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Research Article
Analysis of the Neutrality of Money for the US Economy

[1]Afsin Sahin and [2]Imdat Dogan

[1]Department of Banking, Gazi University, 06500 Ankara, Turkey
[2]Energy Exchange of Istanbul, 34000 Istanbul, Turkey

Abstract

Background and Objective: Neutrality of money hypothesis is one of the widely researched topics in economics claiming that the effect of money supply on output is positive in the short-run but disappears in the long-run. Besides this level effect, relationship between the volatilities of these two variables is also another interesting subject to investigate. This study aimed to discuss the neutrality of money hypothesis in terms of level and volatility effects of money supply. **Materials and Methods:** Data from the United States economy covers the period of 1959: 01-2016: 05. First, mean equation of EGARCH model is utilized to investigate for a lagged effect of the stationary variables of money supply growth on output growth in the short-run. Second, Asymmetric Dynamic Conditional Correlation Model (ADCC-EGARCH) is employed to analyze the dynamic relationship between short-run volatilities of money supply growth and output growth. Last, Detrended Cross Correlation Analysis (DCCA) is applied to explore for a long-run relationship between non-stationary variables of money supply and output. **Results:** The lagged effect of money supply growth on output growth is positive in the short-run according to the results of EGARCH's mean equation. According to the ADCC-EGARCH analysis's dynamic cross conditional correlation results, the volatility of money supply growth and volatility of output growth vary substantially in the short-run by time. Moreover, DCCA results indicated a positive simultaneous long-run relationship between money supply and output in levels. **Conclusion**: It is concluded that a non-neutrality of money in the short-run and the dynamic conditional correlations vary over time.

Key words: Neutrality of money, money supply, output, dynamic conditional correlation, detrended cross-correlation

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Corresponding Author: Afsin Sahin, Department of Banking, Gazi University, Besevler, Ankara, Turkey

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Economic output is affected from endogenous and exogenous events. Exogenous shocks such as Vietnam War (1965-1975), which is one of the major examples of military spending in US history increased the volatility in economic output[1]. These kinds of shocks leading a high government spending usually create budget deficits and had been often financed by the Federal Reserve Bank of the United States (FED) through monetization in the past. During 1970's, FED adopted an expansionary monetary policy by increasing liquidity, which along with on-going recession led to a stagflation. According to Mervyn King[2], FED's this action stimulated the independency of the central banks around the world.

Following 1980s, central banks as independent institutions have started to choose their instruments to achieve their policy goals. Concerning the success of monetary targeting as adopted in some countries, there should be a stable relationship between the target variable and the monetary aggregates[3]. This relationship is outlined in two mainstream concepts. First, the neutrality of money concept, which points out that money supply does not have any real effects on real output[4]. Moreover, it is called super-neutrality of money if nominal money supply growth does not have any effect on real output. Second, long-run and short-run effects of nominal money supply on economic output are investigated within monetary economics literature. Keeping these in mind, this study contributed to the empirical monetary economics literature in both ways by applying Asymmetric Dynamic Conditional Correlation Model (ADCC-EGARCH)[5] and Detrended Cross-Correlation Analysis (DCCA)[6].

Tobin[7] rejected the superneutrality of money hypothesis, which is based on neoclassical models of Solow[8] and Swan[9]. According to Tobin[7], money and real assets are substitutes and in the case of an increase in inflation, households will increase their demand for real assets and money demand will diminish. Therefore, Tobin[7] claimed that an increase in inflation also stimulates the capital accumulation and economic growth. However, Sidrauski[10] does not reject the neutrality of money hypothesis and claims that money supply does not have any long-run effect on capital accumulation and production. Algan and Ragot[11] criticized Sidrauski[10] and assert that the neutrality of money will not hold when the borrowing constrains are binding. On the other hand, according to Lucas[12], money is neutral in the long-run. Finally, Gimenez and Kirkby[13] claimed that quantity theory of money is valid for the US in the long-run but not in the short-run.

Besides the theoretical models, the relationship between money supply and output is analyzed in empirical sense. For instance, according to Dewald[14] there is a long-run relationship between money supply growth and economic growth for the US economy. Berger and Osterholm[15] investigated the impact of money growth on output growth in the US for 1960-2005 period and find an evidence that money Granger- causes output. Aksoy and Piskorski[16] explore that the money supply Granger- causes inflation and output in the US for 1981-2005 period. However, Lu *et al.*[17] as a recent study found no causality from money supply to GDP for the US economy. Besides for post-2000 period, the initial effect of money supply on GDP is negative that is explained by an increasing financialization tendency. Darrata *et al.*[18] employed the Johansen co-integration method and find a long-run relationship between money supply and output for the post-1980 US economy. Ogunmuyiwa and Ekone[19] investigated the impact of money supply on economic growth utilizing causality test and error correction model for 1980-2006 periodin Nigeria and cannot explored a significant relationship. Liu and Jin[20] investigated long-run and short-run effects of money supply on economic growth.

The purpose of this study was to contribute and advance new knowledge to the empirical monetary economics literature by adopting non-common and nonlinear methodologies in the analysis of the effects of money supply on production dynamics. This study unveils a short-run non-neutrality of money supply volatility on output volatility. The findings may guide researchers and monetary policy makers to uncover the effects of volatilities on the macro-variables while taking decisions.

The main aim of this study was to investigate a relationship between volatilities of two variables rather than their means. Therefore, the neutrality of money hypothesis for the US economy over the post-1959 period by using Asymmetric Dynamic Conditional Correlation Model (ADCCM) is analyzed. There are several papers estimating the effects of macroeconomic variable's volatility on output in the literature. For instance, Fountas and Karanasos[21] employed the univariate Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model to test the causal effect of real and nominal macroeconomic volatility on inflation and output growth for the G7 covering the 1957-2000 period. Wang and Han[22] used the multivariate GARCH model (MGARCH-BEKK) and explore a co-volatility between money supply growth and economic growth for China.

MATERIALS AND METHODS

Friedman and Schwartz[23] claimed that there is a high correlation between the standard deviations of income and money supply and this high correlation varies over the time. The scatter diagram in Fig. 1 indicates that the relationship between M1 money supply growth and output growth is not clear. Moreover, as shown in Fig. 2, lagging and leading effects of M1 money supply growth on output growth has a cycling behavior and dynamic in the sense of a standard correlation analysis.

In this study, Asymmetric Dynamic Conditional Correlation (ADCC-EGARCH) model, which allows to explore the relationship between volatilities of money and output, was employed. The US monthly data of seasonally adjusted M1 money supply and seasonally adjusted industrial production index (2012 = 100) from January, 1959 to May, 2016 was utilized. Both data are gathered from the database of Federal Reserve Bank of St. Louis Electronic Data System. Following Walsh[24], detrended log of seasonally adjusted industrial production (DETLOGIND) and detrended log of seasonally adjusted M1 money supply (DETLOGM1) were constructed by using Hodrick-Prescott filtering methodology.

The descriptive statistics of the data are provided in Table 1. Both variables are stationary according to Augmented Dickey Fuller Unit Root (ADF) test statistics. The distribution for industrial production is skewed to the left and money supply is skewed to the right. The thickness of the tales statistics about the distribution indicates non-normality. Jarque-Bera (JB) statistics rejects the normal distribution. Breusch-Pagan-Godfrey (BPG), ARCH-LM test and white test indicate heteroscedasticity in the residuals for each of the variables. Ljung-Box Q statistics fails to reject the null of no-autocorrelation. Autocorrelation functions statistics (AC) indicate a positive but low level of persistency.

The DCC methodology is initially developed by Engle[5] and has been used for modelling volatility relationships in the sense of multivariate GARCH. An application of asymmetric DCC models are used in several areas in finance and economic research. Constant Conditional Correlation (CCC) can be found by Sahin and Dogan[25]. Yin[26] applied a DCC-GARCH model to analyze the correlation between uncertainty and oil futures returns. Shaw *et al.*[27] benefited from GARCH-BEKK model to investigate the volatility transmission between future and spot interest rate markets.

Following Kim *et al.*[28], asymmetric DCC-EGARCH (1,1) model is estimated by Eq. 1-4. The mean equations are as follows.

Model I mean Eq. 1:

$$DETLOGMI_t = Constant+\beta_1 DETLOGIND_{t-1}+\beta_2 DETLOGMI_{t-1}+u_{1,t} \quad (1)$$

Model II mean Eq. 2:

$$DETLOGMI_t = Constant+\alpha_1 DETLOGIND_{t-1}+\alpha_2 DETLOGMI_{t-1}+u_{2,t} \quad (2)$$

Constant is for the constant term in the Eq. 1. The β_1 is the effect of DETLOGIND at time t-1 on DETLOGIND at time t. The β_2 is for the effect of DETLOGM1 at time t-1 on DETLOGIND at time t. Mean Eq. 2 of the model II is provided as Eq. 2.

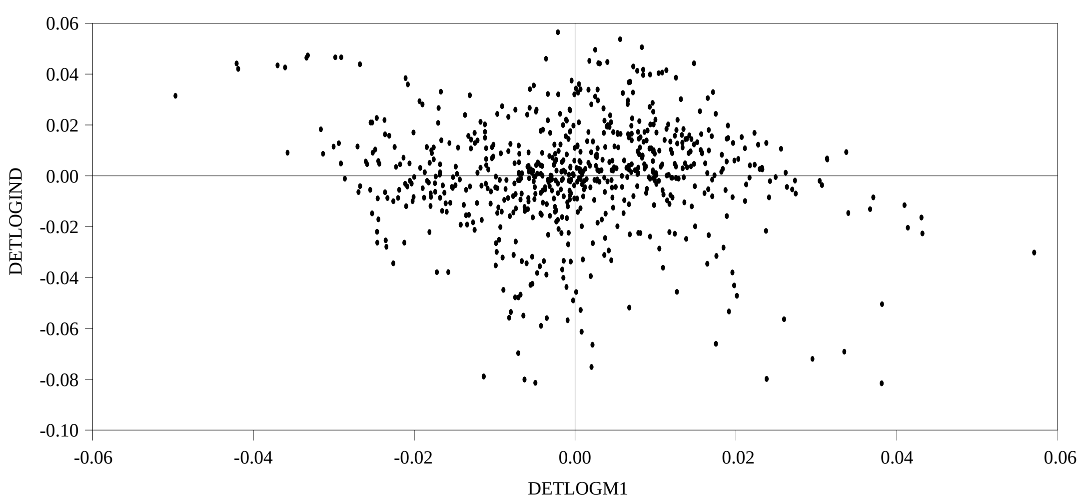

Fig. 1: Scatter diagram of detrended logarithm of M1 money supply and detrended logarithm of industrial production

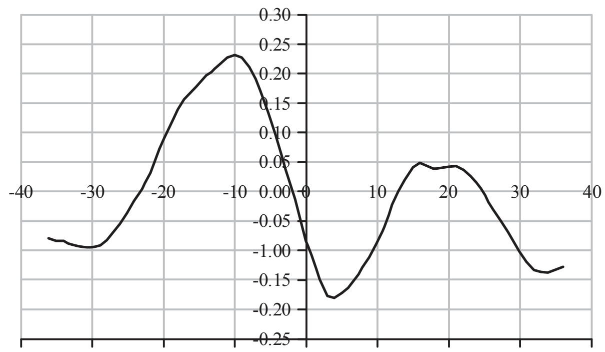

Fig. 2: Dynamic standard correlations (1959: 01-2016: 05)
y axis is for dynamic correlations between Y_i and M_{t+i}, x axis shows the lags and leads

Table 1: Descriptive statistics of the variables

	DETLOGIND	DETLOGM1
Standard deviation	0.0220	0.0141
Skewness	-0.7232	0.0487
Kurtosis	4.6708	3.6634
JB statistics	140.191***	12.905***
Observations	689	689
ADF unit root test w. C	-7.1686***	-6.8922***
ADF unit root test w. T and C	-7.1653***	-6.8875***
ADF unit root test w.o. T and C	-7.1740***	-6.8972***
BPG test	0.0000***	0.0000***
ARCH LM test for heteroscedasticity		
ARCH LM(6)	0.0000***	0.0000***
ARCH LM (8)	0.0000***	0.0000***
ARCH LM (10)	0.0000***	0.0000***
White test for heteroscedasticity	0.0000***	0.0000***
Ljung-box Q test for autocorrelation		
Q (6)	0.9160	0.9950
Q (8)	0.8790	0.8680
Q (10)	0.9510	0.9060
AC (6)	0.4250	0.4360
AC (8)	0.2390	0.2570
AC (10)	0.0440	0.0940

Analysis are conducted by Eviews 9.0. p-values are given in brackets, ***Statistical significance at 10% levels, respectively

Constant is again for the constant term. The α_1 parameter is for the effect of DETLOGIND at time t-1 on DETLOGM1 at time t. The α_2 parameter indicates the effect of DETLOGM1 at time t-1 on DETLOGM1 at time t. Equations 3 and 4 are for the variance equations of the EGARCH model. Conditional variance equation (log h_t) is obtained from the asymmetric EGARCH (1,1) model and can be written by Kim *et al.*[28].

Model I variance Eq. 3:

$$\log h_{DETLOGIND,\,t} = c_1 + a_1\,(|u_{1,\,t-1}| - d_1 u_{1,t-1}) + b_1 \log h_{DETLOGIND,t-1} \quad (3)$$

Model II variance Eq. 4:

$$\log h_{DETLOGM1,\,t} = c_2 + a_2\,(|u_{2,\,t-1}| - d_2 u_{2,t-1}) + b_1 \log h_{DETLOGM,t-1} \quad (4)$$

The parameter c_1 is the constant of model I variance Eq. 3. The a_1 is the ARCH parameter. The b_1 is called the GARCH parameter and represents the effect of log $h_{DETLOGIND}$ at time t-1 on log $h_{DETLOGIND}$ at time t. The parameter c_2 is the constant of model II variance Eq. 4. The a_2 is the ARCH parameter. The b_2 is again called GARCH parameter and represents the effect of log $h_{DETLOGM1}$ at time t-1 on log $h_{DETLOGM1}$ at time t.

RESULTS

Panel B of Table 2 shows the specification results. The constant is shown by C in the variance equation. The ARCH parameter is given by A and GARCH parameter is shown by B. The parameter D indicates the coefficient for an asymmetry term. The parameters are estimated by RATS 8.1 computer programme. The asymmetry parameter is significantly positive indicating that unexpected negative monetary shocks to output growth affects the volatility more than the positive shocks which is a common finding in the economic and financial research literature a la leverage effect.

The parameters of the nonlinear model presented in Table 2 are used to obtain conditional covariances and conditional correlations. Conditional covariance $h_{12} = \rho_{12}\sqrt{h_{11,t},\, h_{22,t}}$ is gathered from ADCC-EGARCH (1,1). The H_{11} is the conditional variance for output. The h_{22} is the conditional variance for money supply. The H_{12} is the covariance between output and money supply. Figure 3 presents the time-varying conditional correlation graph obtained from ADCC-EGARCH model I and II. Gray lines indicate NBER business cycle dates for US. Highest negative relationship between the volatilities of money supply growth and output growth exists during the recent 2008-2009 Global Financial Crisis and 1974, 1982, 1991 and 2001 recessions where the uncertainty increased and correlation coefficient is over -0.40 in absolute term.

Caveat: Analyzing the correlation of two non-stationary variables rather than the correlation between their first differences maybe aimed. At this stage, traditional correlation methods which are based on Gauss-Markov's assumptions cannot be benefited. Log of real income and log of money supply variables are not stationary and have increasing positive trends. Therefore, the standard correlation dynamics in Fig. 4 using levels of the variables would be biased. On the other hand, correlation analysis provided in Fig. 2 is detrended versions of these two variables and had given results for the short-run dynamics. One may claim that cointegration analysis could be employed to overcome this problem for long-run relationships. This view is widely adopted in the monetary

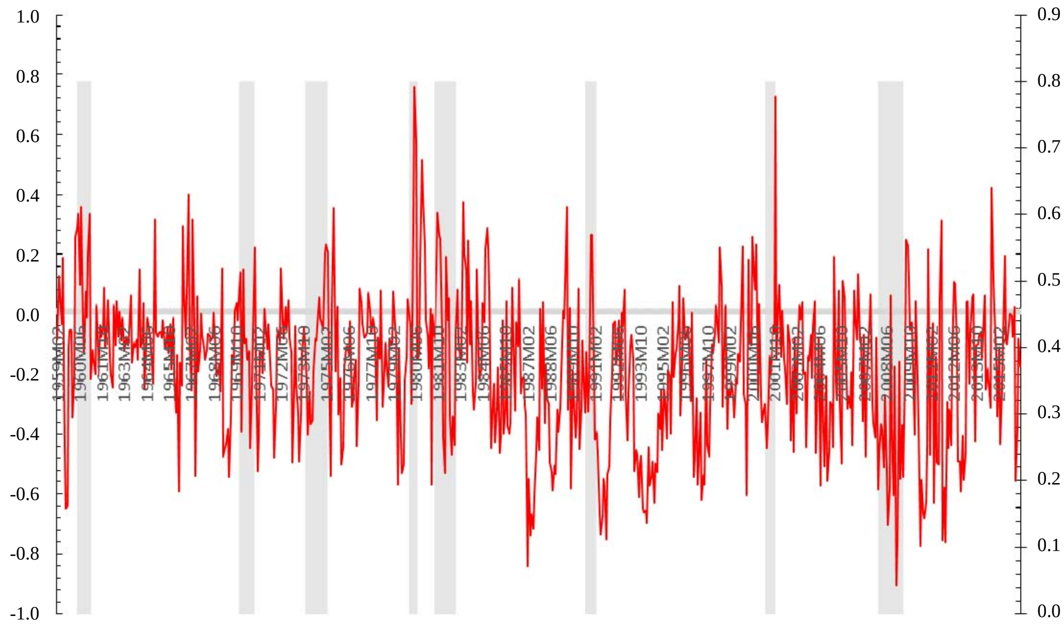

Fig. 3: Asymmetric DCC-EGARCH graph
y axis is for simultaneous dynamic conditional correlations between output growth volatility and money supply growth volatility. x axis indicates time

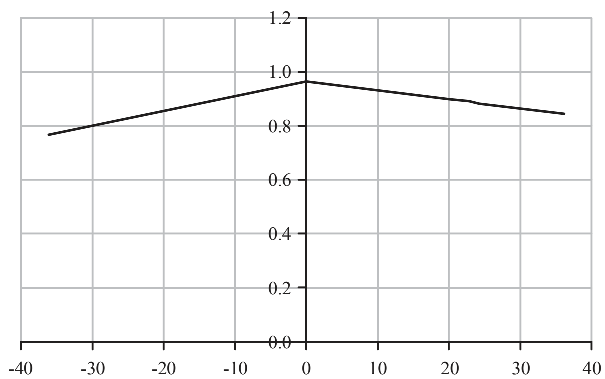

Fig. 4: Dynamic correlations using levels (1959: 01-2016: 05)
y axis is for dynamic correlations between $LOGIND_i$ and $LOGM1_{t+i}$. x axis shows the lags and leads

economics literature, some of which were cited in text. To increase the contribution of the study to the existing related literature on the US economy, in this study, Zebende[6] provided the methodology that may add another insight over the long-run neutrality of money debate.

Zebende[6] developed a methodology to handle two non-stationary variables by cross-correlation analysis. In this caveat section, the results of Detrended Cross-Correlation Analysis (DCCA) and its correlation coefficient (ρ_{DCCA}) are discussed to investigate the interaction between logarithm of money supply (LOGM1) and logarithm of output (LOGIND). The ρ_{DCCA} is calculated as[29] in Eq. 5. One can also refer to Hussain *et al.*[30] for an application of DCCA.

Table 2: Asymmetric DCC-EGARCH model results

	Model I	Model II
Panel A: Mean equation estimation		
Constant	0.0015***	0.0004***
	0.0000	0.0000
$DETLOGIND_{t-1}$	1.1652***	0.0108***
	0.0000	0.0000
$DETLOGM1_{t-1}$	0.5122***	0.4735***
	0.0000	0.0000
Panel B: Variance equation estimation results		
C	-6.3131***	-8.1257***
	0.0000	0.0000
A	0.1118***	0.0886***
	0.0000	0.0000
B	0.3446***	0.4219***
	0.0000	0.0000
D	2.3423***	9.5507***
	0.0000	0.0000

***Statistical significance at 10% levels, respectively, p-values are presented in brackets. The asymmetry terms are normalized by one hundred

$$\rho_{DCCA}(n) \equiv \frac{F^2_{DCCA}(n)}{F_{DFA_{\{LIND\}}}(n).F_{DFA_{\{LIND\}}}(n)} \quad (5)$$

Detrended Fluctuation Analysis (DFA) is presented by Peng *et al.*[31] to analyze the long-range power-law correlations for the variables that are not stationary. For the advantage of DFA[32]. The DFA lets one to interact root mean square fluctuation ($F_{DFA}(n)$) and the time scale n. If $\alpha>0.5$ then there is a high correlation between variables:

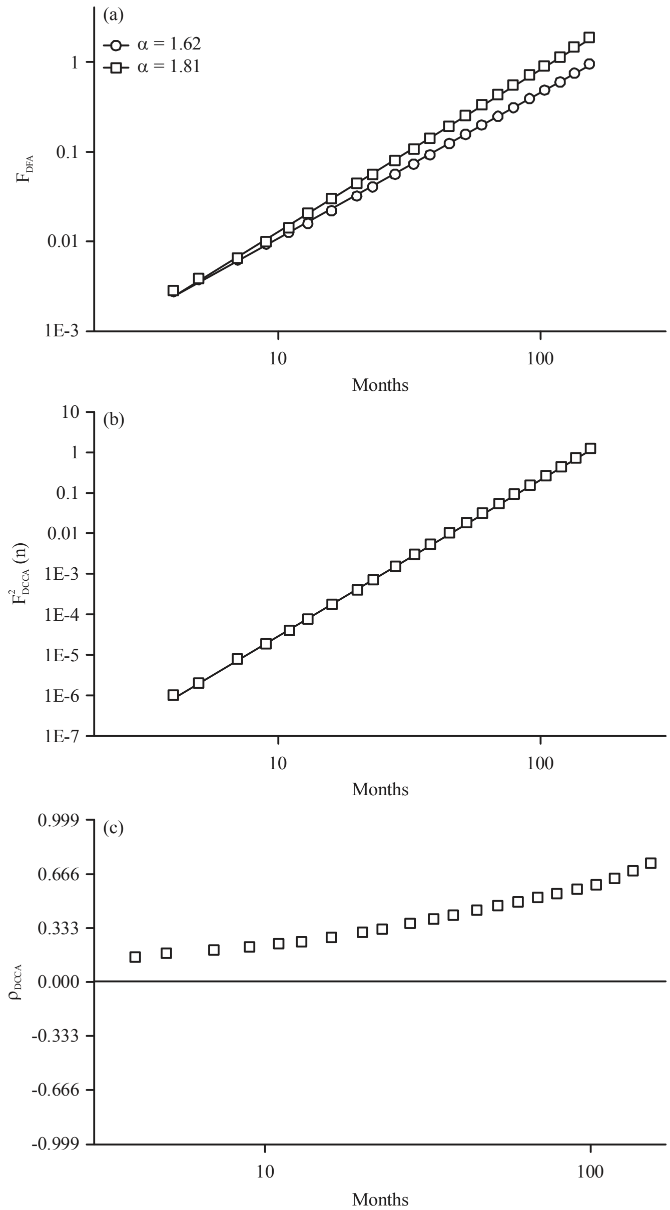

Fig. 5(a-c): Cross-correlation coefficient as a function of (n: months), 1959: 01-2016: 05, obtained from DCCA

$$F_{DFA} \alpha n^{\alpha}$$

Detrended Cross-Correlation Analysis (DCCA) is similar to DFA and can be used to analyze the long range cross-correlations if the variables are not stationarity[33]. In this sense, we have a detrended covariance function F_{DFA} (n). According to Zebende *et al.*[34], if self-affinity appears then a power-law exists in the cross-correlation function where, λ is called as the long-range power-law cross-correlation exponent:

$$F^2_{DCCA} \alpha n^{2\lambda}$$

In Panel A of Fig. 5, circle is the DFA analysis of LOGIND and square is the DFA analysis of LOGM1, α corresponds to the linear fit on the graph of Log FDFA in function of Log n and can be called as a DFA exponent. If the value of α is greater than 0.5, then we conclude that the time series are persistent and the auto-correlations are power-law. Note that in Panel A, there are two α for these two variables LOGIND and LOGM1 respectively. Panel B provides the λ_{DCCA} value as 19.94 that is a DCCA exponent. Panel C provides a graph of $-1 \leq \rho_{DCCA} \leq$ which is the DCCA cross-correlation coefficient between LOGIND and LOGM1. Here, ρ_{DCCA} is a function of n where n is the time scale (months), thus 4<n<N(points)/4. ρ_{DCCA}, the correlation coefficients, point out that there is a change from a weak cross-correlation to a strong cross-correlation by the time being.

DISCUSSION

Central banks being responsible from monetary policy are the major institutions, creating money and trying to affect the overall prices and production dynamics. They create an extensive amount of liquidity within the market through increasing money supply, especially during the economic recessions and crises. Since the consequences of these recessions were so extreme that the liquidity provision policy has not been sufficient to overcome the problems, policy makers have started to focus on the slope of the yield curve through quantitative easing. Therefore, central banks questioned the validity of nominal dichotomy in the economy. However, a change in money supply has negligible effects over real output in the long-run that is called neutrality of money but the effect in short-run is apparent[35]. For this purpose, money supply should be kept stable due to dynamic short-run effects on the economy[36].

According to the results of this study, volatility of money supply growth affects the volatility of output growth in the short-run. This finding is consistent with the Friedman and Schwarz[23] hypothesis that standard deviation of money supply has a relationship between standard deviation of output. An increase of volatility in money supply, which is not desirable, gives a negative signal for the cost of production and supply side of the economy. Monetary uncertainty delays the production in the economy since firms would wait until the marginal cost of production stabilizes. On the other hand, labor would be indifferent between leisure and working. Labor supply will diminish and would have negative effects on the output volatility.

The DCCA findings in this paper is consistent by Westerlund and Costantini[37], Skare *et al.*[38], Ekomie[39] in terms of finding long-run positive effects of money supply but contradicts with Serletis and Koustas[40], Asongu[41] and Lee[42] which indicated neutrality of money supply in the long-run.

CONCLUSION

This study employing ADCC-EGARCH model concludes that money supply growth volatility has an effect on output growth volatility in the short-run. The lagged effect of money supply growth on economic growth is also apparent in the short-run. Moreover, money supply in levels has a positive effect on output in levels in the long-run according to the results of detrended cross correlation analysis. The results might shed some lights for monetary policy makers during their decision making process in conducting monetary operations.

SIGNIFICANCE STATEMENTS

This study discovered that the lagged effect of money supply growth on output growth is positive in the short-run. Moreover, the relationship between volatility of money supply growth and volatility of output growth is not always positive or negative in the short-run. The results also indicate a positive simultaneous long-run relationship between money supply and output in levels. This study will help the researchers and Central Bankers to uncover the critical areas of neutrality of money that many researchers were not able to explore.

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REFERENCES

1. Gordon, R.J., 2012. Macroeconomics. 12th Edn., Pearson Education Limited, USA., ISBN-13: 978-0138014919, pp: 463-464.
2. King, M., 2016. The End of Alchemy: Money, Banking and the Future of the Global Economy. 1st Edn., W. W. Norton Publ., UK., ISBN-13: 9780393247039, pp: 5.
3. Mishkin, F., 2016. Monetary Targeting. In: The Economics of Money, Banking and Financial Markets, Mishkin, F.S. (Ed.). Pearson Education Limited, USA., pp: 4.
4. Orphanides, A. and R.M. Solow, 1990. Money, Inflation and Growth. In: Handbook of Monetary Economics, Volume 1, Friedman, B.M. and F.H. Hahn (Eds.). Chapter 6, Elsevier Science Publishers, Netherland, ISBN-13: 9780444880253, pp: 224-259.
5. Engle, R., 2002. Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. J. Bus. Econ. Stat., 20: 339-350.

6. Zebende, G.F., 2011. DCCA cross-correlation coefficient: Quantifying level of cross-correlation. Phys. A: Stat. Mech. Applic., 390: 614-618.
7. Tobin, J., 1965. Money and economic growth. Econometrica, 33: 671-684.
8. Solow, R.M., 1956. A contribution to the theory of economic growth. Quart. J. Econ., 70: 65-94.
9. Swan, T.W., 1956. Economic growth and capital accumulation. Econ. Rec., 32: 344-361.
10. Sidrauski, M., 1967. Rational choice and patterns of growth in a monetary economy. Am. Econ. Rev., 57: 534-544.
11. Algan, Y. and X. Ragot, 2010. Monetary policy with heterogeneous agents and borrowing constraints. Rev. Econ. Dyn., 13: 295-316.
12. Lucas, Jr. R.E., 1996. Nobel lecture: Monetary neutrality. J. Political Econ., 104: 161-182.
13. Gimenez, J. and R. Kirkby, 2014. How to model money? Racing monetary frameworks against the quantity theory of money. Working Paper, January 8, 2014, pp: 1-45.
14. Dewald, W.G., 1998. Historical U.S. money growth, inflation and inflation credibility. Federal Reserve Bank of St. Louis, November/December 1998, pp: 13-24.
15. Berger, H. and P. Osterholm, 2009. Does money still matter for U.S. output? Econ. Lett., 102: 143-146.
16. Aksoy, Y. and T. Piskorski, 2006. U.S. domestic money, inflation and output. J. Monetary Econ., 53: 183-197.
17. Lu, X., K. Guo, Z. Dong and X. Wang, 2017. Financial development and relationship evolvement among money supply, economic growth and inflation: A comparative study from the U.S. and China. Applied Econ., 49: 1032-1045.
18. Darrat, A.F., M.C. Chopin and B.J. Lobo, 2005. Money and macroeconomic performance: Revisiting divisia money. Rev. Financial Econ., 14: 93-101.
19. Ogunmuyiwa, M.S. and A.F. Ekone, 2010. Money supply-economic growth nexus in Nigeria. J. Social Sci., 22: 199-204.
20. Liu, L. and Y.H. Jin, 2005. Money supply, inflation and economic growth of China-The experimental analysis based on cointegration analysis. Stat. Res., 3: 1-20.
21. Fountas, S. and M. Karanasos, 2007. Inflation, output growth and nominal and real uncertainty: Empirical evidence for the G7. J. Int. Money Finance, 26: 229-250.
22. Wang, Q. and X.T. Han, 2011. Can Monetary Policy Target on Asset Price?-Evidence from Chinese Real Estate Market. In: Studies on Financial Markets in East Asia, Susai, M. and S. Uchida (Eds.). World Scientific Publications, India, ISBN-13: 9789814460699, pp: 41-49.
23. Friedman, M. and A.J. Schwartz, 1963. Money and business cycles. Rev. Econ. Stat., 45: 32-64.
24. Walsh, C.E., 2010. Monetary Theory and Policy. 3rd Edn., The MIT Press, Cambridge, USA., ISBN-13: 9780262013772, pp: 4-8.
25. Sahin, A. and I. Dogan, 2017. Relationship between the Istanbul chamber of wholesale general price index and its components: Asymmetric conditional correlation analysis on Turkey, 1968-2015. J. Yasar Univ., (In Press).
26. Yin, L., 2016. Does oil price respond to macroeconomic uncertainty? New evidence. Empir. Econ., 51: 921-938.
27. Shaw, F., F. Murphy and F. O'Brien, 2016. Interest rate dynamics and volatility transmission in the European short term interest rate market. J. Econ. Finance, 40: 754-772.
28. Kim, H.S., H.G. Min and J.A. McDonald, 2016. Returns, correlations and volatilities in equity markets: Evidence from six OECD countries during the US financial crisis. Econ. Modell., 59: 9-22.
29. Filho, A.M., M.F. da Silva and G.F. Zebende, 2014. Autocorrelation and cross-correlation in time series of homicide and attempted homicide. Physica A: Stat. Mech. Applic., 400: 12-19.
30. Hussain, M., G.F. Zebende, U. Bashir and D. Donghong, 2017. Oil price and exchange rate co-movements in Asian countries: Detrended cross-correlation approach. Phys. A: Stat. Mech. Applic., 465: 338-346.
31. Peng, C.K., S.V. Buldyrev, S. Havlin, M. Simons, H.E. Stanley and A.L. Goldberger, 1994. Mosaic organization of DNA nucleotides. Phys. Rev. E, 49: 1685-1689.
32. Moret, M.A., G.F. Zebende, E. Nogueira Jr. and M.G. Pereira, 2003. Fluctuation analysis of stellar X-ray binary systems. Phys. Rev. E, Vol. 68, No. 4. 10.1103/PhysRevE.68.041104.
33. Podobnik, B. and H.E. Stanley, 2008. Detrended cross-correlation analysis: A new method for analyzing two nonstationary time series. Phys. Rev. Lett., Vol. 100, No. 8. 10.1103/PhysRevLett.100.084102.
34. Zebende, G.F., M.F. da Silva and A.M. Filho, 2013. DCCA cross-correlation coefficient differentiation: Theoretical and practical approaches. Phys. A: Stat. Mech. Appl., 392: 1756-1761.
35. Bekaert, G.J. and R.J. Hodrick, 2014. International Financial Management. 2nd Edn., Pearson Education Ltd., UK., ISBN-13: 9781292021393, pp: 157-158.
36. Su, C.W., J.J. Fan, H.L. Chang and X.L. Li, 2016. Is there causal relationship between money supply growth and inflation in China? Evidence from quantity theory of money. Rev. Dev. Econ., 20: 702-719.
37. Westerlund, J. and M. Costantini, 2009. Panel cointegration and the neutrality of money. Empir. Econ., 36: 1-26.
38. Skare, M., M. Benazic and D. Tomic, 2016. On the neutrality of money in CEE (EU member) states: A panel cointegration analysis. Acta Oeconomica, 66: 393-418.

39. Ekomie, J.J.T., 2013. A multivariate long-run money neutrality investigation: Empirical evidence for CAMEU. Mod. Econ., 4: 384-390.
40. Serletis, A. and Z. Koustas, 2015. Monetary neutrality. Working Papers 2015-06, Department of Economics, University of Calgary, Canada.
41. Asongu, S.A., 2014. A note on the long-run neutrality of monetary policy: New empirics. Eur. Econ. Lett., 3: 1-6.
42. Lee, J., 2012. Nonparametric testing for long-run neutrality with applications to US money and output data. Comput. Econ., 40: 183-202.