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Monetary Policy and House Price Index: A VAR Analysis for Saudi Arabia

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Abstract
The primary purpose of this paper is to determine how the house price index (HPI) in Saudi Arabia is changing under the influence of monetary policy instruments such as money supply (M2) and Saudi Arabia's Short-Term Interest Rate (SIBOR). The paper examines the impact of monetary policy on the house price index in Saudi Arabia with a VAR model and investigates the Granger causality, impulse response functions, and variance decompositions. The results show that SIBOR has a stronger impact than M2 on housing prices in Saudi Arabia. Specifically, the results show that SIBOR does Granger cause the housing price; whereas, M2 does not Granger cause the housing price. Therefore, the results show that SIBOR is an effective monetary policy instrument for the central bank in Saudi Arabia to use to affect housing prices. Variance decompositions show that SIBOR has considerable explanatory power over the variations of house price index in the long run and SIBOR is the better monetary policy intermediate target variable.

Key Words: Monetary Policy, Housing Prices, VAR, Saudi Arabia.

1. Introduction

Interactions between monetary policy instruments and housing prices have been the subject of a wide range of studies in economics and finance. There is a considerable amount of interest among researchers and academicians in understanding and investigating those interactions. It has been accepted that monetary policy instruments affect not only prices of goods and services but also asset prices (Rigobon and Sack, 2004). Monetarists believe that the quantity of money is the single most important factor determining price levels of goods and services in any economy. Even if prices are not flexible in the short run, the central bank can influence the real interest rate, which, in turn, should impact real output as well as nominal prices (Bjørnland and Leitemo, 2009).

This paper aims to study the problem further in that it attempts to investigate the impact of monetary policy instruments on housing prices. The primary focus of the paper is to investigate whether two monetary policy variables, short-term interest rates (SIBOR) and level of money supply (M2), affect housing prices in Saudi Arabia using a vector autoregression model (VAR). Additionally, Granger causality tests, impulse response functions, and variance decompositions are employed to analyze these impacts. It is against this backdrop that this paper attempts to answer the question: Do monetary policy instruments have an impact on housing prices in the Saudi Arabia economy?

The paper consists of five sections. Section 1 presents the Introduction. Section 2 provides the Literature Review. Section 3 discusses Methodology. Section 4 contains the Empirical Results and a Conclusion closes.

2. Literature Review

Monetary policy refers to those policies used by the central bank to achieve specific objectives. It involves adjustments and management of the amount of money supply and the interest rate to achieve macroeconomic objectives that then affect the broad aspect of the national economy. The transmission mechanism of monetary policy describes how monetary policy influences the real economy (Bindseil, 2004)

A central bank influences the amount of money banks have to loan in the market through excess reserves in the banking system by using monetary policy instruments such as open market operations involving government bonds and discount interest rates charged on loans to private banks by the central bank. If the central bank is doing expansionary monetary policy, for example, the supply of loans (money) will increase and cause the interest rates in the markets to decrease. This drop in interest rates in the mortgage market will increase the demand for housing leading to an increase in real estate prices (Berlemann and Freese, 2013).

Several research articles in the last decade have focused on interactions between asset prices and monetary policy. Chi-Wei et al (2019) found a bidirectional causal link between housing prices and money supply in China. Yan (2019) found that both money supply and interest rate have an impact on real estate price in China. Shen et al (2018) results showed that changes in interest rates and money supply affected housing prices.

In a paper investigating the response of housing prices to changes in short-term and long-term interest rates in forty-seven advanced and emerging markets, Sutton (2017) found short-term rates to have the most influence on housing prices and that this influence is gradual rather than immediate. Additionally, Sutton found that the U.S. interest rates affected housing prices outside the U.S. as well.

Tsai (2015) determined that excessive expansionary monetary policies led to housing price bubbles. Likewise, McDonald and Stokes (2013), using the U.S. federal funds rate data for the period of 1987 to 2010, found interest rate changes brought about by monetary policy was a cause of housing price bubbles. Both studies showed that interest rates affect housing prices.

In Tan (2013) monetary aggregates such as M2 were found to have a greater effect on housing prices than M2 and housing prices had on GDP and CPI. This provides support of the importance of monetary aggregates as monetary policy targets as opposed to interest rates.

Results from Xiaoqing and Tao (2012) show that monetary policy variables are the drivers of the housing prices in China as well as a bullish stock market. The current paper complements the above-mentioned literature by identifying the impact of monetary policy determinants on housing prices in Saudi Arabia.

3. Methodology

Quarterly data of housing price index (HPI), the interest rate measured by the SIBOR and the money supply measured by M2 were collected from the Saudi Arabian Monetary Agency (SAMA) annual reports.

House Price Index (HPI) for Saudi Arabia has been published recently by the Saudi Credit Bureau (SIMAH). It was built from a sample of over 40,000 property records supplied by leading mortgage providers and measures changes in residential property prices quarter on quarter, from a base point of 100 set in the first quarter of 2013. The HPI was built using a technique called Hedonic regression, the same statistical technique employed by other housing price indices in other countries, such as the UK, Australia and the US.

The paper adopted the VAR approach due to the fact that VARs are capable of dealing with possible endogeneity problems (Dreger and Wolters 2009a). The VAR model allows the three variables (HPI), (M2) and (SIBOR) to influence each other.

Below is the empirical equation:

$$\ln HPI_t = \alpha + \beta 0 \ln M2_t + \beta 1 \ln SIBOR_t + U_t \quad (1)$$

$\ln HPI_t$ = Logarithm of housing pricing index, proxy of housing prices (dependent).
$\ln M2_t$ = Logarithm of broad money supply M2, proxy of monetary policy (independent).
$\ln SIBOR_t$ = Logarithm of interest rate, proxy of interest rate (independent).
U_t= the error term.

In order to achieve the reverting mean of relationships and to make econometric testing procedures valid, the time series data are transformed into logarithmic forms. Calculations are conducted using the E-views 10 software.

4. Empirical Results

4.1 Unit Roots

Variables were tested for unit root stationarity based on Dickey & Fuller (1981). Results related to unit root tests are reported in Table 1. Hypothesis that the variables HPI, M2 and SIBOR contain a unit root were rejected at the 5% significance level.

Table 1: Unit Root at Levels

Null Hypothesis: M2 has a unit root			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.998146	0.0013
Test critical values:	1% level		-4.728363	
	5% level		-3.759743	
	10% level		-3.324976	
Null Hypothesis: M2 has a unit root			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.352739	0.0226
Test critical values:	1% level		-3.711457	
	5% level		-2.981038	
	10% level		-2.629906	
Null Hypothesis: SIBOR has a unit root			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.874778	0.0296
Test critical values:	1% level		-4.394309	
	5% level		-3.612199	
	10% level		-3.243079	

4.2 Establishing VAR Model

With variables found to be integrated of the same order it is possible to examine the cointegration among those variables. The paper postulated vector autoregression (VAR) model to get a long run relationship. The lag structure of the VARs was six based on the Akaike Information

Criterion (AIC). The optimal lag length turned out to be two for the VAR. For HPI the optimal lag length was five, for M2 it was two and for SIBOR was six.

The VAR model was estimated as follows:

HPI=49.364-0.952HPI(-1)-0.472HPI(-2)-0.004M2(-1) +0.007M2(-2)-2.513SIBOR (-1)-2.262SIBOR (-2) (2)

Tables 2 and 3 present the estimates of the VAR model. R-squared is 0.85, signifying 85% of the variation in the housing prices variable is explained by the explanatory variables (M2 & SIBOR).

Table 2: **Vector Autoregression Estimates**

	HPI	M2	SIBOR
HPI(-1)	0.952040	9.343388	-0.006261
	(0.29515)	(6.17888)	(0.01980)
	[3.22564]	[1.51215]	[-0.31624]
HPI(-2)	-0.471638	-13.65211	-0.013505
	(0.24866)	(5.20561)	(0.01668)
	[-1.89674]	[-2.62258]	[-0.80974]
M2(-1)	-0.003697	0.054641	-0.000962
	(0.01296)	(0.27141)	(0.00087)
	[-0.28513]	[0.20132]	[-1.10577]
M2(-2)	0.007306	0.561178	0.001688
	(0.01035)	(0.21671)	(0.00069)
	[0.70580]	[2.58959]	[2.43070]
SIBOR(-1)	-2.512654	53.84848	1.175743
	(3.15186)	(65.9838)	(0.21141)
	[-0.79720]	[0.81609]	[5.56141]
SIBOR(-2)	-2.262369	-61.56292	-0.526570
	(3.15230)	(65.9931)	(0.21144)
	[-0.71769]	[-0.93287]	[-2.49039]
C	49.36436	1091.435	1.262124
	(17.2230)	(360.562)	(1.15523)
	[2.86619]	[3.02704]	[1.09253]
R-squared	0.849197	0.865003	0.943311
Adj. R-squared	0.792646	0.814379	0.922053
F-statistic	15.01648	17.08686	44.37376

Table 3: Estimates

Dependent Variable: HPI				
Method: Least Squares (Gauss-Newton / Marquardt steps)				
HPI = C(1)*HPI(-1) + C(2)*HPI(-2) + C(3)*M2(-1) + C(4)*M2(-2) + C(5)				
*SIBOR(-1) + C(6)*SIBOR(-2) + C(7)				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.952040	0.295148	3.225640	0.0053
C(2)	-0.471638	0.248657	-1.896739	0.0761
C(3)	-0.003697	0.012964	-0.285129	0.7792
C(4)	0.007306	0.010351	0.705795	0.4905
C(5)	-2.512654	3.151859	-0.797197	0.4370
C(6)	-2.262369	3.152301	-0.717688	0.4833
C(7)	49.36436	17.22301	2.866187	0.0112
R-squared	0.849197	Mean dependent var		89.92609
Adjusted R-squared	0.792646	S.D. dependent var		6.441218
S.E. of regression	2.933080	Akaike info criterion		5.235773
Sum squared resid	137.6473	Schwarz criterion		5.581358
Log likelihood	-53.21139	Hannan-Quinn criter.		5.322687
F-statistic	15.01648	Durbin-Watson stat		1.913036
Prob(F-statistic)	0.000009			

For estimating the long-run equilibrium level of housing prices, this paper tests the long-run relationships between the housing price and the two monetary policy instruments using the traditional Johansen (1988) methodology. Evidence of cointegration was found to exist among the variables. The results are reported in Table 4. Both the maximum eigenvalue test statistic and the trace test statistic indicate the presence of two cointegrating vectors. Based on trace statistics and maximum eigenvalues statistics, the null hypothesis of no cointegration is rejected. The cointegration tests also indicate a cointegrating vector (long-run equilibrium relation) in the variables. In addition, the researchers tested and established the absence of both autocorrelation and heteroscedasticity in the data.

Table 4: Johansen Cointegration

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05Critical Value	Prob.**
None *	0.612782	41.64355	29.79707	0.0014
At most 1 *	0.540326	19.82190	15.49471	0.0104
At most 2	0.081106	1.945453	3.841465	0.1631
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05Critical Value	Prob.**
None *	0.612782	21.82165	21.13162	0.0400
At most 1 *	0.540326	17.87645	14.26460	0.0129
At most 2	0.081106	1.945453	3.841465	0.1631

4.3 Granger Causality

The paper tested for Granger causality to check the causal relationship between variables. Table 5 shows the results of the Granger causality test in the VAR model. Data reflects a one-way Granger causality between SIBOR and House Price Index (HPI). SIBOR is shown to cause House Price Index to change. Changes in house price index do not Granger cause changes in SIBOR. Statistically, M2 does not Granger cause house price index. Additionally, SIBOR and M2 jointly do not Granger cause house price index. Thus, SIBOR can serve as a proxy for a monetary policy instrument.

Table 5: Causality tests

Null Hypothesis:	Obs	F-Statistic	Prob.
M2 does not Granger Cause HPI	23	1.24695	0.3110
HPI does not Granger Cause M2		3.64951	0.0467
SIBOR does not Granger Cause HPI	23	3.84721	0.0406
HPI does not Granger Cause SIBOR		0.13610	0.8736
SIBOR does not Granger Cause M2	26	0.05567	0.9460
M2 does not Granger Cause SIBOR		3.28261	0.0575

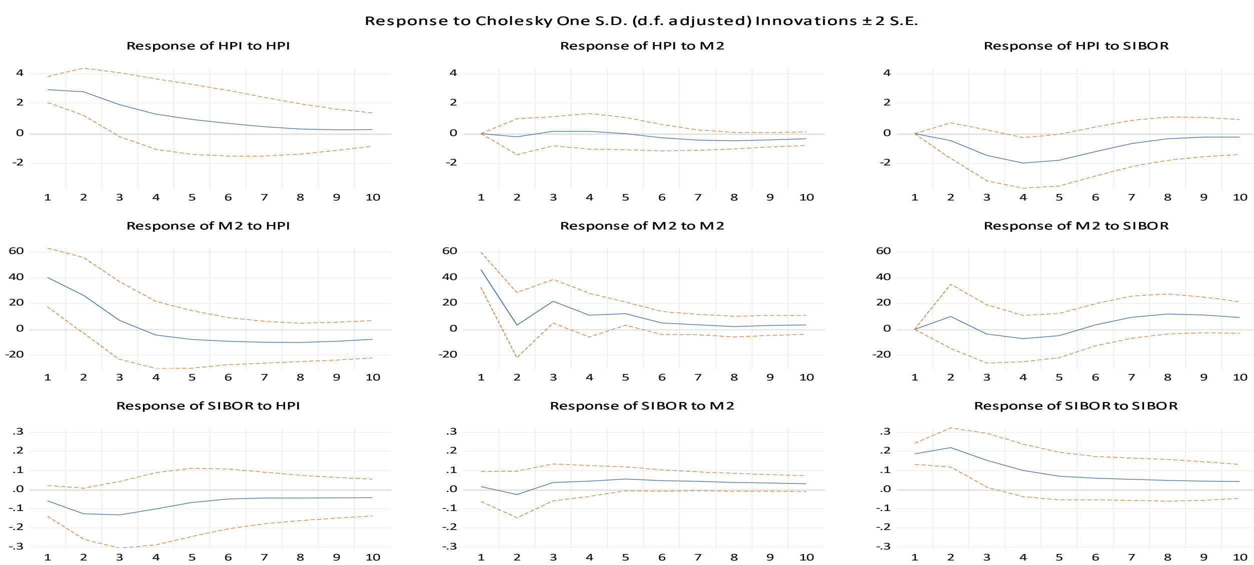
4.4 Impulse Response Function

The impulse response functions assess the dynamic behavior of the model. It examines the response of the housing price to a one standard deviation innovation of M2 and SIBOR for a period of twenty-four quarters of aftershocks. Figure 1 reflects decomposition analysis.

The blue line depicts the movement of the housing price. The two yellow dash lines represent the confidence interval with two standard deviations. Figure 1 reflects that a positive shock to SIBOR can cause the housing prices to decline. But the initial decline is not significant. The decline of the housing prices becomes significant after the 4th period with an increase in quarter ten. The effect will pass through the market to the housing price and bring it a shock in the opposite direction with long-term effect. The housing price index has a slight response to a shock on M2 throughout the entire twenty-four quarters. The results of the impulse function demonstrate the significant impact of the SIBOR effects on house prices and only a slight impact of M2 on the house price index.

Results of the impulse function are consistent with the Granger causality tests. The impact of the SIBOR on housing prices supports the theory of Bernanke and Gertler (1995). Bernanke argued that a contractionary monetary policy reduces the housing prices and expansionary policy leads to an increase in housing prices. The results are also in conformity with recent studies by Shen et al (2018), Sutton et al (2017) and McDonald and Stokes (2013).

Figure 1: Impulse Functions



4.5 Variance Decomposition

This section determines the degree of importance of the monetary variables. That is, how do they influence housing prices beyond the sample period? It is possible to decompose the total variance of housing prices in each of the future periods and then determine how much each monetary variable explains. Table 6 shows the outcome of the variance decomposition for the period of twenty-four quarters. In the short run, the SIBOR cannot explain more than 10.5% of the forecast error variance of the housing price during the first three quarters. Whereas, M2 cannot explain more than 1% of the forecast error variance of the housing price during the same three quarters. Together, the two variables cannot explain more than 11% in the short run. However, it is worth noting that the shocks of the two variables tend to explain more than 35% of the variances in the long run. Results of the variance decomposition show that SIBOR is an effective monetary instrument. As shown in Table 6, in the longer horizon, 65.00% of the variation in HPI is due to its own shocks. The rest of the variation is attributable to monetary policy. Our results are in line with theoretical predictions that expansionary monetary policy of lower SIBOR will increase HPI.

Table 6: Variance Decompositions

Variance Decomposition of HPI:				
Period	S.E.	HPI	M2	SIBOR
1	2.933080	100.0000	0.000000	0.000000
2	4.081407	98.40299	0.270584	1.326424
3	4.743375	89.23447	0.301067	10.46446
4	5.297459	77.52584	0.321514	22.15265
5	5.668099	70.49754	0.280989	29.22147
6	5.841589	67.73063	0.499130	31.77024
7	5.913167	66.68949	1.037663	32.27285
8	5.950000	66.12274	1.667122	32.21014
9	5.974574	65.74892	2.152433	32.09865
10	5.994818	65.49215	2.469330	32.03852
Variance Decomposition of M2:				
Period	S.E.	HPI	M2	SIBOR
1	61.40369	43.06021	56.93979	0.000000
2	67.69795	50.68786	47.09786	2.214279
3	71.55324	46.30616	51.47052	2.223318
4	72.86410	45.00052	51.91874	3.080732
5	74.45042	44.18550	52.44529	3.369205
6	75.25612	44.70860	51.76916	3.522240
7	76.58115	44.84697	50.22690	4.926130
8	78.18860	44.67302	48.26415	7.062828
9	79.56726	44.45710	46.75763	8.785278
10	80.53957	44.28170	45.82642	9.891882
Variance Decomposition of SIBOR:				
Period	S.E.	HPI	M2	SIBOR
1	0.196736	8.890584	0.688904	90.42051
2	0.321905	18.66059	0.877697	80.46171
3	0.382047	25.16004	1.604016	73.23595
4	0.409985	27.84070	2.572315	69.58698
5	0.424941	28.38844	4.113504	67.49806
6	0.434473	28.42404	5.098511	66.47745
7	0.442097	28.42750	5.893583	65.67892

8	0.448518	28.55827	6.441635	65.00009
9	0.454143	28.75885	6.867012	64.37414
10	0.459055	28.96996	7.167802	63.86224

5. Conclusion

This paper examines the impact of monetary policy instruments, specifically short-term interest rate (SIBOR) and money supply (M2), on housing prices. The paper utilized the VAR model in which Granger causality, response functions, and variance decomposition were also analyzed. The findings and contributions of this paper have both academic and policy implications. First, the results show that SIBOR is a key monetary policy variable in the Saudi Arabia economy. Specifically, the SIBOR is a more effective and reliable monetary policy instrument than M2. Thus, the Saudi Arabia Monetary Authority (SAMA) should rely more on the SIBOR as an intermediate target to conduct its monetary policy in the short-run. Second, the Granger causality tests and the impulse response functions indicate that SIBOR has an effect on housing prices, but M2 is shown to have limited effect on housing prices. Based on these results, the paper recommends SIBOR as an effective monetary policy tool target.

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