
	None	**Constant**	**Constant /Trend**	**None**	**Constant**	**Constant/ Trend**	**None**	**Constant**	**Constant/ Trend**
ADF Test Statistic	7.6793	3.9854	1.176268	11.19474	4.766549	0.872339	2.368749	1.018689	-1.299517
P Value	1.0000	1.0000	0.9999	1.0000	1.0000	0.9998	0.9958	0.9967	0.8840
Critic Values									
1%	-2.5818	-3.4781	-4.025924	-2.581349	-3.476805	-4.023975	-2.66936	-3.477144	-4.024452
5%	-1.9431	-2.8824	-3.442712	-1.943090	-2.881830	-3.441777	-1.95641	-2.881978	-3.442006
10%	-1.6151	-2.5779	-3.146022	-1.615220	-2.577668	-3.145474	-1.60850	-2.577747	-3.145608

Table 2: ADF Test Results of Variables on Their First Differences

	CPI			M3			EXC		
	None	**Constant**	**Constant /Trend**	**None**	**Constant**	**Constant/ Trend**	**None**	**Constant**	**Constant/ Trend**
ADF Test Statistic	7.6793	3.9854	1.176268	11.19474	4.766549	0.872339	2.368749	1.018689	-1.299517
P Value	1.0000	1.0000	0.9999	1.0000	1.0000	0.9998	0.9958	0.9967	0.8840
Critic Values									
1%	-2.5818	-3.4781	-4.025924	-2.581349	-3.476805	-4.023975	-2.66936	-3.477144	-4.024452
5%	-1.9431	-2.8824	-3.442712	-1.943090	-2.881830	-3.441777	-1.95641	-2.881978	-3.442006
10%	-1.6151	-2.5779	-3.146022	-1.615220	-2.577668	-3.145474	-1.60850	-2.577747	-3.145608

As it can be seen from both Tables 1 and 2 CPI, M3 and EXC series are all non-stationary on their own levels. The null hypothesis of non-stationarity of series can not be rejected at 0.05 level for all models (none, constant, constant and trend). When series are differenced once all variables become stationary except for CPI and EXC series non-stationary only for one model (no trend and no constant).

Table 3: Lag Length Criteria Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3087.682	NA	6.24e+16	47.18598	47.25183	47.21274
1	-2349.421	1431.437	9.12e+11	36.05223	36.31561*	36.15925
2	-2330.735	35.37500	7.87e+11	35.90435	36.36526	36.09164*
3	-2324.292	11.90200	8.18e+11	35.94339	36.60183	36.21095
4	-2317.109	12.94027	8.42e+11	35.97113	36.82711	36.31895
5	-2303.917	23.16128	7.91e+11	35.90714	36.96064	36.33522
6	-2296.092	13.38113	8.08e+11	35.92507	37.17611	36.43342
7	-2284.026	20.07892	7.74e+11	35.87826	37.32683	36.46688
8	-2273.164	17.57905*	7.55e+11*	35.84983*	37.49593	36.51871
9	-2267.895	8.285383	8.04e+11	35.90679	37.75043	36.65594
10	-2264.376	5.372628	8.81e+11	35.99047	38.03164	36.81989
11	-2254.302	14.91843	8.74e+11	35.97407	38.21278	36.88376
12	-2251.756	3.653736	9.76e+11	36.07261	38.50884	37.06256

** indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

As series become stationary at their first differenced levels they might become integrated of order one I(1). If the series are cointegrated then VECM can be used. Therefore, the first step is to determine the optimum lag length. Table 3 shows that according to both LR, FPE and AIC criterions eight is the optimum lag length for this model. The Johansen and Jeselius cointegration analysis provides that for both rank tests (Trace and Maximum Eigenvalue) there are one cointegrating equations when the deterministic trend assumption of the test is chosen as intercept but no trend in CE (cointegrating equation). The test details can be seen from Tables 4 and 5. As a result VECM was estimated by using eight lags and the same deterministic trend assumption.

Table 4: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.02 Critical Value	Prob.**
None *	0.181882	49.86736	38.71685	0.0007
At most 1	0.099435	22.96698	23.07043	0.0207
At most 2	0.064489	8.932802	11.23272	0.0553

Trace test indicates 1 cointegrating eqn(s) at the 0.02 level
** denotes rejection of the hypothesis at the 0.02 level*

Table 5: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.02 Critical Value	Prob.**
None *	0.181882	26.90038	25.06941	0.0106
At most 1	0.099435	14.03418	18.37120	0.0957
At most 2	0.064489	8.932802	11.23272	0.0553

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.02 level
** denotes rejection of the hypothesis at the 0.02 level*
***MacKinnon-Haug-Michelis (1999) p-values*

Table 6: Vector Error Correction Estimates

Included observations: 134 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1		
CPI(-1)	1.000000		
M3(-1)	-1.90E-07 (1.1E-07) [-1.70210]		
EXC(-1)	-82.92006 (60.3569) [-1.37383]		
C	-96.42705 (45.4652) [-2.12090]		
Error Correction:	D(CPI)	D(M3)	D(EXC)
CointEq1	-0.010260	-63557.19	-0.000147

Table 6 reveals VECM results where the parameters of the cointegration equation which provides the long-run relationship can be observed. The long–run coefficients matrix $\Pi=\alpha\beta'$ and the short-run coefficients matrix Γ was constructed by using the information from the model above.

$$\alpha = \begin{bmatrix} -0.010260 \\ -63557.19 \\ -0.000147 \end{bmatrix} \qquad \beta = [\,1 \quad -1.90\text{E}-07 \quad -82.92006] \qquad \Gamma = \begin{bmatrix} 0.209 & \dots & -0.532 \\ -2182940 & \dots & -38100785 \\ -0.009 & \dots & -0.131 \end{bmatrix}$$

$$\Delta CPI_t = \alpha_{1,1}(\beta_{1,1}CPI_{t-1} - \beta_{1,2}M3_{t-1} - \beta_{1,3}EXC_{t-1} - C) + \Gamma_{1,1}\,\Delta CPI_{t-1} + \dots + \Gamma_{1,8}\,\Delta CPI_{t-8} + \Gamma_{1,9}\,\Delta M3_{t-1} + \dots + \Gamma_{1,16}\,\Delta M3_{t-8} + \Gamma_{1,17}\,\Delta EXC_{t-1} + \dots + \Gamma_{1,24}\,\Delta EXC_{t-8}$$

$$\Delta M3_t = \alpha_{1,2}(\beta_{2,1}CPI_{t-1} - \beta_{2,2}M3_{t-1} - \beta_{2,3}EXC_{t-1} - C) + \Gamma_{2,1}\,\Delta CPI_{t-1} + \dots + \Gamma_{2,8}\,\Delta CPI_{t-8} + \Gamma_{2,9}\,\Delta M3_{t-1} + \dots + \Gamma_{2,16}\,\Delta M3_{t-8} + \Gamma_{2,17}\,\Delta EXC_{t-1} + \dots + \Gamma_{2,24}\,\Delta EXC_{t-8}$$

$$\Delta EXC_t = \alpha_{1,3}(\beta_{1,1}CPI_{t-1} - \beta_{1,2}M3_{t-1} - \beta_{1,3}EXC_{t-1} - C) + \Gamma_{1,1}\,\Delta CPI_{t-1} + \dots + \Gamma_{3,8}\,\Delta CPI_{t-8} + \Gamma_{3,9}\,\Delta M3_{t-1} + \dots + \Gamma_{3,16}\,\Delta M3_{t-8} + \Gamma_{3,17}\,\Delta EXC_{t-1} + \dots + \Gamma_{3,24}\,\Delta EXC_{t-8}$$

$$ECT_{t-1} = \beta_{1,1}CPI_{t-1} - \beta_{1,2}M3_{t-1} - \beta_{1,3}EXC_{t-1} - C$$

The parameters of α (3x1)matrix consists of the adjustment coefficients. β (1x3) reveals coefficients of the error correction equation. Γ is a (3x24) matrix where the numbers represent the short run coefficients. The set of equations above represent the VECM estimates.

$$CPI_{t-1} = 1.90\text{E}-07M3_{t-1} + 82.92006EXC_{t-1} + 96.42705 \qquad (9)$$

Table 7: Error Correction Term Results

	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha_{1,1}$	-0.010260	0.002748	-3.733123	0.0003

The long-run relationship between the variables are as it is shown in Equation 9. The adjustment parameter or the coefficient of the ECT_{t-1} in ΔCPI_t equation is -0.010260. The minus sign shows that the model corrects itself when it departs from its equiibrium state from the previous period. Therefore when the difference between CPI, M3 and EXC is positive in one period CPI will fall in the next period or the opposite happens when the difference is negative. The adjustment coefficient in this model is farily small though it is highly significant.

As it can be observed, in the long run when M3 rises by a 100 billion TL CPI index increases by 19 points and when TL/USD exchange rate increases by 1 TL (or if TL depreciates 1 TL) CPI increases by 82.9 points.

The short run coefficients of the model are also important as they present whether the differenced past values of CPI, M3 and EXC lead to changes in differenced CPI parameters.

Table 8: Wald Test Results

Test Statistic	Value	df	Probability
F-statistic	5.849688	(8, 109)	0.0000
Chi-square	46.79750	8	0.0000

Null Hypothesis: $\Gamma_{1,1}$=$\Gamma_{1,2}$=.....$\Gamma_{1,8}$ =0

Test Statistic	Value	df	Probability
F-statistic	0.739011	(8, 109)	0.6569
Chi-square	5.912086	8	0.6571

Null Hypothesis: $\Gamma_{1,9}$=$\Gamma_{1,10}$=.....$\Gamma_{1,16}$ =0

Test Statistic	Value	df	Probability
F-statistic	1.773285	(8, 109)	0.0900
Chi-square	14.18628	8	0.0770

Null Hypothesis: $\Gamma_{1,17}$=$\Gamma_{1,18}$=.....$\Gamma_{1,24}$ =0

As it can be seen from the Wald test results above that differenced past values of CPI (ΔCPI_{t-1} ,……, ΔCPI_{t-8}) significantly cause changes in differenced CPI (ΔCPI_t) as the null hypothesis of $\Gamma_{1,1}$=$\Gamma_{1,2}$=.....$\Gamma_{1,8}$ =0 can be rejected at even 0.01 signifiance level. Although the differenced past values of M3 ($\Delta M3_{t-1}$,……, $\Delta M3_{t-8}$) does not cause changes in differenced M3 ($\Delta M3_t$) as the null hypothesis of $\Gamma_{1,9}$=$\Gamma_{1,10}$=.....$\Gamma_{1,16}$ =0 can not be rejected at as the probability is 0.65. Nevertheless the differenced past values of EXC (ΔEXC_{t-1} ,……, ΔEXC_{t-8}) significantly cause changes in differenced EXC (ΔEXC_t) as the null hypothesis of $\Gamma_{1,17}$=$\Gamma_{1,2}$=.....$\Gamma_{1,24}$ =0 can be rejected at 0.10 signifiance level though can not be rejected at 0.05 level.

Table 9: VEC Granger Causality/Block Exogeneity Wald Tests

Dependent variable: Δ(CPI)			
Excluded	**Chi-sq**	**df**	**Prob.**
Δ(M3)	5.912086	8	0.6571
Δ(EXC)	14.18628	8	0.0770
All	25.43445	16	0.0625
Dependent variable: Δ(M3)			
Excluded	**Chi-sq**	**df**	**Prob.**
Δ(CPI)	12.45658	8	0.1320
Δ(EXC)	13.09643	8	0.1086
All	24.07915	16	0.0878

The causal relationship between variables can also be detected by conducting VEC based Granger Causality tests for the same error correction model estimated above. As it can be seen that the null hypothesis of differenced past values of M3 does not cause changes in differenced CPI can not be rejected. Though the null hypothesis of differenced past values of EXC does not cause changes in differenced CPI can not be rejected at 0.05 level but can be rejected at 0.10 level. More importantly both differenced past values of and M3 and EXC does not cause changes in CPI can not be rejected 0.10 significance level where the probability (0.0625) is very close to 0.05 level. Also it can be seen that neither CPI nor EXC alone does not cause M3 at 0.05 significance level only they jointly are significant at 0.10 level.

The last step of the analysis involves the tests for normality, auto-correlation, heteroscedasticity and model specification.

Graph 1: Jarque-Bera Test Results

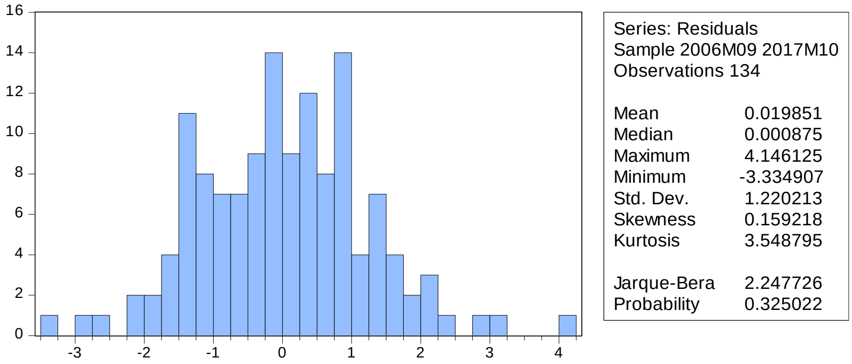


Table 10: Breusch-Godfrey Serial Correlation LM Test Results

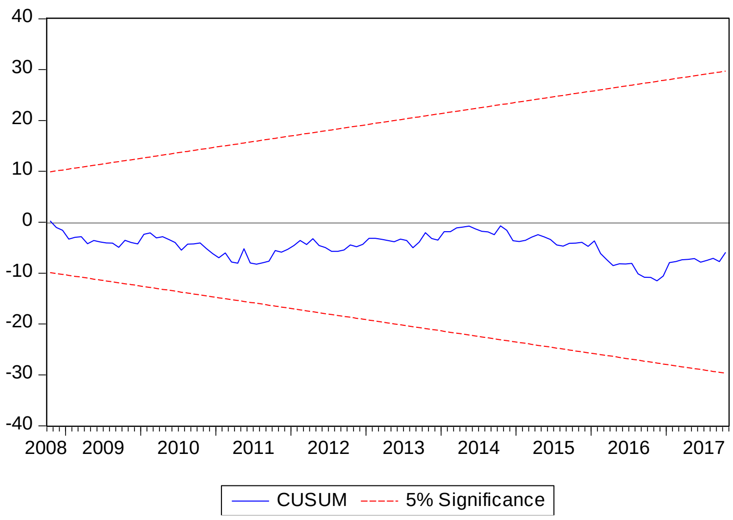
F-statistic	1.516894	Prob. F(8,101)	0.1606

Table 11: Breusch-Pagan-Godfrey Heteroskedasticity Test Results

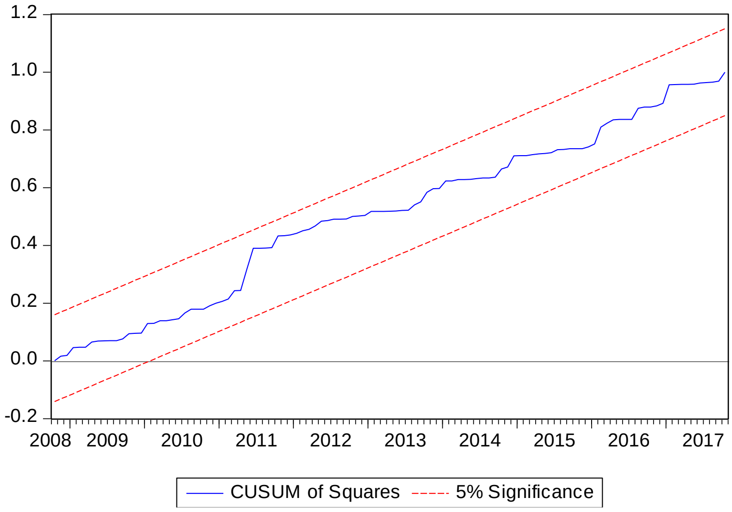
F-statistic	0.856718	Prob. F(27,106)	0.6688

The test results show that the null hypothesis of series are normality distrubuted for Jarque – Berra test and the null hypothesis of no serial correlation for Breusch – Godfrey LM Test and the null hypothesis of no heteroscedasticity for Breusch – Pagan – Godfrey test can not be rejected. Therefore the residiuals are normally distrubuted with no serail correlation and no heteroscedasticity which are statistically desired properties for the validitiy of the model.

Graph 2: CUSUM Test

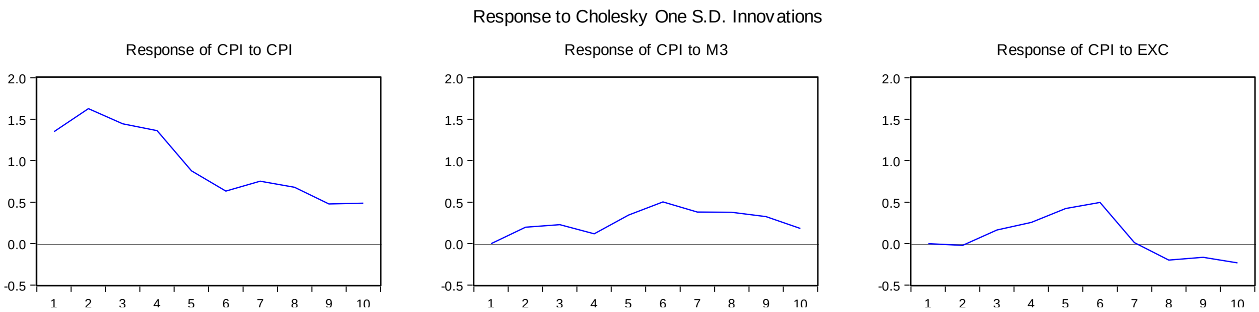


Graph 3: CUSUM of Squares Test



It can be seen from the graphs of both stability tests (cusum and cusum of squares) that the graphs for the recursive estimates both lie within the confidence bands which displays the parameter stability for the model.

Graph 4: IRF for The Series CPI, M3 and EXC



The impulse response function graphs reveal that when a unit standard deviation shock is impulsed to CPI the future CPI rates respond positively and the magnitude is higher in the short run where the effect seems to persist even after 8 months though it declines. The effect of M3 on CPI is moderate and the effect is positive. Nevertheless the effect of EXC on CPI seems more complicated as for the next 7 months the sign is positive then the sign becomes negative.

5. CONCLUSION

Highly volatile and persistent inflation rates were present for a prolonged period of time in Turkey. Even though there has been a downward trend after 2001 -as a result of couple of structural measures taken such as the explicit inflation targeting- still the inflationary inertia seems to be dominant as the yearly rate of inflation was %12,15 as of May 2018. More often this phenomenon was regarded as the result of several factors: monetisation of public debt, high rates of growth of monetary aggreagtes, time inconsistent monetary policies, fiscal imbalances, strong exchange rate pass through effect, wage-inflation spiral and supply side restrictions. The existence of inflation inertia reflects that rather than the targeted level declared by The Central Bank the past levels of inflation drives the expectations. In other words expectations might hardly become rational as a result of repeated failure of reaching the declared target.

In this study as the unexpected changes in the rate of inflation in Turkey has long been considered as a heavy burden on the society as a whole a long run relationship between the CPI and the two important causes of changes in price levels –money supply and exchange rates- were investigated by using an error correction model. An important feature of this study is that variables are taken on their own levels to reveal a long-run equation as most of the studies reviewed in the literature either differenced or took the percentage changes of the variables for stationarity purposes. In line with our predictions the results showed that 100 billion TL rise in M3 is accompanied by 19 points increase in the CPI and 1TL depreciation of local currency (appreciation of $) leads to 82.9 points upswing in CPI. Also in the short run when VEC based causality tests were conducted changes in M3 and EXC together cause changes in CPI at .10 significance level. Moreover the changes in CPI and EXC do also cause changes in M3 at .10 significance level which might be considered as a sign of money supply endogeneity. Besides the IRF reveal that CPI responds to changes in past CPI values even after 10 months though the response becomes smaller which depicts the existence of a strong inflation inertia. This study mainly is in line with other studies that found significant relationships between monetary aggregates, exchange rates and price levels either conducted abroad mostly in emerging markets or domestically. Also it worths mentioning that no serial correlation, no heteroscedasticity and a normal distrubution were observed with structural parameter stability which might be admitted as desired econometric properties for the validity of this study.

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