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Housing Prices: Fueling or Crushing Economic Growth? - A Study on the Effect of Shocks of Housing Prices on GDP in Taiwan

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The Taiwanese government has long regarded the real estate sector as a key driver of economic growth because of its perceived multiplier effects. However, rising housing prices and worsening affordability have raised concerns about whether the housing market contributes meaningfully to long-term economic development. This study re-examines the relationship between housing prices and the macroeconomy in Taiwan by using quarterly data from 2006Q1 to 2025Q3 within a vector error correction model framework. The results confirm the existence of long-run cointegration among housing prices, gross domestic product (GDP), construction activity, population, and inflation. Housing prices are found to be weakly exogenous, while GDP, construction activity, population, and inflation adjust to restore equilibrium following shocks. In the long run, housing prices are influenced by supply-side conditions, demand pressures, financial factors, and structural shocks such as the global financial crisis and COVID-19 pandemic. In the short run, housing price shocks exert limited effects on broader economic performance. Overall, the findings suggest that although the real estate sector is closely linked to macroeconomic conditions, its contribution to sustained economic growth is limited.

Keywords

Housing Prices, Effect of Shock, GDP, Structural Breaks, Time Series

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1. Introduction

The purpose of this study is to conduct an econometric analysis of the relationship between housing prices and their shocks on economic factors in Taiwan from 2006Q1 to 2025Q3. During this period of time, housing prices surged to levels that became unsustainable, and the general public frequently raised the issue of housing affordability. However, the Taiwanese government viewed the real estate sector as a major contributor to economic growth, and cited its strong multiplier effect[1] on other sectors of the economy. Government statistical reports indicated that the real estate sector accounted for about 10% of the gross domestic product (GDP) growth[2]. Many scholars, however, contend that this estimation is inflated, and suggest that investing in real estate does not stimulate broader economic activity but rather leads to stagnation. With the rising housing affordability issue, questions have been raised regarding the actual contribution of the real estate sector to the economy of Taiwan.

Between 2006Q1 and 2025Q3, Taiwan faced several significant economic challenges, including the 2008 global financial crisis, 2018 US-China trade war, and COVID-19 pandemic in 2020. In response, the government implemented quantitative easing and adopted a loose monetary policy, which led to a surge in housing prices. According to the Sinyi House Price Index[3], the index rose from 58.59 in 2008Q1 to 168.73 in 2025Q3. A decade of housing market prosperity allowed many homeowners to see significant increases in their property values, which spurred speculative behavior. By 2023, the household ownership rate in Taiwan reached 84.68%, and the vacancy rate stood at 9.25% (Bourassa and Peng, 2011; Chu and Chen, 2018; Chen, 2020). While the high ownership rate was largely driven by speculators, the middle-aged and younger populations faced significant housing affordability challenges (Galster and Lee, 2020; Rietdijk, 2022; Chen, 2024). As housing prices soared while incomes stagnated[4], affordability became a pressing societal issue (Rohe and Stegman,

[1] The multiplier effect refers to the economic process where an initial increase in spending or investment leads to a larger overall boost in economic activity, as the money circulates through the economy and generates further spending.

[2] According to the data from the Statistical Analysis System of the Ministry of Economic Affairs of Taiwan, the real estate industry contributed over 1.93 trillion NTD (61 billion USD) to the gross production value in 2018, which accounted for approximately 10.5% of the national GDP for that year. It then grew for at least five consecutive years, with its share rising to 11.03% in 2020.

[3] The Sinyi House Price Index is a real estate index developed by Sinyi Realty. The firm tracks housing price changes in Taiwan, thus providing insights into the national real estate market trends. It is used to gauge market conditions and fluctuations.

[4] According to the statistics released by the Taiwan Directorate-General of Budget, Accounting, and Statistics, the average total salary for employees in 2022 reached NTD693,000 (USD21,039), thus reflecting a 3.44% annual increase, the highest growth in four years. However, among the 8.17 million employed workers, 4.08 million had an annual salary below NTD518,000 (USD15,726) (with a monthly salary of less than NTD43,000 (USD1,305). Furthermore, the top 10% earners made over 4.12 times more

1994; Dietz and Haurin, 2003; Anacker, 2019; Arundel et al., 2022; Barrett, 2022; Leung and Yiu, 2022).

Initially, the government argued that housing development and construction are key drivers of economic growth, with strong spillover effects onto other sectors. According to the Ministry of Economic Affairs, the real estate sector contributed approximately 10.5% of the national GDP in 2018, which grew for at least five consecutive years, with its share reaching 11.03% in 2020. However, scholars have criticized the idea that real estate is the main engine of economic growth. The reported contribution was inflated due to the inclusion of imputed rent[5] for rental housing, and the direct contribution of the construction industry to the GDP was less than 2% annually. Chang et al. (2024) examine how housing price fluctuations impact macroeconomic variables in Taiwan, including GDP, investment, and total factor productivity (TFP). Their preliminary results suggest that housing price surges have little effect on the output of the construction sector but lead to a significant decline in the manufacturing sector. Employment in construction increased, but manufacturing employment remained largely unchanged, and the TFP in both sectors declined sharply. Chang (2025, quoted in Chen, 2025)[6] states, "現階段台灣經濟已進入惡性循環的狀態，銀行大多資金都在房地產，房價不斷高漲，而每個家庭多數收入都用扛房貸，大家剩下的錢就不多，消費降級、導致內需不振，而內需產業賺不到錢，員工薪資也無法提升，內需廠商也不會再去跟銀行借錢投資、擴增，銀行又繼續把更多錢放到房地產上 (Taiwan had entered a vicious cycle where bank funds were increasingly concentrated in real estate, inflating housing prices. As a result, household income was primarily allocated to mortgage payments, leaving little disposable income, which reduced consumption and weakened domestic demand. With stagnant wages and low investment in businesses, the economy was further strained, and banks continued to allocate funds to real estate)". The housing affordability crisis worsened, with the property price-to-income ratio[7] reaching 22.1[8] in 2023Q2.

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than the bottom 10% earners.

[5] Imputed rent refers to the estimated value of housing services that homeowners receive from their own property, which is not paid in cash. It is the hypothetical rent a homeowner would pay if he/she was renting his/her own home. Imputed rent is often used in national income accounting to reflect the value of owner-occupied housing as part of the GDP, even though no actual rental payment is made.

[6] Chen, W. F. (2025). *Dújiā/táiwān rén yǐ qíhǔnánxià? Fángdìchǎn dāng jīngjì huǒchētóu! Zhāngdìngxuān: Shèng yītiáo lù zǒu dào hēi* 獨家／台灣人已騎虎難下？房地產當經濟火車頭！章定煊：剩一條路走到黑. 24 February. Available at: https://www.setn.com/News.aspx?NewsID=1613941. Accessed on 25 February 2025.

[7] The price-to-income ratio measures housing affordability by dividing the median house price by the median annual household income. A larger ratio indicates less affordability, while a smaller ratio suggests more affordability.

[8] Property Prices Index by Country 2023 Mid-Year. Numbeo. Available at:

In response, the government introduced regulatory measures, such as tightening transaction taxes, imposing withholding taxes, and raising borrowing constraints. In 2024Q3, the Central Bank of Taiwan announced the seventh round of credit controls[9], which aims to suppress housing prices, but the long-term effects remain uncertain.

The surge in housing prices has not only worsened housing affordability for many in Taiwan but also raised questions about whether these high prices could cyclically stimulate economic growth (Lin et al., 2019; Cheng et al., 2020; Lee et al., 2020). From a social stability perspective, it is unclear whether homeownership is primarily for consumption or investment. If the government intensifies its suppression of housing prices through monetary and fiscal policies, there is a risk of a housing market downturn, which could negatively impact the broader economy (Tsai and Chen, 2013; Chang and Hsieh, 2018; Chen, 2018; Chen, 2020; Chen and Chen, 2024). Over-investment in housing can be inefficient because significant capital is tied up and long-term liquidity is inhibited. It is argued that housing price growth beyond a certain threshold relative to the overall economic growth is unsustainable (Strassman, 1970; Leung, 2003; Chang et al., 2024). However, if the housing sector continues to contribute positively to economic growth, the government should prioritize policies that support housing investment, regardless whether doing so results in high vacancy rates.

This study examines the effects of housing price shocks on the national economy of Taiwan by using quarterly data from 2006Q1 to 2025Q3. A vector error correction model (VECM) is applied to analyze both long-run equilibrium relationships and short-run dynamics between housing prices and key macroeconomic indicators, including GDP, total construction (TOTALCON), real estate agency services, housing supply, and credit conditions. To account for major external disruptions, structural break dummy variables are introduced for the 2008 global financial crisis, 2018 US-China trade war, and the COVID-19 pandemic in 2020. The work seeks to evaluate whether changes in housing prices exert significant effects on economic growth and capital formation over time. To further capture the dynamic interactions among variables, impulse response functions (IRFs) are employed to trace the effects of housing price shocks on macroeconomic indicators over time, while forecast error variance decomposition is used to quantify the contribution of housing price innovations to fluctuations in each variable.

The results provide empirical evidence on the transmission mechanism of housing price shocks, which shows how their impacts evolve and dissipate across the economy. The findings offer insights into the role of the real estate

https://www.numbeo.com/property-investment/rankings2023-mid. Accessed on 22nd August 2024.

[9] The main measures of the seventh wave of credit controls focus on "mortgage grace periods" and limit the loan amounts and repayment terms for homebuyers.

sector within the broader macroeconomic system, thus highlighting whether housing price movements act as a driving force or respond to underlying economic conditions. These results carry important policy implications for monetary policy design, housing market regulation, and resource allocation, while also contributing to discussions on housing affordability in Taiwan.

2. Literature Review

Traditionally, the real estate industry has been considered a key driver of national economic growth, with residential investment believed to significantly contribute to economic development through its impact on employment, productivity, savings, investment, and labor. Studies have explored the relationship between economic growth rates and housing prices. Iacoviello and Neri (2010) find that a decline in home prices negatively affects consumption and real GDP, a finding supported by other studies (Goodhart and Hofmann, 2008; Madsen, 2012), which identifies a strong short-term relationship between economic growth and housing prices. Renigier-Biłozor and Wiśniewski (2012) also confirm that economic conditions heavily influence housing prices. In particular, if economic growth is accompanied by rising price levels or inflation, the effect of economic growth on housing prices may be weakened.

In Taiwan, Lin et al. (2019) outline the role of real estate during different phases of national development. From the 1950s to 1970s, real estate was seen primarily as a consumer product. In the 1980s and 1990s, real estate was viewed as the engine that was driving economic growth and industrial activity. Since the 1990s, real estate has been regarded as a generator of wealth and an investment product. These views have evolved over time, although their relative importance has varied. Similar research conducted in countries like Brazil (Thut and Zimand, 2003), China (Iwase, 2004; Zhang et al., 2020), India (Tahsin and Sen, 2014), Namibia (Sunde and Muzindutsi, 2017), the United Kingdom (UK) (Battaglia et al., 2010), Switzerland (Bourassa and Hoesli, 2006; Borowiecki, 2009; Drechsel and Funk, 2017), and the United States (US) (Meen, 2002; Garriga et al., 2019; Kaplan et al., 2020) have also identified the real estate market as a significant economic driver.

Housing market demand is influenced by factors such as economic growth, price levels, borrowing costs, loan availability, income, wages, and population growth (Madsen, 2012; Myrmo, 2012). Economic growth affects household consumption and firm production, which in turn impact housing demand. For example, a decline in GDP leads to reduced housing demand due to lower firm revenue and household income (Iacoviello and Neri, 2010). This suggests that weaker economic growth hinders the ability of households and firms to obtain mortgage loans. Additionally, housing demand is inversely related to price levels: when prices increase, household purchasing power decreases, thus leading to a reduction in housing demand as consumers adjust their spending (Goodhart and Hofmann, 2008). Housing expenses are typically the second-

largest expenditure for households after food, which highlights the significant impact of changes in purchasing power on housing costs (Kalili et al., 2008). Thus, both economic growth and price levels are critical determinants of housing demand.

Empirical studies have shown that housing prices respond to changes in interest rates and mortgage loan availability (Agnello and Schuknecht, 2011; Xu and Tang, 2014; Panagiotidis and Printzis, 2015; Agnello et al., 2018). The interest rate is a key determinant of housing demand, as most homes are financed through loans. For instance, Xu and Tang (2014) identify interest rate as a critical factor that influences UK house prices, and note that households and firms adjust their housing investments based on fluctuations in interest rates. Changes in interest rates affect mortgage loan availability, with lenders adjusting their investments accordingly. In Taiwan, Chen and Chen (2024) find that a loose monetary policy plays a significant role in driving up housing prices. Apergis (2003) also identifies mortgage loan rates as a major determinant of housing prices in the European Monetary Union, a finding that Agnello and Schuknecht (2011) and Panagiotidis and Printzis (2015) support. Increased loan availability can stimulate construction activities, thereby boosting housing supply. Borowiecki (2009) finds that construction activity is sensitive to the mortgage market, which indicates that interest rates and mortgage bonds affect both the demand and supply sides of the housing market.

In addition to economic growth and price levels, changes in interest rates and mortgage loan availability also influence housing demand. The relationship between house prices and interest rates is negative and depends on the level of competition in the banking sector. Some researchers (Tsatsaronis and Zhu, 2004; Goodhart and Hofmann, 2008) argue that interest rates are among the most important macroeconomic factors that affect the housing market, given that most homes are purchased through mortgage bonds sensitive to interest rate changes. When interest rates rise, borrowing costs increase, thus discouraging potential buyers (Panagiotidis and Printzis, 2015). Higher interest rates also negatively affect mortgage loan demand, which in turn reduces real house prices (Xu and Tang, 2014). A drop in real house prices reduces the capital of banks, thus limiting their lending capacity and discouraging investment in the housing market (Case et al., 2000). Housing demand also increases with population growth. Lai (2016) finds that population growth leads to higher housing demand, particularly in the long term. Urbanization, driven by migration to urban areas for better living conditions and employment opportunities (Todaro and Smith, 2020), is associated with increased urban housing demand.

However, some studies have found limited or no significant relationships between housing prices and certain macroeconomic variables. For example, Borowiecki (2009) finds that real GDP has a minor short-run impact on Swiss house prices. Mokhtar et al. (2021) analyze the macroeconomic determinants of the Malaysian housing market and find that inflation does not significantly

affect house prices. Borowiecki (2009) also observes that the interest rate has a limited impact on house prodaroices in Switzerland, thus suggesting that in countries with relatively stable and low interest rates, like Switzerland, the effect of interest rates on the housing market may be minimal. As such, the determinants of house prices are sensitive to the specific economic policy of a country and should be analyzed in context. In Taiwan, Chen and Patel (1998) examine the dynamic causal relationships between house price and its five determinants, including total household income, short-run interest rates, stock price index, construction costs, and housing completions, in the Taipei new dwelling market. The findings suggest that housing prices in Taipei are mainly driven by economic fundamentals, including income, interest rates, construction costs, and housing supply, with a clear long-run relationship among these factors. Housing prices are largely influenced by their own past values, while supply and demand factors play a secondary role. Overall, the results suggest that housing prices reflect the underlying economic conditions rather than acting as a strong driver of economic growth. Chu (2018) analyzes the volatility of housing prices and transactions between 2011 and 2015 in Taiwan. Her findings indicate that residential property taxes and higher interest rates are effective in curbing speculative transactions and have long-term effects on moderating housing prices. Conversely, measures like transfer taxes or decreasing loan-to-value ratios have only short-lived impacts on the housing market. Chang et al. (2024) examine how housing price changes affect various industries and macroeconomic variables, such as output, investment, employment, and TFP. Their results suggest that sustained increases in housing prices divert capital and labor to real estate-related industries, which crowd out resources from other vital sectors, thus ultimately hindering economic growth, investment, and productivity.

3. Data and Methodology

The current housing environment in Taiwan meets the necessary conditions for conducting the investigation in this study, which include: 1) a surge in housing prices over a specific period; 2) a high homeownership rate and low housing loan interest rates in the region; and 3) widespread negative effects on society due to high housing prices.

3.1 Data Collection

The data used in this study include the housing index, total GDP and related categories (TOTALCON and real estate agency and management services (AGENCY)), housing supply (total floor area supply (FLOOR) and construction costs), borrowing constraints (home loan interest rates and total bank outstanding home loan balances (MORT)), and common factors (consumer price index (CPI) and population (POP)). The data source of the total

GDP, TOTALCON, CPI, FLOOR, POP, and construction costs is from the data arc of the Taiwan Economic Journal (TEJ) database. The data for real estate agency services and management are extracted from the National Statistics of the Republic of China (Taiwan). MORT and home loan interest rates from five banks are extracted from the open data of the Central Bank of the Republic of China (Taiwan). The housing index is extracted from the Sinyi House Price Index of the Sinyi Realty Research Center. The study uses a quantitative analysis of a quarterly index series, from 2006Q1 to2025Q3. Variable name, abbreviation, and details of the data are shown in Table 1.

Table 1 Abbreviation, Variables, Sample Period, Data Type and Date Source

Abbreviation	Variable	Sample period	Data type	Data source
HP	Sinyi Realty Housing Index	2006Q1-2025Q3	Quarterly	Sinyi Realty
FLOOR	total floor area supply	2006Q1-2025Q3	Quarterly	TEJ
GDP	total GDP	2006Q1-2025Q3	Quarterly	TEJ
TOTALCON	GDP fixed capital formation on total construction	2006Q1-2025Q3	Quarterly	TEJ
AGENCY	GDP consumption expenditure on real estate agency services and management	2006Q1-2025Q3	Quarterly	National Statistics
CPI	Consumer price index	2006Q1-2025Q3	Quarterly	TEJ
POP	Total population	2006Q1-2025Q3	Quarterly	TEJ
MORT	Total bank outstanding home loan balance	2006Q1-2025Q3	Quarterly	Central Bank
IRATE	Average mortgage rate from five banks	2006Q1-2025Q3	Quarterly	Central Bank
CONCOST	Construction costs	2006Q1-2025Q3	Quarterly	TEJ

Sources: National Statistics of the Republic of China (Taiwan), Taiwan Economic Journal (TEJ), Central Bank of the Republic of China (Taiwan), and Sinyi Realty Research Center.

3.1.1 Definition of Housing Index (HP)

The basis of the calculations for the Sinyi House Price Index rests on transaction prices of completed and pre-owned houses. The base year is set at 2013/06=100.

3.1.2 Definition of FLOOR

FLOOR refers to the building area covered by building use permits issued by the Taiwanese government, measured in square meters. This data can be used to understand the scale and trends of construction activities in Taiwan and has

significant importance for analyzing the development of the real estate market and construction industry.

3.1.3 Definition of Total GDP

The GDP is a key economic indicator that represents the total value of all goods and services produced within the borders of a country during a specific time period. The calculation of GDP takes into account various economic activities, including consumption, investment, government spending, and net exports (exports minus imports). The adopted GDP is Seasonally Adjusted by Expenditures (at Current prices) - Grand Total (NT$ million).

3.1.4 Definition of Fixed Capital Formation on TOTALCON

TOTALCON is the portion of the GDP that is attributed to the net increase in physical assets (fixed capital formation) within the construction sector. TOTALCON indicates the contribution of construction-related investments to the overall economic output of a country or region. This metric is important for understanding the role of construction activities in economic development and growth.

3.1.5 Definition of AGENCY

AGENCY is the portion of the GDP that is attributed to the net increase in consumption expenditure. AGENCY include industries involved in real estate development, residential housing, management of construction investment in buildings and other structures, real estate buying and selling, leasing, and brokerage. AGENCY also encompasses industries engaged in the management of real estate for others. Management ensures rent collection and supervises other services (maintenance, security, cleaning) related to the operation of real estate. Management does not include financing-oriented leasing, and facilitative-composite support services, such as real estate appraisal or real estate insurance breakage.

3.1.6 Definition of Consumer Prices Index (CPI)

The CPI is a measure that examines the weighted average of prices of a basket of consumer goods and services, such as transportation, food, and medical care. The CPI is used to gauge changes in the cost of living over time and a key indicator of inflation or deflation in an economy. The base year is set at 2016/07=100.

3.1.7 Definition of Total POP

Total POP is a crucial demographic statistic used to understand the overall size of the POP in a region. Here, total POP refers to the total number of people in the Taiwan region, which encompasses residents of all nationalities, ages,

genders, and other demographic characteristics. Total POP serves as a fundamental reference point in government policymaking, social planning, and various other related fields.

3.1.8 Definition of MORT

MORT refers to the aggregate amount of loans that all banks have issued and that are currently unpaid or outstanding. This category is the total outstanding loans from all banks to individuals for the purpose of purchasing real estate.

3.1.9 Definition of Average Mortgage Rate from Five Banks (IRATE)

The new lending interest rates undertaken by the five major banks, namely the Taiwan Cooperative Bank, Land Bank of Taiwan, Hua Nan Commercial Bank, First Commercial Bank, and Bank of Taiwan, for new home loans is calculated by using a weighted average method.

3.1.10 Definition of Construction Costs (CONCOST)

CONCOST refers to the total expenses incurred in the construction of a project, and its three components are quantity, prices, and fee. The main elements of CONCOST include direct costs (labor, materials, equipment, construction machinery usage) which are based on drawings, quotas, and list specifications. CONCOST also involves enterprise management, contingency and regulatory fees, profits, and taxes. CONCOST specifically denotes the prices of a project, thus representing the anticipated or actual value of building and installation projects formed through transactions such as bidding in the market for land, equipment, technical services, and contracting. The sum of CONCOST is based on building constructions that have been issued a building usage permit.

3.2 Descriptive Statistical Analysis

Table 2 shows the descriptive statistics of series that include the mean, medium, maximum value, minimum value, standard deviation, skewness, kurtosis, and Jarque-Bera normality test results. The results in the descriptive analysis of the variables in Table 2 and Figures 1 to 10 show that the trivial skewness statistics for most of the series are significantly skewed. The kurtosis statistics is less than three except for home loan interest rate (IRATE) and the Jarque-Bera statistics reject the null hypothesis which shows that the rest of the series are light-tailed and not normally distributed.

Figure 1 GDP

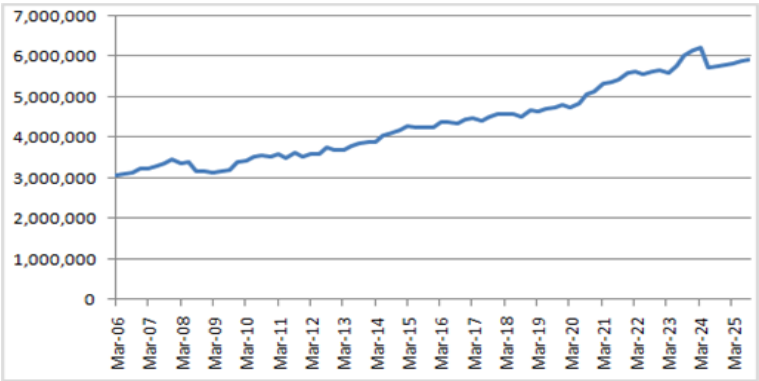


Figure 2 TOTALCON

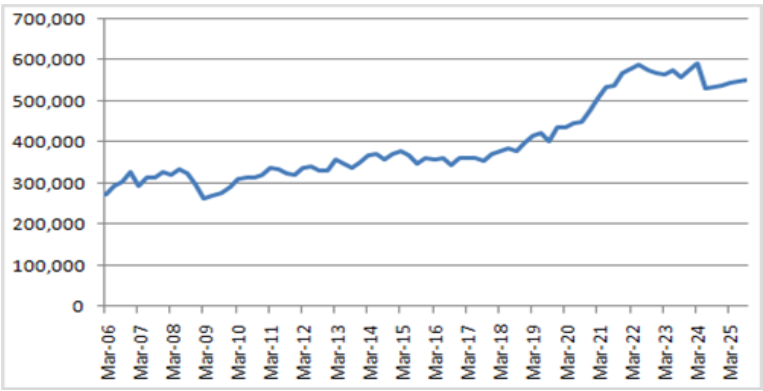


Figure 3 Housing Index (HP)

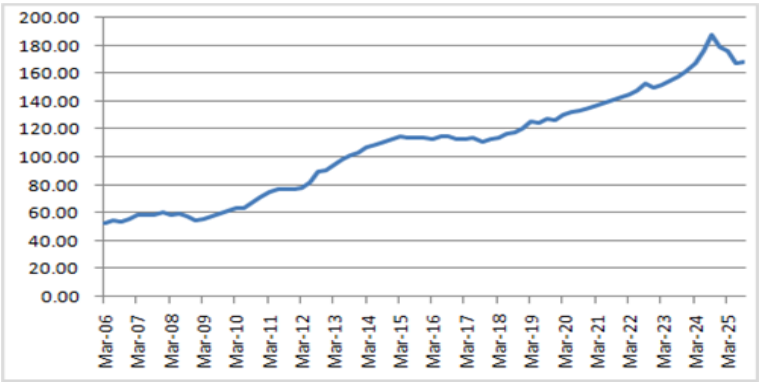


Figure 4 AGENCY

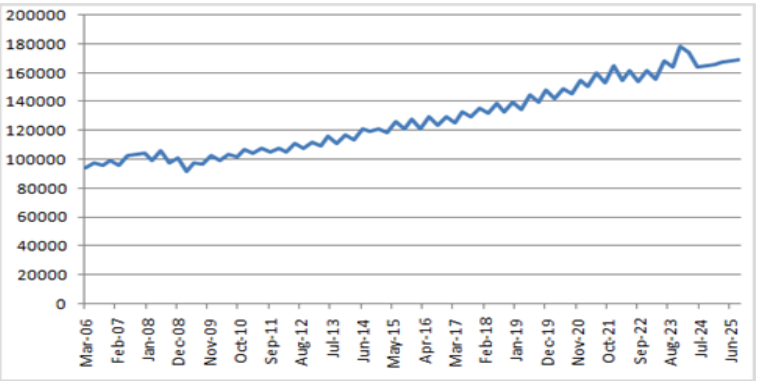


Figure 5 Total Bank Outstanding Balance (MORT)

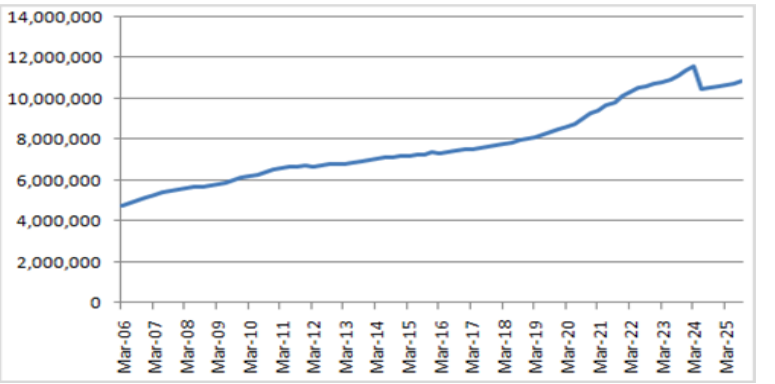


Figure 6 Construction Cost (CONCOST)

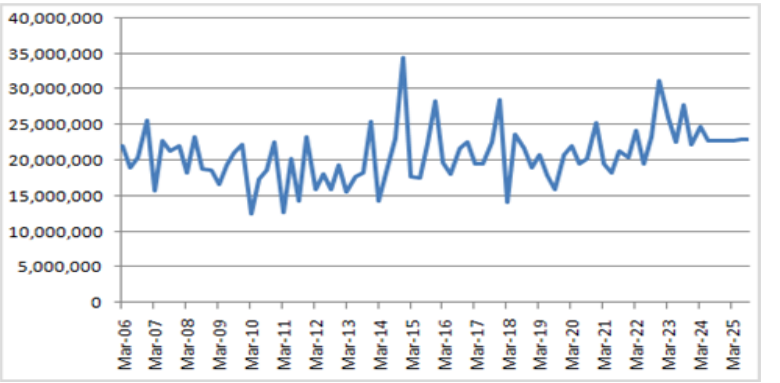


Figure 7 Home Loan Interest Rate (IRATE)

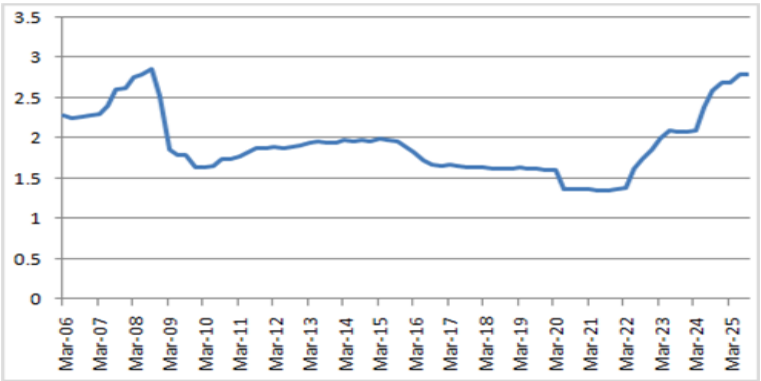


Figure 8 Consumer Prices Index (CPI)

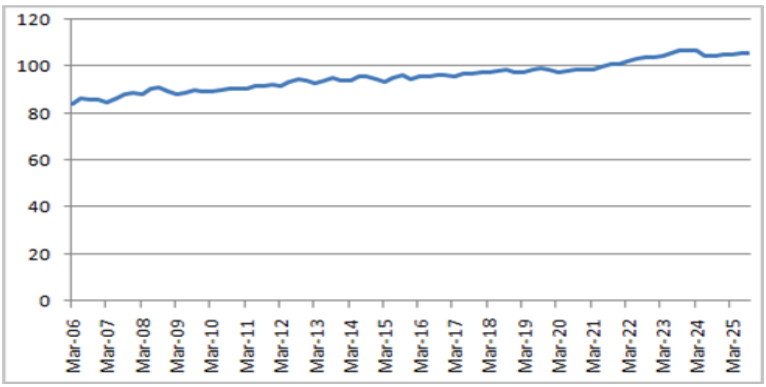


Figure 9 Population (POP)

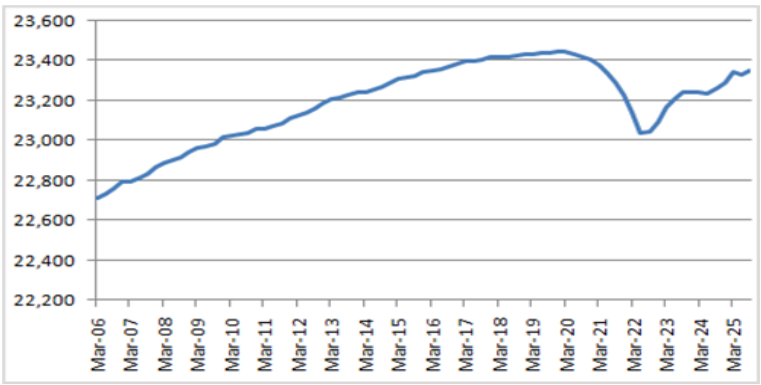
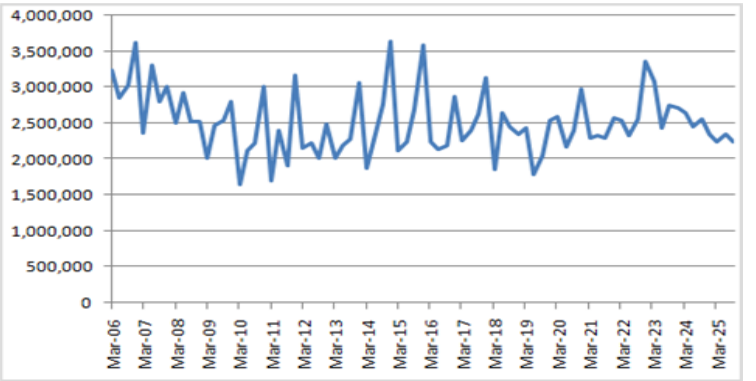


Figure 10 Total Floor Area Supply (FLOOR)



3.3 Methodology

Donald Jud and Winkler (2003), Borowiecki (2009), and Sunde and Muzindusti (2017) note that individual country analyses primarily rely on cointegration and error correction models, as well as vector autoregressive (VAR) systems. Borowiecki (2009) further points out that country-specific conclusions based on panel parameter estimates may pose the problem of homogeneity assumptions. Therefore, this study adopts the VECM as the methodology.

3.4 Statistical Model

This study employs a time series analysis to examine the relationship between housing price shocks and key economic factors, including GDP and categories related to fixed capital formation (such as TOTALCON and AGENCY), housing supply (FLOOR and construction costs), borrowing constraints (home loan interest rates and MORT), and common factors (CPI and POP). The primary objective is to extend univariate methods into a multivariate system of equations, thereby providing a better understanding of the interrelationships among these economic variables and developing a more structured economic model.

Given that most overall economic changes are non-stationary time series, a unit root test is conducted on the research variables prior to constructing the VECM to determine whether the time series are stationary. In cases where the test results indicate non-stationarity, the common approach is to eliminate this condition by taking first differences. However, this method may disregard long-run equilibrium information inherent in the data, thus retaining only short-run dynamics and potentially leading to over-differencing. To address this issue, the Johansen cointegration test is conducted to determine whether a long-run equilibrium relationship exists among the variables. If cointegration is

confirmed, the VECM is employed for further analysis. This model allows for the integration of both short-run adjustments and long-run equilibrium relationships, thereby providing a more comprehensive depiction of dynamic interactions through IRFs and variance decomposition.

In addition, structural break dummy variables are incorporated to capture the effects of major external shocks that may influence the housing market and macroeconomic conditions. Specifically, dummy variables are constructed for the 2008 global financial crisis, 2018 US–China trade war, and COVID-19 pandemic in 2020. These dummy variables are included in the model to control for abrupt structural changes and ensure that the estimated relationships are not biased by extraordinary events.

While the unit root tests and optimal lag selection are standard procedures in time series analyses, they are not discussed in detail in this study. Instead, the focus is placed on the Johansen cointegration test and the application of the VECM to assess whether housing prices influence fixed capital formation in GDP.

4. Empirical Result

4.1 Unit Root Test Results

The traditional regression model assumes that the time series data are stationary, and thus non-stationary data would result in a spurious regression. In this study, the seasonality of the data is adjusted from the ordinary least square (OLS) regression which includes the intercept, time trend, time trend square, and seasonal dummy variable. The results on the variable data are time related with seasonality. Logarithm and differencing are performed on all data, and seasonal adjustments are conducted on the log values of all consumption data. Unit root tests are conducted at the significant level and first difference for each of the series. Augmented Dickey-Fuller (ADF) testing is adopted to examine the existence of unit roots in the series. The series is I (0) if it is level stationary and I (1) if it is stationary at the first difference. Table 3 shows the results of the ADF tests. All of the variables except for mortgage are stationary at the 1% and 5% significance levels. The mortgage variable is stationary at 1% significance level after first differencing.

Table 2 Descriptive Statistics for Variables

Panel A. Descriptive Statistics

Variables	HP	FLOOR	GDP	TOTALCON	AGENCY	CPI	POP	MORT	IRATE	CONCOST
Mean	108.364	2,516,817	4,368,310	398,276.30	127,995.60	95.537	23.203	7,764,606	1.841	20.773
Median	113.48	2,448,146	4,274,767	361,829	124,021	95.46	23.244	7,323,270	1.791	20.763
Maximum	188.06	3,638,510	6,221,847	590,951	177,978	106.58	23.493	11,558,493	2.859	34.537
Minimum	53.01	1,643,971	3,073,792	262,447	91,975.80	83.86	22.709	4,776,099	1.346	12.421
Std. Dev.	37.765	433,200.10	934,958.40	97,995.72	24,736.13	5.98	0.217	1,848,465	0.354	3.942
Sum	8,560.75	1.99E+08	3.45E+08	31,463,826	10,111,652	7,547.39	1,833.03	6.13E+08	145.408	1,640.00
Sum Sq. Dev.	111,242.20	1.46E+13	6.82E+13	7.49E+11	4.77E+10	2,789.72	3.684	2.67E+14	9.749	1.21E+03
Observations	79	79	79	79	79	79	79	79	79	79

Panel B. Distribution Statistics

Variables	HP	FLOOR	GDP	TOTALCON	AGENCY	CPI	POP	MORT	IRATE	CONCOST
Skewness	0.119	0.566	0.376	0.752	0.352	0.121	-0.563	0.485	0.948	0.578
Kurtosis	2.007	3.19	1.887	2.14	1.801	2.212	2.238	2.121	3.703	4.308
Jarque-Bera	3.437	4.344	5.935	9.888	6.367	2.237	6.084	5.639	13.453	10.028
Probability	0.179	0.114	0.051	0.007	0.041	0.327	0.048	0.06	0.001	0.007

Notes: Currency units are reported in New Taiwan Dollars (TWD) for GDP (million TWD), TOTALCON (million TWD), AGENCY (million TWD), MORT (million TWD), and CONCOST (million TWD). The exchange rate used is 1 USD = 31.5 TWD. Other variable units are as follows: HP and CPI are reported as indices, FLOOR is measured in square meters (m^2), IRATE is expressed as a percentage (%), and POP is reported in millions of persons.

The Jarque-Bera (JB) test statistic, JB=N (6-1S2 +4-1 (K - 3)2), where (S) denotes skewness and (K) denotes kurtosis, was proposed by Jarque and Bera (1987) to test the normality of a series. The null hypothesis ((H_0: JB = 0)) indicates that the series is normally distributed, whereas the alternative hypothesis ((H_1: JB > 0)) rejects the null hypothesis of normality.

4.2 Selection of Optimal Lag Length

The results of Table 4 show that that results of two information criterions - the Akaike and Schwarz information criterions (AIC and SIC), differ. However, due to the number of observations, the SIC is used in this study as the SIC penalizes free parameters more strongly than the AIC. Therefore, lag one is the optimal lag for the variables of all the data series. For a finite order autoregressive process, the AIC asymptotically overestimates the order with positive probability, as shown by Shibata (1976), whereas the SIC is consistent in choosing the correct order of an autoregressive model and tends to choose the more parsimonious model. Koehler and Murphree (1988) and Lütkepohl (1985) further indicate that the SIC is superior to AIC in time series analysis.

4.3 Test for Cointegration

The cointegration test examines whether a long-run relationship exists between housing prices and other variables. Table 5 shows that the null hypothesis of no cointegration is rejected, thus indicating the presence of a cointegrating relationship among the variables in the model. This statistically significant result suggests a long-run equilibrium relationship and supports the existence of stable linear relationships with important economic implications, which are consistent with the initial assumptions of this study. To account for major external shocks that may influence the long-run relationship, structural break dummy variables are included for the 2008 global financial crisis, 2018 US-China trade war, and COVID-19 pandemic in 2020.

Table 3 Test for Unit Roots

Unit root test	ADF	
	Level	First Difference
HP	-6.69***	-9.12***
FLOOR	-2.31	-5.48***
GDP	-9.38***	-10.25***
TOTALCON	-4.37***	-7.01***
AGENCY	-4.74***	-6.58***
CPI	-4.01***	-6.77***
POP	-3.01**	-6.02***
MORT	-1.02	-5.92***
IRATE	-5.65***	-8.34***
CONCOST	-13.94***	-11.67***

Notes: *, **, ***, represents statistically significant at 10%, 5%, and 1% significance levels.

Table 4 Lag Length Selection

Rank	AIC	SIC
0	-47.9113*	-47.5999*
1	-49.7828	-46.3578*
2	-50.2715	-43.733
3	-50.916	-41.2638
4	-52.0207	-39.255
5	-53.3798*	-37.5005

Notes: * indicates lag order selected by the respective information criterion.

Given the statistically significant presence of cointegration among all of the data series, the VECM is considered to be appropriate for conducting further analysis. However, some of the data series indicate the presence of multiple cointegrating relationships. According to Sims (1980), when multiple cointegrating vectors exist, adopting a single cointegrating relationship helps to maintain the simplicity and interpretability of a VECM framework.

Table 5 Johansen Test for Cointegration

Trace Test			Maximum Eigenvalue Test		
Hypothesized No. of CE	Trace Statistic	0.05 Critical Value	Hypothesized No. of CE	Max-Eigen Statistic	0.05 Critical Value
None	734.2628	NA	None	164.0893	NA
At most 1 *	570.1735	334.9837	At most 1 *	141.8519	76.57843
At most 2 *	428.3216	285.1425	At most 2 *	86.67886	70.53513
At most 3 *	341.6428	239.2354	At most 3 *	74.41116	64.50472
At most 4 *	267.2316	197.3709	At most 4 *	65.53139	58.43354
At most 5 *	201.7002	159.5297	At most 5	49.95475	52.36261
At most 6 *	151.7455	125.6154	At most 6	45.50433	46.23142
At most 7 *	106.2411	95.75366	At most 7*	42.66298	40.07757
At most 8	63.57817	69.81889	At most 8	22.43555	33.87687
At most 9	41.14261	47.85613	At most 9 *	18.85372	27.58434

Notes: 1. Trace test indicates 8 cointegrating eqn(s) at the 0.05 level. Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.05 level. 2. * denotes rejection of the hypothesis at the 0.05 level. 3. **MacKinnon-Haug-Michelis (1999) p-values.

4.4 Vector Error Correction Model

The VECM is employed to fully capture the dynamic adjustment process among the time series variables by incorporating both long-run equilibrium relationships and short-run adjustments. To account for potential structural changes, dummy variables are included to represent major external shocks, namely the 2008 global financial crisis, 2018 US-China trade war, and COVID-19 pandemic in 2020. All variables are examined within this framework to assess the significance of their relationships with changes in housing prices, thus allowing for a more comprehensive understanding of both persistent and shock-driven dynamics in the system.

4.4.1 Long-Run Equilibrium Relationship

The result of Table 6 of the long-run cointegrating results, normalized on HP (Sinyi House Price Index), reveal that HP in Taiwan are shaped by a combination of structural economic factors and external shocks. Among the key determinants, both the demand-side and supply-side variables exhibit strong and statistically significant relationships with HP. POP (coefficient = 43.611, t = 4.39) and inflation (CPI; coefficient = 12.858, t = 8.31) positively influence HP, thereby indicating that population pressure and general price levels are major drivers of long-term housing demand. Similarly, supply-related factors, including total floor area (FLOOR; coefficient = 1.46, t = 6.30) and TOTALCON (coefficient = 2.491, t = 6.91), are positively associated with HP, which suggests that expansion in housing development and construction activity coincides with rising price levels. The real estate agency sector (AGENCY; coefficient = 1.81, t = 5.20) further reinforces this relationship, thus reflecting the importance of market activity and intermediation in the housing market.

Financial conditions play a critical role in moderating housing price dynamics. Interest rates (IRATE) show a strong and highly significant negative effect (coefficient = -3.373, t = -12.15), which highlights that higher borrowing costs significantly suppress housing demand and prices in the long run. In contrast, GDP (coefficient = 0.24, t = 0.45) and mortgage lending (MORT; coefficient = -0.11, t = -0.15) are not statistically significant, which suggest that overall economic growth and credit volume do not directly determine HP over time. This indicates that HP are more closely linked to structural market conditions than aggregate economic performance.

Structural break dummy variables provide important insights into how major external events influence both HP and the broader economy. The global financial crisis (D_GFC; coefficient = -0.08, t = -3.38) and COVID-19 pandemic (D_COVID; coefficient = -0.05, t = -3.29) both have significantly negative effects on HP, thus indicating that adverse shocks reduce housing market performance in the long run. These results suggest that HP are sensitive to systemic economic disruptions, thereby reflecting declines in confidence,

investment, and market activity during crisis periods. Conversely, the trade-related dummy (D_TRADE; coefficient = 0.05, t = 4.33) shows a positive and significant effect, which implies that external economic adjustments, such as trade restructuring, may indirectly stimulate housing demand.

Table 6 Vector Error Correction Model (Long-run Equilibrium Relationship)

	Coefficient	t-statistics
HP(-1)	1	—
GDP(-1)	0.24	0.45
FLOOR(-1)	1.46	6.30***
IRATE(-1)	-3.37	-12.14***
MORT(-1)	-0.11	-0.15
POP(-1)	43.61	4.38***
TOTALCON(-1)	2.49	6.91***
CPI(-1)	12.85	8.31***
CONCOST(-1)	-0.38	-1.91*
AGENCY(-1)	1.81	5.19***
D_GFC(-1)	-0.08	-3.38***
D_TRADE(-1)	0.05	4.33***
D_COVID(-1)	-0.05	-3.28***
C	-0.11	—

Notes: 1. The results are the estimates of cointegrating equation of long-run equilibrium relationship from VECM. 2. The t-statistics are presented beside the corresponding coefficients. 3. ***p<0.01, **p<0.05, and *p<0.1.

Overall, the long-run findings indicate that HP interact strongly with demographics, supply, and financial variables, while structural shocks play a crucial role in shaping both housing market outcomes and broader economic conditions. HP are therefore not only influenced by internal market fundamentals but also external macroeconomic disturbances, thus highlighting their sensitivity to both domestic and global economic environments.

4.4.2 Short-Run Dynamic Adjustment

The result of Table 7 shows the short-run dynamics from the VECM and illustrate how housing prices (HP) interact with key macroeconomic variables and respond to external shocks. The error correction term in the housing price equation is statistically insignificant (coefficient = -0.002, t = -0.05), thus indicating that HP do not adjust to restore long-run equilibrium in the short run. This suggests that HP behave as a weakly exogenous variable and are not directly influenced by short-term disequilibrium in the system.

In the short run, HP movements are primarily driven by their own past changes. The first lag of HP changes shows a significantly negative effect (coefficient = -0.52, t = -3.74), thus indicating a short-term correction mechanism, where previous increases are partially reversed. However, most macroeconomic variables, including GDP, interest rate, POP, and construction activity, do not exhibit statistically significant direct effects on HP in the short run. This implies that the transmission from economic fundamentals to HP is limited in the short term.

Structural break dummy variables provide additional insights into how external shocks influence both HP and the broader economy. The global financial crisis (D_GFC) and COVID-19 pandemic (D_COVID) do not show statistically significant direct effects on HP changes, thus indicating that HP are relatively insulated from immediate external disturbances. However, these shocks significantly affect other economic variables within the system. For instance, the global financial crisis has a strong negative impact on interest rates (t = -5.21), thereby reflecting tightening financial conditions, while the COVID-19 shock significantly influences GDP and POP dynamics (t = 2.23 and t = 2.71, respectively), thus suggesting policy responses and structural adjustments during the pandemic period.

These findings indicate that even though HP do not respond strongly to short-run economic fluctuations or external shocks, they indirectly interact with the economy through broader system dynamics. External shocks primarily affect macroeconomic conditions, which may subsequently influence HP over time rather than immediately right away. Overall, the short-run results highlight that housing price dynamics are largely self-driven, with limited immediate responsiveness to economic variables, while structural shocks play a more pronounced role in shaping the broader economic environment.

4.4.3 Diagnostic Checks for Serial Correlation, Stability, and Normality

The serial correlation Lagrange multiplier (LM) test results in Table 8 point to some evidence of autocorrelation at lag 1 (p = 0.0284) and borderline significance at lag 2 (p = 0.0515). However, for higher lags (3-6), the null hypothesis of no serial correlation cannot be rejected, thus suggesting that the residuals are generally well-behaved. Overall, while there may be minor short-run specification issues, the model does not exhibit serious serial correlation problems.

The normality test examines whether the residuals follow a multivariate normal distribution; see Table 9 for the results. The results show that the null hypothesis of normality is strongly rejected at the joint level (Jarque-Bera = 6120.061, p = 0.0000), thus indicating that the residuals are not normally distributed. Several components exhibit significant skewness and excess kurtosis, particularly Components 4, 5, and 6, which suggest the presence of asymmetry and heavy tails in the residual distribution. Although a few variables do not individually

reject normality, the overall test results confirm substantial deviations from normality across the system. This implies that the model residuals may be influenced by outliers or extreme values, which is common in macroeconomic time series data. While non-normality does not invalidate the VECM estimation, it may affect statistical inference, and therefore, the results should be interpreted with caution.

Table 7 Vector Error Correction Model (Short-Run Dynamic Adjustments)

	Coefficient	**t-statistics**
CointEq1	0.002	-0.051
D(HP(-1))	-0.522	-3.740**
D(HP(-2))	-0.201	-1.392
D(GDP(-1))	0.163	0.891
D(GDP(-2))	0.042	0.203
D(FLOOR(-1))	-0.021	-0.282
D(FLOOR(-2))	0.043	0.950
D(IRATE(-1))	-0.041	-0.311
D(IRATE(-2))	-0.122	-1.604
D(MORT(-1))	0.980	1.482
D(MORT(-2))	-0.081	-0.134
D(POP(-1))	-4.372	-1.123
D(POP(-2))	3.081	0.664
D(TOTALCON(-1))	0.001	0.013
D(TOTALCON(-2))	0.151	1.342
D(CPI(-1))	-0.452	-1.172
D(CPI(-2))	-0.471	-1.480
D(CONCOST(-1))	0.034	0.690
D(CONCOST(-2))	-0.022	-0.621
D(AGENCY(-1))	-0.011	-0.123
D(AGENCY(-2))	-0.090	-0.911
D(D_GFC(-1))	-0.030	-1.362
D(D_GFC(-2))	0.011	0.313
D(D_TRADE(-1))	-0.023	-0.791
D(D_TRADE(-2))	0.023	0.612
D(D_COVID(-1))	-0.011	-0.532
D(D_COVID(-2))	0.002	-0.091
C	5.23E-05	0.017

Notes: 1. The results are the estimates of error correction of short-run dynamic adjustment from VECM. 2. The t-statistics are presented beside the corresponding coefficients. 3. ***p<0.01, **p<0.05, and *p<0.1

Table 8 VEC Residual Serial Correlation LM Tests

Lags	LM-Stat	Prob
1	205.7401	0.0284
2	200.0459	0.0515
3	133.2868	0.9804
4	181.9563	0.2347
5	152.3054	0.8168
6	179.263	0.2798

Notes: Null Hypothesis: no serial correlation at lag order h; Sample: 2006Q1 2025Q3; and Included observations: 76Probs from chi-square with 169 df.

The cumulative sum (CUSUM) stability test for the housing price equation in Figure 11 is used to assess whether the model parameters remain stable over time. The plotted CUSUM values fluctuate around the zero line throughout the sample period, thus indicating no clear systematic drift in the residuals. Although there are periods with noticeable spikes and volatility, the movements do not show a persistent trend or structural break. Overall, the pattern suggests that the model is relatively stable over time, with no strong evidence of parameter instability in the housing price equation. The temporary fluctuations observed may reflect short-term shocks or external events, but do not appear to compromise the overall stability of the model.

4.4.4 Findings from Vector Error Correction Model

The VECM findings suggest that HP significantly influence certain macroeconomic variables, particularly the real estate services and construction sectors. In the long run, HP positively affect AGENCY, inflation (CPI), and construction costs. On the other hand, HP negatively impact TOTALCON and housing loan interest rates. However, HP do not have a statistically significant effect on GDP, FLOOR, MORT, or population growth in the long term.

In the short run, HP exhibit mean-reverting behavior, with their effects on TOTALCON delayed but positive. This could be attributed to rising property prices which deter new construction. Additionally, GDP and inflation do not show significant responses to short-term fluctuations in HP.

4.5 Impulse Response Function

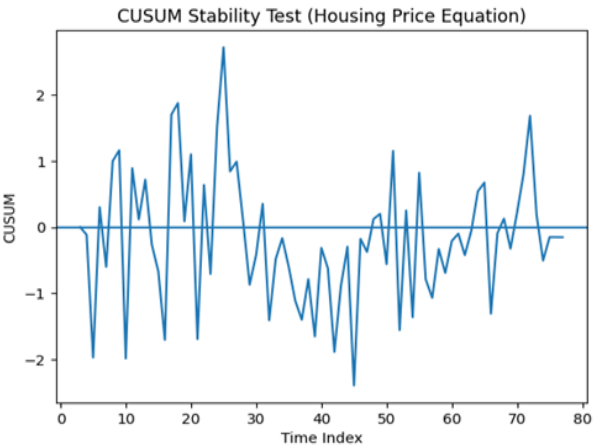
The IRF is commonly used in time series analysis to describe how a shock to one variable affects another variable over different periods of time. Using the obtained estimations, this study calculates IRFs for housing price shocks, thus providing a more informative picture of the dynamic effects on the national economy. A graphical representation of the IRF values from the developed VECM is presented, along with 90% and 95% confidence intervals.

Table 9 VEC Residual Normality Tests

Component	Skewness	Chi-sq	df	Prob.	Kurtosis	Chi-sq	df	Prob.	Jarque-Bera	df	Prob.
1	-0.6569	5.4658	1	0.0194	5.3449	17.4116	1	0.0000	22.8774	2	0
2	-0.3905	1.9313	1	0.1646	3.3979	0.5014	1	0.4789	2.4326	2	0.2963
3	0.276	0.9651	1	0.3259	3.2569	0.2090	1	0.6475	1.1741	2	0.5560
4	2.4472	75.8554	1	0.0000	15.6049	503.1362	1	0.0000	578.9916	2	0.0000
5	-1.3017	21.4636	1	0.0000	14.1910	396.5908	1	0.0000	418.0544	2	0.0000
6	5.4425	375.1951	1	0.0000	41.3998	4669.387	1	0.0000	5044.5820	2	0.0000
7	0.351	1.5605	1	0.2116	3.0620	0.0122	1	0.9121	1.5727	2	0.4555
8	-0.7082	6.3526	1	0.0117	4.4815	6.9499	1	0.0084	13.3026	2	0.0013
9	0.1869	0.4426	1	0.5059	2.6718	0.3412	1	0.5592	0.7837	2	0.6758
10	0.2479	0.7786	1	0.3776	3.3063	0.2970	1	0.5858	1.0756	2	0.5840
11	-0.6129	4.7577	1	0.0292	3.8305	2.1842	1	0.1394	6.9419	2	0.0311
12	0.1016	0.1308	1	0.7176	3.8837	2.4727	1	0.1158	2.6035	2	0.2721
13	-0.6941	6.1022	1	0.0135	5.4858	19.5673	1	0.0000	25.6694	2	0.0000
Joint		501.0014	13	0.000		5619.0606	13	0.0000	6120.0615	26	0.0000

Notes: Orthogonalization: Cholesky (Lutkepohl); Null Hypothesis: residuals are multivariate normal; Sample: 2006Q1 2025Q3; and Included observations: 76.

Figure 11 CUSUM Stability Test



4.5.1 Impulse Response of Housing Prices on GDP

In Figure 12, the IRF of GDP to a shock in HP shows a positive but fluctuating response over the observed periods. Initially, GDP reacts positively to a housing price shock, thus indicating that increases in HP may stimulate economic activity in the short term, possibly through wealth effects or increased investment in related sectors. However, this response is not stable and exhibits noticeable oscillations across subsequent periods, with peaks and declines occurring intermittently. Although the magnitude of the response remains relatively small, the consistently positive values suggest that housing price shocks have a limited but persistent effect on GDP. Over time, the impact gradually stabilizes at a modest level, which implies that while HP can influence economic output, their effect is not strong or sustained enough to drive long-term economic growth.

4.5.2 Impulse Response of Housing Prices on TOTALCON

In Figure 13, the IRF of HP to a shock in GDP shows a positive but highly volatile pattern over time. Following an initial positive response, HP fluctuate significantly across the different periods, with sharp increases and decreases indicating instability in the short-run transmission from GDP to the housing market. Although the responses remain mostly positive, their magnitude varies considerably, which suggests that economic growth does not translate into consistent or stable increases in HP. Over time, the effect gradually diminishes and stabilizes at a relatively low level, thereby indicating that GDP shocks have only a limited and short-lived impact on HP. This pattern reinforces the notion that HP are not strongly driven by overall economic growth, but instead respond weakly and inconsistently to changes in GDP.

Figure 12 Impulse Response of GDP

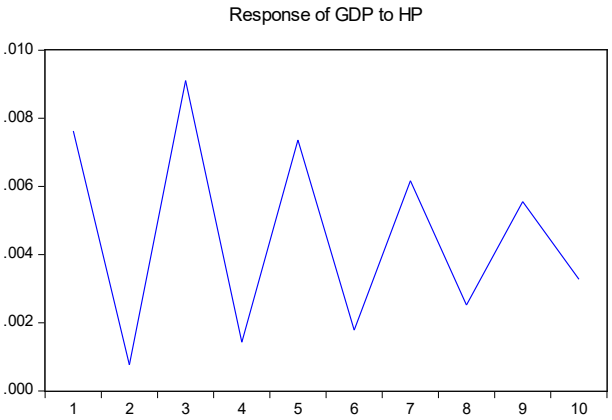
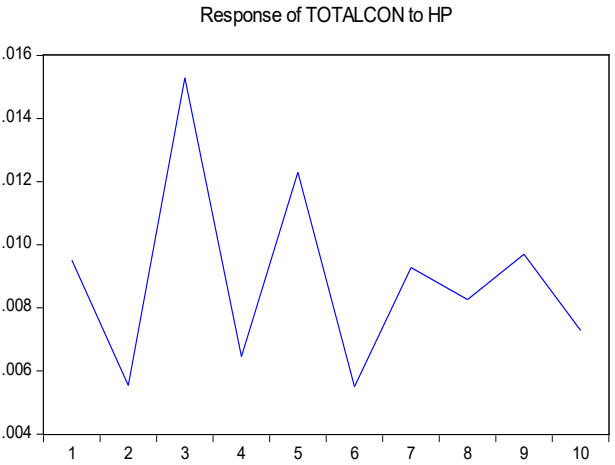


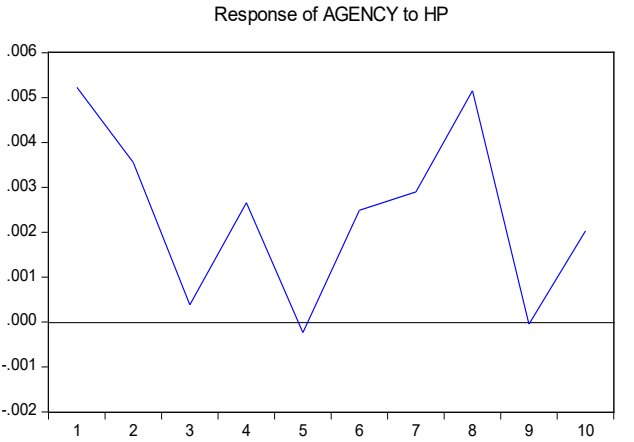
Figure 13 Impulse Response of TOTALCON



4.5.3 Impulse Response of Housing Prices on AGENCY

In Figure 14, the impulse response of AGENCY to an HP shock shows a positive but highly volatile pattern. While rising HP initially stimulate agency activity, the response quickly fluctuates and becomes unstable across periods. The effect is inconsistent, occasionally turning negative, suggesting that higher HP may also reduce transaction activity. Overall, the impact is short-lived and weak, indicating that housing price shocks have limited and unstable effects on the real estate service sector.

Figure 14 Impulse Response of AGENCY



4.5.4 Findings of Impulse Response Function

The impulse response analysis reveals that housing price shocks have generally positive but limited and unstable effects on key economic variables. GDP responds positively to housing price shocks, particularly in the short run, thus suggesting that increases in HP may stimulate economic activity through wealth effects or related investments. However, this impact is relatively small and fluctuates over time, which indicate that it is not strong or sustained enough to support long-term economic growth.

The interaction between HP and TOTALCON also shows an unstable pattern. Although there are periods of positive response, the fluctuations and eventual decline suggest that economic growth does not consistently translate into increased housing market activity, and the overall effect remains weak and short-lived. Similarly, AGENCY initially benefit from rising HP, but the response is highly volatile and occasionally turns negative, thus reflecting sensitivity to market conditions and transaction volume. Overall, the results suggest that while housing price shocks can influence economic activity in the short term, their effects are inconsistent, limited in magnitude, and diminish over time, which indicate a weak and unstable transmission mechanism to the broader economy.

4.6 Variance Decomposition

Variance decomposition is a technique used to partition the total variance of a dependent variable into components attributable to various independent variables or shocks. This method helps to provide an understanding of the relative importance of different factors that influence the variability in the outcome of interest.

4.6.1 Forecast Error Variance Decomposition of GDP

In Table 10, the variance decomposition results show that GDP is primarily driven by its own shocks in the short run, which account for about 84% of its variation in the first period, but this influence declines to around 42% over time. HP emerge as a consistent secondary factor, which contribute roughly to 16–20% of the GDP variation in the long run, thus indicating a moderate and persistent influence. Structural shocks, particularly the global financial crisis (D_GFC), become increasingly important, which explain up to 19% of the GDP fluctuations in later periods, while the COVID-19 shock has a smaller but stable effect of around 3%. Other variables, including population, construction, and financial factors, contribute only modestly. Overall, GDP becomes less self-driven over time, with HP and major external shocks playing a more significant role in explaining its long-term variation.

4.6.2 Forecast Error Variance Decomposition of TOTALCON

In Table 11, the variance decomposition results for TOTALCON show that it is largely driven by its own shocks in the short run, which account for about 68% of its variation in the first period. Although this influence declines slightly over time, it remains dominant at around 60–61% in the later periods, thus indicating strong persistence in construction activity. HP play a notable secondary role, with their contribution increasing from about 5% initially to around 11% over time, which suggest that housing price dynamics have a moderate and growing influence on construction activity. Structural shocks, particularly the global financial crisis (D_GFC), also contribute significantly in the early periods (around 14%) but gradually decline to about 6%, which indicate that their impact weakens over time. Financial conditions, such as interest rates (IRATE), and demographic factors like POP, consistently contribute around 4–6%, while GDP and other variables have relatively minor effects. Overall, the results suggest that TOTALCON is primarily self-driven, with HP and external shocks playing important but secondary roles in shaping its variation over time.

4.6.3 Forecast Error Variance Decomposition of AGENCY

In Table 12, the variance decomposition results show that AGENCY are primarily driven by their own shocks, which account for over 50% of the variation across the different periods of time. Mortgage lending and TOTALCON are the main external contributors, which indicate that agency activity is closely linked to credit conditions and market transactions. HP have only a minor influence, and contribute around 1–2%, while structural shocks such as the global financial crisis and COVID-19 play a limited role. Overall, agency activity is largely self-driven and more influenced by financial and market factors than housing price movements.

Table 10 Forecast Error Variance Decomposition of GDP

Period	S.E.	HP	GDP	FLOOR	D_TRADE	D_GFC	D_COVID	IRATE	MORT	POP	TOTALCON	CPI	CONCOST	AGENCY
1	0.01	16.08	83.91	0	0	0	0	0	0	0	0	0	0	0
2	0.02	11.42	65.66	0.12	1.33	9.18	3.17	0.15	0.25	4.21	1.04	0.83	2.55	0.06
3	0.02	21.02	53.45	0.84	1.49	10.21	2.64	0.15	0.22	3.42	2.38	0.77	3.37	0.05
4	0.02	18.42	50.25	0.73	2.12	13.65	3.17	0.62	0.51	4.1	2.37	0.71	3.19	0.17
5	0.03	20.3	45.64	1.15	1.7	16.08	3.16	0.63	0.66	3.45	2.99	0.64	3.45	0.14
6	0.03	19.04	44.39	1.34	2.07	16.55	3.25	0.63	0.68	4.22	3.4	0.61	3.68	0.15
7	0.03	20.43	43.23	1.54	1.9	16.82	3.06	0.56	0.69	4.15	3.47	0.57	3.39	0.18
8	0.03	19.12	43.71	1.51	1.87	17.86	3.09	0.86	0.65	3.97	3.32	0.66	3.2	0.17
9	0.03	19.58	42.04	1.6	1.76	18.46	3.19	0.79	0.67	3.92	3.93	0.61	3.3	0.15
10	0.03	19.18	41.92	1.67	1.73	18.92	3.15	0.75	0.69	4.16	3.83	0.58	3.28	0.15

Table 11 Forecast Error Variance Decomposition of TOTALCON

Period	S.E.	HP	GDP	FLOOR	D_TRADE	D_GFC	D_COVID	IRATE	MORT	POP	TOTALCON	CPI	CONCOST	AGENCY
1.00	0.04	4.58	1.92	0.10	0.04	14.29	0.23	7.74	1.07	1.59	68.44	0.00	0.00	0.00
2.00	0.05	4.65	2.78	2.67	0.53	13.09	0.24	8.12	1.04	2.93	63.02	0.73	0.19	0.01
3.00	0.06	10.90	3.71	2.21	0.43	10.64	0.27	7.69	4.41	2.44	56.25	0.59	0.16	0.30
4.00	0.06	10.33	3.41	1.90	0.37	9.02	0.58	7.05	4.24	4.06	56.90	0.56	0.34	1.26
5.00	0.07	11.34	2.73	1.51	0.32	7.57	0.46	6.12	3.92	3.99	59.92	0.51	0.29	1.32
6.00	0.07	10.94	2.82	1.53	0.53	6.97	0.51	6.03	4.32	4.01	60.09	0.50	0.48	1.27
7.00	0.08	11.05	3.07	1.37	0.46	6.53	0.49	6.10	4.62	4.03	60.20	0.51	0.42	1.14
8.00	0.08	11.22	2.90	1.52	0.49	6.36	0.45	6.31	4.58	4.28	59.73	0.49	0.47	1.20
9.00	0.08	11.46	2.76	1.47	0.47	6.14	0.42	6.02	4.48	4.15	60.55	0.46	0.49	1.13
10.00	0.09	11.40	2.89	1.39	0.45	5.77	0.39	5.94	4.48	4.08	61.10	0.54	0.49	1.09

Table 12 Forecast Error Variance Decomposition of AGENCY

Period	S.E.	HP	GDP	FLOOR	D_TRADE	D_GFC	D_COVID	IRATE	MORT	POP	TOTALCON	CPI	CONCOST	AGENCY
1.00	0.04	1.78	4.40	4.03	0.09	0.01	0.08	0.31	14.63	0.57	3.23	11.55	0.80	58.52
2.00	0.04	2.16	5.18	3.39	0.28	0.93	1.17	1.20	13.10	0.50	8.51	9.92	4.28	49.37
3.00	0.05	1.55	3.71	4.62	1.17	0.96	0.94	0.91	11.81	0.44	6.32	8.54	3.29	55.73
4.00	0.05	1.66	3.42	5.40	1.25	3.15	1.22	0.88	11.70	1.40	6.80	9.08	3.02	51.00
5.00	0.06	1.22	2.72	4.66	1.38	2.33	0.91	0.68	8.81	1.76	5.74	9.49	2.23	58.06
6.00	0.06	1.27	2.50	5.65	1.51	2.59	0.88	2.01	8.37	1.99	8.18	9.13	2.49	53.41
7.00	0.07	1.30	2.32	5.03	1.86	2.71	0.85	1.87	7.55	1.86	7.26	8.86	2.43	56.10
8.00	0.07	1.75	2.18	5.81	1.93	3.27	0.82	1.83	7.15	3.00	7.90	9.19	2.37	52.82
9.00	0.08	1.52	2.02	5.76	1.95	3.07	0.71	1.59	6.35	2.72	7.12	9.54	2.06	55.59
10.00	0.08	1.52	1.94	6.51	2.12	3.18	0.68	2.09	6.14	2.94	7.89	9.40	2.28	53.30

4.6.4 Findings from Forecast Error Variance Decomposition

The forecast error variance decomposition results indicate that GDP, TOTALCON, and real estate agency services are largely driven by their own shocks in the short run, but external influences become more relevant over time. HP emerge as a consistent secondary factor, which have a moderate and persistent influence on GDP and TOTALCON, while their impact on real estate agency services remains minimal. Structural shocks, particularly the global financial crisis, play a significant role in explaining GDP fluctuations and, to a lesser extent, construction activity, though their effects diminish over time. Financial conditions and demographic factors contribute modestly across all variables. Overall, the findings suggest that while these sectors are primarily self-driven, HP and major external shocks play important but varying roles in shaping their long-term dynamics, with the strongest influence observed in GDP and construction rather than real estate service activities.

4.7 Discussion of Findings

The econometric analysis conducted in this study highlights the complex relationship between housing prices and macroeconomic variables in Taiwan from 2006Q1 to 2025Q3. The findings from the VECM, IRF, and variance decomposition provide critical insights into how housing price shocks influence economic factors such as GDP, TOTALCON, and real estate agency services. These results are essential in assessing whether the housing sector is a true engine of economic growth or if its expansion primarily leads to inefficiencies and affordability concerns.

4.7.1 Impact of Housing Prices on Economic Growth

The empirical findings from the VECM, impulse response analysis, and variance decomposition indicate that HP have a limited and indirect impact on economic growth in Taiwan. The VECM results show that, in the long run, HP are not significantly linked to GDP (coefficient = 0.243, t = 0.45), which suggests a weak structural relationship between the housing market and overall economic performance. Instead, HP are more strongly influenced by demographic and structural factors such as POP (t = 4.39), inflation (t = 8.31), housing supply (FLOOR, t = 6.30), and construction activity (TOTALCON, t = 6.91), as well as financial conditions, particularly interest rates (t = -12.15). In the short run, HP are largely self-driven, with limited responsiveness to macroeconomic variables.

The impulse response analysis further shows that GDP responds positively to housing price shocks; however, the effect is small, fluctuating, and diminishes over time, thereby indicating that housing price increases do not generate sustained economic growth. This is supported by the variance decomposition

results, where HP account for only about 16–20% of the GDP variation in the long run, compared to the own shocks of GDP and other factors.

Moreover, the structural dummy variables reveal that major external shocks, such as the global financial crisis (coefficient = -0.082, t = -3.38) and COVID-19 pandemic (coefficient = -0.053, t = -3.29), have significantly negative impacts on HP and play a more substantial role in influencing economic fluctuations than housing price movements themselves. Overall, these results suggest that HP do not act as a strong engine of economic growth, but instead have a modest and indirect influence, with economic dynamics being more strongly driven by structural and external factors.

4.7.2 Housing Prices and Construction Sector

The VECM, impulse response analysis, and variance decomposition indicate that HP have a moderate but unstable relationship with the construction sector in Taiwan. In the long run, HP are positively associated with construction activity, as TOTALCON shows a strong and significant relationship with HP (coefficient = 2.491, t = 6.91), which suggests that expansion in construction and housing development is linked to rising prices. However, this relationship reflects co-movement rather than a clear causal effect from HP to construction. In the short run, the influence of HP on construction is weak and inconsistent. The impulse response results show that construction initially responds positively to housing price shocks, but the effect quickly becomes volatile and oscillates over time, thereby indicating an unstable transmission mechanism. This suggests that increases in HP do not consistently stimulate construction activity in the short term.

The variance decomposition results further support this finding, and show that HP explain for only a modest share of the construction variation, which increases from about 5% to around 11% over time, while construction remains largely driven by its own shocks (around 60%). Structural shocks, particularly the global financial crisis, have a higher short-term impact on construction activity, although their influence declines over time.

Overall, the results suggest that while HP and construction activity are positively related in the long run, the impact of HP on the construction sector is limited, unstable, and not a dominant driving force. Instead, construction activity is primarily influenced by its own dynamics and broader economic conditions.

4.7.3 Speculative Behavior and Housing Affordability

A crucial issue raised in the introduction is whether the high homeownership and vacancy rates in Taiwan indicate a speculative-driven housing market. The VECM results show that HP are largely self-driven in the short run, with significant dependence on their own past values and weak responsiveness to

macroeconomic fundamentals. This suggests the presence of price persistence and momentum, which are commonly associated with speculative dynamics. In the long run, HP are not significantly linked to GDP, but are strongly influenced by factors such as population, inflation, and supply conditions, thus indicating that price increases may not be supported by real economic growth. The impulse response analysis further supports this interpretation, as HP respond weakly and inconsistently to GDP shocks, while still exhibiting internal fluctuations. This indicates that price movements are not fully grounded in economic fundamentals. Additionally, the variance decomposition results show that HP play only a moderate role in explaining for economic activity, while being influenced by their own dynamics and external shocks.

4.7.4 Policy Implications and Considerations

The results consistently show that HP only have a limited and indirect impact on economic growth, while being more strongly influenced by demographic factors, supply conditions, and financial variables such as interest rates. This suggests policies that rely on the housing market as a primary engine of economic growth may be ineffective and could lead to imbalances. The impulse response and variance decomposition analyses further indicate that housing price shocks do not generate strong or sustained effects on GDP or construction activity, while structural shocks, such as the global financial crisis and COVID-19 pandemic, play a more significant role in shaping economic fluctuations. This highlights the importance of macroeconomic stability and resilience over reliance on asset price appreciation.

Given these findings, policymakers should prioritize measures that address structural issues in the housing market, particularly housing affordability and supply constraints. Policies aimed at stabilizing interest rates, improving housing supply, and enhancing market transparency may be more effective in promoting sustainable development. In addition, monitoring speculative behavior and implementing targeted regulations in the housing sector could help to mitigate price volatility and reduce affordability pressure.

Overall, the evidence suggests that a balanced policy approach which focuses on long-term economic fundamentals rather than short-term housing price growth, is essential for achieving sustainable economic development and housing market stability in Taiwan.

5. Conclusion

This study reexamines the impact of HP on economic growth in Taiwan by using a VECM, impulse response analysis, and variance decomposition. The results consistently show that HP have a limited and indirect influence on economic growth. In the long run, HP are not significantly linked to GDP but

are instead driven by demographic factors, housing supply, and financial conditions such as interest rates. In the short run, HP are largely self-driven, with minimal responsiveness to macroeconomic variables.

The impulse response analysis indicates that while housing price shocks generate a positive response in GDP, the effect is small, unstable, and diminishes over time. Similarly, the variance decomposition results show that HP only contribute moderately to GDP fluctuations, while structural shocks, particularly the global financial crisis, play a more substantial role in explaining for economic variation. In addition, the construction sector and real estate services are found to be influenced more by their own dynamics and financial conditions than housing price movements.
Overall, the findings suggest that the housing market does not function as a strong engine of economic growth in Taiwan. Instead, HP reflect the underlying economic conditions and are influenced by structural and external factors, thus raising concerns about speculative behavior and housing affordability.

Policymakers should reduce reliance on the housing sector as a driver of economic growth and instead focus on more productive sectors. Improving housing affordability through increased supply and better market regulation is essential. Financial policies should carefully manage interest rates and credit conditions to prevent excessive price volatility. In addition, monitoring speculative activity and strengthening resilience to external shocks are important for maintaining housing market stability and supporting sustainable economic development.

This study has several limitations. First, the analysis is constrained by data availability, as some variables may not fully capture all aspects of the housing market, particularly informal or unobserved factors. Second, the model is based on a partial macroeconomic framework and does not incorporate all potential determinants of HP and economic growth, such as policy interventions or regional variations. Third, although structural dummy variables are included to account for major shocks, including the global financial crisis and COVID-19 pandemic, they may not fully capture the complexity and duration of these events. Finally, the use of aggregate national data may obscure the regional differences in the housing market of Taiwan, thus limiting the generalizability of the findings. Future research could address these limitations by incorporating more detailed data and expanding the model specifications.

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