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# Housing prices in South African economy: Investigating macroeconomic drivers using time-varying approach

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**Abstract**. Despite being one of the least liquid assets, housing is unarguably the most significant asset class and the biggest contributor to household wealth. The goal of the current empirical research is to examine the macroeconomic drivers of housing prices. Thus, the study examines the impact of macroeconomic variables and oil prices on housing prices using monthly time series data from 2003(M1) to 2023(M3). Generalized Autoregressive Score Model (GAS) is employed to appraise the time-varying relationships between housing prices and macroeconomic variables, as well as housing prices and oil prices. The findings resulting from the empirical analysis indicate that the housing market in South Africa is substantially influenced by macroeconomic factors and oil prices. Therefore, the South African government and policy makers must maintain strong macroeconomic policy formulation and environment as they have an impact on housing prices, which, in turn, have an impact on the welfare and quality of life of the populace.

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## 1. INTRODUCTION

Housing is the most important asset category and the biggest part of households' wealth, despite being one of the least liquid assets. Every household prefers to store wealth in the form of housing rather than other classes of assets. The role and the importance of housing market in the monetary policy transmission and improving the socio-economic variables performance cannot be overstated. Theoretically, the

contribution of monetary policy and hot money to a rise in housing prices has been substantiated by numerous studies. The global savings glut is one of the important channels through which hot money or monetary policy dynamics affect housing prices. This phenomenon was first introduced by Bernanke (2005), who posited that increased capital inflow from abroad pushes down the long-term real interest rates. Fall in interest rates directly increases the desire of the investors for alternative investment like housing (Taylor, 2013; Huang, Jin, & Zhang, 2021). The means by which housing market is affected by monetary policy activities were succinctly summarized by Mishkin (2007); the author distinguished, *inter alia*, the users' expectation of the capital cost channel, the supply channel, and the credit channel. According to the former channel, increased short-term interest rate raises the long-term mortgage rates and thus raises the user's interest rate on mortgage. Consequently, this leads to reduced demand for housing which results in falling housing prices (Huang, Jin, & Zhang, 2021).

Theoretical models of the housing market are based on the supposition that housing markets clear instantaneously. Equilibrium between the demand for housing and the existing supply is maintained by the automatic adjustments in prices (Meen, 1998; Muellbaur & Murphy, 1997). However, empirical studies have established that owner-occupied housing market does not generally adjust instantaneously to market conditions (Case & Shiller, 1989). For instance, Dipasquale & Wheaton (1994) argued that housing price adjustments reflect changes in market conditions only after some time. The continuous effects of the independent variables influencing the market have been adduced as a possible factor in this. Neoclassical theory has traditionally argued that the demand and supply factors largely determine the price. On demand side, population growth and increased income are examples of demand factors while on the supply side, interest rates (lending rates), bank credit, new houses availability among others are imperative supply-side variables playing significant roles in determination of housing prices. It has also been argued that economic and speculative factors are the prime determinants of housing price. Speculative-driven demand in the housing market is determined by the certainty or otherwise of the housing prices. So many factors such as the population size and its urbanization, interventions policy of the government, monetary policy, prices and returns of other types of as well as speculative activities in housing market are all responsible for housing market movements and dynamics. Housing market can be considered both at the individual and aggregate levels while the resultants findings vary from one to another.

The oil price impacts on housing market is imperative to the discussion under consideration. The extant studies have identified some ways via which housing and energy prices could be related. One of such channels is the demand and income effect means. Through this means, it is believed that increase in energy price directly and indirectly affect the disposable income level and spending by household (Spencer et al., 2012; Michieka, Gearhart III, & Ampatzidis, 2021). Similarly, energy price affects the construction costs and housing maintenance cost which in turns affect the housing price. Also, an increase in oil returns due to oil increased oil price, would motivate mobility of funds to the oil market at the detriment of investment in housing market. This could result in housing price reduction because commodity markets become more attractive when compare with asset markets (Antonakakis et al., 2016; Breitenfellner et al., 2015). Meanwhile, an increased oil or energy price can also be reflected through core inflation which can cause restrictive monetary policy response. Restrictive monetary policy in form of reduction in interest rate causes liquidity constraints and thereby reducing housing demand. Meanwhile, depreciating domestic currencies makes domestic properties more attractive to foreign buyers which in turns increase the housing price due to increased demand (Agnello et al., 2017).

Oikarinen (2009) contends that the analysis of housing price determinants should be carried out using regional variables. However, region-specific data on the determinants of housing price is not available. Consequently, macroeconomic variables have been mostly adopted in analysis of housing price determinants. This is consequent upon the submission of Hekman (1985) as he argues that macroeconomic

factors and regional economic factors normally move in the same direction, and hence could provide accurate assessment impacts on housing price. This is consistent with Karakozova (2004). He argued that macroeconomic variables are useful in predicting housing price dynamics on regional basis. As a result, empirical research on housing price dynamics at the macro levels provide insightful information. This will help in designing and formulating relevant macroeconomic policies on housing price dynamics. The aim of this study is to evaluate macroeconomic drivers of housing market price in South African economy. Empirical studies on determinants or drivers of housing market price at macro-level have not received the significant research attention. Mallick & Mahalik (2015) argued that it is demanding to consider all the macroeconomic parameters in house price macro modelling and hence empirical studies have been greatly differ in modelling and variables considered in their investigations. Also, the nature of the economy under investigation also play an important role in macroeconomic factors consideration. For instance, macroeconomic factors that importantly explain the housing price dynamics in developed economies may not be so important in developing economy context. This could be as a result of several factors such as institutional and the maturities of the financial market among others. The current empirical study contributes to literature by specifically focusing on South African economy. Studies on macroeconomic determinants of housing price in South African economy are lean. Hence, this study. Also, the study uses GAS known as the Generalized Autoregressive Score Model to look at the time-varying relationships between macroeconomic variables as well as oil price and housing price. GAS is used because it is better than earlier suggested volatility models. GAS was created specifically to determine outliers/jumps effects in the variables Additionally, the application of GAS has the ability to identify asymmetry and the rare deviation. The GAS model integrates single source of error models with other well-known volatility models, including GARCH known as Generalized Autoregressive Conditional Heteroscedasticity, ACD known as Autoregressive Conditional Duration, ACI popularly known as Autoregressive Conditional Intensity among others.

South African housing price has been rapidly growing since the crash of 2008/2009. However, the growth has not been as rapid as obtained before 2008/2009 crash, though the price has been growing steadily. South Africa's housing price has continued to grow and was steady during the pandemic period. The price grew by 2.5% in the first two months of 2023 which can be seen to be a significant fall from 4.2% in 2022. It was reported by Rode's Report on the South African Property Market that 2023 Q1 housing price's slower growth when compared with the same period in 2022 could be attributed to lower effective demand for property as a result of dismal performance of the economy, coupled with increased cost of living and higher interest rates. The boom in country's 2020/21nominal and real house prices was occasioned by decreasing the prime interest rate to 7% in order to strengthen the households' consumption in the wake of the Covid-19 pandemic. As at early 2023, the prime interest rate rovers around 11.25%. This is a reflection of successive hike in the interest rate since the economy came out of the pandemic. Other macroeconomic factors have been documented in the literature are inflation, unemployment, wage level, growth of the economy and other macroeconomic fundamentals (Lum, 2002; Apergis & Rezitis, 2003; Fraser, Hoesli, & McAlevey, 2008; Yu, 2010; Mahalik & Mallick, 2011). The outline of the research is systematized as follows: the empirical literature are reviewed in Section 2, and the empirical methodology is covered in Section 3. The empirical findings are discussed in Section 4. In section 5, the conclusion is outlined.

## 2. LITERATURE REVIEW

Survey of empirical literature shows that studies on the macro and micro determinants of housing price is very scanty in literature (Mallick & Mahalik, 2015). While evidence shows there is dearth of empirical

studies on this subject matter in emerging economies like South Africa. Meanwhile available studies on macroeconomic determinants of housing price show that there is lack of agreement on housing price determinants. Mallick & Mahalik (2015) argued that lack of consensus in the literature could be consequent upon varying methodological approach and perhaps the nature of data employed in the study. The macro and micro determinants of housing price can be regional specific or country specific (Kavarnou & Nanda, 2015). Factors such as unemployment rate, interest rate, bank credit, population size among others have been cited in the literature as common factors to all countries, while regional characteristics in each of these factors cannot be ignored (Coskun, Seven, Ertugrul, & Alp, 2020; Kavarnou & Nanda, 2015; Mallick & Mahalik). Changes in housing price has been identified primarily to be a response to changes in macroeconomic fundamentals or speculative activities (Piketty, 2014). Speculative activities are due to uncertainties in market fundamentals or unusual connections between housing prices and economic aggregates (Xiao & Tan, 2007; Hui & Yue, 2006). Put differently, Stiglitz (1990) argues that house price bubble can be described as scenario in which the changes in housing price is not motivated by changes in its fundamentals. In other words, it could be driven by factors other than market fundamentals. For instance, willingness to pay high inflated prices sequel to future expected increase in house price was identified as one causes of such bubble (Case & Shiller, 2003). As such, it is unsustainable changes in housing price (Kindleberger & Aliber, 2005).

There is no consensus as regard the relationship between housing market and changes in market fundamentals. There is a strand of literature who argued that property market does not instantaneously respond to changes in market aggregates (Kuo, 1996; Hill *et al.*, 1997; Gu, 2002; Schindler, 2011; Shiller, 2015). On the contrary, there is another strand of literature who argued that changes in housing price can be largely explicated by macroeconomic factors. There exist an ample of empirical evidence in the literature that suggests that macroeconomic variables greatly impact the house price changes (Mikhed & Zemcik, 2009; Tsatsaronis & Zhu, 2004; Hofmann, 2004; Plazzi *et al.*, 2010; Egert & Mihaljek, 2007; Mahalik & Mallick, 2011). Several variables such as population growth, inflation rate, real wages, interest rate, GDP and the unemployment rate among others have been documented to influence housing price (Wong, 2008). For instance, Hilbers *et al.* (2008) and Jacobsen *et al.* (2005) conclude that disposable income has a significant and positive effects on housing price. The line of argument is that higher income increases housing demand and hence increasing housing prices.

Jud & Winkler (2002) also established the direct link between cost of construction and housing price. Increased construction cost will be driven by inflation and this also leads to increase in housing price. Also, evidence of negative correlation is found between housing price and interest rate. This is consistent with Karol (2009). Similarly, Apergis & Rezitis (2004) investigate the impact of mortgage rate, inflation, money supply and employment level on housing price in Greek economy. Their findings suggest that macroeconomic variables play significant roles on housing price changes. Evidence from Central and Eastern Europe show that households' wealth and income positively impact housing price while interest rate has a negative correlation with housing price (Egert & Mihaljek, 2007). This is consistent with findings from the United State of America as empirical finding suggest that macroeconomic variables such as interest rate, personal income and construction cost among others exert significant influence on housing price (Mikhed & Zemcik, 2009). Empirical studies in Turkey have also emphasized macroeconomic fundamentals such as inflation, unemployment, GDP among others as important determinants of housing price in Turkey (Badurlar, 2008; Öztürk & Fitöz, 2009; Uçal & Gökkent, 2009; Hepşen & Aşıcı, 2013).

In the same vein, the association between the housing price and oil prices has continued to receive attention in the literature. An et al. (2014) employ quarterly series to appraise the relationship between oil prices shocks and housing price in United State. The empirical findings suggest that increased oil prices are detrimental to housing prices. This finding is consistent with Kilian & Vigfussion (2013). Antonakakis et al.

(2016) investigate the dynamics between housing price and oil price from 1859 to 2013 along with other variables like economic growth, and interest rates, using a DCC-GARCH model. Their findings suggest the presence of negative relationships between house prices and oil price. Gao et al. (2014) assesses how shocks in oil prices affect the housing price and other macroeconomic variables in the United States. They conclude that an increased oil price increases the housing price. This consistent with previous studies such as Nandha & Faff (2008). From another perspective, Cesa-Bianchi's (2013) using GVAR approach identifies the presence of US housing price shock in the world economy. Delcoure & Singh (2018) investigate the linkage between housing market and oil price in the US economy by means of DCC- GARCH model. Their findings show that the effect of oil price on real estate is not significant. This is however at variance with previous studies such as Carr & Beese (2008) among others. For instance, Carr & Beese (2008) associated the 2008 crisis in the mortgage sector to changes in oil price. This is position is further corroborated by Agnello et al. (2017). Agnello et al. (2017) investigate the relationship between oil price shock and housing price in 20 net oil exporting and importing industrial countries. Their findings show that oil price increase significantly affect the housing price in both oil exporting and importing industrialized economies. Similarly, Beltratti & Morana (2010) concludes that oil price changes account for about –7% of variability in prices of housing in Canada, US, the Euro-12 area, Japan and the United Kingdom. Specifically, they argue that upward movement in prices of oil contract prices of housing in all the regions under study except Japan. Findings from Khiabani (2015) and Yiqi (2017) show that an increase in oil price increases housing price in ran and Norway respectively.

## 3. METHODOLOGY

### 3.1. Data summary

Monthly series on the selected macroeconomic variables, housing price index and oil price were employed in the study. Data on inflation, GDP, interest rate are taken from South African Reserve Bank Data Base. Monthly data on housing price index is obtained from FNB data base. The study aims at investigating the macroeconomic determinants of housing price in South African economy, and as well housing price response to oil price shocks.

### 3.2. Methodology of generalized autoregressive score model

The application of the conditional density function score to derive the parameters of time-varying nonlinear equations is an important peculiarity of GAS technique. Assuming that $Y_t \in \Re^N$ is random vector (N-dimensional) at time t with the distribution being conditional:

$$Y_t | Y_{1:t-1} \sim p(Y_t; \theta_t), \quad (1)$$

$Y_{1:t-1} \equiv \left(Y_t^{'} \dots \dots \dots Y_{t-1}^{'}\right)^{'}$ contains the lagged values of $Y_t$ till time $t-1$, while $\theta_t \in \ominus \subseteq \Re^J$ is a vector of parameters from time-varying estimation and exemplifies the probability density function, which is a function of $Y_{1:t-1}$ as well as other static parameters such as $\xi$, by implication, $\theta_t \equiv \theta(Y_{1:t-1}, \xi)$. The evolution of the time-varying parameters should be emphasized as the primary characteristic of GAS. The autoregressive part is outlined as:

$$\theta_{t+1} \equiv \varkappa + \mathrm{A}s_t + \mathrm{B}\theta_t, \quad (2)$$

$\varkappa$, A, B, are coefficients in vector form, and dimensions taken in $\xi$, and $s_t$ is a vector and is relative to the score of equation (1). This can be stated as:

$$s_t \equiv S_t(\theta_t) \nabla_t (Y_t, \theta_t),$$

$S_t$ is $J \times J$ vector of positive definite scaling of the matrix, and is stated as:

$\nabla_t (Y_t, \theta_t) \equiv \frac{\partial log \mathrm{P}(Y_t, \theta_t)}{\partial \theta_t}$,

Scaling matrix $S_t$ to a power $\gamma > 0$ of the inverse of the Information Matrix of $\theta_t$ helps to capture the variance of $\nabla_t$ (Creal et al.,2013) This is denoted as:

$S_t (\theta_t) \equiv \mathcal{I}_t (\theta_t)^{-\gamma}$

With $\mathcal{I}_t (\theta_t) \equiv E_{t-1} \left[ \nabla_t (Y_t, \theta_t) \nabla_t \left( Y_t, \theta_{t_t} \right)' \right]$ (3)

And the expectation is taken concerning the conditional distribution of given $Y_t$ assuming that $Y_{1:t-1}$ is given.

A key feature of our models is that the log-likelihood function can be easily evaluated via the forecasting the error decomposition. Maximum Likelihood (ML) is useful in estimating both the vectors of the parameter and the samples of the data.

The robustness of our analysis is done using the DCC- GARCH.

The DCC- GARCH is type of multivariate model calls Dynamic Conditional Correlation (DCC) model. The DCC- GARCH is employed to investigate the time dependent association between each of the selected macroeconomic variables and housing price index. The adopted GARCH(p,q) model is computed by means of MLE method. The DCC- GARCH model can be summarized as follows:

$r_t = \theta_0 + \epsilon_t$ (4)

$\epsilon_t \sim (0, \sigma_t^2)$

where $r_t$ is a stochastic term from VAR equation

$log(\sigma_t^2) = \alpha_0 + \sum_{j=1}^{p} \beta_j \ log\left(\sigma_{t-j}^2\right) + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2$ (5)

$\epsilon_t$ is a stochastic term. The logarithm of deviation of $\epsilon_t$ is represented as a function of the previous values $\epsilon_t$and disturbance terms. In the R statistics package, the following DCC version is used for estimation:

$Q_t = (1 - \alpha - \beta)\bar{Q} + \alpha z_t z_t' + \beta Q_{t-1}$ (6)

where $Q_t$is the DCC, $z_t$is the stochastic term from GARCH's. $\alpha, \beta$ are the correlation persistence, $\bar{Q}$ is the correlation vector at $t = 0$ i.e $\bar{Q} = Q_{t=0}$.

$Q_{t=0} =$ correlation of standardized error terms of GARCHS. The computed correlations would provide insight into the dynamic interactions between the variables.

### 3.3. BLR methodology

In addition to GAS model, the study also makes use of BLR. The BLR equations can be stated as:

$Y = X\beta + \varepsilon$ (7)

Where $Y$ connotes a vector of the endogenous variable,

$X$ is a matrix of exogenous variables

$\beta$ is a matrix of regression parameters $\varepsilon$ is a matrix of stochastic terms.

The likelihood density function is stated as follows by means of the Bayesian approach:

$p(Y/X, \beta\ \sigma^2) = \frac{1}{\sqrt{2\pi\sigma^2}} exp\left\{-\frac{1}{2\sigma^2}(Y - X\beta)^T\ (Y - X\beta)\right\}$ (8)

The probability function can be written as:

$$p(Y/X,\beta\ \sigma^2) = \Pi_{i=1}^{n} \frac{1}{\sqrt{2\pi\sigma^2}} exp\left\{-\frac{1}{2\sigma^2}(Y-X\beta)^T\ (Y-X\beta)\right\} \quad (9)$$

$$p(Y/X,\beta\ \sigma^2) = (\sigma^2)^{-n/2} exp\left\{-\frac{1}{2\sigma^2}(Y-X\beta)^T\ (Y-X\beta)\right\} \quad (9)$$

$$p(Y/X,\beta\ \sigma^2) \propto (\sigma^2)^{\frac{-v}{2}} exp\left[\frac{-vs^2}{2\sigma^2}\right] \times (\sigma^2)^{-n/2} exp\left\{-\frac{1}{2\sigma^2}(Y-X\beta)^T\ (Y-X\beta)\right\} \quad (10)$$

Regression analysis using the Bayesian method employs a number of prior distributions. The marginal posterior can be iterated through to estimate parameters using a Bayesian technique. Prior distribution and likelihood function are multiplied to produce the posterior distribution.

$$p(\beta,\sigma^2/Y,X) \propto p(Y/X,\beta,\sigma^2)p(\sigma^2)p(\beta/\sigma^2)$$

$$p(\beta,\sigma^2/Y,X) \propto (\sigma^2)^{-n/2} exp\left\{-\frac{1}{2\sigma^2}(Y-X\beta)^T\ (Y-X\beta)\right\} \times\ (\sigma^2)^{-\left(\frac{v}{2}+1\right)} exp\left[-\frac{vs^2}{\sigma^2}\right] \times$$

$$(\sigma^2)^{\frac{-k}{2}}\ exp\left[-\frac{1}{2\sigma^2}\ (\beta-\mu)^T\Lambda(\beta-\mu)\right]$$

To evaluate the parameters for the regression model, the study uses the MCMC (Markov Chain Monte Carlo) algorithm. The MCMC algorithm employs the Gibbs Sampling method. The South African Reserve Bank (SARB) is the main source of our data. Monthly Data from January 2003 to March 2023 are sourced from SARB. The variables used include housing price index, interest rate, inflation rate, credit allocated to private sector, exchange rate oil price and mortgage loan.

## 4. EMPIRICAL RESULTS AND DISCUSSION

### 4.1. Descriptive analysis

The summary statistics are shown in Table 1. The table demonstrates that the variables exhibit strong internal consistency in the range between their maximum and minimum values. The fact that the variables' standard deviations are low further demonstrates that their variances are not excessively big. The minor skewness and kurtosis of the variables further support this. The normalcy characteristic of the data is captured by Jarque-Bera statistics. There are no grounds for rejection of the null hypothesis of normality at a 1% level of significance. The nearness of the mean and median numbers supports this assertion. The likelihood that the series will be normally distributed increases with the proximity of the mean and median values. Figure 1 displays the graphical exposition of housing price, selected macroeconomic variables and the oil price.

Table 1

Variables summary

| **Statistics** | HPI | IR | EX | INF | ML | CA | OP |
|---|---|---|---|---|---|---|---|
| Mean | 3.706 | 4.027 | 4.412 | 2.016 | 2.720 | 2.12 | 2.515 |
| Median | 3.517 | 3.313 | 4.824 | 2.073 | 2.037 | 2.516 | 0.0038 |
| Maximum | 3.107 | 3.471 | 2.869 | 3.016 | 3.816 | 3.910 | 7.973 |
| Minimum | 3.712 | 3.802 | 4.984 | 0.716 | 2.460 | 1.726 | 5.273 |
| Std. Dev. | 0.452 | 0.098 | 0.041 | 0.523 | 0.106 | 0.139 | 0.088 |
| Skewness | 0.326 | 0.213 | -0.351 | -0.372 | -0.621 | -0.371 | -0.95 |
| Kurtosis | 2.276 | 1.615 | 1.705 | 3.563 | 1.781 | 3.417 | 4.430 |
| Jarque-Bera | 4.010 | 2.908 | 2.986 | 4.817 | 3.012 | 3.289 | 4.710 |
| Probability | 0.156 | 0.345 | 0.173 | 0.105 | 0.304 | 0.231 | 0.183 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Observes | 243 | 243 | 243 | 243 | 243 | 243 | 243 |

*Source*: Authors' results.

Furthermore, the variables movement during the study period is contained in Figure 1. The graphical representation shows that housing price has been moving upwardly. The macroeconomic variables have all been oscillating over the period with the exception of inflation that can be seen to be consistently growing upward.

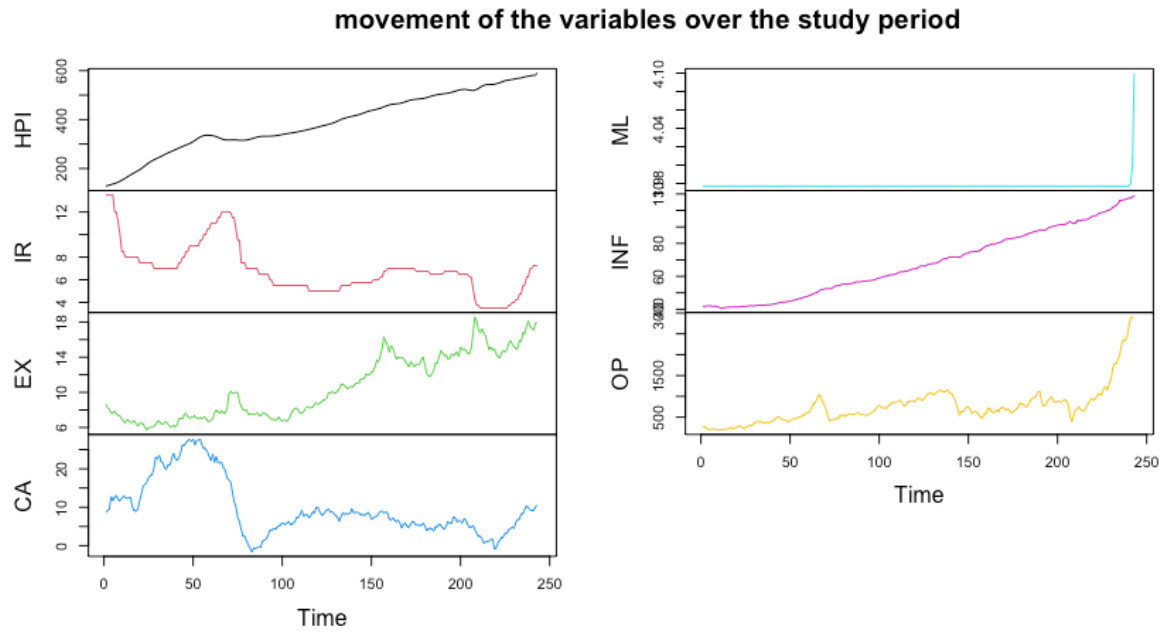



**Figure 1. Graphical presentation of the variables**

*Source*: Authors' results.

Figure 2 displays the correlation plot among the variables, commonly called static correlation coefficient. The correlation coefficient between housing price and interest rate is found to be negative. Similarly, the coefficient of correlation of housing price and credit allocated to private sector is also found to be negative. The correlation coefficients of housing price with the rest of the macroeconomic variables (inflation, mortgage loan, exchange rate and oil price) are positive. It should be noted that the coefficients of the correlation are found to be high with the exception of mortgage loan.

Although static correlation only reveals an instant association across time, these coefficients have been criticized for failing to reveal the correlation changes that takes place over time. In order to analyze time-dependent relationships, the study uses GAS. The histogram plots of our variables are presented in Figure 3.

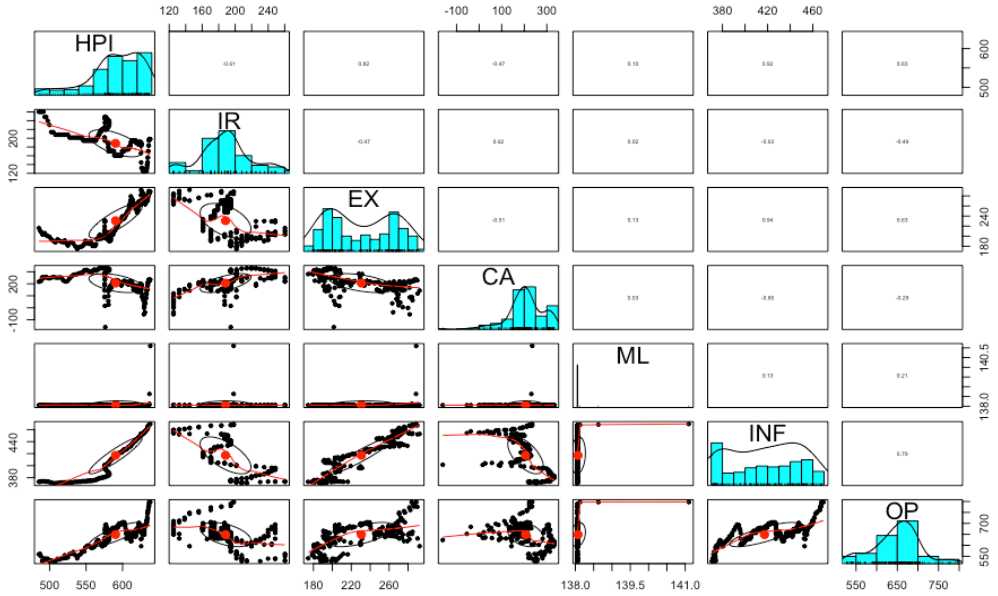



**Figure 2. Correlation chart of housing price with macroeconomic variables & oil price**
*Source*: Authors' results.

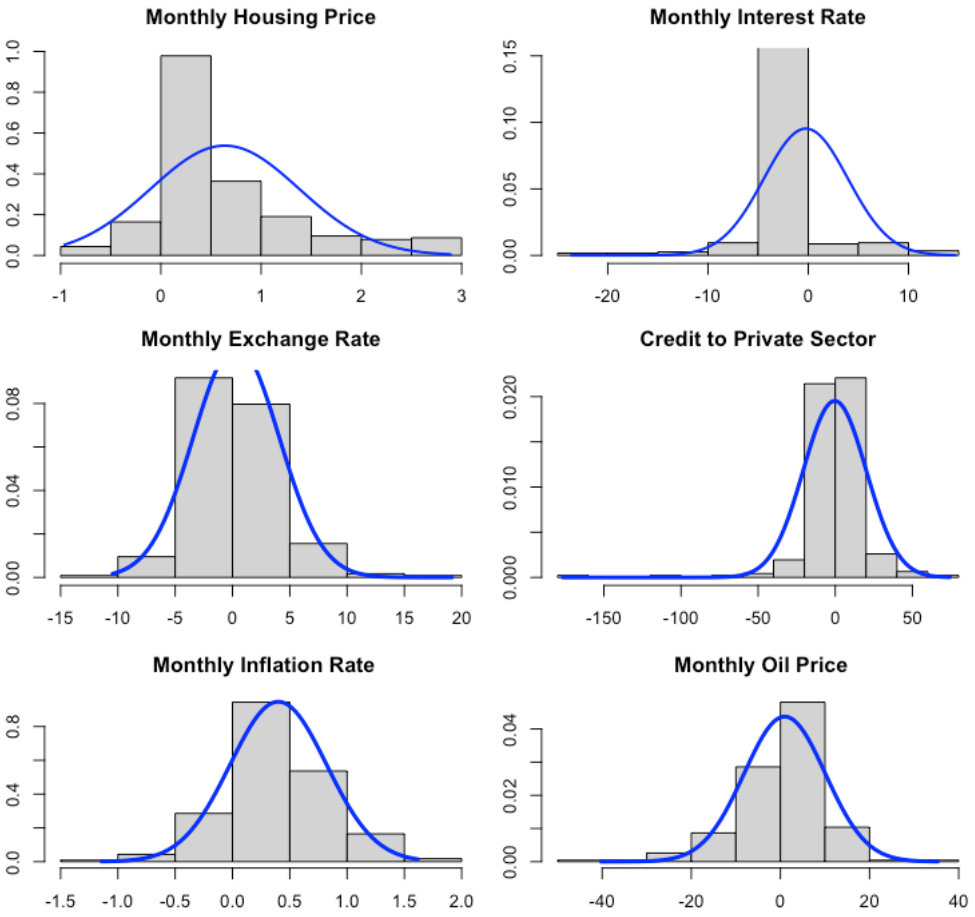



**Figure 3. Histogram representation of the variables**
*Source*: Authors' results.

### 4.2. Findings from GAS

The findings from the GAS are contained in this section. GAS is adopted to determine the time-dependent correlations as opposed the static correlation. Our estimation is done by means of MLE approaches. Investigation of the time series properties of the variables shows that all our variables were stationary after first differencing, and this was fitted into our model.

The time-dependent correlation between housing price and interest rate, and time-varying association between housing price and exchange rate are illustrated in Figure 4. As illustrated in Figure 4, the time-dependent association between housing price and interest rate is discovered to be basically oscillating between -1 and -0.2 during the study period. Most of the coefficients are observed to be more than -0.5. The implication of the negative coefficients is that an increase in the interest has a downward effect on housing price in South African economy. This is because an increase interest rate causes liquidity constraint which consequently reduces the demand for housing, and hence fall in housing price.

The time-varying correlation coefficients between housing price and exchange rate are found to oscillate between -0.5 and 0.5. There are more cases of positive coefficients and few cases negative coefficients. The positive coefficients imply that an increase in exchange rate, which is the same as depreciation of Rand, means that South African housing becomes more attractive to the foreigners, hence increase in demand for South African housing from abroad. This then places the upward pressure on housing price. The overall picture is that interest rate and exchange rate are significant drivers of housing price in South African economy.

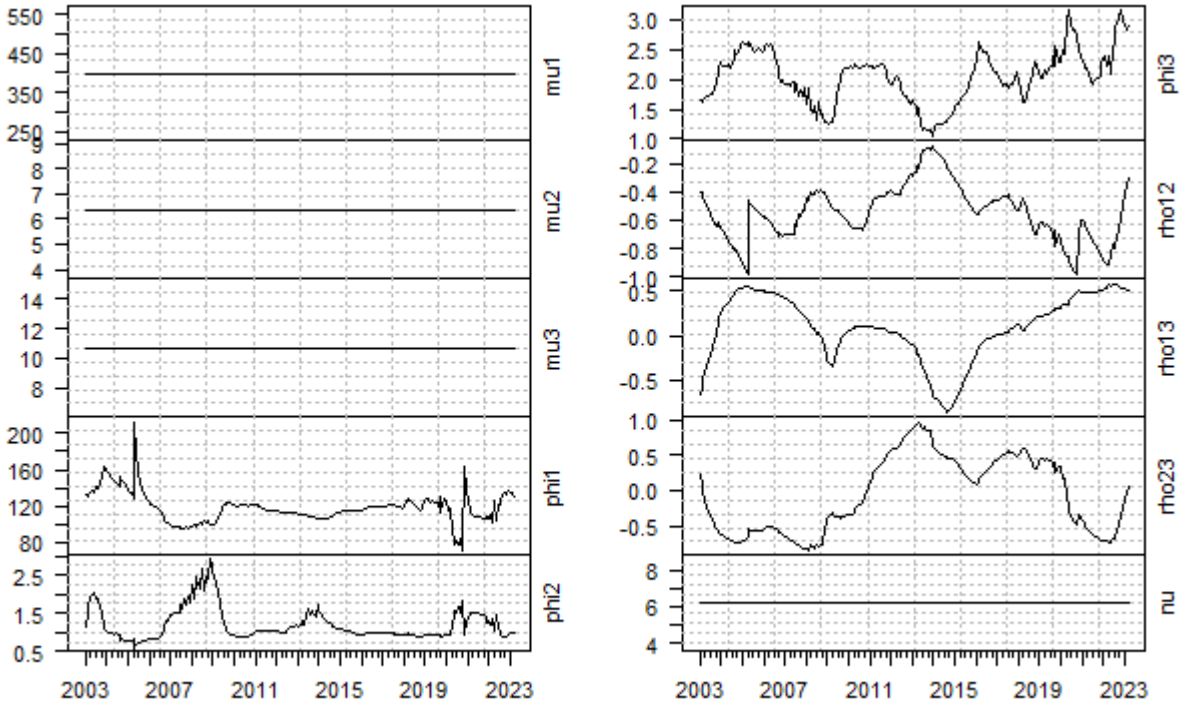



**Figure 4. Time-varying correlation coefficients between housing price and interest rate & exchange rate**

*Source*: Authors' results.

The time-varying correlation between housing price and credit allocated to private sector, and time-dependent correlations between housing price and mortgage loan are illustrated in Figure 5. As displayed in

Figure 5, the time-varying correlation between housing price's returns and interest rate is established to be principally oscillating between -0.4 and -0.8 during the study period. This shows that increased credit to private sector of the economy has a reducing effect on housing price. This is logically coherent with economic principle as increased credit to private sector will increase supply of housing in South African housing market. This in turns reduces the housing price.

The time-varying correlation between housing price and mortgage loan are found to oscillate between 0.1 and 0.7. The coefficients are entirely positive during the study period. The positive coefficients imply that an increase in mortgage loan, which is usually from demand side of housing market, will increase demand for housing. This consequently puts upward pressure on housing price. The general deduction is that the housing price in South Africa is significantly influenced by credit allocated to private sector and mortgage loan.

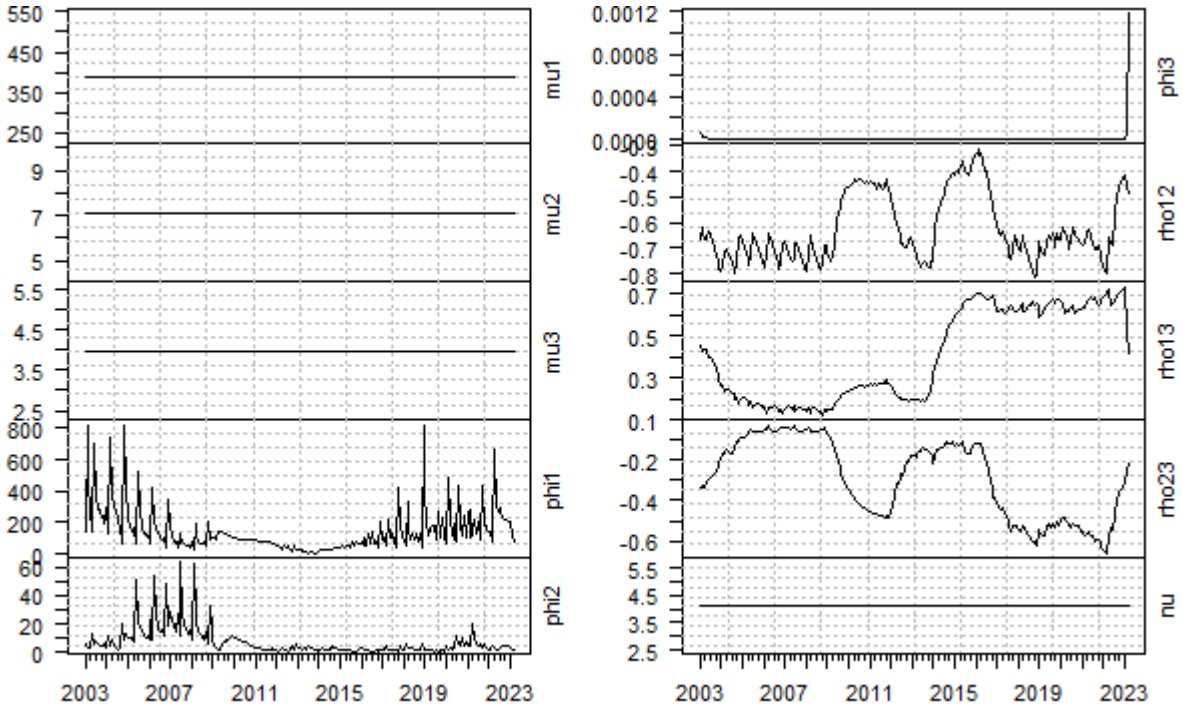



**Figure 5. Time-varying correlation coefficients between housing price and credit to private sector & mortgage loan**

*Source*: Authors' results.

The time-varying correlation between housing price and inflation rate on one hand, and time-varying correlation between housing price and oil price are depicted in Figure 6. As displayed in Figure 6, the time-varying correlation coefficients between housing price and inflation are observed to be largely positive with few cases of negative coefficients during the study period. From this finding, it is observed that inflation has upward effect on housing price in South African economy. This is not unexpected as inflation pushes the cost of housing materials upward and construction cost. This in turns reduces the housing supply and consequently an increase in housing price.

The time-varying correlation coefficients between housing price and oil price are found to be entirely positive. The positive coefficients are mostly above 0.5 with high degree of volatility. This implies that oil price is a significant driver of housing price in South African economy. Increased oil price is observed to

positively impact inflation and hence increase in housing price. Over all, both inflation and oil price are found to be an important determinants of housing price in South African economy.

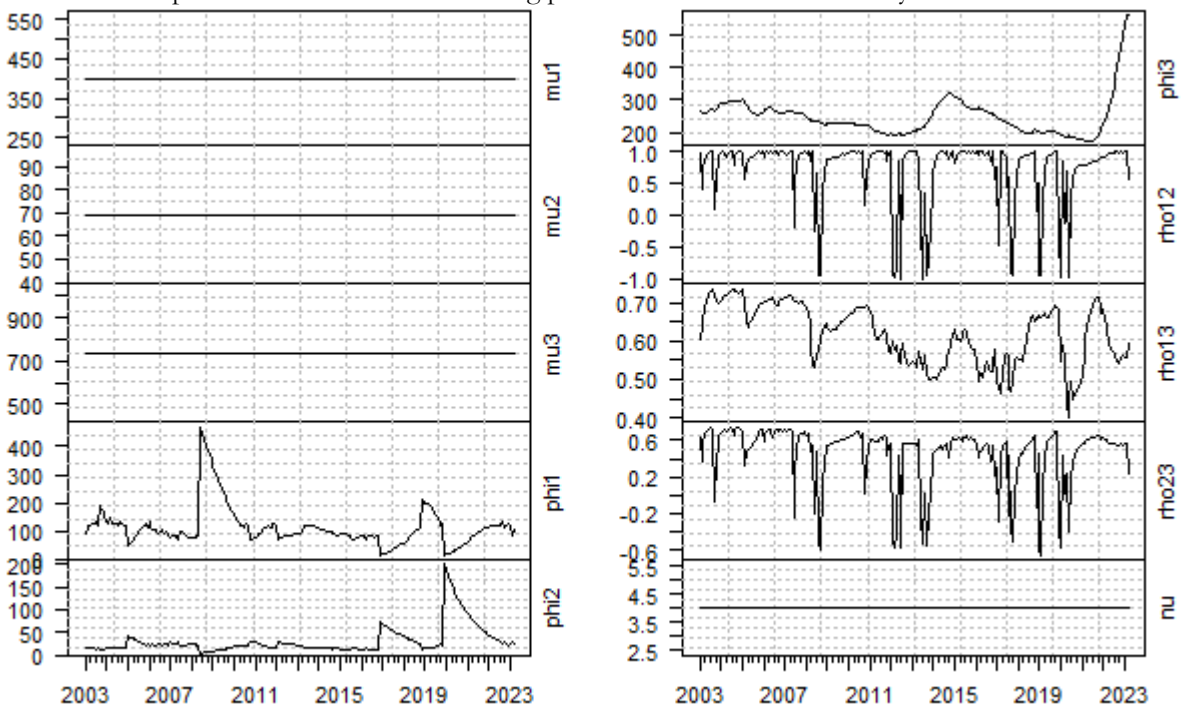



**Figure 6. Time-varying correlation coefficients between housing price and inflation rate & oil price**

*Source*: Authors' results.

### 4.3. DCC GARCH results

The GARCH-DCC model is employed to determine the robustness of our findings based on the Generalized Autoregressive Score Model (GAS). The results of GARCH-DCC are presented in Figures 7 to 9. The findings from GARCH- DCC model is consistent with findings from GAS.

Figure 7 shows that time-dependent correlation between housing price and interest rate are majorly negative. As explained earlier, increased interest reduces the housing price in the economy under consideration. Similarly, the Figure 7 shows that time-varying correlation coefficients between housing price and exchange rate are basically oscillating between negative and positive regions with more episodes of positive coefficients. This also confirms the earlier findings.

Based on the GARCH-DCC results, time-varying correlation coefficients between housing price and allocated credit to private sector, together with time-dependent association coefficients between housing price and mortgage loan are presented in Figure 8. As disclosed in Figure 8, GARCH-DCC results are consistent with findings from GAS estimation approach as most of the coefficients are in the negative region for credit allocated to private sector. As stated earlier, increased allocated credit to private sector of the economy will push housing price downward. Also, for mortgage loan, the coefficients are mainly positive, showing that increase in mortgage loan will lead to increase in housing price through increased demand. This also corroborates our earlier position.

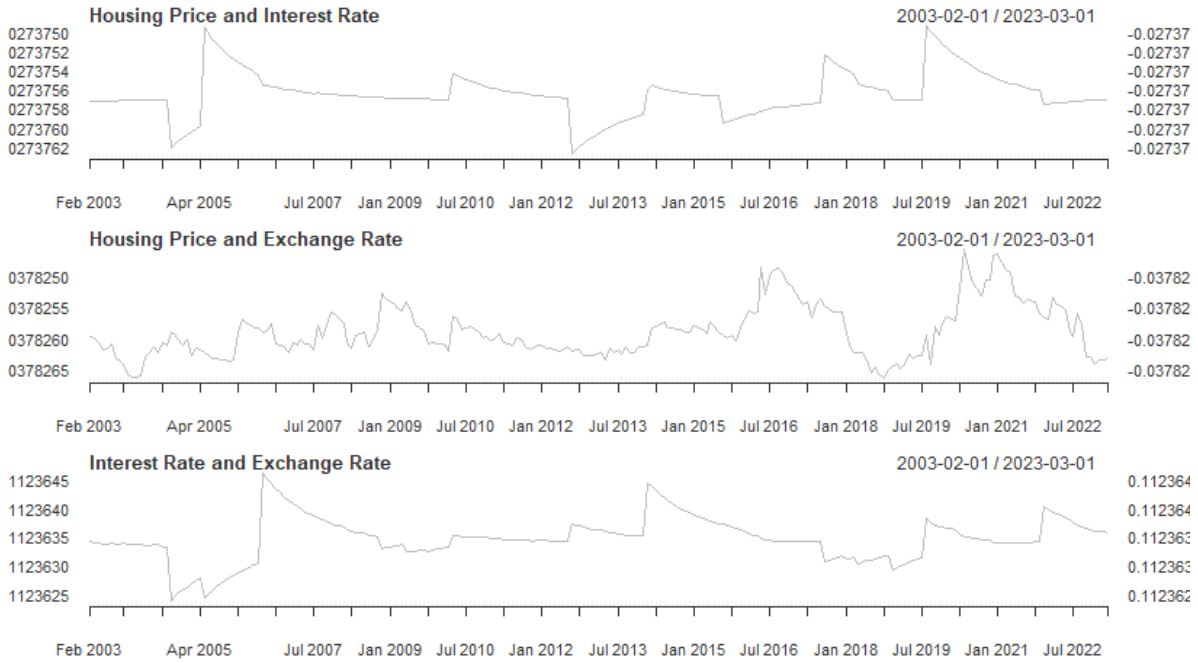



**Figure 7. Time-dependent correlation between housing price and interest rate & exchange rate**

*Source*: Authors' results.

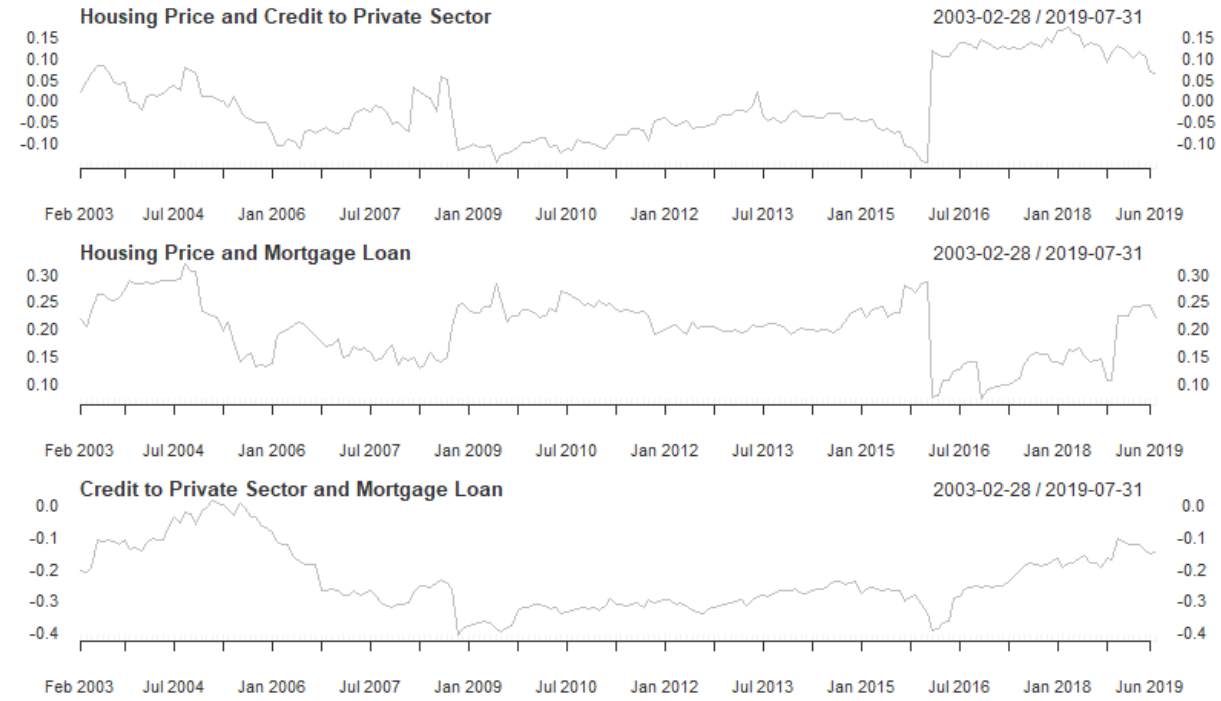



**Figure 8. Time-varying correlation coefficients between housing price and credit to private sector & mortgage loan**

*Source*: Authors' results.

Finally, GARCH DCC findings confirms our earlier findings on time-varying correlation between housing price and inflation rate as well as oil price. This is contained in Figure 9. the time-varying relationship

between housing price and inflation rate are positive. While the time-varying relationship between housing price and oil price is also established to be positive. This supports the findings from GAS results.

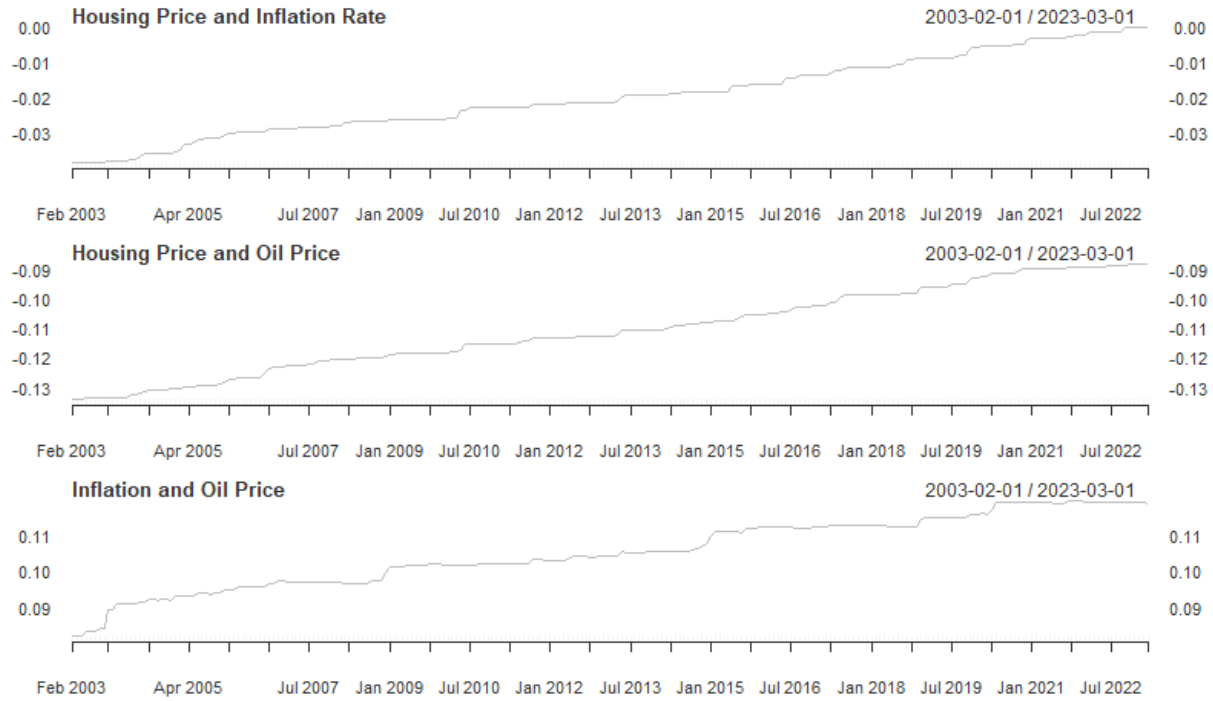



**Figure 9. Time-dependent correlation coefficients between housing price and inflation rate & oil price**

*Source*: Authors' results.

### 4.4. BLR Results

In the Bayesian estimation procedure, algorithm of Gibbs Sampling approach with the Markov Chain Monte Carlo (MCMC) method is used to generate the posterior distribution. Up to 10,000 iterations were employed, with burn in at 500 and thin at 1.

Table 2 displays the BLR findings of the determinants of housing price in the economy of South Africa. The distributions of the posterior are plotted in Figure 10. From the findings in Table 2, the interest rate and allocated credit to private sector effects are negative. This confirms our earlier submission that an increase in interest rate will reduce the liquidity volume in the economy and consequently lower the housing price. Similarly, increase in allocated credit to private sector will increase the investment in housing market thereby increasing the housing supply which in the long run lower the price.

Also, increase in exchange rate exerts positive impact on the housing market. This confirms the findings of GAS model. On the basis of our findings, we can conclude that there is a 95% likelihood that the housing price will reduce by 0.048 with one additional unit rise in exchange rate. Also, we can deduce that with additional unit rise in mortgage loan, housing price will increase by 0.0018. Both inflation and oil price are found to exert positive impacts on housing price. This is consistent with GAS estimation results.

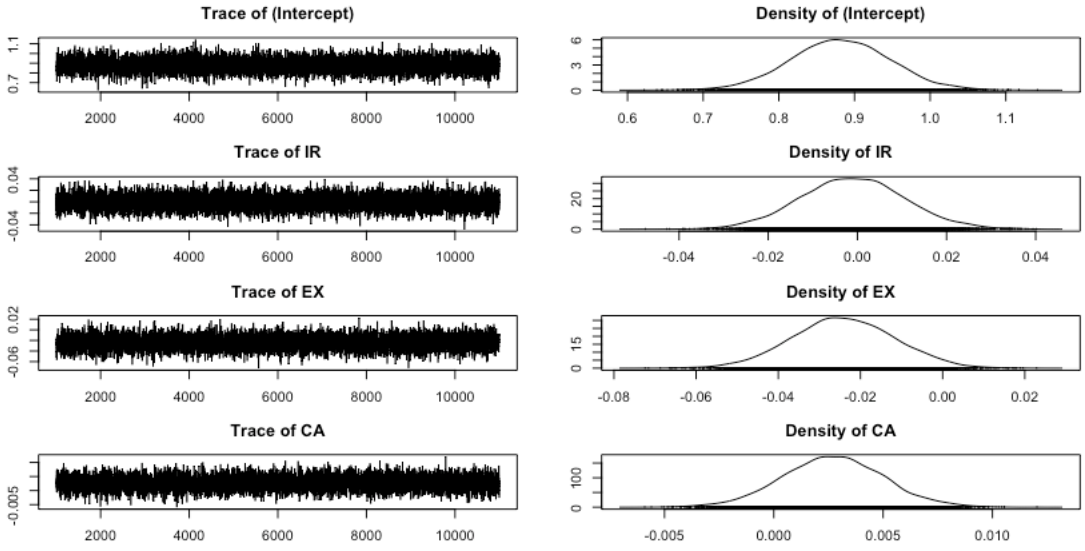
Table 2

BLR results

| **HPI=Dependent variable** | Posterior mean | Posterior STD | 2.5% | 97.5% |
|---|---|---|---|---|
| constant | 0.0288 | 4.291 | -7.291 | 7.611 |
| IR | -0.06 | 0.012 | -0.023 | 0.0227 |
| EX | 0.0241 | 0.027 | 0.048 | 0.0058 |
| CA | -0.00269 | 0.00230 | -0.0018 | 0.0075 |
| ML | 0.0334 | 0.2821 | 0.0018 | 0.0896 |
| INF | 0.0601 | 0.1158 | 0.0832 | 0.0383 |
| OP | 0.0047 | 00.0051 | -0.0543 | 0.0146 |

*Source*: Authors' results.

From our findings, macroeconomic variables are important determinants or drivers of housing price in the economy under consideration. This finding is coherent with available empirical findings and as well at variance with other empirical studies. For instance, Plazzi *et al.*, (2010) Tsatsaronis & Zhu, (2004), Hofmann (2004), Mikhed & Zemcik (2009), and Mahalik & Mallick, (2011) all argued that macroeconomic variables do not influence housing price. The conclusion by these studies is at variance with our findings as our analysis suggest that macroeconomic variables are important drivers of housing price. Our findings are supported by host of other empirical studies. For instance, Hilbers *et al.* (2008), Wong (2008), Jacobsen *et al.* (2005) among others confirm our empirical position that macroeconomic aggregates such as interest rate, the exchange rate and inflation rate among others significantly affect the housing price.



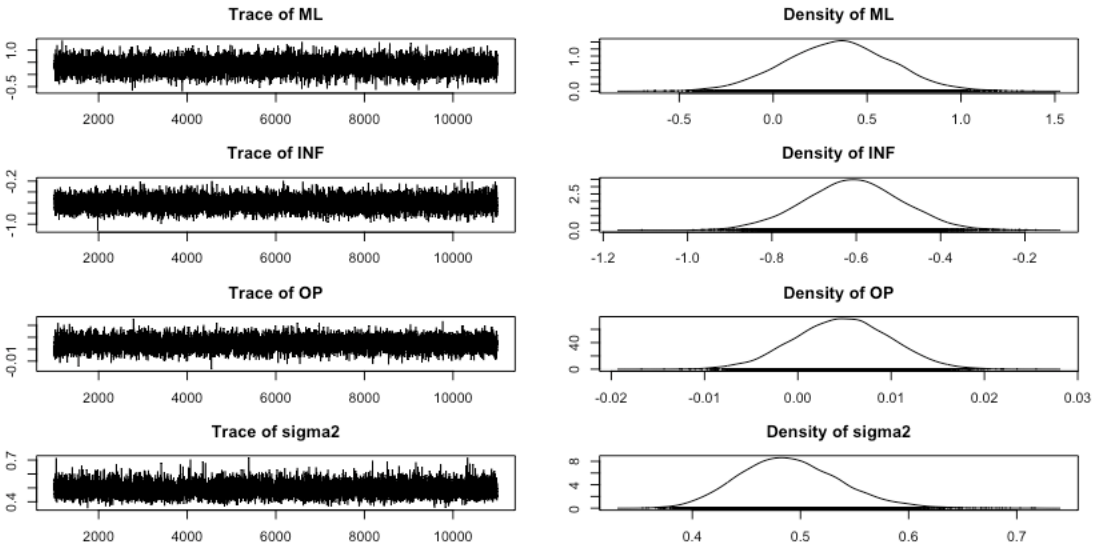



**Figure 10. Posterior distribution plot**

*Source*: Authors' results.

On the oil price and housing price dynamics, our findings corroborate existing empirical submission. For instance, An et al. (2014) and Antonakakis et al. (2016) argued that oil price significantly impacts on housing price. This was also corroborated by Kilian & Vigfussion (2013) and Gao et al. (2014). Findings from Khiabani (2015) and Yiqi (2017) also support our submission as they argued oil price affect housing price in Iran and Norway respectively.

## 5. CONCLUSION

The current study provides empirical position on the macroeconomic drivers of housing price in South African economy. Housing is the most significant asset class and, while being one of the least liquid assets, the greatest component of household wealth. In comparison to other asset classes, housing is the preferred form of wealth for every household. It is impossible to overstate the role and significance of the housing market in transmission of macroeconomic variables and enhancement of socioeconomic variable performance. Hence, this study investigated the macroeconomic determinants of housing price in South Africa, using monthly from 2003(M1) to 2023(M3) on selected macroeconomic variables and oil price. The data were mainly sourced from the South African Reserve Bank (SARB) and FNB data base on housing price.

In addition to contributing to existing lean studies on macroeconomic drivers of housing price in South Africa, the study is also peculiar because it employs Generalized Autoregressive Score Model (GAS) to look at the time-varying relationships between macroeconomic variables as well as oil price and housing price. GAS is adopted because it is better than earlier suggested volatility models. The study also employs Bayesian Linear Regression Model to determine quantitatively the impacts of macroeconomic variables and oil price on housing price in South African economy

The empirical observations could be stated accordingly: (1) the time varying correlation coefficients between housing price and interest rate are mainly negative. The implication is that increase in interest rate will reduce the liquidity in the economy and hereby reduces the demand for housing leading to lower housing price; (2) exchange rate is also observed to be a significant driver of housing price. The time varying coefficients are mainly positive, showing that depreciation of Rand makes South African housing market to be attractive to foreigners and hence increased housing price as a result of increased demand. (3) the time

varying correlation coefficients between housing price and credit to private sector are majorly negative, this suggests that increased credit allocation to private sector increases the supply of housing, and hence fall in housing price; (4) the time varying correlation coefficients between housing price and mortgage loan are also largely positive. The implication here is that increase in mortgage loan increases demand for housing and consequently increased housing price and (5) time-varying correlation coefficients between the housing price and inflation as well as oil price are entirely positive.

Similarly, empirical findings from Bayesian Linear Regression Model (BLR) show that all the selected macroeconomic variables exert upward pressure on housing price with the exception of allocated credit to private sector and interest rate. This affirms the findings from GAS. Conclusively, it is apparent from the empirical findings that macroeconomic variables significantly impact housing price in South African economy. As a result, South African government and policy makers should continue to ensure sound macroeconomic policy formulation and environment as they all feedback into housing price, which in turns impact on the welfare and the quality of life of the citizens.

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