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Exchange Rate Pass Through to Domestic Price and Output in Nigeria

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Abstract: This study examines, the pass through of exchange rate to both domestic price level and output in Nigeria using a VAR model that incorporates a distribution chain with the Nigerian real annual data (oil price, exchange rate, money supply, output and CPI) from 1970-2006. The study, though establishes long run relationships among the variables employed, finds no evidence of any exchange rate volatility induced inflation and growth (both in the short and long-run) in the period under consideration. On the other hand, much of the variability in the domestic price level, apart from its own shock, has been explained significantly by both output and money supply shocks. Hence, the policy implication here is that the volatility of exchange rate has no significant effects on domestic inflation and output in Nigeria. Therefore, domestic policies (monetary or fiscal) could play a significant role in controlling domestic inflation and output variability in Nigeria.

Key words: Exchange rate pass through, domestic price level, output, vector autoregressive, Nigeria

INTRODUCTION

Fundamental to monetary policy in any economy is the goal of stabilizing the domestic and external value of the currency. More specifically, one of the major responsibilities of central banks pertains to ensuring healthy monetary and financial environment. The extent, to which exchange rate volatility influences domestic prices and output is a major concern for monetary policy purpose. In other words, the exchange rate pass through to consumer prices and output is an important link in the monetary policy transmission. Fluctuation in the exchange rate value (appreciation or depreciation) will not only result in major changes in the prices of imported goods, but also imported inputs, which affect the cost of the finished goods. Meanwhile, beyond policy implications, economists have long been interested in investigating the influence of exchange rate and its volatility on both domestic price level and output.

Various researches on exchange rate pass through could be broadly classified into three categories. The first category are those studies, which aim at investigating the exchange rate pass through into import prices for specific industries (Feinberg, 1989; Klitgaard, 1999) while, the second category concerns studies which examine exchange rate pass through into aggregate import prices (Hooper and Mann, 1989; Campa and Goldberg, 2005). The last category relates to those studies that examine the pass through as relates to wholesale and consumer prices (McCarthy, 2000). Although, this subject has spawned many studies over the years, the empirical evidence as regards the exchange rate pass through to domestic prices and output remains inconclusive in both industrialized and developing countries. As a result, different and sometime conflicting results have been established.

This study, therefore, aims at contributing to the economic study on exchange rate pass through by investigating the exchange rate pass through to domestic price and output in Nigeria. Specifically, the study shall employ the McCarthy's (2000) recursive VAR methodology. The model tracks the pass through from exchange rate movements to each stage of distribution in a simple integrated framework. The aim here is to generate the forecast error variance decomposition in order to quantify the effect of an exchange rate shock on domestic price and output in Nigeria.

Figure 1 shows the exchange rate pass through mechanisms. Given that Nigeria is a developing economy and also open to external trade among other countries, its economy is not in any case impervious to external shocks. More specifically, as a result of its considerable degree of openness to foreign trade, Nigeria's domestic price level is susceptible to exchange rates volatility (depreciation or appreciation) and also changes in import prices. Looking at Fig. 1, domestic prices can be influenced through two main channels-direct and indirect. As epitomized, with depreciation in the value of naira, domestic prices are affected through direct changes in the prices of imported finished goods and imported inputs. These goods simply become expensive in naira terms. Eventually, as a result of higher costs of imported raw materials and capital goods, marginal costs of production increases and hence, domestically produced goods become more expensive.

On the other hand, in the case of indirect effect, naira depreciation affects the net exports which in turn influence the domestic prices through the change in

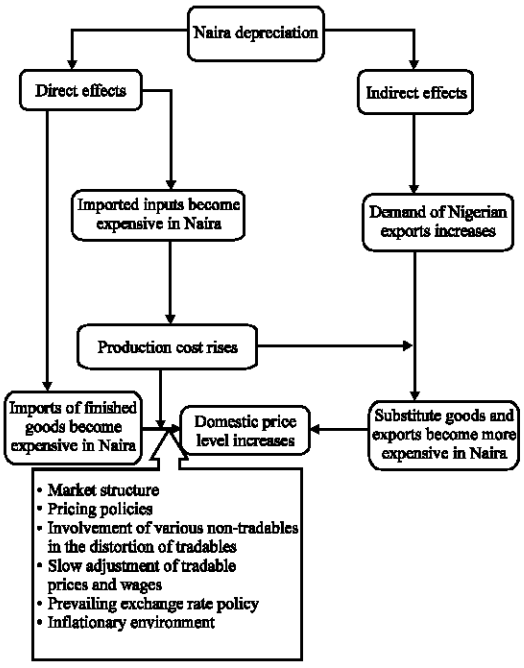

Fig. 1: Exchange rate pass-through mechanism to domestic prices in Nigeria

aggregate demand putting upward pressure on domestic prices. Also, import competing firms might increase prices in response to foreign competitor prices increase with the aim of maintaining their profit margin. The opposite is the case when naira appreciates.

Meanwhile, the extent, speed and magnitude of exchange rate pass through to domestic prices and output, of course, depend on some factors. Among other factors are domestic market structures, pricing policies, inflationary environment and involvement of non-tradables in the distribution of tradable etc. These factors either deepen or lessen the impact of exchange rate volatility on the domestic prices.

The aim of this study therefore, is to investigate the exchange rate pass through to both domestic price level and output in Nigeria.

MATERIALS AND METHODS

Data sources and definitions: With the aim of examining the exchange rate pass through to domestic price and output in Nigeria, this study shall employ the following variables: Oil price inflation, Π^{oil}, which is used as a measure of external supply shock in our model; growth in output, Δy, proxied by gross domestic product; growth in money supply, $\Delta m2$; change in nominal exchange rate, ΔER and consumer price index inflation, Π^{cpi}. Data are sourced mainly from the Central Bank of Nigeria (CBN) Statistical Bulletin 2006. The study covers the periods from 1970-2006.

The model: It is not uncommon in study, when examining the influence of exchange rate pass through to domestic prices and output to employ recursive Vector Autoregressive (VAR) approach. Hence, in this study the VAR approach, which is proposed by McCarthy (2000) shall be used. The model considers pricing along distribution stage in the following order:

$$\Pi_t^{oil} = E_{t-1}[\Pi^{oil}] + \varepsilon_t^{oil} \quad (1)$$

$$\Delta y_t = E_{t-1}[\Delta y_t] + \alpha\varepsilon_t^{oil} + \varepsilon_t^{\Delta y} \quad (2)$$

$$\Delta m2_t = E_{t-1}[\Delta m2_t] + \beta_1\varepsilon_t^{oil} + \beta_2\varepsilon_t^{\Delta y} + \varepsilon_t^{\Delta m2} \quad (3)$$

$$\Delta ER_t = E_{t-1}[\Delta ER_t] + \lambda_1\varepsilon_t^{oil} + \lambda_2\varepsilon_t^{\Delta y} + \lambda_3\varepsilon_t^{\Delta m2} + \varepsilon_t^{\Delta ER} \quad (4)$$

$$\Pi_t^{cpi} = E_{t-1}[\Pi^{cpi}] + \delta_1\varepsilon_t^{oil} + \delta_2\varepsilon_t^{\Delta y} + \delta_3\varepsilon_t^{\Delta m2} + \delta_4\varepsilon_t^{\Delta ER} + \varepsilon_t^{cpi} \quad (5)$$

From Eq. 5, consumer inflation in period t is assumed to be comprised of several components. The first component is the expected inflation at that stage based on the available information at the end of period t-1. The second and third are the effects of period t domestic supply and demand shocks on inflation at that stage. The fourth component is the growth in money supply used to incorporate the role of monetary policy in the model. The fifth component is the effect of exchange rate shocks on inflation at a particular stage and finally, the model includes the inflation shock at that particular stage. This is simply that portion of inflation that cannot be explained by using information from period t-1 plus information about other variables in the model and period t inflation at previous stages of the distribution chain.

Model restrictions: There are several ways of specifying restriction in order to achieve identification of the structural parameters. In the study, the simple method of orthogonalising reduced form errors by Cholesky decomposition as originally applied by Sims (1980). Consequently, the Forecast Error Variance Decomposition statistics are employed in the analysis of exchange rate pass through to domestic price and growth. FEVD separates the variation in an endogenous variable into the component shocks in the VAR system and also, variance decompositions of domestic price level and output are used to assess how much of the variance in domestic price and output over the period is attributed to exchange rate fluctuations.

Analytical procedures: While, the primary objective of this study is to investigate the exchange rate pass through to domestic price and output in Nigeria, however, for ease of rendition, the order of presentation shall be of the following nature: First, we shall examine the statistical properties of the time series employed. This is necessary for the purpose of determining the underlying properties of the process that generate these time series variables and hence, avoid the econometric pitfall of running a spurious regression. Second, the study shall proceed to investigating the long run relationship among the variables using Johansen (1991) cointegration technique. After the examination of the long run relationship, the study shall then inspect the dynamic behavior of the variables under consideration in a VAR system through Forecast Error Variance Decomposition (FEVD). Since the FEVD simply apportions the variance of forecast error in a given variable to its own shocks and those of other variables in the VAR system, this would therefore, help in tracing the pass through of exchange rates to both the domestic price level and growth. Thus, we can easily trace how much of the variances in the variables under consideration, especially price level and output is being explained by the exchange rate shock.

RESULTS AND DISCUSSION

Unit root test: Table 1 demonstrates, the result of the stationary test in this study. Here, the Ng-Perron modified unit root tests are applied on the variables under consideration. The four tests of Ng-Perron involve modifications of the following four unit root tests: Phillips-Perron Za and Zt, Bhargava R_1 and ERS opimal point tests. The results show that all variables are stationary at first difference, i.e., I (1). Thus, this evidence suggests that the first differencing is sufficient for modeling the time series in this study. Engle and Granger (1987) discussed that if a set of economic series is not stationary, there may have to exist, some linear combination of the variables that is stationary. Now, when all the variables are non-stationary at their level, but stationary in their first difference, this allows proceeding further for the implementation of Johansen (1991) co-integration technique.

Cointegration test: A vector of variables integrated of order one is cointegrated if there exists linear combination of the variables, which are stationary. In this study, following the approach of Johansen (1991), two likelihood ratio test statistics, the trace and maximal eigenvalue test statistics, were utilized to determine the number of cointegrating vectors. The results of the trace and maximal eigenvalue test statistics are presented in Table 2. The null Hypothesis (H_o), states that there are no cointegrating vectors. A rejection of the hypothesis would lead to testing the alternative Hypothesis (H_A). The test statistics indicate that the hypothesis of no cointegration among the variables (H_o), can be rejected. The results reveal that, at least, two cointegrating vectors exist among the variables of interest. Since, the variables are cointegrated, there is therefore, a long run relationship among the variables.

Table 1: The Ng-perron modified unit root tests results

Variables	MZa	MZt	MSB	MPT
Y	0.35254	0.22226	0.63045	28.19530
Δy	-13.64260	-2.61147	0.19142	1.79699
Oil	-0.15297	-0.06930	0.45305	16.44070
Δoil	-17.93080	-2.98902	0.16670	1.38527
Ms	-3.23198	-0.99198	0.30693	7.27950
Δms	-15.76180	-2.77244	0.17590	1.68399
Cpi	4.34988	2.69577	0.61974	48.38760
Δcpi	-9.37416	-1.83824	0.19610	3.78335
Exr	1.76047	1.07903	0.61292	34.22770
Δexr	-17.75380	-2.97217	0.16741	1.40633
Level of significance				
1%	-13.80000	-2.58000	0.17400	1.78000
5%	-8.10000	-1.98000	0.23300	3.17000

While, Δ symbolizes first difference, the critical values for each of the test for 1 and 5% level of significance are specified

Forecast error variance decomposition results: The variance decomposition of the variables as depicted in their respective. Table 3-7 show, the percentages of variance as explained first by the shock from the variable itself and the shocks from other variables in the model. A closer look reveals that most of the variances in the variables have been as a result of their own shocks, however, variables such as output and money supply could be said to have had a substantial impact on the variables variances through the share of their shocks to these variables. Meanwhile, variance in the oil price has been highly exogenous. The variance in oil price has solely been explained by its own shock through the period under consideration (Table 3).

On the other hand, the share of the exchange rate shock to other variables variances which actually explain the pass through of exchange rate to other variables has been highly negligible over the time horizon under consideration. More specifically, when tracing the extent of the shocks of the exchange rate to CPI and output (which is the core of this study), it is evident that no significant portion can be attributed to exchange rate (Table 4 and 5). Rather, as apparently depicted in Table 5, money supply contributes significantly to the variance in output, especially from second period downward. In this Table 5, apart from its own shock (output), which contributes about 99% in the 1st year and about 60% in

Table 2: Johansen (1991) cointegration test

Trace test (k = 2)					Maximum eigen values test (k = 2)				
			Critical values (%)					Critical values (%)	
H_o	H_A	λ trace	5	1	H_o	H_A	λ max	5	1
r≤0	r>0	83.601550*	68.52	76.07	r = 0	r = 1	36.201580*	33.46	38.77
r≤1	r>1	47.399980*	47.21	54.46	r = 1	r = 2	32.566080*	27.07	32.24
r≤2	r>2	14.833900	29.68	35.65	r = 2	r = 3	9.355333	20.97	25.52
r≤3	r>3	5.478567	15.41	20.04	r = 3	r = 4	5.471339	14.07	18.63
r≤4	r>4	0.007228	3.76	6.65	r = 4	r = 5	0.007228	3.76	6.65

r represents the number of cointegrating vectors, while k represents the number of lags in the unrestricted VAR model. *(**) denotes rejection of the null hypothesis at the 5 (1%) level

Table 3: Variance decomposition of oil price

Periods	SE	OIL	CPI	Y	EXR	MS
1	0.272098	100.00000	0.000000	0.000000	0.000000	0.000000
2	0.346601	96.48611	0.004501	0.381446	2.088815	1.039132
3	0.369074	92.90699	0.492553	0.354947	2.894032	3.351475
4	0.394074	85.79062	1.875438	0.491173	4.426275	7.416497
5	0.410479	83.73457	3.055225	0.656503	4.347739	8.205960

Table 4: Variance decomposition of CPI

Periods	SE	OIL	CPI	Y	EXR	MS
1	3.398322	1.061589	72.27708	22.915220	3.652048	0.094061
2	5.803854	0.701632	65.47649	24.700730	7.127321	1.993833
3	7.717724	0.874983	64.05198	19.188790	5.055236	10.829010
4	9.423523	1.147075	57.36827	13.359800	3.398271	24.726580
5	10.95259	1.106946	49.66738	9.919530	3.806512	35.499630

Table 5: Variance decomposition of output

Periods	SE	OIL	CPI	Y	EXR	MS
1	0.091308	0.265927	0.000000	99.73407	0.000000	0.000000
2	0.166986	0.370588	2.145485	60.36332	7.066398	30.054210
3	0.235694	0.784197	1.942728	39.97525	7.469778	49.828050
4	0.287997	1.561188	1.334181	30.52764	6.017436	60.559560
5	0.327275	2.472181	1.173458	25.90162	4.826041	65.626710

Table 6: Variance decomposition of exchange rates

Periods	SE	OIL	CPI	Y	EXR	MS
1	10.20331	11.363730	0.000000	12.77454	75.67775	0.183977
2	12.79979	7.246160	2.895881	17.37380	67.25722	5.226942
3	13.94775	6.118431	3.061279	19.34759	63.78933	7.683376
4	14.15547	5.982322	2.972650	18.86486	64.71584	7.464330
5	14.40727	5.776804	3.914387	19.94661	62.89066	7.471541

Table 7: Variance decomposition of money supply

Periods	SE	OIL	CPI	Y	EXR	MS
1	0.139045	23.66364	0.000000	21.01436	0.000000	55.32200
2	0.198991	34.89526	1.725586	22.23431	5.171519	35.97332
3	0.229934	41.47502	2.756717	20.09794	8.533543	27.13678
4	0.240540	45.41739	2.590053	18.52436	8.453522	25.01468
5	0.246292	46.41534	3.237941	17.97748	8.336956	24.03228

Table 8: Average variance decomposition matrix

Variables	Oilp	CPI	Output	Exch. rate	MS
Oilp	91.783660	1.08554	0.376814	2.751372	4.0026130
CPI	0.978445	61.76820	18.016810	4.607877	14.6286200
Output	1.090816	1.31917	51.300380	5.075930	41.2137100
Exch. rate	7.297489	2.56883	17.661480	66.866160	5.6060333
MS	38.373330	2.06205	19.969690	6.099108	33.4958100

the second period falling to 25% in the last period, the contribution of money supply shock to the variance of output continues to experience an increasing trend recording about percent in the second period and 65% in the last period.

Again, following the result of CPI variance decomposition as depicted in Table 4, apart from its own shock, shock from output contributes significantly (in the 1st-3rd period) to the variance of price level and money supply shock also, impact significantly on the

variance of price level (in the third to last period) in Nigeria. Hence, the policy implication here is that the volatility of exchange rate has no significant effects on domestic inflation in Nigeria; therefore, domestic policies (monetary or fiscal) could play a significant role in controlling domestic consumer inflation. However, the results obtained from the variance decomposition in this study are largely dependent on the ordering of the VAR system. A change in the ordering of the variables in VAR system is likely going to generate different results.

Table 8 shows, the average variance decomposition result of all the variables in the VAR system. This information is arrived at by simply finding the average, over the entire period (5 years), of the percentages of variation or variance being explained by a given variable over all other variables. Thus, the information contained in the respective rows relates to different shares of variance of a particular variable as explained by other variables. For instance, in the Exch. rate row, there are five corresponding variable columns. The value in each column thus, represents the contribution of exchange rate shock to each variable in the VAR system in the corresponding columns. Obviously, the weakness of exchange rate volatility shock, on the average, in explaining variations in other variables in this study given the time frame is revealed.

Meanwhile, the information contained in Table 8 individual variable basis for ease of appreciation.

CONCLUSION

This study focuses on investigating the pass through of exchange rate to both domestic price level and output in Nigeria. The study, though establishes a long run relationship among the variables employed, finds no proof of any exchange rate volatility induced inflation (both in the short and long-run) in the case of Nigeria in the period under consideration.

On the other hand, much of the variability in the domestic price level, apart from its own shock, has been contributed significantly by both output and money supply shocks. Hence, the policy implication here is that the volatility of exchange rate has no significant effects on domestic inflation in Nigeria; therefore, domestic policies (monetary or fiscal) could play a significant role in controlling domestic consumer inflation. While, the study has been able to contribute to the literature with respect to investigating the plausible channels, through which exchange rate volatility could impacts on both the domestic and output trends in Nigeria, the result should be interpreted and handled with care.

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