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An Empirical Investigation of The Exchange Rate Pass-Through To Domestic Prices in Nigeria "Exchange Rate Pass-Through To Domestic Prices"

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ABSTRACT

The sensitivity of prices to fluctuations in the nominal exchange rate of the Nigeria's currency has become a prominent subject for business and policy makers. The persistent depreciation in exchange rate and high domestic prices currently above the policy target is the basis of this study. The study adopted secondary data of monthly frequency covering January-2000 to June-2017, to test the exchange rate pass-through to domestic prices in Nigeria while controlling for effects of other variables such as monetary aggregates and fuel prices. Impulse response functions and variance decomposition under the purview of Vector Auto-regressive (VAR) modelling approach are employed for the analyses. It finds that the exchange rate pass-through to domestic prices is complete six months after exchange rate shock. However money supply and fuel price effect are stronger than the exchange rate effect although the fuel price impact decay over time. Given the stronger impact of money supply on prices, the study concludes that inflation is a monetary phenomenon thereby giving credence to the current policy anchor on money supply as a policy tool to control inflation. It therefore recommends that policy makers should continue to pursue and maintain exchange rate stance that eases the depreciation pressure.

Keywords: Inflation, Exchange rate, Vector Auto-Regression
JEL Codes: C32, E31, F31,

INTRODUCTION

The transmission of exchange rate movements to changes in the domestic price level has become an increasingly important issue in developing and emerging economies as the adoption of inflation targeting, floating exchange rates, and the elimination of capital controls has become more fashionable in recent times. Since no economy operates in isolation, the sensitivity of domestic prices to fluctuations in the nominal exchange rate of the country's currency has become prominent in international economics and monetary policy especially in developing and emerging markets.

The adoption of inflation targeting by many countries in the past two decades, with its reliance on inflation forecasting, has probably enhanced interest in Exchange Rate Pass-Through (ERPT). Many have adopted floating exchange rates and eliminated capital controls thereby exposing countries to speculative pressures, contagion, and capital flows reversals. Having confirmed a strong correlation between exchange rate pass-through and inflationary environment in emerging and developing economies (Hakura 2001), monetary policymakers in small, open economies may face price stability challenges in countries with greater import dependence and highly volatile exchange rate susceptible to shock (McCarthy, 2006).

Thus, appropriate monetary policy response to currency movement is critical in the move towards achieving price stability – one of the major objective of monetary policy. Apart from the fact that understanding of pass-through magnitude contributes to the design of country's trade policy, estimates of the pass-through can help guide exchange rate policy and provide

insights into the degree of exchange rate flexibility that is appropriate considering the characteristics of the economy (Frankel, David, and Shang-Jin 2005; Ho and McCauley, 2003).

Furthermore, low exchange rate pass-through may explain the persistence of trade deficit despite secular declines in the domestic currency. It therefore follows that economies may be less concerned about the potential inflationary consequences of exchange rate fluctuations. While the extent of exchange rate pass-through has important macroeconomic implications, it is predominantly a microeconomic phenomenon and significantly depends on the types of goods being traded.

The evaluation of pass-through in Nigeria is necessitated by the recent persistent weakness of the naira, with the currency exchanging currently at all-time lows of ₦365/$ and ₦305/$ in Parallel and NIFEX markets respectively as at August-2017. Essentially, we are interested in the impact, and strength of the ERPT as well as whether the pass through from exchange rate to price is complete. The paper also seeks to determine whether the degree of ERPT is generally declining or intensifying over time.

The objective of the study is to estimate the ERPT to the price level specifically consumer price index in Nigeria in the presence of conditioning variables. In doing this, we hypothesize non-zero, incomplete pass-through from exchange rate shocks to inflation as in most countries. The outcome of this study will serve as useful guide to policy maker in determining appropriate anchor for containing inflationary pressure. A basic contribution of this study to existing literature is the inclusion of petrol motor spirit (generally known as fuel) price as a control variable in the modelgiven therising cost of doing business engendered by self-generated power supply and transportation cost.

Following the introduction, the rest of the paper is organised as follows: Section two presents a brief stylized facts of exchange rate in Nigeria. Section three presents the review of the literature. Section four discusses the methodology and data. Section five presents an analysis of the empirical result of the model while section six concludes and proffer recommendation for policy.

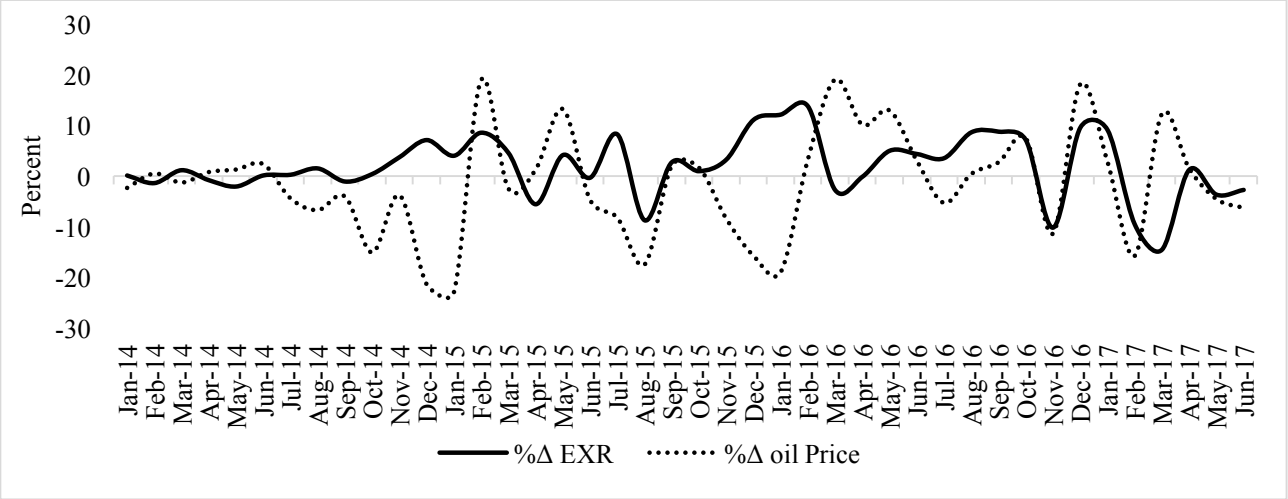
LITERATURE REVIEW

Stylized Facts: Exchange rate in Nigeria

The Nigerian currency has been weak owing to the decline and persistently low oil price in the international market that have come to stay. The weakness of the Naira stems from the fact that the country is a near mono-product economy which depends on oil export as a major source of foreign exchange supply and budgetary spending. As shown in Fig 1, the relationship between change in exchange rate and change in oil price (Nigeria bonny Light) is quite strong but negative with exchange rate tracking oil price with a lag. This means that although it takes some time for exchange rate to respond to change in oil price but every decline in oil price will lead to a depreciation in exchange rate (rise in the unit of Naira to Dollar) whilst a rise in oil price will lead to an appreciation in exchange rate (decline in the unit of Naira to Dollar).

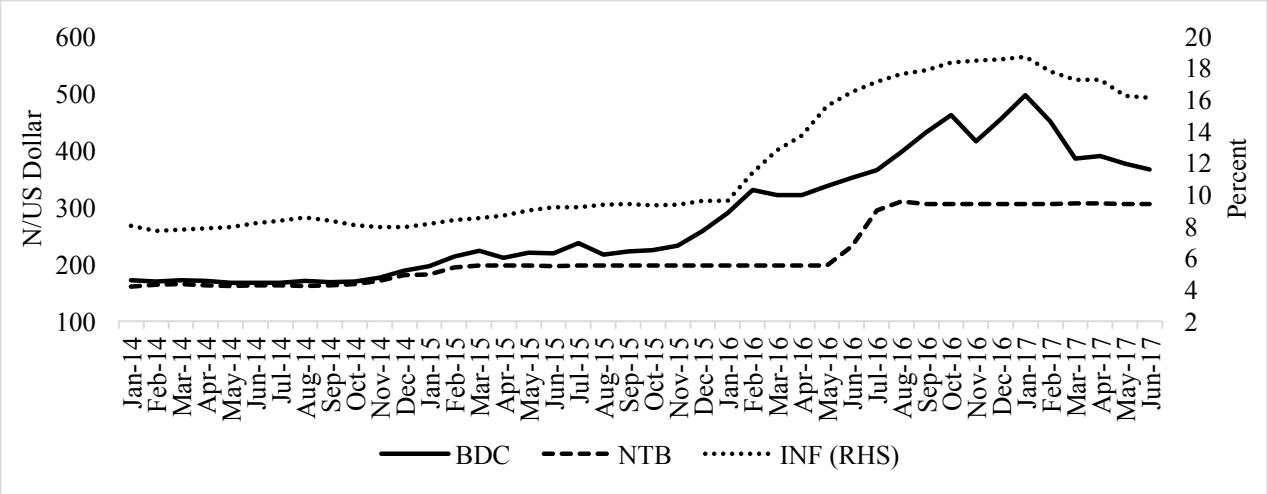
This decline in Naira lead to proliferation of exchange rate with over five different rate amongst which Interbank rate (NTB), Official rate and Bureau de-change (BDC) were the familiar. A major consequence of the speculation and proliferation of exchange rate was a wide premium (₦60 as at August-2017) between the interbank and BDC rate (see Fig 2) thereby encouraging arbitrage activities.

Fig 1: Exchange rate and Oil Price Trend



The weakness of the exchange rate has become a source of concern to both policy maker, consumers and business as the rate of price change (inflation) stands outside the current maximum policy target of 11 percent (16.1 percent – June 2017) as the persistent pressure on the Naira remains transmitted to prices. In a bid to tackle the weakness of the Naira policy makers have enacted several policies ranging from the ban of over forty items to partial deregulation and adjustment of the exchange rate window to ₦305/$ from ₦197/$. In spite of these policies which led to a lower premium compared to the all-time high premium of ₦191 as at Feb-2017, inflation remains persistent and above the target for 2017 amidst a five months consecutive decline. Other major source of pressure on prices are rising cost of doing business engendered by self-generated power/energy and transportation cost. This links the price of Petrol Motor Spirit (PMS) also known as fuel to changes in domestic price.

Fig 2: Exchange rate Premium and Inflation rate



Theoretical and Empirical Review

Considerable literature exists on exchange rate pass-through as an accurate understanding of the adjustment of domestic prices following changes in the exchange rate allows policy makers to formulate appropriate macroeconomic policies. The pricing-to-market as proposed by Krugman (1986) portends the micro theoretical foundation for the possibility of a direct but less than a one-for-one relationship between exchange rate and domestic inflation. Pricing-to-market may be defined as percentage change in prices in the exporter's currency due to a one percent change in the exchange rate, but in this regards importers may absorb shock in

exchange rate by adjusting profit margin. However, if import prices change by the same proportion as the change in the exchange rate, the result is full or complete pass-through and hence no pricing-to-market.

Also, the theoretical relationship derived from the law of one price (Purchasing Power Parity {PPP}) posits that exchange rate depreciation translates directly into import thereby suggesting a one-to-one relationship between exchange rate changes and changes in the consumer price. However, most empirical studies have shown that movements in the exchange rate and prices are not only directly related.

Lafleche (1996) finds existence of direct exchange rate pass-through which works through import price of finished or intermediate goods; and indirect channels of exchange rate pass-through engendered by high demand for substitute goods or more competitive export. Similarly, Dubravko and Marc (2008) conclude that the most direct way of transmitting nominal exchange rate changes into domestic inflation is by altering the domestic currency prices of imported goods. In the words of Taylor (2000), responsiveness of domestic prices to exchange rate fluctuation depends positively on inflation.

However, ERPT to domestic prices maybe high or low (Burstein, Eichenbaum and Rebelo {2002}, Bhundia {2002}) depending on the definition of shock (Bhundia {2002}) and the inflation environment (Yelena, 2008). Specifically, Bhundia (2002) concludes that average exchange rate pass-through in South Africa was low, it is however higher for nominal than for real shock. The effect of exchange rate pass-through may be long lasting (Goldfajn and Werlang {2000}, Leigh and Rossi {2002}). Yelena (2008), using a Phillips curve framework to analyze exchange rate pass-through to aggregate prices and inflation with a focus on real exchange rate finds that reduction in pass-through can be attributed in part to the low-inflation environment. More explicitly, Charles, Simon and Daniel (2008), opine that the rate of pass through amongst others depends on the quality of the imported good, price elasticity of demand, openness, and the monetary policy of the central bank and Stock market volatility.

In the purview of multivariate co-integration Kim (1998), concludes that exchange rate contribute significantly to the producer prices in the United States. Using time series data for six industrialized OECD countries and a recursive VAR, McCarthy (1999) found that exchange rate has a modest effect on consumer prices and pass-through is correlated with the degree of economy openness. Similarly, following the conclusion of correlation, Goldfajn and Werlang (2000) also found pass-through coefficient to increase immediately after a devaluation and reaches a peak after 12 months. Following the floating of the Real in Brazil, Rabanal and Schwartz (2000) found that the pass-through to domestic price in Brazil lasted 20 months.

In Nigeria, Aliyu, Yakubu, Sanni and Duke (2008) employing the vector error correction methodology for time series data covering 1986-Q1 to 2007-Q4 finds a significant and persistent exchange rate pass-through to consumer prices but pass through to import price was slightly higher. Adetiloye (2010) adopts the correlation and Granger causality method and finds a high positive correlation between the ratio of imports and price index and a unidirectional causality running from import ratio to consumer prices. Ogundipe and Egbetokun (2013), using the variance decomposition analysis derived from a structural estimate found a large pass-through and conclude that exchange rate has been more important in explaining Nigeria's rising inflation phenomenon than the actual money supply. Using similar methodology as Ogundipe and Egbetokun (2013), Zubair, Okorie and Sanusi (2013) find that pass-through is incomplete, low and fairly slow.

Previous studies on exchange rate pass-through in Nigeria were carried out using quarterly data. The current study deviates from period studies by using monthly data on relevant variables to examine exchange rate pass-through to domestic prices in Nigeria. This is because higher frequency data will yield more reliable results than data with lower frequency of observation.

MODEL AND METHODOLOGY

In the estimation of pass-through, a review of the literature suggests that both the simple and the systems of equations method has been employed however, the most dominant method was the Vector Auto-regression (VAR). The primary research question that we set out to answer is whether the exchange rate pass-through to domestic price is complete as well as the speed of adjustment. To provide answers to the research questions, we will use secondary data sourced directly from the Central Bank of Nigeria Statistical Bulletin (CBN) and the National Bureau of Statistics (NBS). The variables of interest are time series monthly data of Consumer's price index (CPI), Exchange rate, Money supply and price of Fuel (PMS) over the period Jan-2000 to June-2017.The choice of the period is the availability of the 2009 base year Consumer Price Index (CPI) data. Furthermore, the exchange rate used for the analysis is the parallel market (Bureau de Change) rate given that most business depends on the supply of forex from the parallel market.

Following Zubair, Okorie and Sanusi (2013), the unrestricted VAR approach will be employed to contribute to the body of already existing study in Nigeria. The choice of this modeling techniques lies in its flexibility by allowing for endogenous interactions between the exchange rate and other macroeconomic variables. The pass-through relationship assumes a unidirectional causal relationship between exchange rate and domestic variables, with causality running from exchange rate to domestic prices. However, a reverse causation – impact of domestic prices on the exchange rate may also exist. In addition, the Variance Decomposition (VDC) will be employed to analyse the pass-through of exchange rate to prices, while the impulse response function analysis will be done to examine the effect of exogenous shock to exchange rate on domestic prices (if the estimated baseline VAR model is found to be stable. We would also perform the usual diagnostic/robustness checks on our models, seeking to detect and correct for serial correlation, heteroscedasticity and multicollinearity among others.

The multivariate VAR contains four variables in a log-linear form. These are price of fuel (PMS) and broad money supply (M2), parallel market exchange rate – Bureau de Change (BDC), and the domestic inflation (INF) measured as the monthly percentage changes in the Consumer Price Index (CPI). The exchange rate and domestic inflation are the key variables of interest.
The unrestricted VAR is in the form:

$$\beta(Z)y_t = \varepsilon_t$$

Where

$$\beta(Z) = \sum_{i=0}^{i} \beta_i z_i \text{ ---------- 1}$$

y_t is a column vector of the endogenous variables, that is
y_t =[ΔPMS, ΔM2 , ΔBDC, ΔCPI];

Where Δ represents the first difference operator

$\beta(Z)$ is a 4 × 4 matrix polynomial in the lag operator Z and ε is a column vector of serially independent errors:

$$\varepsilon_t = (\varepsilon_t^{PMS}, \varepsilon_t^{M2}, \varepsilon_t^{BDC}, \varepsilon_t^{CPI})$$

Data analysis

The statistics below especially the Jarque-Bera statistic suggests that data are normally distributed whereas the standard deviation show that there is minimum variance and as such model analysis from the data boast high reliability.

Table 1: Descriptive Statistics

	L_CPI	L_BDC	L_M2	L_PMS
Mean	4.4715	5.0726	29.3930	3.9560
Median	4.4886	4.9982	29.7549	3.6889
Minimum	3.3810	4.6474	27.1979	2.9957
Maximum	5.4560	6.2086	30.7976	4.9767
Std. Dev	0.5583	0.3112	1.0475	0.5647
Skewness	-0.1499	1.9313	-0.3627	0.0647
Kurtosis	1.9344	6.4922	1.6933	1.9516
Jarque-Bara	10.723***	237.26***	19.543***	9.7637***

Note: *** indicates significant at the 1 percent level

The correlation coefficient is shown in Table 2. Result represent a positive relationship between all variables. This relationship as shown in the table suggests a high relationship of 74 percent, 98 percent and 97 percent between domestic price level and nominal exchange rate, broad money supply and price of fuel respectively. We also found a positive and high relationship of 65 percent between Money supply and exchange rate and also about 93 percent between fuel price and money supply.

Table 2: Correlation Coefficient

Variables	L_CPI	L_BDC	L_M2	L_PMS
L_CPI	1.0000	0.7446	0.9820	0.9679
L_IFEM		1.0000	0.6540	0.7576
L_M2			1.0000	0.9334
L_PMS				1.0000

RESULT AND ANALYSIS

In determining the stationarity and order of integration, the Augmented Dickey Fuller (ADF) test for unit roots was conducted. Results suggests that domestic prices and fuel price are stationary at levels whilst the parallel market exchange rate and broad money supply were stationary only after taking a first difference of the series. However, econometricians have resolved the debate that stationarity and non-stationarity of variables is irrelevant for VAR modelling and as such, level VAR is allowed.

Table 3: Unit Root Test of Logged Variable

Variables	Levels	First Difference	Comment
L_CPI	-3.3560**	-14.1068***	I(0)
L_BDC	-1.0151	-10.5987***	I(1)
L_PMS	-3.6544**	-16.6922***	I(0)
L_M2	-1.2207	-17.4014***	I(1)

The table shows the result of the Augmented Dickey-Fuller (ADF) set of unit root test with I(1) indicating integrated of order 1. The symbol *** and **, indicate significant at the 1 percent and 5 percent level of significance respectively.

The VAR Model

Using the Aikaike and schwarts criterion, a 1 period lag was selected. The model as expected suggests that change in domestic prices is endogenously reinforce by domestic prices itself. However, the effect of exchange rate and money supply was positive and significant whilst the effect of fuel price was positive but insignificant. Also, the AR roots graph (see appendix, fig 2) suggests that the VAR model is stable while the Trace and the Maximum Eigenvalue tests concludes that there is no co-integration. Furthermore, an exogeneity Wald test (See appendix) was conducted to test the direction of causality. The result suggest that domestic prices is prone to collective shocks in all variables however, causality is unidirectional running from exchange rate to domestic prices, from money supply to domestic prices while fuel price was a concurrent variable.

The Pass-Through

Impulse response functions (IRF) and variance decompositions (VD) from a VAR are used to assess the pass-through from exchange rate to domestic prices. The pass-through to domestic prices over T periods is defined as the accumulated effect of a structural one-standard deviation shock of exchange rate in period t on domesticprices in period T. (Sanusi, 2010).

The Table below shows the accumulated response of price to a structural one standard deviation shock to each of the variables. It is clear from the plot (see appendix) that there is an evident significant and positive elasticity effect of an exchange rate, money supply and fuel price shocks on domestic prices however, all these shocks have a delayed impact. Specifically, the effect of a 1 percent shock to the exchange rate at a period, say period 1 for instance will result in a one month delayed increase in price level by about 0.0006 (or 0.06 percent).This result suggests that exchange rate pass-through in Nigeria is small at impact but becomes successively large if shocks are sustained or reinforces and pass-through is complete six months after shock.

Table 4: Impulse Response of CPI

Period	L_CPI	L_BDC	L_M2	L_PMS
1	0.0158	0.0000	0.0000	0.0000
2	0.0153	0.0006	0.0009	0.0008
3	0.0149	0.0013	0.0017	0.0013
4	0.0145	0.0019	0.0024	0.0016
5	0.0141	0.0024	0.0030	0.0017
6	0.0138	0.0029	0.0036	0.0017
7	0.0135	0.0034	0.0041	0.0017
8	0.0132	0.0039	0.0046	0.0015
9	0.0129	0.0043	0.0050	0.0013
10	0.0127	0.0047	0.0053	0.0010
11	0.0125	0.0051	0.0056	0.0007
12	0.0123	0.0055	0.0059	0.0004

Money supply and fuel price effect are stronger than the exchange rate effect however the fuel price impact decays with time. The Money supply shocks effect on domestic prices was positive and significant with a delayed effect of 0.09 percent increase in price level but full effect quickly realised as a result of multiple shock following policy adjustments and reversals.

Consistent with the IRFs discussed above, the variance decomposition reveal that money supply shocks contributes more to rate of domestic price change than exchange rate shocks. Specifically, while exchange rate changes account for only 0.08 to 5 percent of the variations of the price level, money supply shocks account for about 0.2 to 7 percent at the same time horizon respectively. This suggests that inflation in Nigeria is highly influenced by money supply change consistent with monetary theoretical relationship between money and rate of price change and therefore calls for a solid monetary surveillance.

Table 5: Variance Decomposition of CPI

Period	**Std. Error**	**L_CPI**	**L_BDC**	**L_M2**	**L_PMS**
1	0.0158	100.0000	0.0000	0.0000	0.0000
2	0.0221	99.6285	0.0864	0.1646	0.1206
3	0.0267	98.8914	0.2839	0.5137	0.3110
4	0.0306	97.8977	0.5852	1.0107	0.5064
5	0.0340	96.7266	0.9805	1.6221	0.6707
6	0.0370	95.4348	1.4589	2.3182	0.7881
7	0.0398	94.0621	2.0088	3.0733	0.8558
8	0.0424	92.6368	2.6186	3.8659	0.8788
9	0.0448	91.1791	3.2771	4.6777	0.8660
10	0.0472	89.7040	3.9739	5.4940	0.8282
11	0.0494	88.2227	4.6989	6.3026	0.7758
12	0.0515	86.7444	5.4433	7.0939	0.7184

CONCLUSION

The paper investigated the exchange rate pass-through to consumer prices for Nigeria using the VAR approach. The degree of exchange rate pass-through was estimated by means of IRFs from the VAR analysis, covering the period January-2000 through to June-2017. The result suggests that exchange rate pass-through to consumer prices in Nigeria is small, delayed and complete in six months. Unlike Ogundipe and Egbetokun (2013), the Variance decomposition analysis indicates that money supply changes dominate exchange rate shocks in explaining Nigeria's high inflation. This provides some support to the theoretical claim that inflation is a monetary phenomenon contrary to findings of Salami and Kelikume (2013).

The likely drawback of the work is the inability to add the supply shock variable of output proxied by the Gross Domestic Product (GDP) because data are not available in monthly series. Nevertheless, the strong impact of money supply on domestic inflation implies that the continuous use of monetary policy tool to achieve price stability in Nigeria is laudable however since the impact of exchange rate increases with time, policy maker should continue to maintain and strengthen the current exchange rate stances that has tend to ease the depreciation pressure.

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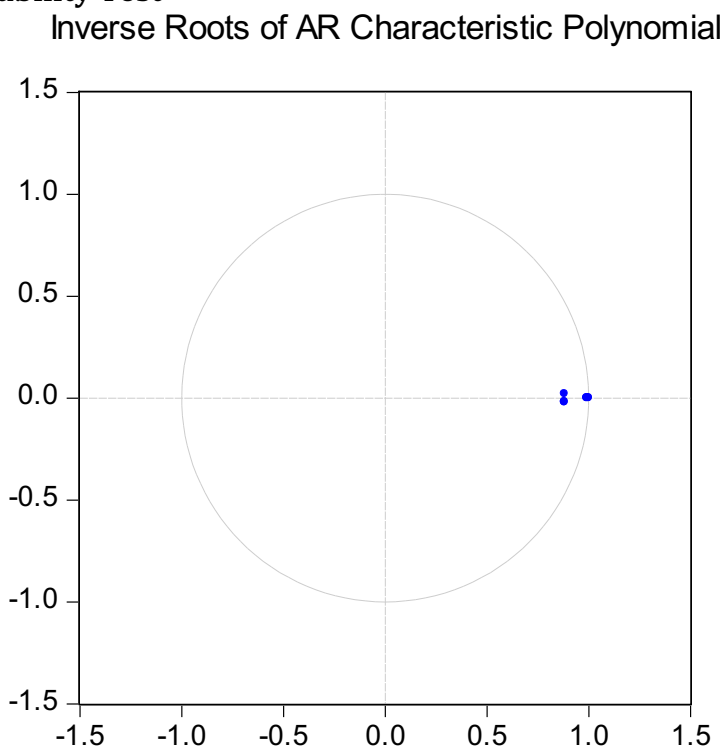
APPENDIX

Appendix 1: VAR Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	75.08485	NA	5.81e-06	-0.703810	-0.638300	-0.677305
1	1515.382	2809.292	4.37e-12*	-14.80576*	-14.47821*	-14.67323*
2	1529.185	26.37622*	4.46e-12	-14.78401	-14.19442	-14.54546
3	1533.321	7.739880	5.02e-12	-14.66654	-13.81491	-14.32197
4	1542.514	16.83863	5.38e-12	-14.59915	-13.48547	-14.14855
5	1550.614	14.51574	5.82e-12	-14.52093	-13.14521	-13.96431
6	1564.759	24.78828	5.94e-12	-14.50256	-12.86480	-13.83992
7	1573.987	15.80659	6.37e-12	-14.43551	-12.53571	-13.66685
8	1588.567	24.39620	6.49e-12	-14.42145	-12.25961	-13.54677

Appendix 2: VAR Stability Test



Appendix 3: Exogeneity Wald Tests

Dependent variable: LCPI

Excluded	Chi-sq	df	Prob.
LBDC	7.236210	2	0.0268
LM2	5.170931	2	0.0754
LPMS	1.508760	2	0.4703
All	9.292840	6	0.1578

Dependent variable: LBDC

Excluded	Chi-sq	df	Prob.
LCPI	1.575948	2	0.4548
LM2	0.420226	2	0.8105
LPMS	4.345386	2	0.1139
All	5.890964	6	0.4355

Dependent variable: LM2

Excluded	Chi-sq	df	Prob.
LCPI	3.816170	2	0.1484
LBDC	3.756395	2	0.1529
LPMS	2.215287	2	0.3303
All	5.803900	6	0.4455

Dependent variable: LPMS

Excluded	Chi-sq	df	Prob.
LCPI	0.114868	2	0.9442
LBDC	5.639949	2	0.0596
LM2	0.975207	2	0.6141
All	15.12668	6	0.0193

Appendix 4: Cointegration Tests

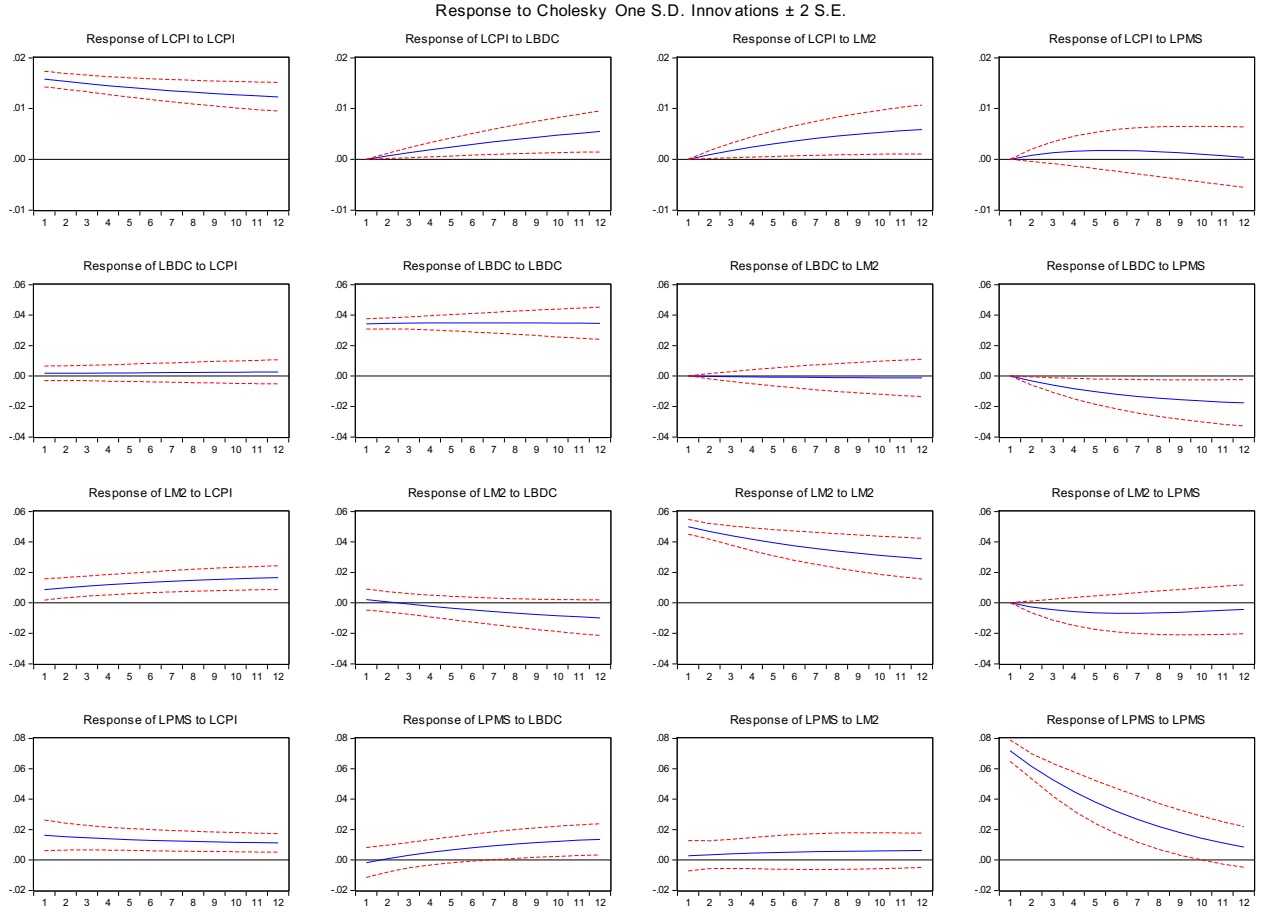
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.082484	40.96277	47.85613	0.1899
At most 1	0.074973	23.14307	29.79707	0.2391
At most 2	0.032629	7.011079	15.49471	0.5764
At most 3	0.000696	0.144225	3.841466	0.7041

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.082484	17.81970	27.58434	0.5102
At most 1	0.074973	16.13199	21.13162	0.2172
At most 2	0.032629	6.866854	14.26460	0.5050
At most 3	0.000696	0.144225	3.841466	0.7041

Appendix 5: Combined Impulse Response Function for the 4-Variable VAR



Appendix 6: Variance Decomposition for the 4-Variable VAR