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Relationship between Housing Price Index and Consumer Price Index in Saudi Economy: A Vector Autoregression Approach

ABSTRACT

This is a pioneering attempt to examine the existence of the causal relationship between the housing price index (HPI) and the consumer price index (CPI), in Saudi Arabia. Vector Autoregression (VAR) approach has been used to analyze the data during the period 2013:1-2022:2. Granger Causality tests, variance decomposition analysis, and impulse response functions have also been employed to explore the nature of that relationship. The VAR estimates reveal that the CPI has an inverse relationship with the HPI in the first three lags out of five lags. The analysis of variance and response functions shows that CPI has a high explanatory power over changes in HPI (more than 48%), especially in the short run compared to the long run. The causal tests of Granger show that CPI does Granger cause housing prices index (HPI), and consequently, it suggests that inflation can serve as a precursor to future housing prices. The paper emphasizes the importance of future studies and research in this field.

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1. INTRODUCTION

The importance of housing for all is derived from the fact that shelter has always been one of the basic needs for an economic agent. House ownership and its value are among the main components of a high standard of living and they constitute the bulk of wealth per capita. As such, house ownership is among the largest per capita assets that can be used, along with meeting the need for shelter, in securing access to credit. According to Muellbauer and Murphy (1997), housing costs absorb almost a quarter of a person's disposable income. Housing prices and rents are positively correlated, so housing expenditure occupies a major portion of the household budget whether it is in the form of monthly rent or monthly house lease payments (Leamer, 2002). Therefore, economic activities can be affected by fluctuations in housing prices through variations in housing behavior patterns. There is a lack of research studies that investigate the determinants of housing prices in Saudi Arabia. This paper tries to fill this gap.

Besides, changes in housing prices have important implications for family decisions in terms of investment, consumption, and the overall economy. The global financial crisis in 2007 was triggered by the high-risk mortgage crisis of 2005, which led to negative repercussions not only for the housing markets but also for financial markets throughout the world. The recent financial crisis has also emphasized the significance of the correlation between global financial markets and housing prices. Several macroeconomic factors affect the demand and supply of housing. For example, market sensitivity is measured through housing prices. Many macroeconomic variables affect the housing price index, including the cost of the final goods and raw materials used, as well as inflation.

The objective of this study is to explore how the Housing Price Index (HPI) is affected by the Consumer Price Index (CPI) in an emerging economy like Saudi Arabia. This is a pioneering study about the relationship between CPI and HPI using Saudi data. Analysis of this relationship is important because so far, there has been no empirical research shedding light on this important relationship even though several studies have tried to predict HPI by the changes in CPI and other macroeconomic variables under the context of data from several countries.

The importance of this study emanates from the importance of housing markets in the economy. Housing demand is very sensitive to macroeconomic changes and is often used as an indicator of the business cycle. Consumption expenditure on housing is considered a long-term investment and is sensitive to interest changes. Hence it is very important to explore the relationship of HPI with CPI for the Saudi economy.

Saudi Credit Bureau has recently developed HPI using the Hedonic Regression technique. The primary focus of this paper is to provide an empirical analysis of the effect of CPI on the HPI. Data from the Saudi economy has been analyzed by using the Vector Autoregressive model (VAR) during the study period. This paper derives its importance from the analytical model used which will allow studying the impact of variables to empirically prove the causal associations between HPI and CPI. It is also expected that the results of the study will emphasize a better appreciation of the association between the variables by highlighting an empirical issue that has not got its depth in scientific research in the Saudi real estate sector. It is expected that future housing prices can be better forecasted using aggregate price levels in the KSA.

The research is divided into five parts, including the introduction and conclusion. Section 2 deals with the overview of the Saudi real estate sector, theoretical framework, and literature review, while section 3 discusses data and methodology. Section 4 presents both results and analysis. The last section reviews the findings and recommendations.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Overview of Saudi Real Estate

Saudi real estate sector has witnessed notable developments during the recent past, especially the housing sector, which continues to be affected by ongoing fiscal and monetary policies emphasizing the importance of house ownership as an important pillar of family stability and wealth creation in society. Consequently, the use of housing is no longer just for shelter or investment but rather has become an essential component of the infrastructure of the Saudi economy. Real estate prices, including housing, are related to the consumer price index. Housing prices constitute a significant proportion of the price index. However, as a result of several circumstances, such as variations in the money supply and income, price changes and the cost of living may cause an increase in home prices (Campbell & Cocco, 2004).

The residential real estate sector in the Kingdom of Saudi Arabia plays a significant and active part in the national economy. According to the Saudi General Statistics Authority, nearly 50% of citizens owned houses in Saudi Arabia in 2017. The sector has experienced high growth rates for the past four decades. According to SAMA statistics, the housing sector recorded high growth rates during the period (SAMA: 2003-2012). The annual growth rate in the sector was 11.4% during the said period. Given the social, economic, and developmental roles played by the housing sector, the government continued to pay great attention to the development of this sector. This interest has been reflected in the government's ongoing development policies and strategies to ensure that the housing sector plays a positive role in the national economy. For example, in the year 2008, the government established the so-called General Housing Authority, in addition to formulating a comprehensive housing strategy to encourage investment in housing.

Housing is also one of the largest areas of spending under the National Transformation Program, with a dedicated budget of 59 billion Saudi riyals over five years from the middle of the second decade of the current millennium, which represents a stimulating step for the sector. With a share of 65% of the total real estate market, a sustainable residential sector is formed to achieve ambitious reforms as expressed in the National Transformation Program and Vision 2030. As for the share of the building and construction sector in the GDP, this percentage varied between 6.71% in the year 2015 to 5.18% in the year 2018 (SAMA Annual Report, 2019).

Saudi Credit Bureau (SIMAH) has recently issued the housing price index for the KSA. Principal providers of mortgage service in KSA delivered more than 40,000 real estate records to develop the HPI. Quarterly variations in prices of residential properties were recorded with 2013 as a base year. The hedonic Regression technique was employed to calculate HPI. It is the same technique employed for estimating housing price indicators in major developed countries.

As for the concept of the consumer price index in the economy, it has been defined as a significant and continuous increase in the total volume of demand over the real supply, which leads to a series of sudden and continuous increases in the general price level. Or in a simple statement: there is excess demand for goods over the current supply potential, which results in the rise of commodity prices. As for real estate, it is defined as everything that is fixed in its place and cannot be moved without being damaged, such as lands. It includes buildings, trees, and other fixed objects, and everything that a person has added, such as buildings, improvements, and water and electricity lines. The property is divided into two parts: The first is land which includes residential land, commercial land, investment land, raw land, and agricultural land. As for the second section, the buildings include houses, apartments, palaces, villas, and buildings.

2.2 Systematic Literature Review Using Meta-Analysis

For steadily linking and producing findings from multiple quantitative studies in a research area relevant to this research paper, we used a meta-analysis approach. Meta-analysis is a group of statistical methods that combine the results of a considerable number of studies to postulate a comprehensive summary of knowledge in a research field (Littell et al., 2008). Thus, a meta-analysis combines the findings of single studies for specific relationships, it permits us to achieve accurate conclusions about the strength and direction of a relationship between variables. Therefore, this study follows systematic reviews that involve comprehensive search strategies that enable us to categorize all relevant studies to the research paper (DeLuca et al., 2008).

Thus, in this section of the study, the authors conducted a systematic review of the meta-analysis method to summarize the previous literature review relevant to the study. We first, define the search terms based on focal concepts in our conceptual model to search them in different databases later. For instance, to assess the relationship between housing prices and another explanatory variable such as the Consumer Prices Index (CPI), we consider search terms such as house prices, and Consumer Prices Index (CPI), to search all publications related to their meta-analysis framework.

Secondly, in terms of study inclusion criteria and sample composition, this research paper limited the sample of previous studies published in renowned academic journals to ensure the quality of findings. Finally, regarding the primary effect size measure for the meta-analysis in the field of economics and finance, we are more interested in the examination of correlation effects obtained from the regression model which is directly connected to the research question of the meta-analysis of the study. The basic research question was: is there a relationship between house prices and the Consumer Prices Index (CPI)? We decided to choose the period of (2000–2022) because the concept of housing prices and other macroeconomic determinants gained new momentum and researchers have extensively focused on this area of study since 1990th. Table 1 reflects a review of the Meta statistical approach which summarizes previous literature relevant to the present study.

The aggregate price level is one of the main macroeconomic factors that influences house prices. A set of earlier literature has found that inflation and other macroeconomic factors influence house prices. (Kenny, 1999; Case & Schiller, 1990). Numerous studies have been undertaken recently to understand how inflation affects the housing market. Feldstein (1992) pointed out that rising inflation decreases people's interest in real estate investment, which leads to a reduction in housing demand.

In their research paper, Afsheen and Diah (2022) employed an autoregressive distributed lag model (ARDL) to examine the relationship between GDP and housing prices in Malaysia. The study used quarterly data over the period (2011:1 -2020:4) for the six variables such as gross domestic product (GDP), housing prices (HP), lending rate (LR), exchange rate (EXCHR), and world governance indicators (VAA, PS, GE, RQ, ROL and COC). The results of ARDL cointegration tests running from housing price to GDP provide strong evidence to support the hypothesis that housing price and economic growth are cointegrated.

Rahman and Ridzuan (2020) examined the impact of GDP, CPI, base lending rate, and money supply on the house price index in Malaysia (1988-2017). The ARDL estimation postulated that, in the long run, GDP and base lending rate significantly affect the house price index in Malaysia whereas the money supply and consumer price index reflected a negative impact on the house price index.

Table 1: Literature on the Correlation between the Housing Price Index and the Consumer Price Index

Author (s) year of study	Geographical Location	Time Period	Control Variable	Method
Afsheen and Diah (2022)	Malaysia	2011-2020	Housing prices	ARDL
Rahman and Ridzuan (2020)	Malaysia	1988-2017	housing prices	ARDL
Marfatia et al. (2020)	OECD	1975-2017	Housing prices	ARDL
Korkmaz (2020)	Turkey	2010-2019	housing prices	Causality Test
Viktorija and Karpavičiūtė (2017)	Lithuania	2001-2014	Housing prices	Granger Causality test
Kuang and Liu (2015)	China	1996-2010	Housing prices	The general quadratic equilibrium model
Zandi et al. (2015)	Malaysian	2007-2014	Residential property prices	Analytical descriptive approach
Inglesi-Lotz & Gupta (2013)	South Africa	1970-2011	non-residential housing prices	ARDL model
Fengguang (2012)	China	2000-2010	Housing prices	The theory and method of system engineering
Meidani et al. (2011)	Iran	1990-2008	Housing Prices	Toda and Yamamoto's approach
Valadez (2011)	USA	2005-2009	Housing Prices	Number Crunching Statistical Service
Sari et al. (2007)	Turkey	1961-2000	Housing prices	The generalized variance decomposition approach
Apergis (2003)	Greece	1981-1999	Housing prices	An error correction vector autoregressive (ECVAR) model
Chen and Patel (1998)	Taipei	1971-1993	Housing prices	Granger causality tests, variance decomposition, and impulse response functions are based on the vector error correction model.

Marfatia et al. (2020) examined the time-frequency linkage of macroeconomic drivers and 15 OECD countries' housing markets during the period (1975q1- 2017q3). The results showed that the relationship between house prices and key macroeconomic indicators varies significantly across countries, time, frequencies, and the direction of causation. At the higher frequencies, house prices are more associated with interest rates in the short-run while at the lower frequencies, house prices are most linked to per capita income growth in the long-run. Moreover, at medium frequencies, the relationship between the stock market and the housing market is significant.

The study by Korkmaz (2020) aimed to explore whether the overall inflationary pressures prevailing in the Turkish economy affected housing prices in 26 residential areas, as shown by HPI. The study used CPI and PPI data from 2010:01 to 2019:01. The Konya Causality Test (2006) was employed to study the causal association between the variables. According to the main results inflationary pressures are caused by HPI for some housing areas of Turkey.

Viktorija and Karpavičiūtė (2017) examined the economic, financial, and demographic factors that affect housing prices. The paper discusses factors such as unemployment, inflation, interest rate, GDP, and immigration. Besides, the paper explores the overall impact of economic policies on housing prices in the state of Lithuania, during the period 2001:1 to 2014:4. The paper uses the Granger Causality test and the ADF to test stationary conditions. The paper reaches several conclusions, the most important of which are that housing prices are not caused by interest rates and inflation, rather they are highly dependent on GDP and unemployment in addition to other macroeconomic policies.

Kuang and Liu (2015) analyzed the phenomenon of escalation in house prices during the early part of the third millennium in China. The researchers use the general quadratic equilibrium model, which includes consumers, developers, enterprises, and the central bank to clarify the type of association between inflation and housing prices. Among several conclusions of the study, the most important is the existence of a reciprocal association between inflation and housing prices. Also, the effect of high housing prices on inflation is smaller than the positive influence of high inflation on housing prices.

Zandi et al. (2015) examined the extent of the impact of changes in some economic variables including GDP, inflation, GDP growth rate, and the prevailing interest rate on residential property prices in the Malaysian city of Penang during the period 2007-2014. The researchers used an analytical descriptive approach based on data available from secondary sources from the official authorities in Malaysia. The study discovered a positive association between the GDP and the prices of residential real estate, but no significant relationship between residential real estate prices and the rate of inflation. The authors also found that interest rate directly affects the prices of residential real estate.

Inglesi-Lotz and Gupta (2013) attempted to study the relationship between the prices of goods and services and non-residential housing prices in South Africa using quarterly data from 1970 to 2011. According to the experimental results of the ARDL model, it can be observed that long-term integration exists between the consumer price index and housing prices for all sectors. The results of Fischer coefficients also reveal that the estimates are not statistically different from the unit. The result conforms to the proposed theoretical framework for housing prices and consumer prices excluding housing costs. Overall, the paper concluded that in the long run, housing prices provide a stable, but quantitatively small, hedge against inflation in South Africa.

In their research paper, Fengguang (2012) used the theory and method of system engineering to study the relationship between house price volatility risk and price tolerance of the residents in China. The paper mainly explored the factors of housing price fluctuations, the hazard of price fluctuations, and control challenges. Finally, this paper provided some policy implications to control housing prices in the future.

Meidani et al. (2011) attempted to investigate the presence of a causal relationship between inflation, economic growth, and housing prices in Iran. The Toda and Yamamoto approach was employed by the study for quarterly data from 1990 to 2008. The results revealed that there is proof of a strong, multiple-way relationship between macroeconomic factors and housing prices. The tests for causation showed that CPI and GDP Granger cause housing prices, and that both housing prices and GDP have feedback effects. The study discovers no evidence of Granger causality of changes in real property prices on CPI.

Valadez (2011) investigated the relationship between house prices and GDP in the United States during the period (2005q1-2009q4). The authors employed Number Crunching Statistical Service (NCSS) software to conduct the regression analysis. In the results, it was found that housing price index changes can be used to find quarterly changes in Real GDP. Using the Toda and Yamamoto approach, Meidani et al. (2011) examined the existence of causality among house prices, inflation, and economic growth in Iran from 1990Q1 to 2008Q3. The results showed that consumer price index, gross domestic product, and exchange rates have significant and multidirectional links.

In their research paper, Sari et al. (2007) examined the link between housing prices and certain macroeconomic variables such as interest rates, output, money stock, and employment in Turkey for the period 1961-2000. The authors employed the generalized variance decomposition method. The study reached specific results that indicated that the monetary aggregate has a relatively more substantial impact on housing investment compared to other variables. Whereas, shocks to interest rates, output, and prices have slight effects on changes in housing prices in Turkey.

Apergis (2003) investigated the dynamic changes in prices of houses traded caused by employment, inflation, and housing loan rates in Greece. The study employed the Error Correction Vector Autoregressive model to explore how real house prices are affected by macroeconomic factors. The results of variance decompositions reveal that a major part of fluctuations in housing prices is mainly initiated by the loan rate for housing, followed by inflation and employment.

Chen and Patel (1998) investigated dynamic causal links between housing prices and other factors including short-term interest rates, gross household income, construction costs, stock price indices, and completions of housing, in Taiwan. The study used (VAR), variance decompositions, the Granger causality tests, and impulse response functions. According to the results, all factors have a Granger causal effect on the prices of houses. However, the stock price index and house prices have a bidirectional reaction effect. The results of variance decomposition results show greater fluctuations in future prices caused by turbulences in current house prices. The other five determinants explain 34% of the variance in housing prices.

2.3 Theoretical Framework: Macroeconomic Determinants Affecting Housing Prices

To know housing prices, understanding the primary factors of property pricing is essential. This is because housing is a unique kind of asset that is valuable both as an investment and as a consumer good. Some of the prevailing current literature, as it appears later in some paragraphs of this paper, indicates that movements in housing prices are closely related to several macroeconomic factors. The demand for housing is almost due to macroeconomic fundamentals such as GDP per capita, inflation, unemployment, interest rates, and other demographic factors. It is easy for these macroeconomic variables to be affected by economic changes. On the other hand, other variables on the supply side are almost rigid to respond to economic changes, at least in the short term. Because of these and other considerations, most current literature focuses on the demand side when estimating housing price determinants.

Friedman's (1957) permanent income hypothesis seems to provide the first theoretical insight regarding the wealth effect of house prices. The perception is simple. Since home equity is a vital factor of homeowners'

wealth, an unpredicted house price rise would increase the estimated lifetime wealth of homeowners. Based on the perception that individuals would wish to smooth consumption over their lifetime, the increase in lifetime wealth would surge their desired consumption. Lately, Morris (2006) provided a partial equilibrium model to question the wealth effect and expected that both age and expected mobility affect the wealth effect. Theoretical models, e.g., Skaarup and Bodker (2010), and the empirical literature on the housing market, suggest that over the long-run house prices depend positively on GDP Per Capita. This section illustrates developments in these factors for the Saudi economy. It also presents the data developed for policy, institutional, and structural factors that can affect house price dynamics through their influence on housing prices. GDP per capita plays a key role in shaping house price trends. The higher the GDP Per Capita (GDPP) of households, the more they can spend to purchase a house or service a mortgage, pushing up house prices.

3. DATA AND METHODOLOGY

As mentioned earlier, this study proposes to explore the association between inflation and HPI in Saudi Arabia. Quarterly data for the study variables (HPI & CPI) from 2013:Q1-2022:Q2, has been collected from the annual reports issued by the Saudi Central Bank. The VAR model has been applied by the study because this model can appropriately deal with possible endogeneity problems (Dreger & Wolters, 2009). All system variables are also allowed to be affected by each other internally in a VAR model. Granger Causality test, analysis of variance and impulse response functions were also employed to analyze the association between CPI and the housing price index. An empirical equation is formulated to determine the effect of the general level of prices on the housing price index in the form of a level as follows:

$$HPI_t = \alpha + \beta \ln CPI_t + U_t \qquad\qquad (1)$$

where HPI_t presents Housing Price Index (dependent variable), CPI_t presents Consumer Price Index (independent variable), α and β are the parameters and U_t presents the random term.

Based on the several studies carried out in the context of different countries including Feldstein (1992) and Kuang and Liu (2015) among others, we develop the hypothesis of this study as follows:

H$_A$: CPI has a positive effect on HPI.

4. RESULTS AND DISCUSSION

4.1 Analysis of Unit Roots
To test the stationarity of system variables in the model, Augmented Dickey-Fuller test statistics have been engaged. According to the results, HPI from 2013:Q1-2022:Q2, doesn't have a unit root at the level, while CPI contains a unit root at the level and is non-stationary only at the 1st difference. Table 2 reflects the ADF test results of the mentioned variables. Therefore, these variables are stationary at different levels. The hypothesis that HPI and CPI contain the unit root has been rejected at a level and first difference consecutively at the 5% level of significance.

Table 2: ADF Tests Statistics for Unit Roots

Variables	Levels	1st Difference (intercept)
DHPI	-3.2143*	
DCPI	-2.1689	-6.9652*

Note: * represents significance at a 5% level, respectively.

4.2 Analysis using VAR

The VAR model is usually used to analyze the effect of system-related time-series correlations and random disturbances on system dynamics. Using the D(HPI) and D(CPI) variables to create a VAR model, Table 3 shows the results of the VAR model and estimates of the variables. The data reflects the relationship between the coefficients of CPI and HPI. Table 2 reveals that the CPI has an inverse significant relationship with the HPI in the short run. Findings are also in line with the results of papers reviewed earlier. While the same variable, CPI has an insignificant positive relationship with the HPI in the long run.

The adjusted R-squared test reveals that 99% of the explained variations in the dependent variable which is caused by variations in the independent variable. The value of R-square indicates that the model has an almost perfect fit.

Table 3: Results based on Vector Autoregression

Sample (adjusted): 2014Q3 2022Q2
Included observations: 32 after adjustments
DHPI = C(1)*DHPI(-1) + C(2)*DHPI(-2) + C(3)*DHPI(-3) + C(4)*DHPI(-4) + C(5)*DHPI(-5) + C(6)*DCPI(-1) + C(7)*DCPI(-2) + C(8)*DCPI(-3) + C(9) *DCPI(-4) + C(10)*DCPI(-5) + C(11)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.6173	0.1558	3.9633	0.0166
C(2)	-0.0243	0.2918	-0.0831	0.9377
C(3)	0.3172	0.6502	0.4878	0.6512
C(4)	-1.0190	0.7782	-1.3095	0.2605
C(5)	1.1104	0.4515	2.4591	0.0698
C(6)	-0.1546	0.1317	-1.1735	0.3057
C(7)	-0.4420	0.1555	-2.8421	0.0468
C(8)	-0.1207	0.1358	-0.8888	0.4243
C(9)	0.2139	0.0858	2.4932	0.0672
C(10)	0.1166	0.1056	1.1045	0.3313
C(11)	48.9793	23.4788	2.0861	0.1053
R-squared	0.997019	Durbin-Watson stat		1.642423
Adjusted R-squared	0.989567	S.D. dependent variable		5.738201
S.E. of regression	0.586121	Prob. (F-statistic)		0.000132
Sum squared resid	1.374152	F-statistic		133.7853

4.3 Granger Causality

The study has also conducted the Granger causality test to see whether the HPI and the system variable CPI were causally related. The interval length chosen based on the Akaike Information Criterion for the variables is five. The results of the Granger causality test are shown in Table 4. The test results indicate that the p-value for the CPI is 0.0157 which implies that CPI does Granger cause HPI. This shows that the Granger non-causality from CPI to HPI null hypothesis can be disproved. Therefore, the results confirm the existence of one-way causation from CPI to HPI. According to the findings, future house prices may be predicted by inflation. The findings are also in line with those earlier reviews by Chen and Patel (1998) and Meidani et al. (2011).

Table 4: VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: DHPI			
Excluded	Chi-sq	d.f.	Prob.
DCPI	13.9873	5	0.0157
All	13.9873	5	0.0157

4.4 Test of Source of Volatility

The variance decomposition and impulse response functions are applied to provide additional understanding of the relationships between home prices and their determinants. These two methods allow us to assess the relative significance of the variables outside the sample period and provide a signal of the system's dynamic characteristics.

4.4.1 Impulse Response Function

The paper follows the Cholesky-based VAR model to analyze the effect of CPI on HPI. The housing prices for a standard deviation of another variable for 38 quarters is an example of a variable response that can be described by a response function. The Schwarz Information Creation (SIC) and AIC data indicate that the interval size for our VAR model should be 5. The response of HPI to shocks to CPI based on the impulse response function has been shown in Figure 1. The blue line depicts the HPI movement and represents a yellow confidence dash line with two standard deviations. A positive CPI shock causes HPI to decrease, and this initial decrease is statistically significant as revealed by Figure 1. This result is in line with the findings of Feldstein (1992) and Kuang and Liu (2015).

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.
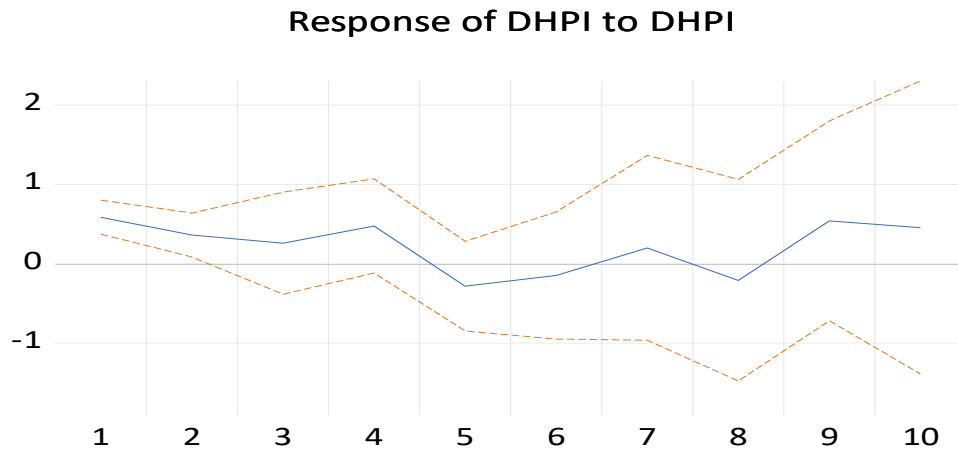
Response of DHPI to DHPI

Figure 1: *Impulse Response Function*

4.4.2 Variance Decomposition

The percentage of variation in housing prices (HPI) induced by shocks originating from the CPI is measured by the variance decomposition. Table 5 shows variance decomposition estimates for a 38-quarter time horizon. Data reflects that the single system variable (CPI) can explain more than 63.94% of the variance of the expected error in the housing prices in the short term as modeled by VAR. Moreover, it should be noted that more than 48% of the housing price disparities in the long-term are explained by the shocks on the CPI which implies that the CPI is a good endogenous variable in the system mainly in the short-run. The finding proposes that people's expectations for future housing price changes are influenced by the current shift in overall prices. The average of 49.9% variability contributed by (CPI) changes, implies that the remaining 50.1% of the variability in (HPI) is explained by itself.

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Table 5: Variance Decomposition of DHPI

Period	S.E.	DHPI	DCPI
1	0.5861	100.0000	0.0000
2	0.7569	82.7524	17.2476
3	1.2246	36.0539	63.9461
4	1.3500	42.0642	57.9358
5	1.4064	42.8387	57.1613
6	1.4153	43.4102	56.5898
7	1.4644	42.4115	57.5885
8	1.4801	43.5301	56.4699
9	1.6224	47.3124	52.6876
10	1.6860	51.1110	48.8890

4.5 Post-Estimation Tests

4.5.1 Serial LM Test
Autocorrelation in the errors in a regression model is tested by the Breusch-Godfrey Serial Correlation LM Test. According to Table 6, the probability of the observed Chi-squared is less than 0.05, which is unsatisfactory. According to the results, the null hypothesis of the absence of serial correlation of errors is rejected which means the presence of autocorrelation problem.

Table 6: Breusch-Godfrey Serial Correlation LM Test

Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	1.6064	Prob. F(2, 2)	0.3837
Obs Chi-squared	9.2450	Prob. Chi-Square(2)	0.0098

4.5.2 Heteroscedasticity Test: Breusch-Pagan-Godfrey
Since the probability of the observed Chi-squared is greater than 0.05, the results are acceptable. According to Table 7, we cannot reject the null hypothesis of no Homoscedasticity.

Table 7: Heteroscedasticity: Breusch-Pagan-Godfrey Test

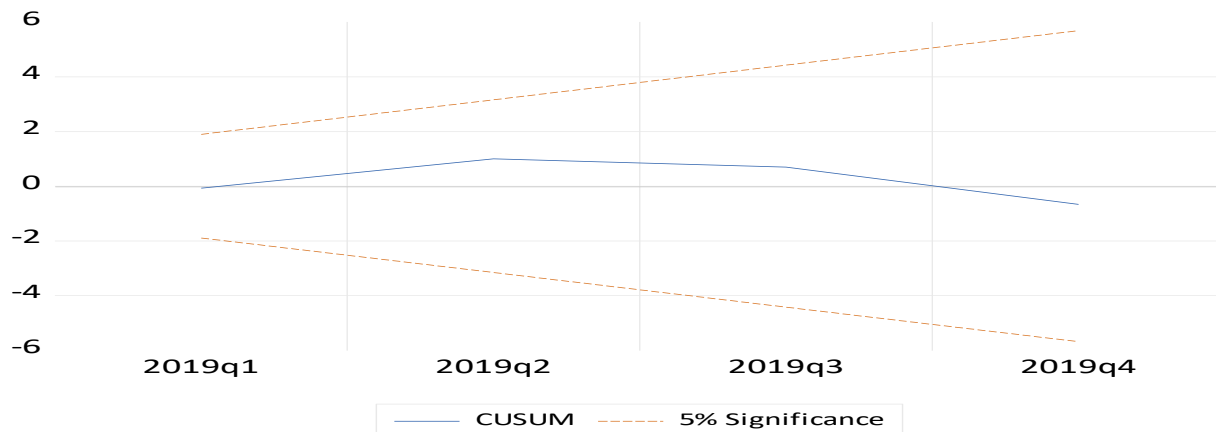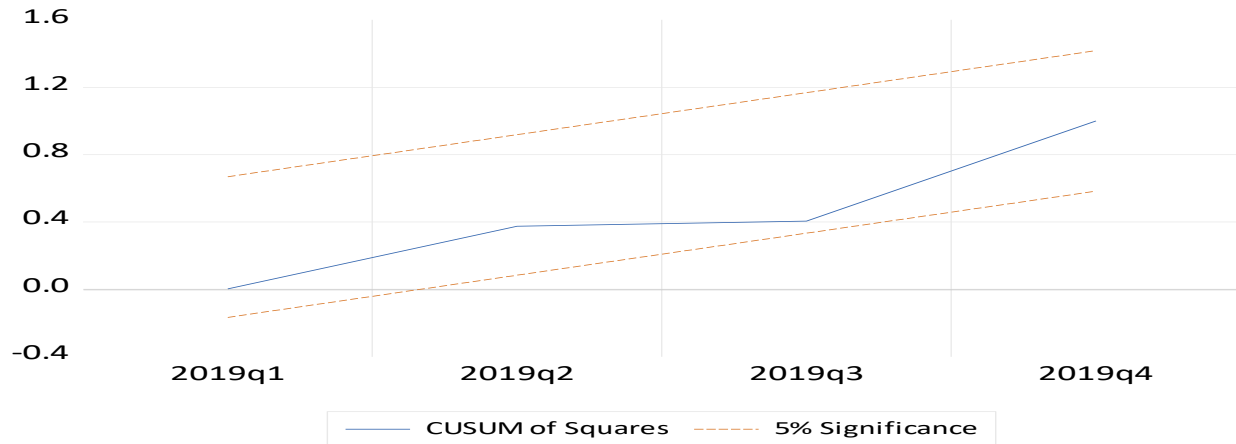| Null hypothesis: Homoscedasticity			
F-statistic	0.1225	Prob. F(10,4)	0.9966
Obs* Chi-squared	3.5166	Prob. Chi-Square(10)	0.9665
Scaled explained SS	0.3422	Prob. Chi-Square(10)	1.0000

Figure 2: Stability Test CUSUM

Figure 3: *Stability Test CUSUM of Squares*

5. CONCLUSION AND POLICY IMPLICATIONS

This paper is a pioneering attempt to examine the relationship between the consumer price index (CPI) and the housing prices index (HPI) in Saudi Arabia during the period from 2013-2022. The Granger causality test, variance decomposition analysis and impulse response functions methods are employed for impact analysis by using the VAR approach. The study has reached several conclusions. The analysis of the variance decomposition function shows that CPI has a high explanatory power over changes in HPI (more than 54%), especially in the short term compared to the long term. This means that CPI is an effective and reliable variable that can be used when dealing with housing prices. The impulse response functions show that a positive shock to the CPI has effects on housing prices, particularly during the third period after the initial shock. The result of the Granger causality test shows that the CPI Granger causes HPI. However, HPI does not Granger cause CPI. The limitation of the study includes the limited availability of data. Although other variables may have their effect on housing prices, this research paper limits the investigation to the relationship between the CPI and housing prices.

The study calls for more future studies and research considering other variables that might affect the housing price index in the Kingdom, such as exchange rates, GDP, money supply, and other demographic and institutional variables. There are important policy implications of this research study. According to the results, CPI Granger causes HPI which necessitates that the government should focus on controlling inflation which will keep housing prices under control.

Conflict of Interests:
The authors have declared that no competing interests exist.

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