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Measuring the response of the property price index to monetary policy shock: Evidence from emerging market economies

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ABSTRACT

This study examined the response of the residential property price index (RPPI) to monetary policy shocks. The analysis utilized a panel vector autoregressive (VAR) estimation covering the markets of 12 emerging countries over a quarterly period from 2000 Q1 to 2022 Q4. In a dynamic data model, the panel VAR estimation could be biased when the coefficients of the endogenous variables differ across countries. The results of the pooling assumption showed that the models contain heterogeneity among samples, indicating the need for a solution to address this problem. Consequently, a mean group estimation for the panel VAR was performed to resolve the heterogeneity issue. The residential property price index negatively responded to changes in housing loan (HL) and central bank (CB) interest rates. In contrast, it positively responded to changes in inflation, gross domestic product, and population. This research provided policymakers with recommendations on emerging market demand. To successfully interfere in the property market, policymakers must pay greater attention to formulating monetary policy, notably central bank interest rates. A steady central bank policy rate prevents growth in the property sector. Future research should include macroprudential policy as an endogenous component in the model.

Contribution/Originality: We showed that the response of the RPPI to monetary policy shock is heterogenous in emerging countries; therefore, a mean group estimation was applied to the panel VAR to solve a heterogeneity problem in the model.

1. INTRODUCTION

During the late 1990s, the housing market became a significant pillar of the global economy. However, it remains a volatile sector (Wu, Chen, Pan, Gallent, & Zhang, 2020), which is an issue of significant importance for central banks (CBs). According to Ryan-Collins (2021), CBs use monetary policy to reduce risk in housing credit. Changes in CB policy interest rates directly impact bank lending activities, including the supply of housing credit (Anwar, Suhendra, Ginanjar, Purwanda, & Kholishoh, 2022; Ferrero, 2015). The reduction of the policy rate to loosen monetary policy has a direct effect on lowering the interest rate and increasing housing credit. However, high housing credit expansion might lead to a property price boom. Bank credit is also influenced by real economic performance.

During the expansion phase, banks tend to increase the supply of housing credit to fulfill higher demand but may be less aware of credit risks. In the contractionary phase, banks tend to reduce credit distribution due to declining demand for credit (Favara & Imbs, 2015).

The relationship between property prices and bank credit is well-established and has important economic implications. The availability of credit provided by banks can increase demand for housing and the associated prices. This is because lower lending rates create an incentive for consumers to seek liquidity (Bhutta, Dokko, & Shan, 2017). Housing prices can also affect housing credit, creating a causal relationship between the property market and credit. Furthermore, the correlation between property prices and bank credit signals a downturn in the financial market (Anwar, 2021; Brunnermeier, Rother, & Schnabel, 2020). Fluctuations in housing prices can also influence banks' lending practices. Meanwhile, the value of banks increases with their assets and property prices to boost lending and decrease the reserve ratio. There is a tendency for bank lending to decrease due to a decline in housing values. This is because banks may experience a reduction in the value of their assets and potentially incur losses when homes are repossessed.

According to Hartmann (2015), CBs also employ a macroprudential policy to limit risk in the housing market. Since the financial crisis in 2008, macroprudential policy has become a growing concern. Even though many countries have implemented macroprudential instruments since the 1990s (Anwar & Suhendra, 2020), the policy has continued to gain popularity. The loan-to-value (LTV) ratio policy is the most relevant to housing credit control among these instruments. The ratio policy compares the value that consumers can borrow using their property as collateral. By limiting the amount borrowed by consumers, the LTV ratio policy can prevent the growth of property loans in the long term and mitigate rising house prices. The aim is to anticipate or prevent the issuance of credit defaults, which could impact the financial system's stability and the real economy. Empirical research has indicated that the application of a tight macroprudential policy by applying the LTV can reduce property prices. According to Hartmann (2015); Vandenbussche, Vogel, and Detragiache (2015); Zhang and Zoli (2016); Akinci and Olmstead-Rumsey (2018); Galati and Moessner (2018) and Kelly, McCann, and O'Toole (2018), macroprudential policy has a significant impact in restraining property price bubbles. Therefore, the LTV ratio policy remains a relevant instrument for CBs in regulating credit markets and ensuring financial system stability.

Prior empirical studies investigated the effect of CB rates on the house price index. For instance, Garriga, Kydland, and Šustek (2017); Robstad (2018); Ume (2018); Alpanda and Zubairy (2019) and Fischer, Huber, Pfarrhofer, and Staufer-Steinnocher (2021) found that the CB rate has a positive effect on the house price index. However, these studies have certain limitations regarding the two concepts. Firstly, they primarily focused on developed countries, and secondly, the cross-country heterogeneity of the CB rates on the house price index was not well explained. These issues have resulted in a research gap regarding the markets in emerging economies. Therefore, the main motivation of this study is to fill this gap. Empirical evidence was provided on the responses of the house price index to a CB rate shock, and a panel VAR was estimated on the market of 12 emerging economies that have implemented the LTV ratio. This study focuses on the markets of emerging economies because the effect of monetary policy on macroeconomic variables differs among these countries, which may be caused by financial structures. Meanwhile, the heterogeneity effect of the corresponding variables was estimated in the market of emerging economies. The panel VAR model was also checked to identify the heterogeneity effect of the CB rate on the house price index. In this study, the Chow and Roy-Zellner tests were performed according to Baltagi and Baltagi (2008). The mean group estimation developed by Pesaran and Smith (1995) was used to investigate the average of CB rate shocks on housing loans. Therefore, a VAR model was estimated for each country, and the coefficient of the shock was determined to provide a set of impulse response functions.

The results showed that the Residential Property Price Index (RPPI) experiences an increase in response to an initial rise in the CB rate from the first to the fifth period following the shock. This implies that a tightening of monetary policy results in an increase in the RPPI. The analysis indicated a similar pattern of the RPPI's response to changes in the housing loan rate and economic growth. This is positive in the initial period but turns negative after the fifth period following the shock. In contrast, shock to inflation and population growth is associated with a negative response in the RPPI. The results indicate that higher inflation and population growth tend to be associated with a lower RPPI.

2. LITERATURE REVIEW

Over the past two decades, the link between monetary policy and property prices has garnered significant interest in macroeconomic policy research. This investigates the effects of property price bubbles and credit booms on the occurrence of financial crises. In particular, Byrne (2020) noted that rising property prices often lead to increased bank credit to the housing sector as collateral. However, the resilience of the banking system plays a critical role in mitigating the impact of property price bubbles on the occurrence of a financial crisis. According to Mieg (2022), the 2008 global financial crisis was initiated by a housing price bubble that caused systematic risk. The increase in housing prices was driven by strong demand and a property price boom.

Luciani (2015) used a structural dynamic factor model estimation on a panel of 109 quarterly variables in the US from 1982 to 2010 to investigate the link between monetary policy and the housing market. The policy of the Federal Reserve between 2002 and 2004 was marginally expansionary and had an insignificant influence on the latest housing cycle. Similarly, Ume (2018) examined the impact of monetary policy on the US housing market using a structural VAR model on data from 1975 Q1–2006 Q4. The study found that housing prices negatively responded to monetary policy shock. Furthermore, Eugenio Cerutti, Hale, and Minoiu (2015) emphasized that property price bubbles are a reliable indicator of financial crises. The study on financial problems in the market of five developed and fifteen developing countries showed that crises are often preceded by rapid credit expansion and increased stock prices. Before the crisis, property and other asset prices often increased sharply, leading to a decline in stock and property prices. An increase followed this decline in bad loans, defaults, and tight liquidity of the interbank market. A financial crisis also increased systematic risks in banking, institutions, and financial needs. Meanwhile, credit expansion was also observed in many countries, including Japan, Latin America, and Europe.

Robstad (2018) conducted an analysis using Bayesian structural VAR models to investigate house prices and household credit reactions to monetary policy shock in Norway between 1994 Q1 and 2013 Q4. It was found to significantly impact house prices, while the response to a shock appears minimal for household credit. Fischer et al. (2021) utilized the factor-augmented vector autoregressive (FAVAR) model to examine the impact of monetary policy on house prices in four distinct regions in the United States. The results indicated that CB monetary policy is more effective in influencing house prices in regions with low supply elasticities.

Furthermore, He, Cai, and Hamori (2018) investigated the effect of housing credit interest rates on house prices. The results showed that the connection between house prices and bank loans is significant and time-varying. The house prices on all bank loans are higher than the reverse effect, while the reciprocal impact varies between the demand and supply sides. Macroeconomic variables also have an impact on property prices. Kuang and Liu (2015) examined the impact of inflation on house prices and found that the result is greater than in the reverse position. The study stated that house prices are an effective safeguard against inflation. Household income and interest rates positively and negatively affect house prices, while economic growth has a smaller impact on inflation than house prices.

3. ECONOMETRIC METHODOLOGY AND DATA

3.1. Econometric Methodology

This study examined the effects of CB policy rate shock on residential property prices in developing countries. A panel vector autoregressive (VAR) model was proposed by Canova and Ciccarelli (2013) and implemented by Anwar and Suhendra (2023) to address this issue. The panel VAR model analyzes the interdependence among key economic factors, such as CB interest rate, stock trading activity, and economic growth, with six endogenous variables, which include residential property prices, CB rate, HL rate, economic growth, inflation, and population. Additionally, the LTV ratio was considered as an exogenous variable.

$$RPPI_{it} = \alpha_{1,i} + \sum_{j=1}^{k} a_{1,j}\ RPPI_{i,t-j} + \sum_{j=1}^{k} b_{1,j}\ CB\ Rate_{i,t-j} + \sum_{j=1}^{k} c_{1,j}\ HL\ Rate_{i,t-j} + \sum_{j=1}^{k} d_{1,j}\ EG_{i,t-j} + \sum_{j=1}^{k} e_{1,j}\ INF_{i,t-j} + \sum_{j=1}^{k} f_{1,j}\ POP_{i,t-j} + g_{1,i}\ POP_{i,t} + U_{1,it} \quad (1a)$$

$$CB\ Rate_{it} = \alpha_{2,i} + \sum_{j=1}^{k} a_{2,j}\ RPPI_{i,t-j} + \sum_{j=1}^{k} b_{2,j}\ CB\ Rate_{i,t-j} + \sum_{j=1}^{k} c_{2,j}\ HL\ Rate_{i,t-j} + \sum_{j=1}^{k} d_{2,j}\ EG_{i,t-j} + \sum_{j=1}^{k} e_{2,j}\ INF_{i,t-j} + \sum_{j=1}^{k} f_{2,j}\ POP_{i,t-j} + g_{2,i}\ POP_{i,t} + U_{2,it} \quad (1b)$$

$$HL\ rate_{it} = \alpha_{3,i} + \sum_{j=1}^{k} a_{3,j}\ RPPI_{i,t-j} + \sum_{j=1}^{k} b_{3,j}\ CB\ Rate_{i,t-j} + \sum_{j=1}^{k} c_{3,j}\ HL\ Rate_{i,t-j} + \sum_{j=1}^{k} d_{3,j}\ EG_{i,t-j} + \sum_{j=1}^{k} e_{3,j}\ INF_{i,t-j} + \sum_{j=1}^{k} f_{3,j}\ POP_{i,t-j} + g_{3,i}\ POP_{i,t} + U_{3,it} \quad (1c)$$

$$EG_{it} = \alpha_{4,i} + \sum_{j=1}^{k} a_{4,j}\ RPPI_{i,t-j} + \sum_{j=1}^{k} b_{4,j}\ CB\ Rate_{i,t-j} + \sum_{j=1}^{k} c_{4,j}\ HL\ Rate_{i,t-j} + \sum_{j=1}^{k} d_{4,j}\ EG_{i,t-j} + \sum_{j=1}^{k} e_{4,j}\ INF_{i,t-j} + \sum_{j=1}^{k} f_{4,j}\ POP_{i,t-j} + g_{4,i}\ POP_{i,t} + U_{4,it} \quad (1d)$$

$$INF_{it} = \alpha_{5,i} + \sum_{j=1}^{k} a_{5,j}\ RPPI_{i,t-j} + \sum_{j=1}^{k} b_{5,j}\ CB\ Rate_{i,t-j} + \sum_{j=1}^{k} c_{5,j}\ HL\ Rate_{i,t-j} + \sum_{j=1}^{k} d_{5,j}\ EG_{i,t-j} + \sum_{j=1}^{k} e_{5,j}\ INF_{i,t-j} + \sum_{j=1}^{k} f_{5,j}\ POP_{i,t-j} + g_{5,i}\ LTV_{i,t} + U_{5,it} \quad (1e)$$

$$POP_{it} = \alpha_{6,i} + \sum_{j=1}^{k} a_{6,j}\ RPPI_{i,t-j} + \sum_{j=1}^{k} b_{6,j}\ CB\ Rate_{i,t-j} + \sum_{j=1}^{k} c_{6,j}\ HL\ Rate_{i,t-j} + \sum_{j=1}^{k} d_{6,j}\ EG_{i,t-j}$$
$$+ \sum_{j=1}^{k} e_{6,j}\ INF_{i,t-j} + \sum_{j=1}^{k} f_{6,j}\ POP_{i,t-j} + g_{6,i}\ LTV_{i,t_{i,t}}$$
$$+ U_{6,it} \quad (1f)$$

The model for each country is:

$$y_{it} = Z_i\, \delta_i + u_i \quad \text{where i = 1,2,...,N} \quad (2)$$

Where $y_i' = (y_{i1}, \ldots, y_{iT}), Z_i = [lT, X_i]$ and $X_i\ is\ T\ x\ K.\ \delta_i'\ is\ 1\ x\ (K+1), u_i\ is\ Tx\ 1.\ \delta_i'$ varies for each individual equation.

The restricted model is given by:

$$y = Z\,\delta + u \quad (3)$$

Where $Z' = (Z_1', Z_2', \ldots, Z_N'),\ \ u' = (u_1', u_2', \ldots, u_N')$

The null hypothesis of the poolability test is:

$$H_0\!: \delta_i = \delta, against\ H_1\!: \delta_i \neq \delta \quad (4)$$

Equation 4 presents the hypothesis of the poolability test. The null hypothesis is that the coefficients of the explanatory variables are the same for all cross-sections, while the alternative hypothesis is that the coefficients are different.

The Chow and Roy–Zellner tests proposed by Baltagi and Baltagi (2008) were used in this study to look into the model's heterogeneity coefficients.

These models were found to contain heterogeneity among country samples, which can be solved by performing the mean group estimation procedure proposed by Pesaran and Smith (1995). This was used by Anwar and Suhendra (2023) to obtain average cross-sectional responses. Specifically, let γ_kl^((i)) be a vector of size h x 1 containing the responses of variable l to an impulse in k over a certain number of periods in country i. The multi-country mean group (MG) responses of variable l to an impulse in variable k over h periods are computed by considering the average of the individual country coefficients.

$$MG_{kl} = \frac{1}{N} \sum_1^N \gamma_{kl}^{(i)} \quad (5)$$

Equation 5 explains that the MG response is the average of individual country responses.

3.2. Data

This study investigated the interrelationship between several key economic indicators, including RPPI, central bank (CB) rate, housing loan (HL) rate, economic growth, inflation, and population, for a total of 12 developing countries. These countries are Indonesia, Thailand, India, Brazil, China, Turkey, South Korea, Saudi Arabia, Poland, Romania, the Czech Republic, and Hungary. Furthermore, the dataset comprises seven variables, including RPPI, CB rate, HL rate, economic growth, inflation, and population. These are endogenous variables, while LTV is an exogenous variable. The dataset covers quarterly data from the first quarter of 2000 through to the fourth quarter of 2022. Tables 1 and 2 provide a detailed description of the data.

The descriptive statistics in Table 2 indicate that the average RPPI from 2000 Q1 to 2022 Q4 was 144.91, with a minimum and maximum of 105.78 and 3602.30, respectively. The average CB rate was 6.1477, with minimum and maximum rates of 0.0500 and 54.0000, respectively. The average mortgage interest rate was 3.2609%, ranging from 0.3460 to 17.023. The average economic growth was 7.2053, with minimum and maximum scores of -4.3161 and 13.451. The average inflation rate was 1.2915, with a minimum and maximum of -0.6176 and 14.029. The average population growth was 0.6855, with minimum and maximum values of -0.9818 and 3.0949, while LTV ranged from 0 to 1.

Table 1. Variable definitions.

Variable	Abbreviation	Measurement	Sources	Period
Residential property price index	RPPI	An index measuring the rate at which the price of residential properties changes over time	Bank for International Settlements	2000Q1–2022Q4
Central bank policy rate	CB rate	Central bank interest rate as monetary policy instrument	International Financial Statistics	2000Q1–2022Q4
Housing lending rate	HL rate	The interest rate for housing credit	Bank for International Settlements	2000Q1– 022Q4
Loan to value	LTV	This has a value of 1 when the LTV is used, and 0 otherwise	Cerutti, Claessens, and Laeven (2017)	2000Q1– 022Q4
Economic growth	EG	An increase in the real GDP	World Development Indicators (WDI)	2000Q1–2022Q4
Inflation	INF	The change in the current consumer price index	WDI	2000Q1–2022Q4
Population	POP	Number of people in a country	WDI	2000Q1–2022Q4

Table 2. Descriptive statistics.

Variable	Mean	Std. deviation	Min.	Max.
RPPI	144.9	109.8	105.7	602.3
CB rate	6.147	5.721	0.050	54.00
HL rate	3.260	3.471	0.346	17.02
EG	7.205	1.767	-4.315	13.45
INF	1.291	1.777	-0.617	14.02
POP	0.685	0.888	-0.981	3.094
LTV	0.551	0.497	0	1

4. EMPIRICAL FINDINGS

4.1. Panel Unit Root Tests

This study used panel unit root tests to check the stationary series of the RPPI, CB rate, HL rate, LTV, economic growth, inflation, and population, as shown in Table 3. The results illustrate that the null hypothesis is rejected at the 5% significance level, since the variables are I(0).

Table 3. Panel unit root tests.

Series	LLC	Breitung	IPS
RPPI	-11.53***	-3.752***	-3.958***
CB rate	-2.096**	-2.080***	-4.261***
HL rate	-5.094***	-2.175**	-2.307***
EG	-4.939***	-4.080***	-2.871***
INF	-4.901***	-3.263***	-6.251***
POP	-13.21***	-3.044***	-4.535***

Note: The symbols ** and *** denote statistical significance at the 5% and 1%, respectively.

4.2. Panel VAR Estimation

4.2.1. Full Sample Countries Panel VAR

By using a panel VAR, the model is anticipated to investigate the interactions between the RPPI, CB rate, HL rate, economic growth, inflation, and population. As indicated in Table 4, lag 4 is the most suitable lag based on the Akaike information criterion.

Table 4. PVAR regression.

Variables	RPPI	CB rate	HL rate	EG	INF	POP
RPPI (-1)	1.291*** (0.046)	-0.007 (0.012)	-0.006** (0.003)	0.153** (0.077)	0.005 (0.003)	0.000 (0.000)
RPPI (-2)	0.145** (0.07)	0.007 (0.021)	0.005 (0.005)	-0.129 (0.127)	-0.009*** (0.003)	0.000 (0.000)
RPPI (-3)	-0.331*** (0.078)	0.022 (0.021)	0.007 (0.005)	-0.164 (0.130)	0.004 (0.005)	-0.000 (0.000)
RPPI (-4)	-0.107** (0.047)	-0.023 (0.012)	-0.006** (0.003)	0.131* (0.078)	-0.001 (0.003)	0.000 (0.000)
CB rate (-1)	-0.024 (0.165)	1.270*** (0.044)	0.104*** (0.01194)	0.325 (0.275)	0.090 (0.012)	0.000 (0.000)
CB rate (-2)	-0.143 (0.262)	-0.387*** (0.071)	-0.056 (0.018)	-0.314 (0.437)	-0.082** (0.019)	-0.000 (0.000)
CB rate (-3)	0.113 (0.267)	-0.273*** (0.072)	-0.029* (0.019)	-0.250 (0.446)	-0.003 (0.020)	0.000 (0.000)
CB rate (-4)	-0.148 (0.174)	0.291*** (0.047)	-0.004 (0.012)	0.354 (0.290)	0.012 (0.013)	0.000 (0.000)
HL rate (-1)	-0.474 (0.700)	1.108 (0.190)	1.401*** (0.050)	0.818 (1.166)	-0.036 (0.052)	0.000 (0.000)
HL rate (-2)	-0.119 (1.187)	-1.065 (0.323)	-0.305*** (0.085)	-0.870 (1.980)	0.009 (0.088)	-0.000 (0.001)
HL rate (-3)	0.548 (1.190)	-0.250 (0.323)	-0.152* (0.086)	-0.584 (1.984)	0.045 (0.088)	-0.000 (0.001)
HL rate (-4)	0.368 (0.650)	0.291 (0.177)	0.037 (0.047)	0.679 (1.085)	-0.030 (0.048)	0.000 (0.000)
EG (-1)	0.016 (0.028)	0.002 (0.007)	-0.001 (0.002)	1.2415** (0.048)	-0.003 (0.002)	-0.000 (0.000)
EG (-2)	-0.008 (0.046)	-0.006 (0.012)	-0.001 (0.003)	-0.253** (0.076)	0.001 (0.003)	0.000 (0.000)
EG (-3)	-0.004 (0.046)	0.009 (0.012)	0.001 (0.003)	-0.162** (0.076)	0.002 (0.003)	0.000 (0.000)
EG (-4)	0.0156 (0.028)	-0.007 (0.007)	-0.001 (0.002)	-0.051 (0.047)	-0.002 (0.002)	-0.000 (0.000)
INF (-1)	0.479 (0.687)	0.294* (0.187)	-0.137 (0.049)	-1.821 (1.145)	1.251*** (0.051)	0.000 (0.000)
INF (-2)	-0.006 (1.119)	0.119*** (0.304)	0.056 (0.081)	1.333 (1.866)	-0.246*** (0.083)	0.000 (0.001)
INF (-3)	-0.766 (1.099)	-0.486* (0.299)	0.055 (0.079)	0.105 (1.832)	-0.195)) (0.082)	0.000 (0.001)
INF (-4)	0.470 (0.659)	0.264 (0.179)	-0.032 (0.047)	-0.177 (1.099)	0.045 (0.049)	-0.000 (0.000)
POP (-1)	3.564 (36.151)	5.031 (9.836)	1.326 (2.615)	29.98 (60.26)	3.715 (2.702)	1.995*** (0.044)
POP (-2)	-39.83 (81.797)	-13.85 (22.25)	-1.776 (5.916)	-24.95 (136.3)	-4.265 (6.114)	-0.748*** (0.100)
POP (-3)	64.71 (81.185)	13.86 (22.09)	-0.189 (5.872)	-14.66 (135.3)	-1.347 (6.068)	-0.540*** (0.099)
POP (-4)	-28.04 (35.38)	-4.914 (9.628)	0.656 (2.559)	10.71 (58.98)	1.944 (2.645)	0.293*** (0.043)
LTV	0.594 (0.333)	0.156 (0.090)	-0.033 (0.024)	-0.658 (0.556)	-0.061 (0.024)	-0.000 (0.000)

Note: The symbols *,** and *** denote statistical significance at the 10%, 5% and 1%, respectively.

RPPI lag 1 positively influences RPPI with a coefficient of 1.2910, which indicates an increase in the previous period by 1% at 1.291009. The test results also showed a positive effect from RPPI lag 1 on economic growth, with a coefficient of 0.152369. Lag 1 positively influences the CB, HL, and inflation rates, with coefficients of 1.270379, 0.104622, and 0.090488, respectively. Furthermore, lag 4 positively affects the CB rate, with a coefficient of 0.291432. Lag 1 positively affects the CB and HL rates, with coefficients of 1.108545 and 1.400798. Furthermore, the RPPI and economic growth lag 1 has a positive effect, with coefficients of 0.153269 and 1.241504. The CB rate at lag 1 and inflation have a positive effect, with coefficients of 0.090488 and 1.251559. Population growth in lags 1 and 4 has a positive effect, with respective coefficients of 1.995278 and 0.293523.

4.2.2. Poolability Test for Panel VAR

Table 5 evaluates the panel VAR regression using the pooled least squares (POLS) method. In a dynamic panel, the POLS estimator is known to be possibly biased when the coefficients on the endogenous variables fluctuate between nations. Baltagi and Baltagi (2008) proposed the Chow and Roy–Zellner tests to evaluate the heterogeneity coefficients in the model. In the present statistical analysis, the null hypothesis states that the coefficients exhibit similarity across all nations under consideration. In contrast, the alternative hypothesis postulates that the coefficients display dissimilarity between countries. According to the Chow and Roy–Zellner tests, this hypothesis is rejected, since the panel VAR coefficients model is heterogeneous.

Table 5. Poolability test.

Test	RPPI	CB rate	HL rate	EG	INF	POP
Chow test						
F-statistic	40.83***	289.42***	562.52***	9.84***	71.52***	642.01
Probability	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Df	[44, 470]	[45, 470]	[45, 470]	[45, 470]	[45, 470]	[45, 470]
Roy–Zellner test						
F-statistic	1796.38***	13023.96.***	25313.62***	442.84***	3218.47***	28890.57
Probability	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Df	[44]	[45]	[45]	[45]	[45]	[45]

Note: The symbols and *** denote statistical significance at 1%.

4.2.3. Mean Group for Panel VAR

The interaction between the RPPI, CB rate, HL rate, economic growth, inflation, and the population is explored by examining the impulse response function (IRF). Figure 1 shows the IRF over 20 quarters for a one standard deviation shock implied by the panel VAR regression using the mean group estimator. The response of the RPPI to CB rate shock is different. The RPPI's response until period 3 was positive and peaked with the highest value of 0.218066%. Therefore, the RPPI is directly proportional to CB rate shock. The sharp decrease in response occurred during period 7, with a value of 0.13764%, which is significantly higher than the shock response observed in others. This suggests that an increase in the CB rate would result in a corresponding decrease in the RPPI. However, after experiencing a decrease in period 15, there was an increase in positive responses. There was a shock response of 0.19066%, which decreased in the last period to a negative response of 0.14602%, though the value was not as high as in the previous period.

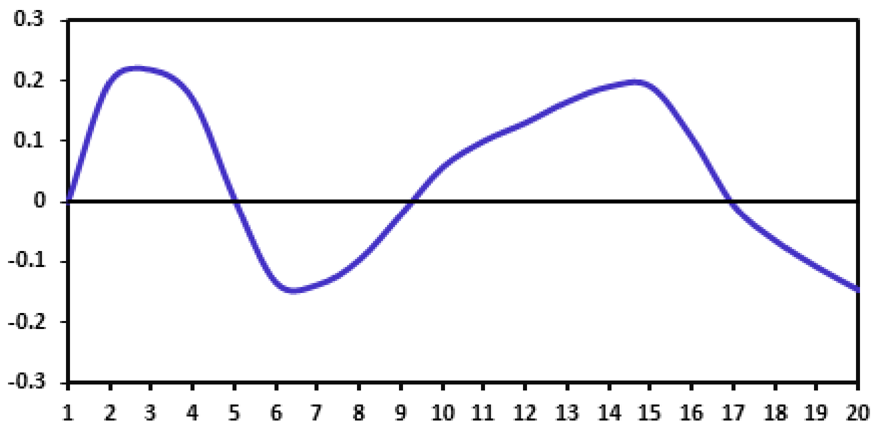

Figure 1. Mean group impulse response function (MGIRF) showing the response of the RPPI to central bank rate shock.

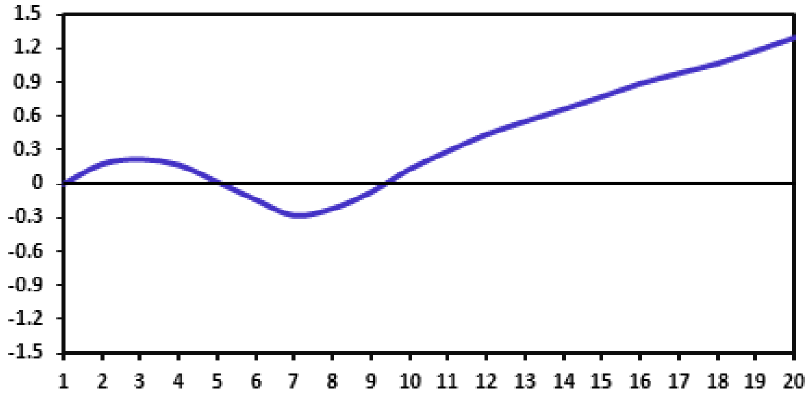

Figure 2. MGIRF showing the response of the RPPI to housing loan rate shock.

Figure 2 shows the RPPI's response to HL rate shock. The results showed that the RPPI experienced a positive response in period 2 of 0.219721%, which increases with HL rate shock. However, there was also a decrease in response during period 7 of 0.28066%. This indicates that an increase in HL rate shock would decrease the RPPI response. Subsequently, in period 20, there was an increase in the response of 1.297748%.

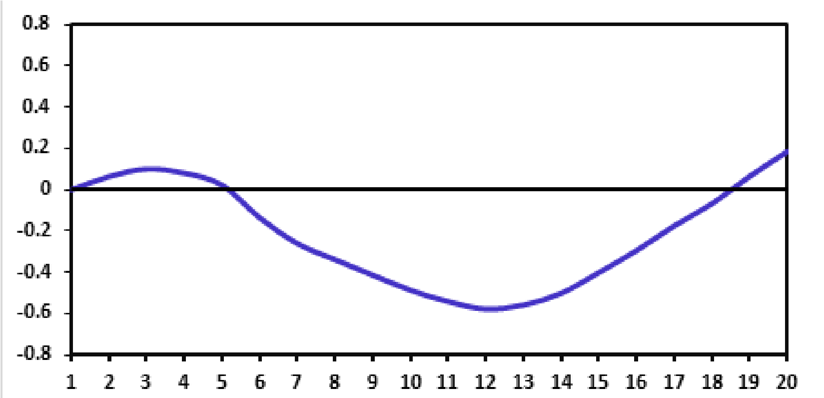

Figure 3. MGIRF showing the response of the RPPI to economic growth shock.

Figure 3 shows the impulse response function of the RPPI to economic growth shock. These results showed that the RPPI response experienced a positive reaction to economic growth shock in period 3 of 0.100594%. This means that the response from the RPPI increases with economic growth. In addition, there was a decrease in response during period 12 of -0.57814. This means that an increase in economic growth shock would decrease the RPPI response. There was also an increase of 0.1856% in positive responses of the RPPI to economic growth shock until period 20.

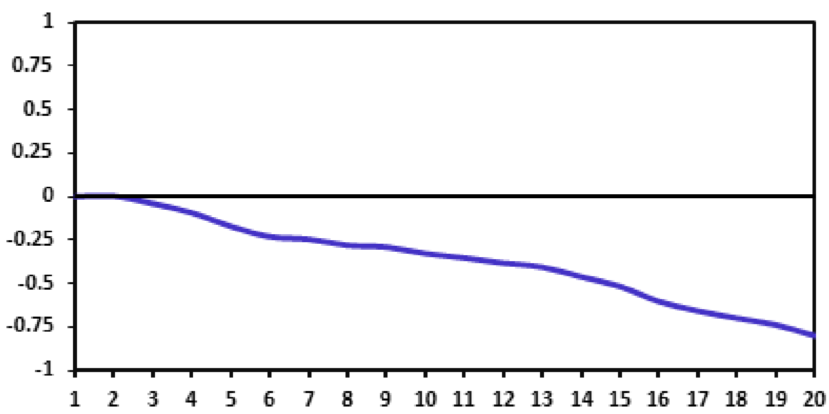

Figure 4. MGIRF showing the response of the RPPI to inflation shock.

Figure 4 shows the response of the RPPI to inflation shock. The only movement observed in the RPPI response to a positive inflation shock was from period 1 to period 2, which increased by 0.002352%. This means that inflation increased with the RPPI response in the first period. However, from period 2 to the last, the response was negative, or declined, and reached -0.80151% in the last period. These conditions indicate that an increase in the inflation variable results in a decrease in the RPPI variable.

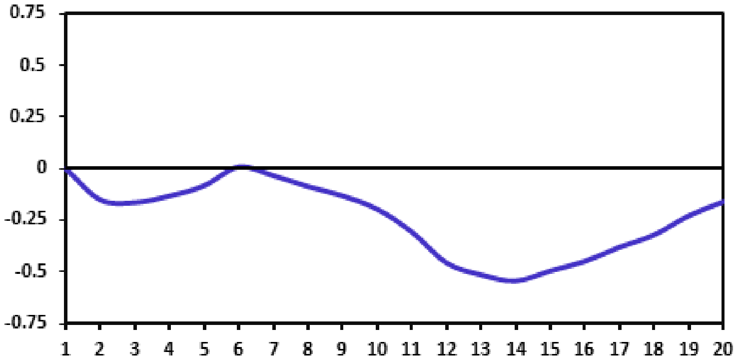

Figure 5. MGIRF for the response of the RPPI on population growth shock.

Figure 5 presents the response of the RPPI to population growth shock, indicating a fluctuating pattern. There was a decline in the RPPI response, decreasing from periods 1 to 5 by -0.08287%. This suggests that an increase in population growth positively affected the RPPI response. There was an increase in the RPPI response in period 6, which was the most substantial increase, at 0.007993%, resulting from population growth. However, this increase only lasted for one period, and the RPPI response decreased to -0.54347% from periods 7 to 14. This indicates that an increase in population growth led to a decrease in the RPPI. There was another increase in the RPPI response, reaching -0.15962%, from the 14th to the last period.

4.2.4. Forecast Error Variance Decompositions (FEVD)

Table 6 shows the FEVD results as well as the contribution of the factors to the variance. Panel 1 demonstrates that stock trading innovations account for roughly 100% of the variance in predicting mistakes over a four-quarter horizon. Furthermore, at the 20-quarter horizon, the contribution of innovations to the stock index reduces to 99%.

Table 6. FEVD of the RPPI.

Period	RPPI	CB rate	HL rate	Economic growth	Inflation	Population growth
1	100	0	0	0	0	0
2	91.616	2.685	2.538	0.861	0.946	1.352
3	84.470	7.152	3.275	1.746	1.377	1.977
4	78.944	8.527	4.996	2.321	2.527	2.681
5	76.493	7.975	6.493	3.303	2.775	2.959
6	72.369	8.038	8.421	4.133	3.441	3.594
7	68.697	8.157	10.876	4.814	3.557	3.896
8	65.057	8.783	11.781	5.663	3.907	4.806
9	62.420	9.343	12.446	6.152	4.286	5.349
10	59.736	10.157	11.746	6.826	4.595	6.936
11	57.763	10.652	11.835	7.296	4.676	7.775
12	56.468	10.785	12.123	7.469	4.747	8.405
13	55.911	10.825	12.325	7.601	4.714	8.621
14	55.593	10.755	12.475	7.721	4.698	8.755
15	55.530	10.826	12.570	7.643	4.668	8.760
16	55.793	10.810	12.620	7.385	4.615	8.773
17	55.872	10.890	12.628	7.209	4.577	8.820
18	55.839	10.919	12.697	7.121	4.530	8.891
19	55.753	11.034	12.869	6.942	4.483	8.916
20	55.610	11.109	13.143	6.723	4.426	8.986

Table 6 shows the FEVD of the RPPI. The largest contribution of the RPPI was 91.61% in the 4th quarter and had decreased to 76.49% in the 20th quarter. The contribution from other variables to the RPPI shows numbers that tend to be small but have increased from quarter 4 to quarter 20. Furthermore, the contribution from the CB rate was between 8.5279% and 11.1098% in quarters 4 to 20. The contribution of the HL rate to the RPPI was between 4.9969% and 13.1431% in quarters 4 to 20. The contribution of economic growth to the RPPI in quarters 4 to 20 was 2.3215 to 6.7233, while inflation increased from 2.5279% in quarter 4 to 4.4267% in quarter 20. Finally, population growth increased from 2.6813 in quarter 4 to 8.9866 in quarter 20.

4.3. Discussion

This study showed that a tight monetary policy, achieved by increasing the CB policy rate, increased the RPPI. This suggests that residential house prices can also increase with the CB interest rate. Meanwhile, CB policy and credit market rates are directly proportional, reducing the demand for borrowing from the bank. The results align with the liquidity preference of money theory (Tobin, 1947), where changes in the interest rate are related to the demand for money; the demand for money increases due to a rise in aggregate expenditure. This is consistent with Ume (2018); Alpanda and Zubairy (2019) and Fischer et al. (2021), who also reported a positive correlation between the CB policy rate and the RPPI.

Furthermore, the RPPI positively responded to the HL interest rate during the first five periods. This implies that the HL interest rate and the RPPI are directly proportional. Because lending is one of the primary activities of commercial banks, especially in emerging markets, a negative correlation exists. Therefore, the increase in lending interest rates can increase banks' revenues by providing sufficient financial resources to improve their housing market services and credit supply capabilities. This enhances the efficacy of the housing market because interest rates are positively correlated with prices. This result is in line with Zhu, Betzinger, and Sebastian (2017); Gasparėnienė, Remeikienė, and Skuka (2016); Kuang and Liu (2015) and Tse, Rodgers, and Niklewski (2014).

The impulse response indicates that the housing loan (HL) rate elicited a negative response from periods 5 to 9. Theoretically, a negative link between the HL interest rate and the RPPI is established. This shows that an increase in the interest rate can decrease the demand for HLs, leading to a decline in the RPPI. The result is consistent with He et al. (2018); Cohen and Karpaviciute (2017); Xu (2017); Cerutti et al. (2015); Engsted and Pedersen (2014) and Simo-Kengne, Balcilar, Gupta, Reid, and Aye (2013), who suggested a negative correlation between mortgage interest rates and the RPPI. An increase in the interest rate on housing credit leads to a reduction in property demand and prices.

This study showed a positive relationship between economic growth and the RPPI. Economic growth indicates an increase in citizens' purchasing power, leading to a rise in demand for housing and house prices. Furthermore, the impulse response results showed a positive reaction of the RPPI to economic growth in the first 5 periods. This aligns with the growth theory of Solow (1988), where economic growth is a long-term process of increasing the production of goods and services, including property prices. These findings are consistent with Li and Lin (2023); Aizenman, Jinjarak, and Zheng (2019) and Gasparėnienė et al. (2016), who suggested a positive correlation between economic growth and the RPPI. An increase in economic growth indicates a rise in welfare and prosperity, leading to an upsurge in property demand and house prices.

According to the Arbitrage Pricing Theory developed by Roll and Ross (1995), an increase in inflation can positively affect property prices and the RPPI. However, these results indicate a contrast with the theory. The impulse response analysis showed a negative response of the RPPI to inflation from periods 2 to 20. This negative relationship occurs because inflation increases the prices of goods and services, prompting households to allocate more of their income to meeting basic needs rather than investing. Additionally, some individuals may sell their property to meet their basic needs, increasing supply in the property market and causing house prices and the RPPI to decrease. These results support Le Goix, Giraud, Cura, Le Corre, and Migozzi (2019) and Tang, Ye, and Qian (2019), where a negative association between inflation and housing prices was reported. A negative response of the RPPI to population growth shock was also obtained. Theoretically, the population is directly proportional to the demand for the development of the property industry. However, this is inconsistent with the study conducted by Law (2021), which found a positive relationship between population growth and the RPPI. An increasing population can lead to a higher demand for property since the amount of land is finite. Furthermore, the demand for property is directly related to population, leading to increased property prices.

5. CONCLUSION

This study provides an empirical analysis of the relationship between the RPPI, monetary policy, and macroeconomic factors. The results showed heterogeneity across different countries in the panel VAR model. The mean group panel VAR was applied by averaging the individual VARs for all samples. The RPPI increased due to tighter monetary policy until period 5 due to shock. However, the response was negative from periods 5 to 9, demonstrating that tight monetary policy has a delayed effect on reducing the RPPI. The response of the RPPI to the HL interest rate is positive during the first four quarters, indicating that the higher cost of credit increases the RPPI. Since economic growth positively impacts the RPPI, an increase in income can positively affect the demand for property. In addition, the responses of the RPPI to inflation and population growth were negative.

This study recommends that policymakers should focus on setting monetary policy, particularly for the CB interest rate, to intervene in the property market effectively. A stable CB policy rate significantly limits the boom of the property sector. Future work should include macroprudential policy as an endogenous variable in the model.

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