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Structural Decomposition of Residential Property Prices in Indonesia: a VAR Approach

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Abstract
Home ownership is so important for human survival. the Residential Property Price Index or IHPR increases every time. It is feared that the continuous increase in house prices exceeding their fundamental value will lead to a property bubble like the one that hit the United States in 2008. This study contributes to look at the IHPR's response to shocks from inflation. BI interest rate, GDP, compensation index for permanent workers and Construction Daily Worker and Construction IHPB. Using time-series data from 2010Q1-2021Q4 and the VAR method shows that the IHPR responds positively to changes in the shock of the inflation variable, the compensation index for permanent workers and construction daily workers and the WPI for Construction. Meanwhile, the IHPR response negatively to changes in interest rates and GDP. Based on the results of the variance decomposition. the construction IHPB is the variable that contributes the most. namely 12.2% to changes in IHPR. Implication of the research to maintain the macroeconomic condition to courage the IHPR on stabil condition.

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Introduction

Building a house or housing requires a large amount of money. Building materials and wages for labor (labor) are components that have a fairly large percentage of construction costs. The Construction Wholesale Price Index (IHPB) increases every month based on data released by BPS. This will certainly have an impact on development costs incurred by developers and individuals. The high cost of construction can reduce the level of housing stock due to a decrease in the number of constructions (Cohen & Karpaviciute, 2017). The increase in the price of building materials (IHPB construction) reflected the inflation that was occurring at that time.

It is feared that high inflation will have a big impact on housing development and make the house prices offered rise. The high price of housing makes some people take loans or credit to meet their needs for a house or place to live. The reference interest rate is used by Bank Indonesia as a monetary policy and is a benchmark for commercial banks in determining the interest on loans or the like offered to customers, both debtors and creditors. In addition, Bank Indonesia also directly supervises developments in property prices in Indonesia, through the Residential Property Price Survey (SHPR). That the Residential Property Price Index (IHPR) for 2018-2020 can explain the tendency for property prices to move up every quarter.

Source : Bank Indonesia
Figure 1. Growth of Residential Property Price

Figure 1 explains that since 2018 there has been a slowdown in the growth of the property sector. This is due to various external conditions that have occurred. that in the range from 2018 to 2019 there has been a slowdown in economic growth caused by low public purchasing power which has an impact on declining purchasing power in the property sector. In 2020 there was a pandemic which caused property growth to decline. The effect of the pandemic shows that residential property prices have decreased. This is because the welfare effect in society has decreased during the pandemic and has resulted in a decrease in demand for property. Research on the property sector has experienced an increase following the 2008 crisis caused by asset price bubbles. The focus of research on the property sector has expanded not only to the macroeconomic and monetary sectors but also to fluctuations in property prices themselves. Research on the property sector is important because it can become an early warning system in maintaining the domestic economy as a whole.

The difference in the research being developed is applying the variables in the production factor sector to property, namely the worker compensation index and the construction IHPB.

The importance of the production factor sector to identify shocks from the upstream side. In addition, the research also applies macroeconomic variables such as GDP, inflation and interest rates. The research contribution as an early warning system of the property sector and knowing the response of the property sector to fluctuations in macroeconomic variables and factors of production (worker compensation index and construction IHPB) in the property sector.

Literature Review

Research related to the property sector has been developed by many previous researchers, such as research by Bernanke and Kuttner (2005) who developed the sensitivity of the property sector to changes in monetary policy. Mishkin (2007) added that the property sector is linked as a transmission in monetary policy. The monetary sector cannot be separated from the property sector, because in certain cases the property sector is used as loan collateral so that it can have an effect on financial system stability. Not only in the monetary sector. several studies link the relationship between the property sector and the economy such as research developed by Ruiz-Silva (2018) and Iacoviello and Neri (2010).

A study states that any increase in Gross Domestic Product (GDP) will have an impact on increasing people's purchasing power in general and in this case can increase the demand for residential property for both consumption and investment motives. Changes in house prices have become a concern for each individual and also for the government because of their impact on socio-economic conditions and their impact on national economic conditions. Expectations of capital gains in investment in the residential property sector have an effect on increasing demand in that sector and also have an impact on rising house prices when supply cannot compensate in the short term (Bilozor and Wiśniewski, 2012). According to Ge & Williams (2015) families or people who rent housing in Sydney have increased drastically due to high house prices and the lack of ability of the community to meet these high housing costs.

It is feared that the continuous rise in house prices and exceeding their fundamental value will lead to a property bubble condition like the one that hit the United States in 2008. Bubble property is a condition where property prices increase unnaturally and at a certain point reach a climax price then fall significantly. Because there are many elements of speculation in it. the condition of the bubble is quite difficult to be predicted by the fundamental factors that can affect the determination of house prices. According to Cohen and Karpaviciute (2017) the determinants of house prices are important to analyze. This is due to their economic and social impact. First. housing is a product that is connected to other markets in the economy. Second, the housing or housing market is quite related to the financial sector. Third, changes in house prices can affect the construction market and other economic variables such as unemployment and inflation.

Method

This research is a study using time-series data in quarter form from 2010Q1-2021Q4 and in outline the equation built is as equation (1):

$$LnIHPR = f(Inf.r.LnPDB.LnWage.LnIHPB) \quad (1)$$

Where IHPR is the residential property price index; inf is inflation; r is the interest rate; GDP is gross domestic product; Wage is the compensation index in the property sector and IHPB is the wholesale price index or construction wholesale trade. According to Arwatchanakarn (2017) that the SVAR model is more interesting and profitable than the VAR model because it can use several economic theories and previous research and know the response of a variable when shocks occur in other variables. We can write the equation for the VAR as proposed by Carillo et al (2020) as equation (2):

$$A^{-1}X_t = C + \sum_{\ell=1}^{p} B_\ell X_{t-\ell} + \upsilon_t \quad (2)$$

Where C is n x 1 and constant. A^{-1} is n x n which is used as a matrix of contemporary structural relationships between the variables in the model, B_ℓ are persistent matrix, and υ_t is a vector of structural innovation with a mean equal to zero, contains no autocorrelation and a variance-covariance matrix equal to E$\{\upsilon_t.\upsilon_t\}$=I$_n$. The model with the derivative will produce a version of the multiplication on the system A as equation (3):

$$X_t = \tilde{C} + \sum_{\ell=1}^{p} \tilde{B}_\ell X_{t-\ell} + \xi_t \quad (3)$$

Where $\tilde{C} \equiv AC$, $\tilde{B} \equiv AB$ and $\xi_t \equiv A\upsilon_t$, which is the derived vector form of the innovation form with the same variance-covariance matrix to E$\{\xi_t.\xi_t\}$=**Ω**. Than the matrixs A follow $AA' = \mathbf{\Omega}$. To fulfill the exogenity block. then the matrix A and $\tilde{B}_\ell$ is a matrix with blocks equal to zero. so it can be written as equation (4):

$$A \equiv \begin{bmatrix} A_{zz} & \mathbf{0} \\ A_{zy} & A_{yy} \end{bmatrix} and\ \tilde{B}_\ell \equiv \begin{bmatrix} \tilde{B}_{zz.\ell} & \mathbf{0} \\ \tilde{B}_{zy.\ell} & \tilde{B}_{yy.\ell} \end{bmatrix} \quad (4)$$

Where A_{zz} is the impact of shocks from variables on the system. A_{zy} indicating the effects of macroeconomic variables and A_{yy} a representation of the impact of shocks on macroeconomic variables and factors of production. So is the notation $\tilde{B}_{zz.\ell}$ are the effect of

variabel with *lagged* ℓ to the variables as they occur. $\tilde{B}_{zy.\ell}$ is the effect of current macroeconomic variables and $\tilde{B}_{yy.\ell}$ effect the macroeconomic variable with *lagged* ℓ and the current of macroeconomic variables. The definition of variables and their sources are in table 1.

Table 1. Definition of Variables

Variable	Definition	Source	Measuring Scale
IHPR	An index that describes the development of house prices in Indonesia.	BI	Index. Basic year 2002= 100.
PDB	The value of all goods and services produced in a country.	BPS	Milyar Rupiah
Inf	Increase in prices of goods and services.	BPS	%
r	The interest rate is the reference for commercial banks.	BI	%
Wage	An index that describes remuneration or wages for construction workers. both permanent workers and daily workers	BPS	Index. Basic Year 2016=100
IHPB	Construction wholesale or wholesale price index	BPS	Index. Basic Year 2010 = 100.

Result and Discussion

Stationery Test

Economic data tends to fluctuate or is not around its average value and is stochastic or not stationary (Basuki & Prawoto, 2017). The author used the Augmented Dickey Fuller Test (ADF) to test the stationarity of the data to be used in this study. Each variable can be said to have no unit root if it has a probability value smaller than the 5% significance level. If the ADF statistic value is less than the critical value, then the variable is stationary at I(0) level, but it can be transformed into the first difference form if it is not stationary. A cointegration test can be performed if the variable is stationary at the first difference I(1) (Kurniawan and A'yun, 2022).

Table 2. Stationery Test in Level

Variabel	Trend and Intercept			Result
	Level			
	Prob	ADF/t-statistik	Mackinnon 10%	
IHPR	0.3254	-1.909045	-2.601424	Non-stasionery
Inf	0.4223	-1.704900	-2.600658	Non-stasionery
R	0.6763	-1.177622	-2.601424	Non-stasionery
PDB	0.7898	-0.866237	-2.602225	Non-stasionery
Wage	0.6710	-1.190504	-2.600658	Non-stasionery
IHPB	0.5355	-1.478831	-2.600658	Non-stasionery

Table 2 shows that the variable Residential Property Price Index (IHPR), inflation, interest rates, Gross Domestic Product (GDP), compensation index for permanent workers and construction daily workers and the Construction Wholesale Price Index (IHPB) are not

stationary at levels -intercepts. Based on these results (table 2), the stationarity test needs to be continued at the first different level. Stationarity test results at the first different level can be seen in table 3.

Table 3. Stationery Test in First Difference

Variabel	Trend and Intercept			Result
	First Different			
	Prob	ADF/t-statistik	Mackinnon 10%	
IHPR	0.0432	-2.990709	-2.601424	Stationery
Inf	0.0000	-8.374062	-2.601424	Stationery
R	0.0005	-4.624863	-2.601424	Stationery
PDB	0.0000	-10.88499	-2.602225	Stationery
Wage	0.0000	-5.364523	-2.601424	Stationery
IHPB	0.0000	-7.056668	-2.601424	Stationery

Based on the results of the stationarity test at the first different level in table 3, it can be said that all the variables used in this study were stationary. This can be seen based on the prob value of all variables that are smaller than alpha 5%.

Optimum Lag

In the VAR system, the autocorrelation problem can be eliminated by testing the optimum lag length. Several criteria are used to determine the optimal amount of lag including Hannan Quinnon (HQ). Akaike Information Criterion (AIC) and Schwarz Information Criterion (SC).

Table 4. Optimum Lag

Lag	LogL	LR	FPE	AIC	SC	HQ
0	503.6096	NA	1.00e-17	-22.11598	-21.87509	-22.02618
1	771.1134	451.7843	3.46e-22*	-32.40504	-30.71882*	-31.77643*
2	804.8076	47.92064	4.17e-22	-32.30256	-29.17101	-31.13515
3	849.6722	51.84353*	3.56e-22	-32.69654*	-28.11966	-30.99033

Based on table 4 the optimum lag used in the model is lag 1 according to the optimum lag length criteria (FPE. SC and HQ), this can be seen through the * sign which indicates the minimum value of each criterion.

Stability Test

Each variable has a modulus value which is an indicator of the stability of the VAR model. If the modulus value < 1 then it can be said that the VAR model is stable and if the modulus value is > 1 then it can be said that the VAR model is unstable (Hafly, 2016). Testing the stability of the VAR model can be done by calculating the roots of the polynomial function. The VAR model which has a modulus value < 1 makes the IRF and FEVD analysis to be carried out considered

valid. The estimation of the VAR model to be used in this study has stabilized as can be seen in table 5 where all modulus values are smaller than 1.

Table 5. Polynomial Test

Root	Modulus
0.970814	0.970814
0.864431	0.864431
0.816516	0.816516
0.625792	0.625792
0.267429 - 0.255161i	0.369629
0.267429 + 0.255161i	0.369629

Impulse Response Function (IRF)

IRF analysis is an analysis that describes the response of an endogenous variable to the influence of change/shock from other endogenous variables. In addition, the duration of the effect of change/shock from one variable to another until the influence disappears or returns to its balance point can also be seen through the analysis of the Impulse response function (IRF). The time period in the future after the change/shock occurs is depicted by the horizontal axis, while the response value will be depicted by the vertical axis. Fundamentally, it will be known whether the response of a variable is positive or negative to the shock of other variables. The figure 2 is the result of Impulse response function (IRF) analysis.

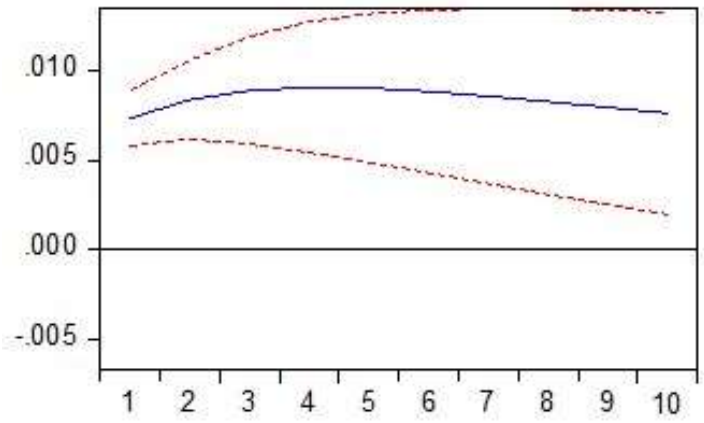

Figure 2. Response of LnIHPR to Shock of LnIHPR

Figure 2 shows the IHPR response to the IHPR variable shock itself. The response given at the beginning of the period was 0.007332 and continued to increase until in period 4 the response given was 0.009058. However, in the next period up to the 10th period the response given decreased. In general, the IHPR response is positive towards the shock of changes in the IHPR itself. This can be seen in the line graph in Figure 2, where the standard deviation value is

above the value 0. The increase in IHPR in this study is the effect of price movements in the previous period.

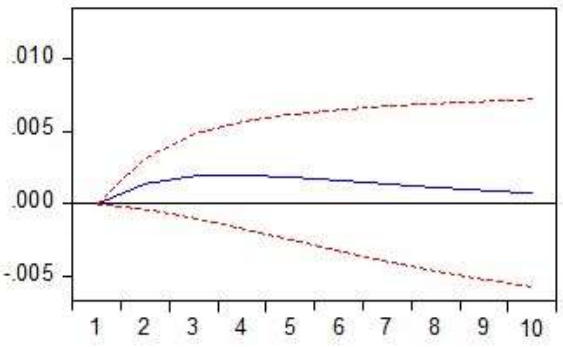

Figure 3. Response of LnIHPR to Shock Inf

Figure 3 is the graph of the IHPR response line for variable shock inflation. The IHPR has not responded in the first period which means changes or inflation shocks have not caused an increase in the IHPR. Then in the second period, the IHPR responded to an inflationary shock of 0.001392 and the response given continued to increase to 0.001986 in the fourth period. Then the response given decreased in the next period to 0.000741 in the tenth period. In general, the IHPR response to the inflation variable shock was positive. This shows that inflation has a direct or positive relationship with IHPR. The effect of rising inflation in this case will affect the total cost of building residential properties, which will result in high sales values.

This is in accordance with the definition of inflation, where the increase in the prices of goods and services in general and on an ongoing basis includes the prices of goods and services related to property prices. Therefore, the IHPR responds positively to the shock from inflation. This is in line with the results of Valerio Fanama's research (2019) which states that the inflation rate has a positive effect on IHPR, a one-unit increase in inflation can give an increase of 0.0056 IHPR units. The continuous increase in house prices makes it increasingly difficult for people to reach them. This is supported by the results of research by Panagiotis & Printiz (2015) which states that inflation has a positive relationship and has an effect of 9% on changes in IHPR.

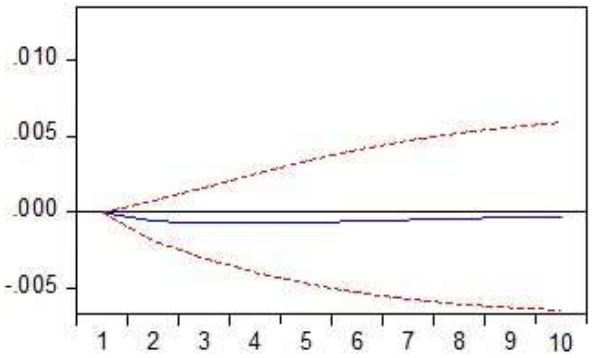

Figure 4. Response of LnIHPR to Shock of r

Figure 4 shows the line graph of the IHPR response to the shock given by the interest rate variable. IHPR began to respond to the shock of changes in interest rates in the second period, which was -0.000555 and continued to -0.000704 in the fourth period. Then in subsequent periods the response given moved towards the starting point where in the tenth period the response given was -0.000260. IHPR's response to the shock from interest rates was negative. This can be interpreted that if the interest rates set by Bank Indonesia (BI) are high, residential property prices will decrease and vice versa.

The benchmark interest rate is a reference or reference for banks in determining interest rates for both loan interest rates and deposit interest rates. If the reference interest rate set by BI decreases, it will be followed by lower interest rates for both loans and deposit rates at commercial banks. Lower interest rates can increase consumption as well as production. In this case. it can increase public interest or demand to buy or invest in residential property. This is in line with research by Shanmuga (2015) which states that statistically interest rates have a negative and significant effect on changes in IHPR. These results indicate that changes in the benchmark interest rate quickly or immediately will have a negative impact on house prices in this case the IHPR. This is supported by the results of Borowiecki's research (Borowiecki, 2016). where when the interest rate rises by 1% it will lower the house price level by 0.7%

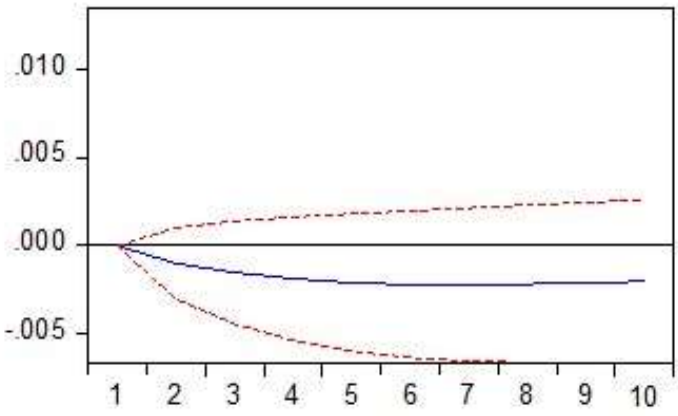

Figure 5. Response of LnIHPR to Shock of LnPDB

Figure 5 you can see the line graph of the IHPR response to the shock given by the PDB variable. Similar to interest rates, the IHPR responds negatively to shocks provided by GDP in each period except at the beginning of the period when the IHPR has not responded to shocks or changes in GDP. The highest response was -0.002201 in the seventh period. Based on figure 5, it can be seen that the IHPR responds negatively to GDP shocks because the standard deviation value is below 0. This means that a decrease in GDP will give an increase in IHPR. Shanmuga (2015) in his research found the same results, where GDP has a negative and significant correlation. These results indicate that if there is an increase in GDP, it will cause a decrease in

the house price level. The results in this study occurred as a result of the declining level of public consumption. The decline in the level of public consumption is reflected in low or declining inflation rates in several periods. Then the decline in interest rates is a policy of Bank Indonesia in increasing the level of public consumption

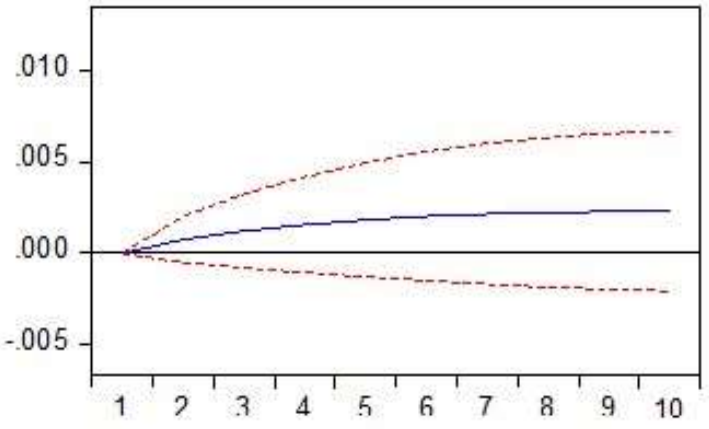

Figure 6. Response of LnIHPR to Shock of LnWage

Figure 6 shows the line graph of the IHPR response to the shock provided by the construction worker compensation index. In the first period, the IHPR did not respond to the construction worker compensation index shock. where the response was 0. Then in subsequent periods. the response always increased. up to the tenth period. which was 0.002304. Based on the standard deviation value above. it can be said that the IHPR responds positively to shocks or changes in the compensation index variable for permanent workers and construction daily. This indicates that an increase in the compensation index for permanent and daily construction workers gives an increase in IHPR and vice versa. This result is in line with the results of Fauzia's research (2019), where statistically wages have a positive and significant effect on changes in IHPR.

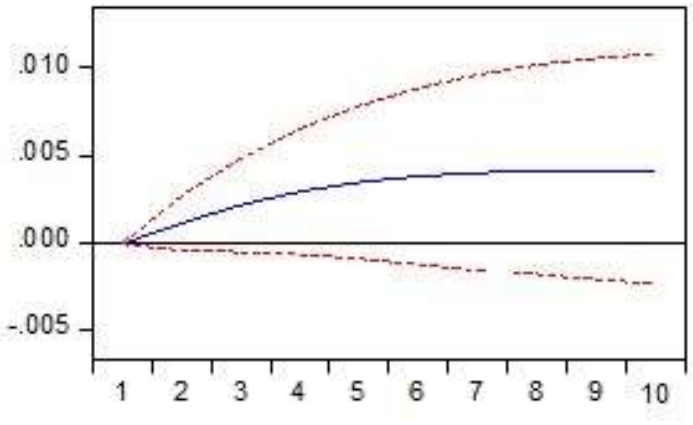

Figure 7. Response of LnIHPR to Shock of LnIHPB

Figure 7 shows the line graph of the IHPR response to the shock given by the construction Wholesale Price Index (IHPB). At the beginning of the period it was found that there was no response to the construction IHPB shock. However, in subsequent periods the response tended to increase up to the ninth period with an IHPR response of 0.004193 and decreased in the tenth period where the IHPR responded to 0.004188. The positive response given by the IHPR means that an increase in the construction IHPB can lead to an increase in the IHPR and vice versa. This is in line with the results of Borowiecki's research (2016) which states that an increase in building prices will increase house prices. where the effect of the increase will be transferred to buyers or in other words, buyers will bear the increase by paying for houses at higher prices.

Forecast Error Variance Decomposition (FEVD)

FEVD analysis is an analysis that describes the composition of a variable in influencing other variables by estimating the variance of the error. In addition, the Forecast error variance decomposition also illustrates the importance of each variable in the VAR system due to shock (Basuki & Prawoto, 2017). Table 6 is the result of the Forecast Error Variance Decomposition (FEVD) test which focuses on the contribution of variables that influence changes in IHPR.

Table 6. Result of Forecast Error Variance Decomposition

Period	S.E.	LnIHPR	Inf	r	LnPDB	LnWage	LnIHPB
1	0.007	100.00	0.000	0.000	0.000	0.000	0.000
2	0.011	95.981	1.502	0.238	0.773	0.436	1.068
3	0.014	91.843	2.555	0.361	1.484	0.929	2.825
4	0.017	88.433	2.977	0.401	2.098	1.403	4.685
5	0.020	85.704	3.040	0.401	2.602	1.850	6.400
6	0.023	83.510	2.938	0.384	2.992	2.262	7.911
7	0.025	81.724	2.771	0.359	3.279	2.639	9.225
8	0.026	80.248	2.585	0.333	3.484	2.980	10.36
9	0.028	79.008	2.404	0.309	3.630	3.287	11.35
10	0.030	77.954	2.238	0.287	3.731	3.563	12.22

Table 6 shows that the estimated error variance in the first period is 100% or wholly explained by the IHPR variable itself. In the following period, the IHPR still dominated the change in the IHPR itself, which was 95.98% followed by the inflation variable at 1.50% the IHPB Construction variable at 1.06%, the GDP variable at 0.77%, the worker compensation index variable at 0.43% and variable interest rate of 0.23%. Each variable in each period makes various contributions to the IHPR until the tenth period. The inflation variable and interest rate variable in the first period to the fifth period experienced an increase but in the sixth to tenth period it decreased. Unlike the GDP variable the worker compensation index and the construction WPI. which have increased every period until the tenth period. Based on the value of the variance error and the results of the analysis, it can be concluded that changes in the IHPR

if sorted by the magnitude of the influence the following sequence is obtained: 1. Construction WPI, 2. GDP, 3. employee compensation index, 4. Inflation, 5. Interest rates.

Conclusion

Based on the results of the analysis that has been carried out in this study. The IHPR responds positively to shocks to changes in inflation. The index of compensation for permanent workers and the construction daily and the construction WPI. All three contributed 17.9% to changes in IHPR. House prices that are continuously increasing can cause a property bubble and make it more difficult for people to reach it. Therefore, the author's advice in this regard is for Bank Indonesia to continue to maintain inflation stability with various policies. One of which is by setting a reference interest rate. In addition to stabilizing the inflation rate, the contribution in this study estimate that the IHPR responds negatively to shocks to changes in the benchmark interest rate, which means that an increase in the benchmark interest rate can reduce the price level of residential houses.

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