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On the Interaction between the Nigerian Residential Property Market and the Macroeconomy.

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Abstract.
Changes in real Gross Domestic Product, changing relativities of exchange rates, as well as inflation rates and short-term interest rates fluctuations exert profound impacts on the bulk of any country's tangible capital and vice-versa. This paper employs a vector autoregressive (VAR) model to examine the interaction between the Nigerian residential property market - using returns from direct residential property as proxy - and the macroeconomy. First, in estimating a parsimonious VAR model, we applied Augmented Dickney Fuller (ADF) test to detect the presence of unit roots (non- stationary) within the variables that enter the model. Secondly, a multivariate information criteria technique is used in selecting the appropriate lag lengths for the variables to be included in each equation so as not to introduce multicollinearity problem and specification errors. The results of the forecast error variance within the VAR model suggest that macroeconomic shocks explain 28% of the variation in residential property rents and that unexplained variation in the behaviour of residential rents may reflect the explanatory power of property market indicators (as varied as yield, vacancy rates and new construction) rather than macroeconomic variables. Furthermore, responses of residential property rents to shocks in real GDP, exchange rates and short-term interest rates reflect the fact that rents from direct residential property and by extension, the market for residential property adjust slowly to changes in macroeconomic events in Nigeria. On this basis, we hypothesise that this relatively slow adjustment will creates arbitrage profits for parties operating within the Nigerian residential property market to exploit.

Keywords: impulse response function, macroeconomic variables, residential property market, residential property rents, shocks, vector auto regressive model, variance decomposition.

1. Introduction

Most real estate literature have analyzed the various impacts of the wider economy on the operation of real estate markets. A classical example among others is the use of a comparative static analysis known as 4 Quadrant model developed by DiPasquale and Wheaton (1996) to determine the magnitude of these influence in the long run equilibrium, within any real estate market. Similarly, studies by Barras (1983), Barras and Ferguson (1985) and Barras and Ferguson (1987a, 1987b) have employed a theoretical framework which has been consistently tested using statistical time series techniques, spectral analysis and simulation in modelling the cyclical influences of different periodicity of building cycle across all property sectors in Britain. Barras, (1994) also examines how a building boom is generated by the interaction of the business cycle in the real economy, the credit cycle in the credit economy and the long cycle of development in the property market. Hekman (1985), Kling and McCue (1987, 1991) investigate the impact of macroeconomy on office and industrial construction cycles respectively and demonstrate that shocks to output, nominal interest rate and money supply affect office construction while employment account for substantial variation in industrial property construction.

Although, the links between real estate and the economy have been established as discussed elaborately in these previous research, interestingly, a point of convergence in this body of work is that there exist an interaction and interdependency between property and the economy. To this, it has been aptly argue by Dehesh and Pugh (2000 p.2581), that in periods of macroeconomic stability, property cycles tend to be endogenous - caused by disequilibria in the sector – and are relatively subdued and in periods of macroeconomic instability, property cycles tend to be exogenous – caused by various conditions in the macroeconomy – and sometimes feature exceptional fluctuations. They further conclude that these exceptional fluctuations with heightened amplitudes and longer periodicity exert relatively deep and protracted impact on the wider economy (see also, Toporowski, 1993 and Stiglitz, 1994 for pertinent details on the cause and feedback loops between property and the economy). Since cyclical behaviour is a feature of most market based system, the focal point of this research however is not on endogenous fluctuations, but rather the nexus between real estate and exogenous influences of the economy.

Again most of the research in this area (for instance, McCue and Kling, 1994; Brooks and Tsolasco, 1999; Ling and Naranjo, 2003) have focused considerably on modern economies such as UK and US, both operating a well integrated, mature and transparent real estate market. However, empirical analyses of the linkages between property and macroeconomic variables in developing countries have somewhat been limited to India (See recent studies by Joshi, 2006; Vishwakarma and French, 2010). A cursory examination of this developing country analyses nevertheless reveals similar striking theme with those of the developed economies: these studies have predominantly used data on paper-backed securities such as returns from Real Estate Investment Trusts (REITs) rather than real or nominal rents from direct property investment. This is against the backdrop that such data are readily available on monthly, quarterly and annually basis, due relatively to high frequency of trading in the stock market.

In this paper we employ an unrestricted vector autoregressive model to examine the interaction and interdependency between the economy and the operation of the residential property market within a time dimension. Our approach is however different in two ways. First, our study is on a developing country in Africa - using Nigeria as an empirical focus - which is a different market from does researched in previous work. Secondly, we explore the effects of using residential rents from direct real estate market instead of real estate returns from the stock market. This is partly because rent has undoubtedly remained a significant feature of most property markets across the world and partly due to paucity of a robust dataset from which a real estate index could be constructed in Nigeria. The remainder of this paper is structured as follows: In section 2, we consider from theoretical and empirical viewpoints a review of previous literature which specifically linked property to the business and economic cycles (national economy). Section 3 provides a description of the data variables used in the analysis and their sources. The methodology aspect of this study is presented in section 4. This is followed in Section 5 by the empirical results. Lastly, we draw conclusions on the basis of these results, on the extent to which the wider economy has impacted on residential real estate market in Nigeria.

2. Review of previous literature linking real estate and the economy

A convenient starting point regarding discussions linking real estate and the economy is the study carried out by Barras (1994) in the UK. He demonstrates by focusing on the user market, how a building boom is triggered through the combinations of conditions in the real economy, credit economy and property market. The author employs a conceptual model which is derived from a theoretical framework, and which has been tested using time-series modelling techniques to uncover these dynamics and operations within the property market (See also, Barras, 1983; Barras and Ferguson, 1987a, 1987b).

Adding to Barras (1994), Dehesh and Pugh (2000, p.2583) have also show considerable evidence that cyclicity in property has deep cause-consequence interdependency on the financial and credit cycles even at a global scale. They surmise that the dynamic growth in financial services, for instance, has necessitated new property sector demand for larger office spaces with modern communication technologies as against older stock which are deemed technically inefficient. They further argue that such structural change resulting from changes in the financial sector requirements may occur contemporaneously with and interact with the fluctuations in both the macroeconomy and the credit markets, thereby heightening inflation, causing financial collapse and leading to recession in the property sectors.

Having said that, previous studies linking property to the economy over time, however, fall principally into two distinct categories: those that centre explicitly on property- backed securities such as real estate investment trusts (Hartzell *et al.,* 1987; Chan *et al.*, 1990; McCue and Kling, 1994; Brooks and Tsolacos, 1999; Ling and Naranjo, 1997; Ling and Naranjo, 2003) as against those on direct property market variables, as diverse as construction series and rents (Kling and McCue, 1987 ; Kling and McCue, 1991 ; Giussani, *et al.*, 1992). In table 1 we summarize previous empirical research linking property with the economy. These empirical investigations are preponderant in the USA with most employing vector autoregressive framework as their methodology and few using regression analysis.

Within the first category, Chan *et al.* (1990) for instance examine the connection between some pre-specified macroeconomic variables and real estate returns from the stock market using regression analysis. They find that changes in risk, unexpected inflation and term structure are significant predictors; while changes in industrial production and expected inflation have no significant influence on real estate returns. McCue and Kling (1994) however extend the examination of the link between property and the economy in another direction. They treat real estate returns as a residual by controlling for the covariance between equity REIT returns and the overall stock market resulting from industry effects. In their analysis, the authors employ vector autoregressive model to test the relationships between this real estate residual and macroeconomic variables and conclude that macroeconomic variables account for 60% variance in real estate returns.

Brooks and Tsolacos (1999) take a similar approach to McCue and Kling (1994) study by also removing the impact of the general stock market on equity REIT series but using UK dataset. They suggest that unexpected inflation and term structure have a contemporaneous rather than a lagged effect on property returns. The absence of lagged effect however implies that changes in unexpected inflation and term structure are quickly incorporated into property returns. The authors further contend that property returns are explained by own lagged values: current property returns may have predictive power for future property returns. They hypothesise that this own lagged effect is partly due to the fact that property returns may reflect property market influences (rents, yield and vacancy rates) rather than macroeconomic variables and partly because macroeconomic and property data are not in a direct measurable form.

A departure from the above categorization is the studies by Kling and McCue (1987) and Kling and McCue (1991) who focus on property market indicator. They advocate the use of construction series from direct real estate investment and employ vector autoregressions to model industrial and office construction cycles. They find that macroeconomic variables influence real estate series indirectly through other macroeconomic variables. The authors also show that adjustment to macroeconomic shocks take place with a lag, resulting from the existence of long production period between new construction starts and completions.

Giussani *et al.* (1992) also examine the relationship between changes in commercial rental values and fluctuations in economy activity using a predictive model. They analyse monthly data from 1983 to 1991 from Europe and find that real Gross Domestic Product (GDP) is the most significant explanatory variable for rental values. This result is consistent with those reported in Hetherington (1988) and Keogh (1994) that GDP is a determinant of rents, to the extent that rents are closely correlated with the business cycle. Against the background that the approaches in all these previous literature vary considerably but are skewed to a particular property market - United States - coupled with the fact that long run equilibrium is always elusive in the residential real estate market, as the market hardly adjusts to exogenous changes (For further review of the long run equilibrium see, Whitehead and Odling-Smee, 1975) there is need for further research in this area.

Table 1. Classification of Studies Linking Property with the Economy.

Author/Year of Publication	Study area	Data type	*Methodology	Significant variables
Hoag (1980)	USA	Property specific variables, national and regional economic factors.	Regression Analysis.	Property specific variables, national and regional economic factors.
Hartzell *et al.* (1987)	USA	Appraised values from real estate fund.	VAR	Expected and unexpected inflation.
Chan et al. (1990)	USA	REITs and some pre-specified macroeconomic variables	Regression Analysis	Risk, unexpected inflation and term structure.
Kling and McCue (1991, 1987)	USA	Construction series from direct real estate assets.	VAR	Output, nominal interest rates, money supply and employment.
Giussani, *et al.* (1992)	Europe	Rental values and macroeconomic variables.	Regression Analysis	GDP
McCue and Kling (1994)	USA	REITs adjusted for stock influences and macroeconomic variables.	VAR	Nominal interest rates, price, output and investment.
Lizieri and Satchell (1997a)	USA	REITs returns and equity returns adjusted for property influences.	VAR	Lagged values of the equity returns.
Lizieri and Satchell (1997b)	USA	REITs returns and real interest rates.	VAR	Real interest rates.
Ling and Naranjo (1997)	USA	REITs returns and macroeconomic variables.	VAR	Term structure, unexpected inflation, real treasury bill rate and growth in real capital consumption.
Brooks and Tsolacos (1999)	UK	REITs adjusting for stock influences and macroeconomic variables	VAR	Unexpected inflation, term structure of interest rate.
Ling and Naranjo (2003)	USA	Capital flows in present and past REITs returns and macroeconomic variables	VAR	Present and lagged REITs returns.
Joshi (2006)	India	Housing share prices and interest rates and credit.	VAR	Interest rates and credit growth.
Vishwakarim and French (2010)	India	REITs and macroeconomic variables.	VAR	Term structure of interest rate.

*VAR in the 4th column depicts Vector autoregressive model.

3. Data Description

The core data for this study were principally drawn from three sources: registered Estate Surveying and Valuation firms operating within the Nigerian residential market, the National Bureau of Statistics (NBS) and Central Bank of Nigeria Statistical Bulletin. The aggregation of rental value data on residential properties were supplied by registered estate surveying firms based on available letting evidence in most parts of Nigeria. The National Bureau of Statistics (NBS) provides a national public access system, as it compiles a computerized record of all macroeconomic indices among others in Nigeria. In this study, the Bureau provides information on national economic data as varied as Gross Domestic Product (GDP) in real terms, short-term interest rates, inflation and exchange rates. These time series data were cross checked and augmented with those published in the Central Bank of Nigeria Statistical Bulletin. The inclusion of these macroeconomic variables in our analysis was based on the assumption that trend in real estate returns is correlated with happenings within the real and credit economy.

For this analysis, the sample period though constrained by the availability of longitudinal data on residential property rents, covers 1984 to 2009 with a total of 26 observations. This dataset available in annual frequency were transformed into their natural logarithm. Table 2 provides some insight into the nature of data (variables and their descriptions) used in this analysis and summarizes the descriptive statistics in form of means, standard deviations, minimum and maximum values.

Table 2. Summary of Descriptive Statistics of Variables.

Variable Name	Description	Mean	Std. Dev.	Min.	Max.
RESDRENT	Nominal residential property rents in Nigerian currency (Naira)	43549.85	52221.11	700	174722.2
INFLATN	Inflation rates (%)	22.91154	18.64314	5.4	72.8
EXCHAG	Exchange rates of Nigerian currency (Naira)to U$1	59.74364	57.7021	0.7649	147.9623
INTEREST	Short term -Interest rates (%)	18.80923	4.538896	9.25	29.08
GDP	Gross Domestic Product in real terms (expressed in Millions of Naira)	419442.4	151679.8	227254.7	885272.5

4. Methodology

We estimate a vector autoregressive (VAR) framework for the period 1984 to 2009 in order to investigate the relationship between residential property market (using RESDRENT as proxy) and macroeconomic variables (INFLATN, EXCHAG, INTEREST, GDP). A vector autoregressive model is a systems regression model in which the variance or current values of the dependent variables can be explained in terms of the different combinations of their own lagged values and the lagged values of other variables as well as their uncorrelated error terms.[1] Unlike the standard regression model, VAR is unrestricted – all variables are treated on equal footing - as there is no prior distinction between endogenous and exogenous variables within the system. The reduced form of the estimated unrestricted VAR model is expressed as:

$$Y_t = \beta_o + \sum_{i=1}^{k} \beta_t \, Y_{t-i} + U_t \qquad (1)$$

Where Y_t = (RESDRENT, INFLATN, EXCHAG, INTEREST, GDP) is a vector of variables determined by k lags of all variables in the system, U_t is a 5 × 1 vector of the stochastic error terms (impulses or innovations or shocks), β_o is a 5 × 1 vector of constant term coefficients, β_i are 5 × 5 matrices of coefficients on the ith lag of Y, while k represents the number of lags of each variable in each equation. Equation (1) which is a vector of 5 variables postulates for instance, that current RESDRENT is related to its own lag or past values, as well as the lag of the other four variables (INFLATN, EXCHAG, INTEREST, GDP). In other words, the information relevant to the prediction of the respective variables is contained exclusively in the time series data of these variables (Koop, 2000; Diebold, 2001; Gujarati, 2003)

Within any estimated VAR model, three sets of test statistics (Block Exogeneity Wald Test, Impulse Response Function and Variance Decomposition) are often constructed, which require all variables within the model to be stationary (Harvey, 1990 and Brooks, 2008). To this, we apply Augmented Dickey-Fuller (ADF) test to the variables in order to detect the presence of unit roots (non- stationary) within these series. With the exception of RESDRENT, the unit roots test strongly rejected the null hypothesis of a stationary series within the four other variables at 5% level of significance. RESDRENT was therefore first differenced to induce stationary for its inclusion in the analysis.[2]

Estimating a parsimonious VAR model also requires the selection of the appropriate lag lengths for the five variables to be included in each equation. With 26 observations in all, inclusion of too many lagged terms will introduce the problem of multicollinearity and consume many degrees of freedom, whilst too few lags will lead to specification errors. Following Lutkepohl (1991) we use the information criteria technique to determine the appropriate length of the distributed lag.[3] The values of multivariate versions of the information criteria are constructed for 0, 1,…..k lags (in this case, a maximum of 2) as seen in table 3 with the objective of choosing the number of lags that minimise the value of the five information criteria.

Table3. VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-870.0182	NA	3.20E+25	72.91818	73.16361	72.98329
1	-764.94	157.6172	4.28E+22	66.245	67.71757*	66.63568
2	-729.7532	8.11906*	2.51E+22*	65.39610*	68.09581	66.11233*

*indicates lag order selection by criterion. Where LR denotes: sequential modified LR test statistic (each test at 5%level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion. While LogL is the log likelihood function.

Comparatively, the Schwarz information criterion (which imposes a stricter penalty term by penalising the inclusion of additional terms more heavily) selects a VAR (1) - one order lag as optimal, while other criteria choose a VAR (2). The choice of an accurate VAR model is therefore one with two lagged terms of each variable.

Within the VAR framework, the coefficient estimates in each equation is obtained using ordinary least square (OLS) method.[4] In our analysis, these coefficients are subsequently used to determine the critical values of the block exogeneity wald tests (F-Tests) of the null hypothesis that collectively the coefficients of all the lags of a particular variable are simultaneously zero. Concomitantly, rejection of the null hypothesis on the basis of the block F-tests suggests the variable(s) in the model which impact significantly on the future values of each of the variables in the system. However, block F-Tests only reveal the association among the variables and not whether variance or change in value of a particular variable has a positive or negative effect on other variables in the VAR system. We therefore estimate variance decomposition and impulse response function (IRF) to examine the strength of such relationships within the VAR system.

As such, we calculate the variance decomposition of RESDRENT, which is the proportion of the variance in RESDRENT that can be explained by its own shocks and shocks to other variables. The forecast error variance (S.E) for an eight (8) period (year) forecast horizon within our estimated variance decomposition determines the proportion of RESDRENT for current and future periods (year 1, 2,3…8.) which is accounted for by innovations to INFLATN, EXCHAG, INTEREST and GDP. It is expected that the total percentage of the forecast variance due to all innovations to the five variables (RESDRENT, INFLATN, EXCHAG, INTEREST and GDP) for each period sum up to 100.

We further generate impulse response function (IRF) for the estimated coefficients matrices in VAR model. The impulse response function traces out the response of RESDRENT in the VAR system to shocks in the error terms U_t in equation (1) to the extent that, if U_t in the RESDRENT equation increases by one standard deviation, such change or shock will change RESDRENT in the current and future periods. Added to this, since the lag values of RESDRENT appear in the INFLATN, EXCHAG, INTEREST and GDP equations, change in U_t will also impact on these four variables. Based on Runkle (1987) argument that interpreting IRF is often fraught with difficulty, we therefore use the Monte Carol integration approach (See, Doan 1992 for elaborate details) employed in McCue and Kling (1994) and Brooks and Tsolacos (1999) to construct confidence bands – two standard deviations - about the impulse responses.

5. Results

Before considering the results of the block F- Tests on the estimated coefficients of the lagged variables, a cursory examination of the pairwise correlations between residential property rent (RESDRENT) and the macroeconomic variables at contemporaneous (zero lag) and lag 2 reveals some striking results as seen in table 4.

Table 4. Pairwise Correlations of Variables at Zero Lag and Lag 2

Pairwise correlations at zero lag

	GDP	INFLATN	EXCHAG	INTEREST	RESDRENT
GDP	1				
INFLATN	-0.221	1			
EXCHAG	0.820	-0.313	1		
INTEREST	0.049	0.349	0.024	1	
RESDRENT	0.911	-0.280	0.903	-0.076	1

Pairwise correlations at lag 2

	GDP	INFLATN	EXCHAG	INTEREST	RESDRENT
GDP	1				
INFLATN	-0.257	1			
EXCHAG	0.829	-0.339	1		
INTEREST	0.119	0.277	0.082	1	
RESDRENT	0.911	-0.302	0.906	-0.025	1

For instance, whereas residential property rents is strongly and positively correlated with changes in real GDP and exchange rates fluctuations, there are negative but not strong correlations between residential property rents and short–term interest rates as well as between residential property rents and inflation rates. Again, except for the short- term interest rates, the pairwise correlations do not diminish at lag 2.

The results of the block F-tests which suffice from the estimated coefficients of the VAR model (the full results of the VAR estimates are presented in the appendix) examine jointly as shown in table 5, the significance of all the lags coefficients of a particular variable in an equation and not the significance of individual coefficient estimate.

Table 5. F-Tests for Block Exegeneity of Significance of Estimated Lag Coefficients.

	Lags of Explanatory Variables				
Equation for:	GDP	INFLATN	EXCHAG	INTEREST	RESDRENT
GDP	0.0000	0.3047	0.1125	0.0281	0.0004
INFLATN	0.7113	0.0000	0.8287	0.7003	0.9325
EXCHAG	0.1198	0.4657	0.0000	0.2172	0.1223
INTEREST	0.5797	0.0314	0.9367	0.0000	0.7455
RESDRENT	0.0138	0.6397	0.0443	0.0160	0.0000

*The F-Tests given as probability values (p-values) in this table are to test the null hypothesis that collectively the lagged coefficients of the explanatory variables are zero. Turning to the fifth column of the second row for instance, the lag coefficients of exchange rates are jointly statistically significant at 2.8%, leading to the rejection of the null hypothesis. Which ipso facto means that lag of exchange rates have significant effects on real GDP.

On this basis it is certainly discernible that with the exception of inflation, all the lag coefficients of each of the macroeconomic variables are statistically significant (p-values are less than 5%) in the residential property rent equation, as indicated in the last row of table 5. This implies that real GDP, changes in exchange rates regime and interest rates fluctuations significantly predict residential property rents. Interestingly the residential property rents own lag is also significant in its equation; connoting that current rent of residential property has a predictive power for future residential property rent. It is conjectured that this lag might probably mirror the fact that the residential property market is a less informational efficient market (asymmetric information exists among users and investors to the point that they are faced with the problem of the current market rent of subject property) such that new information are slowly incorporated into residential property rents.

As a corollary, the preceding F-Tests results further show that while both the short -term interest rates and exchange rates have significant effects in the residential property rents equation, there is evidently 'no reverse significant' of residential property rents (significant only at 75% and 12%),whatsoever in their equations. These results suggest that these two macroeconomic variables (short-term interest rates and exchange rates) 'granger cause' residential property rents.[5] In this case, residential property rents being *granger-caused* by the two macroeconomic variables means that, short-term interest rates and exchange rates contain useful information for predicting residential property rents over and above the past values of other macroeconomic variables in the VAR model.

Conversely, the sets of lags coefficients of residential property rent and real GDP which are glaringly significant in each of their equations illustrate the effect of a feedback relationship between real GDP and residential property rents. Within this F-Test framework, neither the lag coefficients of inflation rates nor that of residential property rent is seen to be statistically significant in the equation of each other. This result suggests that inflation is independent of residential property rents.

Turning to the variance decomposition of residential rents to shocks or innovations in macroeconomic variables (table 6), the relative importance and consequence of each shock further add respective merits to the previous F-Tests results.

Table 6. Variance Decompositions for Residential Property Rent

Period (Year)	FORECAST ERROR VARIANCE (S.E)	RESDRENT	INFLATN	EXCHAG	INTEREST	GDP
1	2417.11	100	0	0	0	0
2	5355.728	78.06968	0.170941	13.24222	0.151164	8.365997
3	8091.48	77.63238	0.755601	10.57953	0.741297	10.29119
4	11528.39	72.85001	1.502439	11.35751	1.166491	13.12355
5	14544.35	73.99007	1.324681	10.398	1.281551	13.0057
6	17939.72	71.85043	0.881417	10.8375	1.740965	14.68969
7	21106.95	72.67846	0.638045	10.07265	1.947556	14.66329
8	24852.91	71.44806	0.461151	10.13941	2.135115	15.81626

Cholesky ordering: RESDRENT INFLATN EXCHAG INTEREST GDP.[6]

Decomposing the forecast error variance (S.E) for eight (8) years ahead reveals that, combined, shocks to real GDP and exchange rates account considerably for 25.9% variation in residential property rents. On its own, the result of the shocks to GDP which explains 15.8% of this variance is intriguing; in view of its feedback relation with residential property rents which suggest that GDP has a contemporaneous rather than lag effect on residential property rents. Comparatively, exchange rates also account for 10.1% of this variance and the reason for this is a bit unclear. A likely explanation lies in the tendency that as the value of the Nigerian currency falls to a U$1, foreign direct investment (FDI) inflow to Nigeria increases, with domestic property assets becoming less expensive to purchase for foreign investors. Short-term interest rates however explain a lowly 2.1% variance in residential rents. This result is consistent with findings of McCue and Kling, (1987); Kling and McCue, (1994) both in the US and Brooks and Tsolacos (1999) in UK that short- term interest rates account for variation in property returns performance. Shock to inflation obviously appears not to explain any variation in residential property rents. This provides support to the F-Tests result that both variables are independent (both sets of lags are not statistically significant). This simply means that returns accruable to residential property hedge inflation – that is inflation does not have any effect of increasing the monetary worth of future residential property rents. However, this result should be interpreted with a bit of caution considering the statistical variability (standard deviation) of residential property rents reported in table 2. In this regards, it has been rightly noted by Brown and Matysiak (2000) that high returns with much variability do not imply that capital assets hedge against inflation.

The impulse response function (IRF) which gives the responses of residential property rents to separate one standard deviation shocks or innovations in each of the macroeconomic variables over eight (8) year forecast horizon is depicted in fig.1. The IRF shows that shocks to short-term interest rates have a negative significant impact on residential property rents, with the shocks getting a bit pronounced after the fifth year. Shocks or innovations in inflation is negative but not significant and the shocks die away instantly even at year zero. Increase in real GDP and exchange rates have significant positive effects on residential rents. In this case, rents appear to settle down quickly to a steady but rising state at the third year due to shocks of GDP and in the fourth year to shocks of exchange rates.

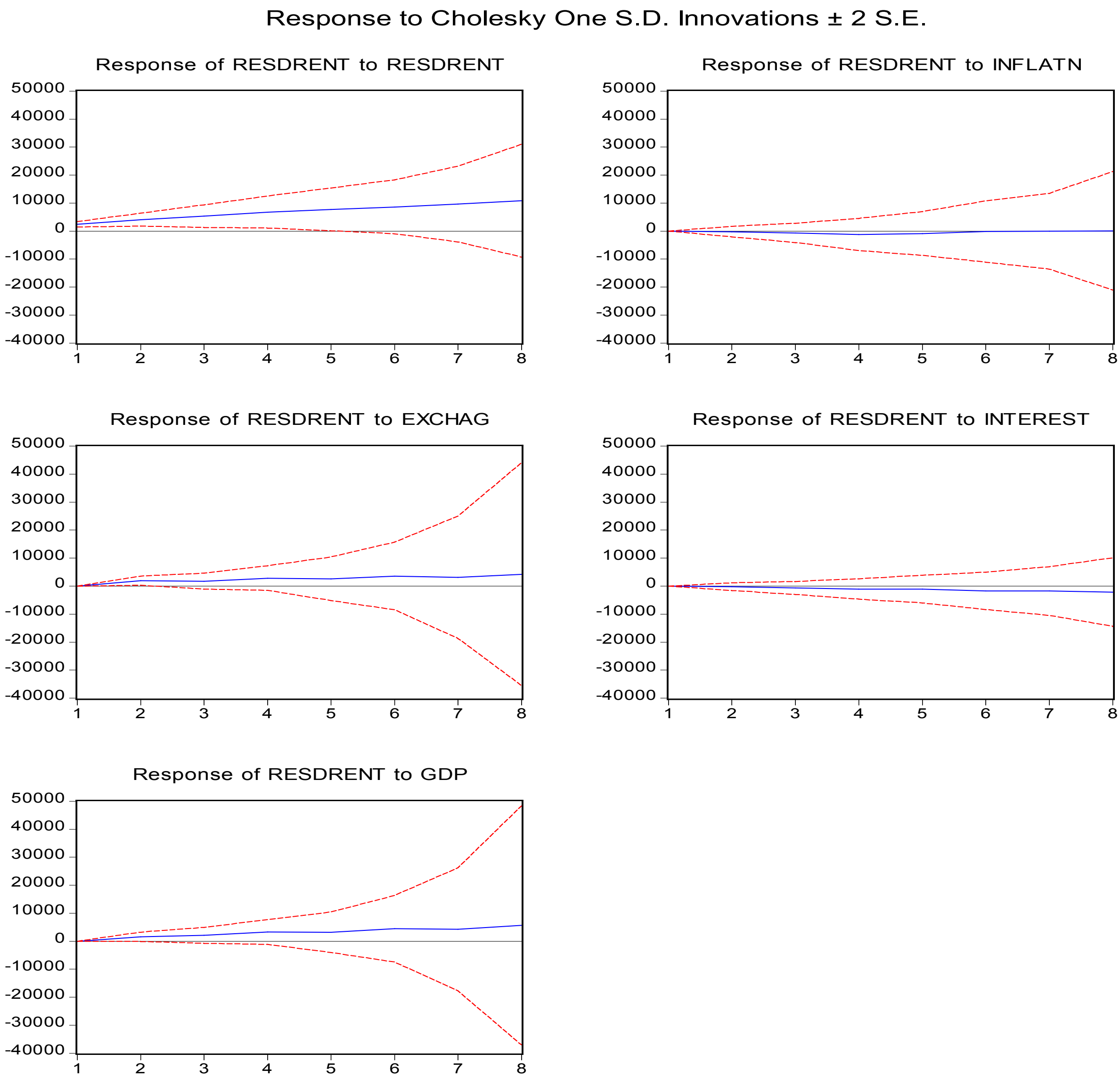

Fig.1. Responses of Residential Property Rent to Shocks in Macroeconomic Variables.

6. Conclusions

This paper investigates the interaction between the Nigerian property market and the macroeconomy by exploring the use of returns from direct residential property. This analysis which is purged of abstract description and simple trend interpolations has been conducted using a vector autoregressive model within which three distinct sets of test statistics (block F-Tests, variance decomposition and impulse responses) are estimated.

The results suggest that the macroeconomy explains 28% of the variation in residential property rents (which is a surrogate for the residential property market). It is however possible that the unexplained variation in the behaviour of residential rents (considering that its own lags are significant) may reflect the explanatory power of property market indicators (as varied as yield, vacancy rates and new construction) rather than macroeconomic variables. Although, real GDP accounts for a substantial proportion (15.8%) of this variation in the residential property market, the presence of a feedback relationship between GDP and residential property rents, which implies that both variables are determined contemporaneously, might reflect a somewhat limited integration of the Nigerian residential property market with the economy. Shock to inflation appears however not to explain any variation in residential property rents. This result further provides empirical support to other previous findings that residential property provides a hedge against long- term inflation. In contrast to the short-term interest rates, exchange rates account for 10.1% of the residential property market variance. This is surprising and the reason for this is a bit unclear. A likely explanation however lies in the tendency that depreciation in the Nigerian currency has made domestic property assets less expensive to purchase for foreign investors.

In particular, the impulse response function shows that in contrast to other macroeconomic shocks, shocks to short-term interest rates have a negative significant impact on residential property market and appear a bit pronounced even after the fifth year. Responses of residential property rents to shocks in real GDP, exchange rates and short-term interest rates, which are felt within three to five years of the eight year forecast horizon reflect the fact that rents from direct residential property and hence the market for residential property adjust slowly to changes in macroeconomic events in Nigeria. It is certainly arguable that this slow adjustment will creates arbitrage profits for parties operating within the Nigerian residential property market to exploit.

NOTES

[1] Gujarati, (2003) in defining vector autoregressive models (VAR) mentions that the term 'autoregressive' is due to the appearance of the lagged value of the dependent variable on the right-hand side of the equation and the term 'vector' is due to the fact that we are dealing with a vector of two or more variables.

[2] First differencing of RESDRENT was necessary even by the examination of the inverse roots of the autoregressive polynomial, which reveals that not all the VAR variables are stationary, since one of the roots has a modulus greater than one and lies outside the unit circle.

[3] Information criteria consist of two components- a term which is a function of the residual sum of squares (RSS) and some penalty for the loss of degrees of freedom resulting from adding new variable or an additional lag to the model. Against the background that the objective is to select the number of lag which minimises the value of the information criteria, addition of an extra term will decrease the value of the information criteria if and only if a fall in RSS is greater than the increased value of the penalty term (See, Lutkephol, 1991 and Brooks, 2008 for further elaborate explanations).

[4] The number of variables estimated in each of the five OLS regression equations is eleven ($1 + 2 \times 5$). This consists of one (1) constant term, two (2) lagged value for each of the five (5) variables.

[5] Correlation or dependence of one variable on the other does not imply causation. As such the presence of a relationship between variables does not give the direction of influence. The statement y granger causes x means that y contains useful information for predicting x over the past histories of other variables.

[6] Cholesky imposes an ordering of the variables in the VAR and attributes all of the shocks in the VAR to the variable that comes first in the VAR system, in this case RESDRENT. Changing the ordering of the variables will change the responses and the variance decompositions of the variables.

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Appendix: Vector Autoregression Estimates and Substituted Coefficients

Vector Autoregression Estimates
Date: 08/02/11 Time: 12:53
Sample (adjusted): 3 26
Included observations: 24 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	RESDRENT	INFLATN	EXCHAG	INTEREST	GDP
RESDRENT(-1)	1.133461	-0.000537	0.001437	-0.000212	10.12807
	(0.23494)	(0.00152)	(0.00146)	(0.00035)	(5.26006)
	[4.82450]	[-0.35403]	[0.98684]	[-0.60843]	[1.92547]
RESDRENT(-2)	-0.221238	0.000637	-0.002496	0.000164	-3.954647
	(0.26348)	(0.00170)	(0.00163)	(0.00039)	(5.89912)
	[-0.83967]	[0.37398]	[-1.52818]	[0.41880]	[-0.67038]
INFLATN(-1)	29.92094	0.689710	0.065588	0.081060	-559.6031
	(38.8080)	(0.25075)	(0.24053)	(0.05769)	(868.875)
	[0.77100]	[2.75056]	[0.27268]	[1.40507]	[-0.64405]
INFLATN(-2)	-32.71811	-0.410619	-0.271347	-0.146672	1284.230
	(37.5090)	(0.24236)	(0.23248)	(0.05576)	(839.793)
	[-0.87227]	[-1.69425]	[-1.16717]	[-2.63041]	[1.52922]
EXCHAG(-1)	115.4352	-0.133770	0.667764	-0.025997	-1360.699
	(48.3620)	(0.31248)	(0.29975)	(0.07189)	(1082.78)
	[2.38690]	[-0.42808]	[2.22773]	[-0.36160]	[-1.25667]
EXCHAG(-2)	-69.30530	0.014410	0.394096	0.020590	-137.5183
	(51.3909)	(0.33206)	(0.31852)	(0.07640)	(1150.59)
	[-1.34859]	[0.04340]	[1.23726]	[0.26951]	[-0.11952]
INTEREST(-1)	-142.2258	-0.035894	0.271971	0.160351	7896.241
	(142.003)	(0.91754)	(0.88014)	(0.21110)	(3179.32)
	[-1.00157]	[-0.03912]	[0.30901]	[0.75960]	[2.48362]
INTEREST(-2)	-431.9259	0.913976	-1.813972	0.166715	2683.697
	(167.901)	(1.08487)	(1.04066)	(0.24960)	(3759.14)
	[-2.57251]	[0.84248]	[-1.74310]	[0.66794]	[0.71391]
GDP(-1)	0.034940	-4.36E-05	0.000134	1.06E-06	-0.810046
	(0.01441)	(9.3E-05)	(8.9E-05)	(2.1E-05)	(0.32257)
	[2.42513]	[-0.46813]	[1.49816]	[0.04953]	[-2.51123]
GDP(-2)	0.021690	6.07E-05	0.000117	2.11E-05	0.207131
	(0.01364)	(8.8E-05)	(8.5E-05)	(2.0E-05)	(0.30528)
	[1.59074]	[0.68874]	[1.38518]	[1.04201]	[0.67850]
C	-5885.959	1.972675	-36.21688	9.563648	289480.1
	(4516.68)	(29.1840)	(27.9947)	(6.71440)	(101124.)
	[-1.30316]	[0.06759]	[-1.29371]	[1.42435]	[2.86262]
R-squared	0.998818	0.608889	0.961466	0.550446	0.924636
Adj. R-squared	0.997908	0.308034	0.931824	0.204636	0.866663
Sum sq. resids	75951468	3170.925	2917.749	167.8463	3.81E+10
S.E. equation	2417.110	15.61785	14.98140	3.593223	54116.90
F-statistic	1098.348	2.023863	32.43610	1.591757	15.94950
Log likelihood	-213.6651	-92.65922	-91.66069	-57.39446	-288.2709
Akaike AIC	18.72209	8.638269	8.555058	5.699538	24.93924
Schwarz SC	19.26204	9.178210	9.094999	6.239480	25.47918
Mean dependent	47098.92	22.94167	64.65317	19.47042	434384.8
S.D. dependent	52851.74	18.77496	57.37673	4.029036	148203.1

Determinant resid covariance (dof adj.)	3.80E+21
Determinant resid covariance	1.77E+20
Log likelihood	-729.7532
Akaike information criterion	65.39610
Schwarz criterion	68.09581

†**VAR Model - Substituted Coefficients:**
===============================
RESDRENT = 1.133461123*RESDRENT(-1) - 0.2212375136*RESDRENT(-2) + 29.92093792*INFLATN(-1) - 32.71810553*INFLATN(-2) + 115.4351846*EXCHAG(-1) - 69.30529663*EXCHAG(-2) - 142.2258147*INTEREST(-1) - 431.9259331*INTEREST(-2) + 0.03493996466*GDP(-1) + 0.02168978441*GDP(-2) - 5885.95876

INFLATN = - 0.0005374253904*RESDRENT(-1) + 0.0006366792446*RESDRENT(-2) + 0.6897097757*INFLATN(-1) - 0.410619094*INFLATN(-2) - 0.1337696912*EXCHAG(-1) + 0.01441036854*EXCHAG(-2) - 0.03589360643*INTEREST(-1) + 0.91397565*INTEREST(-2) - 4.357938756e-005*GDP(-1) + 6.06782597e-005*GDP(-2) + 1.97267538

EXCHAG = 0.001436999843*RESDRENT(-1) - 0.002495639306*RESDRENT(-2) + 0.06558769486*INFLATN(-1) - 0.2713471636*INFLATN(-2) + 0.6677639451*EXCHAG(-1) + 0.3940961691*EXCHAG(-2) + 0.2719707344*INTEREST(-1) - 1.813972461*INTEREST(-2) + 0.0001337833947*GDP(-1) + 0.0001170627864*GDP(-2) - 36.21688345

INTEREST = - 0.0002124973462*RESDRENT(-1) + 0.0001640388125*RESDRENT(-2) + 0.08105992955*INFLATN(-1) - 0.146672036*INFLATN(-2) - 0.02599699017*EXCHAG(-1) + 0.0205898856*EXCHAG(-2) + 0.1603511226*INTEREST(-1) + 0.1667151684*INTEREST(-2) + 1.060801622e-006*GDP(-1) + 2.112101662e-005*GDP(-2) + 9.563647669

GDP = 10.12806701*RESDRENT(-1) - 3.954647202*RESDRENT(-2) - 559.6031183*INFLATN(-1) + 1284.229706*INFLATN(-2) - 1360.699322*EXCHAG(-1) - 137.5183048*EXCHAG(-2) + 7896.241358*INTEREST(-1) + 2683.69718*INTEREST(-2) - 0.8100459856*GDP(-1) + 0.2071310796*GDP (-2) + 289480.148

† These substituted coefficients are extracted from the VAR estimates. In all eleven parameters are estimated in each equation.

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