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BOOMS, BUSTS AND CO-MOVEMENTS: DYNAMIC INTERACTIONS AMONG PROPERTY, EQUITY AND CREDIT MARKETS IN MALAYSIA

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ABSTRACT

This study investigates the complex relationships between property, equity and credit markets in Malaysia from 1994 to 2024. Using wavelet coherence analysis, we examine the co-movements and causal relationships between these markets, considering both time and frequency domains. Preliminary findings, based on conventional approaches, indicated a bi-directional causality between property and equity markets. The comprehensive wavelet analysis revealed significant correlations between property and equity markets, particularly during specific periods such as 2000–2012 and 2020–2024. Furthermore, the results showed that the magnitude and trend of these associations varied across time and frequency intervals, highlighting the possibility of varying diversification advantages for investors with different investment timeframes. Partial wavelet coherence analysis highlights the markets' sensitivity to basic economic fundamentals during pandemics and crises. Our findings have significant implications for both short-term traders and long-term investors, emphasising the important role of the wealth effect and credit-price effect in shaping equity-property relationships.

Keywords: Property market, Equity market, Credit market, Wavelet coherence, Financial linkages

INTRODUCTION

Understanding the dynamic interplay between property, equity and credit markets is increasingly critical for financial stability and investment strategies in emerging economies. While much of the literature has focused on developed economies, the dynamics remain underexplored within such emerging markets as Malaysia, where the property sector plays a significant socio-economic role and financial systems are largely bank-based. Malaysian residential property prices have emerged as a crucial topic in policy and social structure analysis due to their role in creating stability and wealth for households and individuals (Dietz & Haurin, 2003; Rahman, 2010; Sukor et al., 2020; Kartal et al., 2023; Xu & Zhang, 2023; Sukor et al., 2025a; 2025b). From a cultural and psychological perspective, residential property is a key investment tool that reflects social and economic standing (Kim, 2004; Liang et al., 2016; Ngoc, 2023). Logan and Molotch (2007) highlighted that the tangible use of a place is intimately linked to its psychological employment. This issue is becoming increasingly apparent in many countries, especially in emerging Asian economies (Lin & Lin, 2011; Chaudhury et al., 2020; Umar & Olson, 2022). Residential real estate markets are seen as crucial moderating factors in stabilising the national economy due to their wealth effects (Kok et al., 2018; Fan et al., 2019; Guren et al., 2021). Understanding the nexus of the property market with various other financial markets is essential for assessing property liquidity and diversification opportunities for property investors. Financial systems significantly influence housing prices, with global financial crises often triggering cyclical fluctuations (Rubio & Carrasco-Gallego, 2014; Choi & Park, 2018). Global housing price coordination and overconfidence further contribute to these dynamics, leading to subprime lending and financial crises after housing price bubbles (Hoesli, 2020; Lambertini et al., 2013; Reinhart & Rogoff, 2013; Case et al., 2014; Guren et al., 2021). Macroeconomic variables, such as GDP growth, also affect financial and property markets, as exemplified by Malaysia's rising housing prices and affordability concerns (Rangel et al., 2019; Zulkarnain & Nawi, 2024).

The co-movement of Malaysian house-price indices raises questions about potential linkages with other markets. The concept of ripple shocks – introduced by Barros et al. (2012) – emphasises the need to examine how shocks transmit through property markets, potentially leading to bubble bursts and financial crises. This phenomenon, known as spatial multiplier effects in spatial economics (Cohen, 2010), stresses the broader property market's interconnectedness with its regional counterparts (Meen, 1996; Ma & Liu, 2013; Thaker & Ariff, 2020). These findings have stimulated significant discussions among policymakers, the public, and academics in Malaysia, whereby recent studies examining the relationship between property and other financial markets can be broadly categorised into three areas.

First, studies have employed both linear and non-linear co-integration methods, such as fractional, Johansen, and threshold co-integration techniques, to determine the segmentation or integration of selected markets (Liow & Yang, 2005; Liow, 2006; Tsai et al., 2012; Banti & Phylaktis, 2019), which is crucial for industry practitioners and policymakers. Market segmentation suggests that the assets provide investors with risk diversification opportunities under portfolio management, while market integration indicates significant possibilities of asset substitution among property and other financial markets (Wilson et al., 1996). Second, various causality tests have been used, including vector autoregressive (VAR), vector error correction models (VECMs) and threshold error correction models to examine the causal relationship between property and other markets (Okunev et al., 2000; Su et al., 2011; McMillan, 2012; Tsai et al., 2012; Abuzayed et al., 2020; Nguyen et al., 2022). Understanding the inherent causality and its nature can offer valuable insights to investors and policymakers, allowing them to proactively forecast future market performance through the dual transmission channel of the wealth and credit-price effects (Chen, 2001; Kapopoulos & Siokis, 2005). Wealth effect theory suggests that rising stock prices can increase property demand and prices, while the theory of credit-price effect posits that increasing property prices lead to higher stock market prices. Finally, most prior research has employed simple correlation analysis to examine the potential relationship between the property and other markets (Worzala, 1992; Eichholtz & Hartzell, 1996; Quan & Titman, 1999), revealing the synchronicity of different markets and signalling potential diversification benefits for investors.

The credit market serves as a critical transmission channel, connecting the property and equity markets and influencing mortgage access, home affordability, business investment, and, ultimately, market liquidity and asset pricing (Sornette & Woodard, 2010; Deng et al., 2017). Credit expansion or tightening directly affects corporate leverage and household borrowing, mitigating risks during financial cycles. In times of crisis, credit flow disruptions can intensify vulnerabilities across both property and equity markets (Akin et al., 2014; Vogiazas & Alexiou, 2017). Therefore, studying the dynamic linkages among these three markets can provide a more holistic understanding of market behaviour, risk transmission and diversification potential. It also offers valuable insights for policymakers and regulators tasked with safeguarding macro-financial stability, particularly within an evolving economic landscape, such as Malaysia.

Previous research has primarily employed conventional time-based statistical methods, such as correlation analysis, causality tests, and co-integration models, to examine the relationship between the property market and other financial markets. However, these approaches often overlook the evolving nature of market interaction. In particular, they fail to capture the time-varying and frequency-dependent characteristics of financial co-movements, which are increasingly relevant in today's dynamic investment landscape (Liow, 2012; Fan et al., 2019; Costa et al., 2022; Karamti & Belhassine, 2022). Understanding these dynamics is crucial for investors and policymakers to effectively assess portfolio risks and returns due to their influence on diversification and market prediction accuracy. To overcome the limitations of traditional models, this study employs wavelet coherence analysis, which enables the simultaneous examination of time and frequency relationships. This method provides a more granular and intuitive view of how financial linkages evolve, offering valuable insights into short- and long-term co-movements, specifically between property, equity, and credit markets. The Malaysian context – characterised by its emerging market dynamics, strong bank-property nexus and policy sensitivities – offers a compelling case for such an approach. By integrating wavelet analysis into the framework, this article offers a novel empirical contribution to the literature on financial interdependencies and market resilience, extending the methodological frontier beyond traditional approaches.

Further to analysing the dynamic interactions among the property, equity and credit markets, this study also incorporates the regulatory and policy environment to provide a more contextualised understanding. In particular, it examines the role of major housing regulations, such as the Strata Management Act 2013 and the National Housing Policy 2018, which influence market behaviour, investor confidence and overall property market dynamics. Strata Management Act 2013 reformed the structures of property ownership and maintenance through the enhancement of the management bodies, making strata title management more comprehensible and enhancing the dispute resolution system between the owners of units. The changes boosted investor confidence in high rises and mixed-use developments, attracted more people to take part in the property market and led to an increase in the upward prices in the strata segment. In addition, the Act also raised compliance and maintenance costs of developers and owners that indirectly affected pricing structures and market affordability. Similarly, the National Housing Policy 2018 aims to enhance housing affordability and inclusiveness by promoting the development of more affordable housing units, expanding rent-to-own schemes, and strengthening access to housing finance. Although the policy was intended to stabilise prices by addressing supply shortages, it also stimulated demand by improving access to financing and introducing government-supported incentives. The National Housing Policy 2018 consequently influenced price dynamics indirectly by narrowing the affordability gap, increasing transaction volumes in the mid- and low-cost segments, and shaping investor expectations of long-term property value appreciation. By considering these institutional frameworks, the study offers a more comprehensive perspective on how regulatory interventions shape inter-market linkages.

LITERATURE REVIEW

The dynamic interplay between property, equity and credit markets is fundamental to understanding asset price movements, capital flows and the transmission of economic shocks, particularly in emerging economies. These markets are closely linked through investor behaviour, credit availability and shared macroeconomic fundamentals, such as interest rate and GDP growth. This section reviews the existing literature on the relationships between property and equity markets, as well as between property and credit markets.

Property and Equity Markets

Real estate and stock market integration are well-researched academic fields, yielding diverse conclusions through various co-integration techniques. Prior research has argued that the property and equity markets are interconnected via two mechanisms (Kapopoulos & Siokis, 2005). The first, commonly known as the wealth effect, suggests a positive correlation between equity and property market performance, and vice versa. When stock market returns exceed expectations, households experience increased wealth. According to Markowitz (1957), investors can rebalance their portfolios by selling equities and buying other assets, such as property. As both consumption and investment goods, residential properties become attractive options. The second mechanism is the credit-price effect, which focuses on firms' balance sheet assets and their ability to use these as collateral for loans to expand operations and increase profits, which in turn drives equity market performance. When residential and commercial property values significantly rise, firms holding these assets experience increased value, providing additional collateral for securing loans. This expanded borrowing fuels business growth, ultimately boosting overall stock market value. Therefore, the credit-price effect suggests a causal relationship between property and equity markets. Furthermore, as firms expand, demand for commercial and residential properties increases, driving up property prices.

Empirical investigations on the dominance of the wealth effect or credit-price effect have yielded mixed results. Using the capital asset pricing model, Jorion and Schwartz (1986) and Liu et al. (1990) found evidence of US property and equity market segmentation, attributed to information asymmetries within the real estate market. Geltner (1990) corroborated this segmentation hypothesis by highlighting differences in return volatility between the two markets. Conversely, Ambrose et al. (1992) argued for an interconnected property and equity market. Using re-scaled range analysis, they questioned the segmentation hypothesis, suggesting a potential non-linear relationship in its place. Myer and Webb (1993) further supported this view by identifying co-integration between common stocks and real estate investment trusts (REITs). Similarly, Liow (2006) employed the autoregressive distributed lag (ARDL) approach to demonstrate significant co-integration between various stocks, including those related to property, and the property market in Singapore. Okunev and Wilson (1997) introduced fractional co-integration, using a stochastic trend instead of the deterministic drift employed by Ambrose et al. (1992), finding evidence of a fractional integration relationship between US property and equity markets. This innovative approach gained traction, with subsequent literature adopting non-linear fractional co-integration analysis.

Wilson and Okunev (1999) extended this method to the UK, US and Australian markets, identifying a segmented relationship in the UK and US, but partial integration in Australia. McMillan (2012) employed exponential smooth transition models to analyse non-linear causality, demonstrating a one-way relationship from property to equity prices in the UK and the US, consistent with the credit-price effect. Shirvani et al. (2012) also found evidence to support a causal relationship from residential property prices to US equity prices, while Kapopoulos and Siokis (2005), exploring the relationship between stock and real estate prices in Greece, supported the wealth effect hypothesis for property prices only in Athens. Bouchouicha (2013) employed a non-linear Markov switching model to investigate the connection between UK and US residential property sectors and equity markets, finding a predominant credit-price effect in both countries. Jiang et al. (2017) applied Granger causality tests and VAR models across six major global markets, highlighting the increased interconnection between equity and property markets following the global financial crisis.

Based on nonparametric analyses, Aye et al. (2013) unexpectedly observed a bidirectional causal relationship between real housing and stock prices. In contrast, Ibbotson and Siegel (1984) and Eichholtz and Hartzell (1996) discovered an inverse relationship between these markets in Canada, the UK, and the US, whereas Worzala (1992) found a direct relationship in the UK. More recently, Nguyen et al. (2022) examined connectivity dynamics across the profitability of the securitised property, direct property, and equity markets. Using the connectivity index method, their results revealed a high level of interdependence, which significantly increased during the global financial crisis.

While most existing studies have incorporated time-varying components, they have tended to overlook the frequency-varying aspects of the property–equity relationship. Emphasising the time-varying correlation between property and equity markets, Zhou (2010) pioneered the use of wavelet analysis to examine co-movements among six global property markets, finding strong correlations for Singapore, Hong Kong and Japan. Abuzayed et al. (2020) investigated the co-movement between European equity and real estate markets, revealing significant changes in correlation coefficients during economic and financial crises.

Literature on the co-movement of Malaysian housing prices is limited. Hui (2010) used co-integration and causality tests to analyse housing prices in Klang Valley, Pulau Pinang and Johor from 1989 to 2001, finding some level of synchronisation and short-term causality in the movement of property prices in the three regions. Interestingly, Johor's housing prices diverged from those of other regions in the long run. Lean and Smyth (2013) expanded the analysis to all Malaysian states, investigating ripple effects across five property price indices (semi-detached, detached, terrace, aggregate and high-rise properties). Using univariate and panel Lagrange multiplier unit root techniques with structural breaks – as suggested by Meen (1999) – they found evidence of ripple effects, particularly in such developed regions as Kuala Lumpur, Johor and Pulau Pinang. Lean and Smyth (2014) examined the wealth and cred-price effects on the Malaysian stock market and REITs using co-integration and Granger causality. Their results revealed that the wealth effect dominated in the short period, while both mechanisms influenced the long-term relationship between the Malaysian property and equity markets. Interdependence between the two markets was evident, with potential negative impacts on the property market from a broader market decline. Finally, Fereidouni et al. (2016) and Thaker et al. (2021) focused on the specific Malaysian regions of Selangor, Johor, Kuala Lumpur and Pulau Pinang, adopting such approaches as impulse response function, VAR, and causality. Their findings support the concept of ripple effects across the regions, with some similarities to Singapore's property market. Majid et al. (2023) examined the impact of interest rates on property and equity markets, documenting the government's efforts and the property–equity connection. REITs further bridge the property and equity markets, offering investors property ownership with equity-like characteristics. This complex interplay warrants further analysis considering various factors, including macroeconomic conditions, interest rate fluctuations, investor behaviour and financial instruments, such as REITs.

While existing studies have successfully identified ripple effects in housing markets, they face limitations due to their inability to capture time-varying dynamics (Rua, 2010). The use of VAR models can also lead to inconclusive results due to potential model misspecification (Teye et al., 2017). Moreover, research on the time-frequency characteristics of co-movements between Malaysian property and equity markets is limited. Consequently, existing studies offer a restricted view of housing price dynamics across various regions in Malaysia's housing market. To address these limitations, this study employs wavelet analysis to capture both time-varying and frequency-varying characteristics of the relationship between Malaysian property and equity markets.

Property and Credit Markets

In recent decades, credit has played a significant role in driving economic growth. However, it has also led to 'credit bubbles' – namely, periods of excessive credit expansion that can trigger major financial crises (Schularick & Taylor, 2012; Jorda et al., 2015; Alessi & Detken, 2018). Several studies have employed various approaches to identify these bubbles, with the credit-to-GDP ratio being a common metric (Anundsen et al., 2016; Vogiazas & Alexiou, 2017; Floro, 2019). Using this approach, Korkmaz et al. (2016) identified credit bubbles in Turkey. However, given the influence of various factors, credit market complexity requires a more granular approach (Buyukkarabacak & Valev, 2010; Anundsen et al., 2016; Alessi & Detken, 2018; Virtanen et al., 2018). Anundsen et al. (2016) divided the credit market into loans to non-financial businesses and loans to non-profit organisations and households, finding that both credit sectors contribute to banking crisis risk, albeit with credit extension to households posing a greater threat. Similarly, Buyukkarabacak and Valev (2010) emphasised the importance of monitoring household credit due to its growing share of total credit and the potential to increase debt burdens without stimulating long-term growth.

Several studies have proposed alternative approaches to analysing credit risk. Similar to Anundsen et al. (2016), Alessi and Detken (2018) recommended separating credit into loans for non-financial firms and households. Roy and Kemme (2012) highlighted the private sector-to-GDP ratio as a key indicator of banking crises, while Virtanen et al. (2018) even proposed three different measures for identifying credit bubbles. Lee et al. (2020) adopted a broader view, examining credit extended to households and non-financial firms as a percentage of GDP, along with equity capital, to identify financial vulnerabilities and potential spillover effects. In light of the above, it is evident that credit bubbles can trigger a bubble effect in property and equity markets, particularly when banks grant excessive credit to the private sector, fuelling a real estate boom in both residential and commercial properties. Further emphasising this complex relationship, Cerutti et al. (2017) found a strong correlation between high household credit and the emergence of housing bubbles. This easy access to credit incentivises buying, thereby raising property prices (Arestis & González, 2014). As home values increase, homeowners can leverage this equity to secure even more credit (Herring & Wachter, 2003; Agnello & Schuknecht, 2011), thus perpetuating the cycle. However, this surge in demand often outpaces the supply of new housing, leading to further price hikes. Caught up in the apparent wealth creation, households might borrow heavily, potentially overlooking the risks involved (Sornette & Woodard, 2010).

Businesses also contribute to property market bubbles. Real estate companies – reliant on property transactions – often leverage credit to expand their holdings, further inflating prices. Other businesses might divert resources from core operations to invest in property for profit or risk mitigation (Deng et al., 2017). These dynamics are exemplified by the Spanish housing bubble of 2005–2010 (Akin et al., 2014), where stricter regulations on banks led to property appraisers overvaluing properties, thereby further inflating prices (Bian et al., 2018). This can create a feedback loop where higher prices lead to greater credit demand, potentially also influencing household borrowing decisions. Vogiazas and Alexiou (2017) supported these observations with their research on seven OECD economies (Australia, Belgium, Canada, Denmark, Norway, Sweden and the UK) from 2002 to 2015. They confirmed the strong correlation between property prices and credit, and identified bank loan expansion as a primary driver of the housing bubble, alongside such factors as real GDP.

The interplay between property and credit markets is crucial for understanding Malaysia's economic dynamics, given their significant contributions to economic growth. Related research has primarily explored property as collateral and its impact on credit risk within Malaysia's banking industry. Trofimov et al. (2018) and Majid et al. (2023) examined how credit configurations affect Malaysian property consumption, underscoring the significance of credit market conditions in shaping residential property prices. Thaker and Ariff (2020) emphasised the impact of property market fluctuations on solvency and credit risk by highlighting the interconnectedness of financial institutions and borrowers. Pillaiyan (2015) contributed to this understanding by analysing the nexus between credit availability and the commercial property sector in Malaysia. Government policies are also instrumental in shaping the dynamics between property and credit markets, with Cerutti et al. (2017) advocating for well-considered policies to maintain equilibrium in these sectors. Building on this, we aim to examine the dynamic linkages between the property and credit markets using wavelet coherence analysis, as a relatively underexplored technique in the context of the Malaysian economy.

DATA AND METHODOLOGY

Data

This section details the data and methodologies used. This study focuses on examining changes in property prices and their co-movement with equity and credit markets, while considering the effect of GDP growth. The research findings aim to identify appropriate mechanisms and policies for stabilising Malaysia's property financing market.

This study examines the changes in Malaysian property prices from 1994 to 2024, during which the property, credit and equity markets all experienced periods of high volatility, crisis and the COVID-19 pandemic. Therefore, it is pertinent to understand how these different market conditions affect Malaysia's property market and how it co-moves with other economic sectors. This study employed quarterly data from multiple sources, including Datastream, the World Bank and the Bank for International Settlements (BIS). Quarterly data were selected because monthly observations for key indicators such as the property and credit market indices are either unavailable or inconsistent over a long sample period. The quarterly frequency provides an optimal balance between temporal resolution and data reliability, allowing the use of robust time-series and wavelet analytical techniques. It also captures meaningful market fluctuations and macroeconomic dynamics over the 1994–2024 period.

The property market was proxied by the Residential Property Price Index (RPPI), sourced from the BIS, which captures overall movements in housing prices and serves as a representative indicator of property market performance in Malaysia. The equity market was represented by the Kuala Lumpur Composite Index, a broad-based stock market index obtained from Datastream. It reflects the performance of leading Malaysian publicly listed companies and serves as a benchmark for investor sentiment and stock market conditions. The credit market was proxied by the Credit Market Price Index, also sourced from the BIS. This index captures developments in the pricing and conditions of credit markets and is essential for understanding the role of credit availability and cost in influencing asset markets. Moreover, annual GDP data collected from the World Bank were included as a control variable to account for macroeconomic conditions and normalise trends across the three financial markets. The inclusion of GDP enabled a more robust interpretation of market dynamics in relation to broader economic growth. All variables were transformed into natural logarithms to address potential heteroskedasticity and dimensional differences.

To maintain a consistent focus on broad market indicators that reflect the aggregate behaviour of the property, equity, and credit markets, REITs and interest rate shocks were omitted from the analysis. While REITs and interest rate do affect property market dynamics, REITs represent a specialised, asset class specific segment of the property market rather than overall market activity and including them would add complexity without materially enhancing the understanding of broad co-movement patterns. Similarly, incorporating interest rate shocks could complicate the model specification without substantially altering the relationships that this study aims to explore.

Research Methodology

We adopted a multi-step methodological approach to examine the dynamic linkages among Malaysia's property, equity and credit markets. The analysis integrated both time-domain and time-frequency domain techniques to ensure robustness, capture structural dynamics and identify co-movement patterns across different time horizons.

First, we used descriptive statistics to understand the distributional characteristics of the selected variables. To ensure the validity of subsequent tests, unit root tests – specifically, the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests – were employed to determine the stationarity properties of the series. Following this, the study employed both the ARDL bounds testing approach and the Johansen co-integration test to detect the existence of long-term equilibrium relationships among the variables.

Moreover, we also integrated the regulatory and policy environment to provide a more contextualised and policy-relevant perspective, specifically the Strata Management Act 2013 and the National Housing Policy 2018, which are known to influence market behaviour and long-term property sector trends. To assess the influence of different economic environments, the ARDL model was further extended by incorporating dummy variables representing crisis periods, such as the Asian financial crisis (January 1998 to December 1999) and the global financial crisis (October 2007 to September 2009). This allowed us to evaluate whether the relationships between the property market and the equity and credit markets are significantly altered during periods of financial stress. The results from these ARDL models highlight structural shifts and deepen our understanding of how macroeconomic uncertainty shapes inter-market dynamics.

Where the Johansen co-integration test confirms the existence of long-run relationships, a VECM is applied to evaluate both the long-run equilibrium adjustments and short-run dynamics. The error correction term within the VECM captures the speed of adjustment back to equilibrium following shocks. Additionally, Granger causality tests examine the directional relationships and transmission mechanisms among the markets, which enable identifying whether movements in one market precede changes in another. These tests serve to inform interpretations of the wealth or credit-price effects, which underpin this study's theoretical framework.

The ARDL and VECM lag structures were determined using multiple information criteria including the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) and Hannan-Quinn Criterion (HQC). The optimal lag was selected based on the criterion that minimises these values while ensuring model stability, absence of autocorrelation and well-behave residuals. This approach provides a robust specification for estimating both the short-run and long-run dynamics among Malaysia's property, equity and credit markets.

This study employed continuous wavelet transform (CWT) and wavelet coherence analysis to complement the time-domain analysis and capture the evolving nature of market co-movements. Wavelet techniques offer a powerful time-frequency perspective, revealing how the strength and direction of market relationships vary over time and across investment horizons (from short- to long-term cycles). Finally, we used partial wavelet coherence (PWC) by controlling for GDP growth to isolate the direct co-movements between financial markets while accounting for broader macroeconomic influences. This approach helps disentangle the intrinsic interactions among market variables from the common influence of economic fundamentals, offering a more precise interpretation of the market linkages. Together, integrating the ARDL, VECM and wavelet-based approaches provides a comprehensive and robust framework. The time-series models provide clear interpretations of average long- and short-run dynamics, while wavelet methods reveal how these relationships evolve across time and frequency, particularly during periods of economic crisis. This triangulated methodology allows for a deeper and more nuanced understanding of Malaysia's financial market interactions. The following section provides a detailed explanation of the wavelet transformation technique.

Wavelet transformation technique

Finance and economics research is witnessing an expansion in the application of wavelet transformation analysis for frequency domain studies. This technique addresses the limitations of conventional Fourier transforms, which suffer from a narrow time window when analysing co-movement at different frequencies (Rua, 2010; Sleziak et al., 2015; Wu et al., 2021). However, wavelet analysis succeeds in extracting high-quality information within a signal at different intervals and scales.

The wavelet transformation technique is a creative approach that decomposes time-series data into essential parts, called "wavelets". These wavelets represent the calculated displacements and distortions of a selected 'mother' wavelet, which are relevant in both the time and frequency domains. This process translates the data into a time-frequency domain, facilitating pattern recognition and trend analysis. Two main versions of wavelet transformations exist: a stationary wavelet transform, also known as the discrete wavelet transform (DWT), and a non-stationary wavelet transform, also called the CWT. Each offers unique benefits: While the DWT excels at noise reduction and data compression, the CWT is adept at feature extraction and identifying recurring patterns (Grinsted et al., 2004; Loh, 2013). Given the need to explore complex relationships between Malaysia's property, equity and credit markets, we used the CWT to uncover correlations and coherencies within the data.

CWT has emerged as a significant wavelet method due to its ability to identify self-similar patterns within data and reveal hidden information (Loh, 2013). Fan et al. (2019) demonstrated CWT's effectiveness in decoding underlying trends in real estate prices across five major Chinese cities. Building on this foundation, our study explores the co-movement between the property, equity and credit markets in Malaysia.

We anticipated that wavelet analysis would uncover novel trends in the time-frequency domain through cross-correlation and coherence analysis. The mother wavelet – represented as a restricted waveform Ψ(t)W(t) – is an important element of the wavelet transform. Unlike its normalised counterpart, the father wavelet (which integrates to one), the mother wavelet integrates to zero, enabling it to inspect signals at higher frequencies with greater precision. Therefore, our approach involves constructing a wavelet function that incorporates a blend of mother and father wavelets. This is achieved through a series of arranged steps involving transformation and scaling, which can be expressed through the following mathematical notations:

$$\psi_{s,k}(t) = \frac{\psi\left(\frac{t}{2^{s}}\right) - k}{2^{\frac{j}{2}}} \tag{1}$$

$$\Phi_{s,k}(t) = \frac{\Phi\left(\frac{t}{2^{s}} - k\right)}{2^{\frac{s}{2}}} \tag{2}$$

In Equations (1) and (2), s = 1, …., S, while S represents the scaling parameter, and k denotes the translation parameter. Additionally, a signal's wavelet transformation can be shown as:

$$\begin{aligned} y(t) = {} & \textstyle\sum_k \theta_{s,k}\phi_{s,k}(t) + \sum_k d_{s,k}(t) + \sum^k d_{s-1,k}\psi_{s-1,k}(t) \\ & \cdots + \textstyle\sum^k d_{1,k}\phi_{1,k}(t) \end{aligned} \tag{3}$$

In Equation (3), $\theta_{s,k} = \int y(t)_{s,k}(t)$ dt is the smooth coefficient, and $d_{s,k} = \int y(t)$ is the detail coefficient. The combined effect of $\theta_{s,k}$ and $d_{s,k}$ explains the contribution of a wavelet function to the overall signal. By following Rua and Nunes (2009) and Kristoufek (2013), the function of the Morlet wavelet can be expressed as:

$$\psi_{u,s}(t) = \frac{1}{\sqrt{s}}\psi\left(\frac{t-u}{s}\right), \varphi(\,.\,)L^2 \subset \mathbb{R} \tag{4}$$

Here, the cross-wavelet spectrum of the Malaysian property price index is compared with those of the equity and credit markets through wavelet coherence analysis. Wavelet coherency is a powerful tool that offers a three-dimensional view, incorporating time, frequency and the strength of correlation within time-series data (Loh, 2013). This method provides an extensive view, capturing variations in both time and frequency of correlation within series, mapped onto a time-frequency space. This significantly improves the assessment and understanding of co-movement, particularly between the three Malaysian markets under review. Moreover, the results obtained through wavelet coherency are superior to those acquired by dynamic conditional correlation and traditional correlation analyses (Liow, 2012; Loh, 2013). Following Torrence and Webster (1999), the wavelet coherency can be estimated through cross-wavelet and auto-wavelet power spectra as follows:

$$CC^2_{(\tau,s)} = \frac{|\,S(s^{-1}W_{x,y}(\tau,s))\,|^2}{S(s^{-1}|\,W_x(\tau,s)\,|^2)S(s^{-1}|\,W_y(\tau,s)\,|^2)} \tag{5}$$

Equation (5) examines the degree of co-movement between two series in time-frequency domains. In the above equation, the value of $CC^2_{(\tau,s)}$ ranges from 0 to 1, where 0 indicates no co-movement and 1 signifies perfect co-movement between the two-time series.

Moreover, we applied PWC to control for the potential influence of macroeconomic conditions – particularly GDP – which might drive co-movements across these markets. PWC enables isolating the direct relationship between two variables while controlling for the effect of a third variable (i.e., GDP), thus providing a more accurate understanding of the underlying dependencies.

Conceptual Framework

The conceptual framework in Figure 1 illustrates the dynamic interrelationship among Malaysia's equity, property and credit markets, with GDP growth incorporated as a macroeconomic control variable. It depicts how movements in the equity market may influence property prices through the wealth effect, while changes in the property prices may in turn influence equity market performance through the credit-price effect. The credit-price effect suggests that rising property values enhance collateral strength, improve borrowing capacity and elevate investor sentiments, ultimately supporting increases in stock market prices. These transmission channels operate within broader economic conditions shaped by business cycles, financial crises and policy interventions. The framework further incorporates financial market interdependence, to capture the bidirectional relationship between the property and credit markets. Changes in credit availability affect property demand, pricing and investment activity, while property market performance feeds back into the credit market through collateral values, loan growth and overall credit risk conditions. This reciprocal influence highlights how disturbances in one market can propagate to the other, reinforcing the interconnected structure of Malaysia's financial system. GDP growth serves as an overarching macroeconomic conditioning variable by shaping income levels, investment behaviour and credit demand across all three markets. Overall, the conceptual model connects the underlying theories, variables and hypotheses, and guides empirical analysis using ARDL, VECM and wavelet-based techniques. It provides a clear bridge between theoretical foundations and empirical implementation and offers deeper insights into market co-movements, interdependencies, and their policy implications.

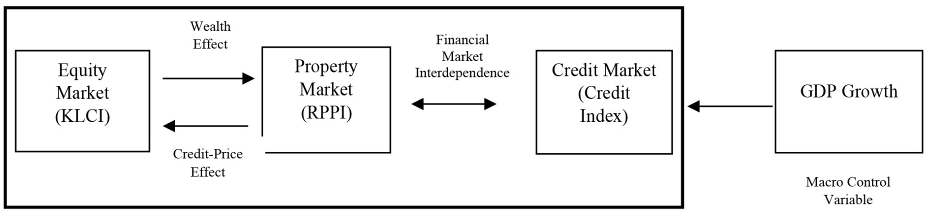

FIGURE 1: Conceptual framework diagram

RESULTS AND DISCUSSION

This section presents the results of various preliminary investigations, including descriptive statistics, unit root tests, co-integration, and Granger causality tests. Table 1 reports the descriptive statistics for the selected variables. As shown, GDP has the highest mean value (10.92), followed by equities (7.07), credit (5.19) and real estate (4.71). The standard deviation findings revealed the credit market as having the lowest volatility, and the real estate sector the highest. All series were positively skewed, suggesting a high probability of positive returns and growth trends. The small kurtosis values for all series indicate distributions with thicker tails than a normal distribution. Finally, the Jarque–Bera (JB) test indicates the non-normal distribution of prices for most variables (at the 5% significance level).

Table 1: Descriptive statistics

Variables	Mean	Max	Min	S.D.	Skew	Kurt	JB
Property	4.7056	5.3487	3.9882	0.4361	0.2611	0.0000	13.09***
LnProperty							
Equity	7.0661	7.5426	5.8945	0.3712	0.0021	0.3566	10.95***
LnEquity							
Credit	5.1879	5.3706	4.9586	0.0927	0.1308	0.2925	3.17
LnCredit							
GDP	10.9188	11.5318	10.105	0.3978	0.4770	0.0000	8.72**
LnGdp							

Notes: This table presents descriptive statistics for the selected variables, indicating mean, maximum, minimum, standard deviation, skewness and kurtosis. JB represents the Jarque–Bera normality test statistic. ** and *** indicate rejection of the null hypothesis (normal distribution) at the 5% and 1% significance levels, respectively. The data include three markets (property, equity and credit) and a control variable (GDP growth rate) for the 1994–2024 period.

We began by examining the time-series characteristics of the selected variables. Unit root tests assess whether the time series is stationary or contains a unit root. The study employed the ADF and PP tests, incorporating both a constant and a time trend in the model. Both tests share similarities, with the latter offering automatic correction for residual terms in the model. The null hypothesis of both tests is that the series has a unit root (non-stationary), while the alternative hypothesis is that the series becomes stationary after first differencing. Table 2 presents the findings of selected unit root tests. According to the ADF test, all series except GDP exhibited non-stationarity at level I(0), but became stationary at the first difference I(1). The highly significant test statistics of the PP test at I(1) further support this conclusion.

TABLE 2
Co-integration and Granger causality tests

Variables	Augmented DF		Philip - Perron	
	I(0)	I(1)	I(0)	I(1)
Property	–0.521	–5.827***	–1.262	–6.102***
LnProperty				
Equity	–3.118	–12.644***	–3.235*	–12.542***
LnEquity				
Credit	–1.395	–7.357***	–1.932	–7.407***
LnCredit				
GDP	–4.785***	–12.504***	–4.697***	–14.256***
LnGdp				

Notes: This table presents the findings of ADF and PP unit root tests. Lag selection for these tests was determined using the Akaike information criterion. Both tests included a constant and a time trend. Significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively. The data include three markets (property, equity and credit) and the GDP growth rate (control variable) for the 1994–2024 period.

The study then investigated the long-term relationship between the variables (property, equity, credit and GDP) using co-integration analysis. Table 3 presents the findings of the Johnson co-integration test. At maximum Rank 0, the null hypothesis of no co-integration (no long-term relationship) was examined against the alternative hypothesis of co-integration between the selected variables. At maximum Rank 1, we examined the null hypothesis of a co-integration of Equation (1) and the alternative hypothesis of no co-integration of Equation (1). The results (shown in Table 3) revealed a strong long-term relationship between the property and equity markets. Both the trace and maximum statistics exceeded the critical values at Rank 0. However, the results at Rank 1 showed no co-integration of Equation (1). Conversely, the trace and maximum statistic values for the property–credit and property–GDP relationships fell below the critical values at Rank 0, indicating no co-integration in these cases. Hence, when considering long-term trends, the property market in Malaysia seems to move in tandem with the stock markets. This implies that investors might not achieve significant diversification benefits by investing in both markets simultaneously.

TABLE 3
Multivariate Johansen Co-Integration Tests

Series	Rank	Test statistics	Trace statistics	Critical value
Property and equity	0	Trace statistics	25.63	15.41
		Maximum statistics	25.45	14.07
	1	Trace statistics	0.178	3.76
		Maximum statistics	0.178	3.76
Property and credit	0	Trace statistics	7.87	15.41
		Maximum statistics	7.64	14.07
	1	Trace statistics	0.238	3.76
		Maximum statistics	0.238	3.76
Property and GDP	0	Trace statistics	18.63	15.41
		Maximum statistics	6.07	3.76
	1	Trace statistics	12.56	14.07
		Maximum statistics	6.07	3.76

Notes: This table reports the results of the multivariate Johansen co-integration tests at Ranks 0 and 1. The null hypothesis (H0) is that there is no co-integration between the variables. The alternative hypothesis (H1) is that there is at least one co-integrated relationship. The critical values for a 5% significance level were taken from MacKinnon et al. (1999). The data include three markets (property, equity and credit) and the GDP growth rate (control variable) for the 1994–2024 period.

We further applied the ARDL model to test the reliability of the existing results. Tables 4 and 5 report the results of bound co-integration and ARDL regression, respectively. In the ARDL framework, the dependent variable is the natural log of property market growth (LnProperty), while the independent variables include the natural log of equity (LnEquity), credit (LnCredit), GDP (LnGDP), as well as two policy-related dummy variables: SB13 (Strata Management Act for 2013) and SB18 (National Housing Policy for 2018). For instance, SB13 is a dummy variable that takes the value of 0 for the period prior to 2013 and 1 for the period starting in 2013 to measure the structural shift or changes in property market growth. Similarly, SB18 is a dummy variable that takes the value of 0 for the period prior to 2018 and 1 for the period starting in 2018 to measure the structural shift in property prices caused by the National Housing Policy for 2018. The ARDL regression was performed with a maximum lag of three for LnProperty and a minimum lag of one for LnEquity and SB18. According to Table 4, the results of the bound test for long-run co-integration reveal that the value of the F-bound test is 14.95, which is greater than the upper limit of Fat 3.77 and 5.61, with $p < 0.01$. The findings demonstrate the presence of co-integration and long-term causality, indicating that the selected independent factors and the dependent variable of property have a long-term connection. After analysing the co-integration requirements between property growth and the independent variables in the bound test, the results of the co-integration regression conducted with ARDL were interpreted (see Table 5). Based on the results shown in Table 5, equity market growth (LnEquity) and SB18 exhibit long-run elasticity and a relationship with the property market. However, the results of credit market growth (LnCredit), GDP and SB13 were not statistically significant in terms of their long-run causal relationship with the property market. Furthermore, the values of adjusted R^2 suggest that the results of the ARDL model show significant predictability of equity market growth with the property market. Another important finding implies that the implementation of the National Housing Policy in 2018 affected the growth of the Malaysian property market. The National Housing Policy was typically enacted to address housing affordability, accessibility and overall market stability.

TABLE 4
ARDL bounds testing

F-bound test	Maximum of three lags imposed (3, 1, 2, 2, 2, 1)		
	F-bound test	Sig. (%)	Result
Upper bound	3.77	10	Co-integration exists
I(1)	5.61	5	
Value	14.95**		

Notes: This table provides the results of the bound co-integration test. ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

TABLE 5
Results of long-run elasticity and coefficients (ARDL)

Variable symbol	Coefficient	Std. error	*t*-stat	Prob.
LnEquity	0.28845	0.01325	2.18	0.031**
LnCredit	0.08705	0.07510	1.16	0.248
LnGDP	0.20807	0.03542	1.12	0.265
SB2013	0.00401	0.00785	0.51	0.612

(*Continued on next page*)

TABLE 5 (*Continued*)

Variable symbol	Coefficient	Std. error	*t*-stat	Prob.
SB2018	–0.01189	0.00551	–2.16	0.034**
Dependent variable: LnProperty R^2 value: 0.9988 Adjusted R^2: 0.9987				

Notes: This table reports the results of the ARDL regression. The dependent variable of property growth (LnProperty) is regressed with the independent variables of equity market growth (LnEquity), credit market growth (LnCredit), a dummy of SB13 measuring the implications of the Strata Management Act for 2013, and a dummy of SB18 measuring the implications of the National Housing Policy for 2018 on property market growth in Malaysia. ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

To test the robustness of the previous findings, the ARDL model was re-run with the same dependent and independent variables for both crisis and non-crisis periods. The results are reported in Panels A and B of Table 6. Panel A reveals that the F-bound test value is 5.989, which is significant and higher than the upper limit of Fat 3.77 and 5.61. These results indicate that the property market exhibits long-term causality and co-integration with the independent variables of LnEquity, LnCredit and LnGDP. However, only GDP has long-term elasticity in relation to the property market during crisis periods. On the other hand, the results during non-crisis periods are more pronounced for the relationship between property and equity markets. The F-bound test value in Panel B is 7.612, which is highly significant and larger than the upper bound values of 3.77 and 5.61. In contrast to the crisis period results, the ARDL test revealed a strong long-run causality between the property and equity markets.

Multiple reasons justify the higher causality between property and equity markets during non-crisis periods in Malaysia. Primarily, during periods of economic growth and stability, property and equity markets benefit from positive indicators, such as GDP growth, low unemployment and increased consumer confidence. Central banks often implement accommodative monetary policies, resulting in lower interest rates that make real estate and equities more attractive investments. Additionally, economic stability leads to higher liquidity and freer capital flows between asset classes, thus attracting investors to allocate funds to both markets. Furthermore, positive market sentiment and higher risk appetite might drive investors to seek returns in both markets, increasing their correlation. Government policies and incentives that promote economic growth can further benefit both markets.

TABLE 6
Results of sub-periods (crisis and non-crisis periods)

Panel A: Results of ARDL regression during crisis periods (January 1998–December 1999 and October 2007–September 2009)				
	Maximum of four lags imposed (1, 3, 4, 3)			
F-bound test	F-bound test	Sig. (%)	Result	
Upper Bound I(1) value	3.77	10	Co-integration exists	
	5.61			
	5.989***	5		
Variable symbol	Coefficient	Std. error	t-stat	Prob.
LnEquity	–0.00483	0.01873	-0.26	0.802
LnCredit	0.08056	0.07205	1.12	0.292
LnGDP	0.29242	0.07174	4.08	0.003***
Dependent variable: LnProperty R^2 value: 0.9962 Adjusted R^2: 0.9945				

Panel B: Results of ARDL regression during non-crisis periods				
	Maximum of three lags imposed, (3, 1, 3, 3)			
F-bound test	F-bound test	Sig. (%)	Result	
Upper Bound I(1) value	3.77	10	Co-integration exists	
	5.61			
	7.612***	5		
Variable symbol	Coefficient	Std. error	*t*-stat	Prob.
LnEquity	0.04782	0.01590	3.01	0.004***
LnCredit	–0.05134	0.07612	–0.67	0.506
LnGdp	0.01498	0.02871	0.52	0.602
Dependent variable: LnProperty R^2 value: 0.3625 Adjusted R^2: 0.3314				

Notes: This table presents the results of the ARDL regression for both crisis and non-crisis periods. Panel A reports the results during crisis periods, while Panel B presents the ARDL regression results during non-crisis periods. The dependent variable of property growth (LnProperty) is regressed with the independent variables of equity market growth (LnEquity), credit market growth (LnCredit), and GDP. ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

A VECM test was conducted to further examine the reliability of the findings (see Table 7). The VECM of the Malaysian property and equity markets was highly significant. The negative coefficient and significant *p*-value confirmed the presence of long-term causality between the property and equity markets in Malaysia. Moreover, unreported results revealed evidence of short-term causality due to the significance of the individual lag coefficients and *p*-values of each independent variable. The reported results also demonstrate that the system corrected its prior period disequilibrium and significant adjustment. In the case of the credit market, a long-term causality from property was weak because the *p*-value was not significant at the 1% level. Moreover, short-term causality was not evident in any lag value. In the case of GDP, the VECM model showed long-term causality with property, although the strength of causality was very weak due to the small coefficient of GDP.

TABLE 7

Vector Error Correction Model (VECM)

VEC model	Co-integrating equation	CointEq1
Property and equity	LnProperty (–1)	1.0000
	LnEquity (–1)	–1.3092
		(0.0990)
		[–13.22]
	C	4.5337
Property and credit	LnProperty (–1)	1.0000
	LnCredit (–1)	–10.5535
		(1.8284)
		[–5.77]
	C	51.3002
Property and GDP	LnProperty (–1)	1.0000
	LnGDP (–1)	–1.2058
		(0.1003)
		[–12.02]
	C	8.5767

Notes: This table presents the results of the VECM models, which were performed separately for the equity market, credit market and GDP growth rates, to examine the causal relationship between these factors and property markets in Malaysia. The samples involve the property, equity and credit markets. GDP growth rate is a controlled variable in the model. The sample period ranges from 1994 to 2024.

Granger causality tests were then employed to investigate the directions of causal relationships between the selected variables (see Table 8). The first row in Table 8 shows that lagged equity prices Granger-cause property prices (p = 0.003), rejecting the null hypothesis of no causal relationship. Similarly, the lagged prices of the property market Granger-cause equity prices, with a p-value of 0.00, indicating a bidirectional causality between property and equity prices. This suggests that an increase in equity market wealth might lead to an increased demand for residential property purchases. Conversely, an expansion of the property market can significantly improve the financial position of real estate companies, potentially encouraging equity investors to raise share prices. These findings provide empirical evidence of both the wealth and credit-price effects in Malaysia. The second row of Table 8 shows that credit prices do not Granger-cause property prices, but property prices Granger-cause credit prices. This indicates a causal direction from the property to the credit market, implying that the expansion of Malaysia's credit market is largely dependent on the property sector. Finally, the results in the last row indicate that changes in real GDP and property prices Granger-cause each other, as the p-values were significant for both equations. This suggests that real GDP has long-term causal links with both the equity and property markets.

TABLE 8
Granger Causality Tests

Test	**Ho: Stock prices do not Granger-cause property prices**		**Ho: Property prices do not Granger-cause stock prices**	
	Statistic	p-value	Statistic	p-value
Chi-square test	11.886	0.003	25.331	0.000
	Ho: Credit prices do not Granger-cause property prices	Ho: Property prices do not Granger-cause stock prices		
Chi-square test	2.465	0.116	16.56	0.000
	Ho: GDP does not Granger-cause property prices	Ho: Property prices do not Granger-cause GDP		
Chi-square test	24.107	0.002	31.289	0.000

Notes: This table presents the results of Granger causality tests using the chi-square method. The null hypotheses of no causal relationship are stated at the top of the column. The data include three markets (property, equity and credit) and the GDP growth rate (control variable) for the 1994–2024 period.

The findings from the above time-series analysis provide substantial evidence on the dynamic interrelationship between Malaysia's property, equity and credit markets, as well as the role of macroeconomic fundamentals. The results confirm a strong long-run linkage between the property and equity markets, supported by co-integration and significant elasticity in the ARDL and VECM models. Notably, the influence of equity market growth is more prominent during non-crisis periods, while GDP plays a stronger role during crisis periods, reflecting the varying sensitivities of the property market to macroeconomic conditions. The implementation of the National Housing Policy in 2018 was also found to significantly impact property market dynamics. Furthermore, the bidirectional causality between the property and equity markets supports both the wealth effect – where equity market gains translate into increased property investment – and the credit-price effect, where rising property values enhance credit availability and financial stability. The unidirectional causality from property to credit further reinforces the real estate sector's critical role in driving credit expansion.

While these time-domain models captured average relationships over the study period, they were unable to reflect the evolution and intensity of these linkages across different time horizons. To address this, we employed a wavelet-based analysis to explore how these relationships vary over time and frequency, providing deeper insights into the co-movement patterns and lead-lag dynamics under changing market conditions.

Wavelet Coherence Analysis

Before discussing the wavelet analysis results, it is imperative to understand the basic classifications displayed in these graphs. The wavelet graph is a multidimensional space, with years on the *x*-axis and a spectrum of frequency (wavelet) scales on the *y*-axis. A lower frequency (closer to the origin on the *y*-axis) indicates a closer connection to sudden changes in property market prices. The strength of the relationship between the two variables is presented by a colour palette beside the graph, ranging from 0 (blue) to 1 (red). Red areas ('hot zones') denote strong correlations, while blue areas ('cold zones') indicate weak correlations between the variables. The cone of influence (COI) – a borderline within the figure – marks the area where edge effects can distort the wavelet results. The black outlines around the red zones denote statistically significant relationships at the 5% level. A wavelet phase difference analysis was applied to identify lead-lag relationships between two variables (e.g., X and Y). This analysis also helps specify the dynamic relationship between selected variables. Arrows symbolise these dynamics, whereby rightward arrows denote positive co-movements (in phase: X and Y), leftward ones signify negative co-movements (out of phase: X and Y), and horizontal arrows (phase difference = 0) indicate that both variables move in the same direction at the same time with no lead-lag connection. An upward-left or downward-right pointing arrow denotes the direction in which the first variable (X) in the equation drives the second variable (Y). The second variable (Y) is said to lead the first (X) if an arrow is pointing downward to the left or upward to the right (see Figure 2).

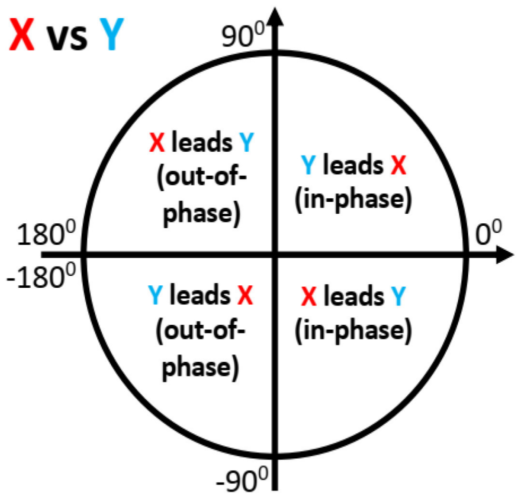

FIGURE 2: Wavelet coherence analysis phase diagram

Figure 3 shows the co-movement of property and equity prices using CWT. The dominant red colour within the COI suggests a strong co-movement between property and equity prices in the time-frequency domain. However, the strength of this co-movement varies across frequencies (time scales). Specifically, the red colour dominates the high-frequency scale area from 1994 to 2006, indicating strong short-term co-movement between the property and equity markets during this period. In contrast, the blue colour dominates the upper portion of the cone; however, a small red patch between 1996–2000 reflects a period of strong long-run co-movement, possibly coinciding with the Asian financial crisis. Similar trends were observed during the global financial crisis and the COVID-19 pandemic, where co-movement strengthened in the medium- and long-term ranges, respectively.

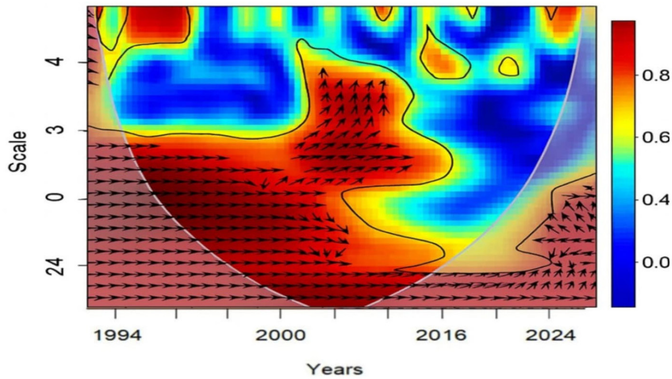

FIGURE 3: Wavelet coherence for property market vs. equity market

Figure 3 also reveals the shifting dynamic between the Malaysian property and equity markets across different periods. During the early period (1994–2003), horizontal arrows at higher frequency scales (i.e., phase difference = 0) indicate that both markets moved in the same direction with no lead-lag relationship. However, from 2007 to 2012, equity market prices drove property prices in the medium term (4- to 16-year frequency range), suggesting that the equity market had a stronger influence on property prices during this period. This trend was reversed between 2020 and 2024, possibly coinciding with the COVID-19 pandemic. Property market gains appeared to predict equity market performance across both low- and high-frequency bands. This suggests that the Malaysian property market might have exerted a notable influence on the equity market during the pandemic. Overall, the results highlight the dynamic and variable co-movement between the Malaysian property and equity markets across time and frequency domains. Interestingly, during crisis periods (1996–1999, 2006–2012 and 2020–2024), high-frequency data indicate that equity market returns tend to lead the property market returns in the short term. These important findings imply that property and equity markets can offer short-term diversification opportunities for investors during crises, whereby investors could potentially minimise their risk exposure by shifting investments between the two markets.

Quan and Titman (1999) highlighted those fundamental factors, such as economic growth, can significantly affect the Malaysian property and equity markets, as well as their interrelationship. This suggests that our wavelet coherence and phase difference analysis results may not fully account for the role of GDP growth. To improve the robustness of our analysis, we controlled for GDP growth in the model and re-examined the relationships using revised wavelet coherence and phase difference analysis (see Figure 4). It is important to note that data within the COI and exceeding a 5% significance level shows a weak co-movement or causal link in the short run. After integrating economic growth variables, Figure 4 indicates that the causality between the Malaysian property and equity markets slightly diverged from our initial observations. For instance, the co-movement disappeared in the 1996–1999 and 2020–2024 periods. The data also showed a weak correlation between the property and equity markets within a 4-year to 16-year frequency range. Between 2007 and 2012, the previously noted positive co-movement considerably declined, with correlations primarily occurring between 2010 and 2012 within the four- to eight-year frequency band. The phase difference results revealed that the equity market led the property market during this period. Interestingly, we observed a consistent and amplified co-movement within the high-frequency range from 2000 to 2015, which corroborated our initial findings without considering economic growth variables. We also observed minimal or insignificant co-movement from 2015 to 2024.

Overall, while PWC analysis revealed a marked long-term co-movement, it is striking that no substantial co-movement was detected across any of the frequency bands during the Asian financial crisis or the COVID-19 pandemic. This implies that economic growth conditions and other macroeconomic factors might have had a stronger fundamental influence on the Malaysian property and equity markets during these turbulent years. Further investigation into the effect of other macroeconomic factors is warranted. In sum, such events as the recent housing bubble burst and stock market crashes appear to be more closely tied to economic growth cycles than to mutual interactions between the property and equity markets.

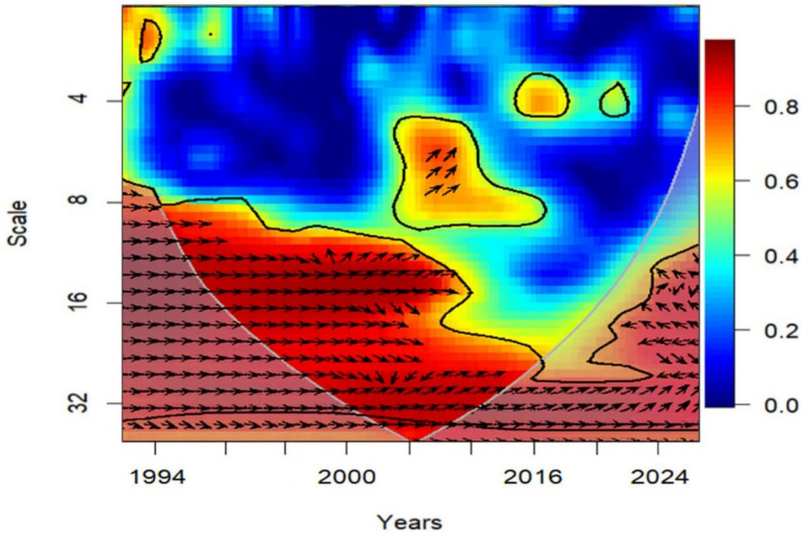

FIGURE 4: Partial Wavelet coherence for property market vs. equity market

Figure 5 illustrates the CWT analysis of the co-movement between the Malaysian property and credit markets. The dominance of the blue colour within the COI suggests the absence of correlation between the two markets across time and frequency domains, albeit with a few exceptions. From 2000 to 2003 (4- to 8-year frequency range), the two markets showed weak co-movement with no lead-lag relationship (as indicated by the arrow direction). Similarly, a co-movement was observed between 2007 and 2013 in the medium-term range, with the credit market leading the property market. The results become more transparent when examining the PWC after controlling for GDP growth (see Figure 6), where the previously noted co-movement between property and credit markets from 2000 to 2003 disappeared. Similarly, the correlation between the two markets became very weak from 2007 to 2013.

In sum, the relationship between the Malaysian property and credit markets is weak, with several factors contributing to this weak correlation. First, Malaysia has implemented various macroprudential policies, such as loan-to-value restrictions, to prevent credit booms and busts. These measures can partially decouple property market prices from credit availability. Additionally, Malaysian financial institutions generally follow international capital adequacy standards and are well-regulated, which reduces the likelihood of excessive credit growth and its direct correlation with the real estate market's performance. Moreover, Malaysia has a diversified economy that is not exclusively dependent on property growth, thus reducing the correlation between the property market and credit expansion. Furthermore, foreign investment often drives property market growth rather than domestic credit conditions. If a significant proportion of property transactions is made by foreign investors, the relationship between the property market and local credit conditions may weaken.

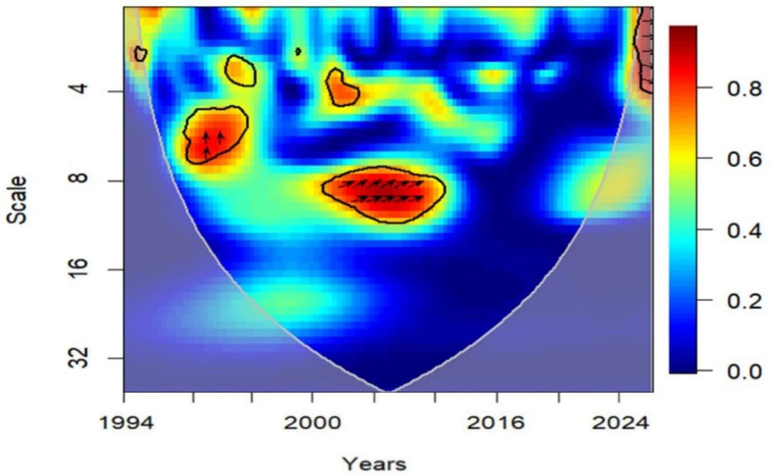

FIGURE 5: Wavelet coherence for property market vs. credit market

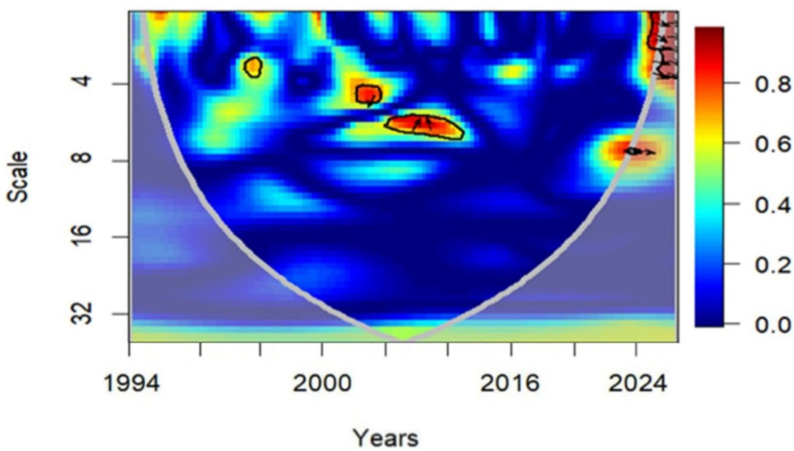

FIGURE 6: Partial wavelet coherence for property market vs. credit market

Discussion of the Time-Frequency Domain Results

The findings, based on wavelet coherence analysis, revealed that the correlation between property and equity markets varies across different time frequencies. Temporally speaking, the analysis identified substantial co-movement between the two markets during the 2000–2012 and 2020–2024 periods. This suggests that, during these periods, combining stocks and property assets in a portfolio could yield relatively higher diversification benefits for investors. In terms of frequency, the co-movement between these markets was more pronounced at higher frequencies, suggesting that the two markets tend to co-move more in the short rather than the long term. Therefore, the diversification advantages of blending stocks and real estate in a portfolio are likely to be greater in the short term. Furthermore, our analysis demonstrated the presence of long-term co-movement between the property and equity markets during crisis periods and the COVID-19 pandemic. However, when controlling for the influence of economic growth using PWC, the long-term correlation slightly weakened, implying that both markets were more responsive to economic conditions during turbulent times. We also found the nexus between the property and credit markets to be weak across time and frequency domains. Although the two markets showed slight co-movement from 2000 to 2003 within the four- to eight-year frequency range, the phase difference analysis indicated no lead-lag relationship between the markets. Furthermore, the PWC analysis confirmed that this weak co-movement disappeared entirely after adjusting for the impact of economic growth.

The time-frequency analysis findings highlight the importance of time horizons for investors. The co-movement between the property and equity markets varies depending on the timeframe considered. Investors with varying time horizons should focus on the co-movements at relevant frequencies to optimise their asset allocation. For example, short-term investors should pay close attention to co-movements at higher frequencies. Understanding the underlying economic factors driving these fluctuations is also crucial. In contrast, long-term investors should focus on co-movements at lower time frequencies and the related underlying variables. Our results revealed that co-movement between the Malaysian property and equity markets was most pronounced at higher frequencies, thus suggesting that diversifying portfolios with both asset classes might be most advantageous for short-term traders compared to long-term investors, such as insurance companies and pension funds. Beyond portfolio diversification strategies, we used a phase difference analysis to shed light on causal links between the Malaysian equity and property markets, offering valuable insights for policymakers and investors. By observing the behaviour of one market, it might be possible to predict future outcomes in another. This predictive strategy hinges on the wealth and the credit-price effects as two key channels. The wealth effect describes how rising equity prices and unexpected stock market gains can lead to increased property prices and consumption. While stocks are not directly consumed, property serves as both a consumption and investment good. Conversely, the credit-price effect asserts that, when property is used as collateral, a rise in its market value lowers borrowing costs, allowing businesses and households to invest and consume more, resulting in higher equity prices.

The findings of this study extend and refine previous Malaysian studies on the relationships between property–financial markets. Most of the earlier studies (e.g., Thaker & Ariff, 2020; Liow, 2012; Rahman, 2010) have estimated static or time-invariant linkages within a co-integration or causality framework. Our wavelet coherence approach captures the time-varying and frequency-dependent nature of co-movements between property, equity, and credit markets. Thus, it offers a more dynamic perspective of how market interactions intensify during economic expansions and slacken during recessions. In fact, this time–frequency evidence provides richer insights for policymakers and investors into the shifting nature of risk transmission and diversification opportunities across Malaysian financial markets. While the current analysis uses an aggregate property price index, the findings might be different when prices are disaggregated into more specific categories, such as residential versus commercial, high-rise versus landed, or regional housing segments. Differences in demand fundamentals, credit access, and regulatory exposure across these categories could alter both the magnitude and persistence of the observed co-movements.

CONCLUSION

This study contributes to the growing literature on property–finance linkages by empirically examining the dynamic interactions between property, equity and credit markets in Malaysia from 1994 to 2024, with GDP as a key macroeconomic control. Drawing on the theoretical underpinnings of the wealth and credit-price effects, the findings provide robust evidence of a bidirectional relationship between the property and equity markets, suggesting that expansion in the former can reinforce investor confidence and equity performance, while gains in the latter can stimulate housing demand. The role of credit is more nuanced, with the results indicating a unidirectional causality from the property market to the credit market, supporting the notion that the health of the Malaysian credit sector is closely tied to developments in the real estate market. These results should also be understood within the structural characteristics of Malaysia's financial system. Although Malaysia operates a bank-based financial regime, a stronger co-movement between property and equity markets suggests that property price dynamics in Malaysia are increasingly influenced by capital market sentiment rather than by traditional credit expansion. Macroprudential measures introduced over the past decades such as Loan-to-Value ratio (LTV) limits, stricter Debt Service Ratio (DSR) assessments, and tighter underwriting standards, have perhaps moderated the responsiveness of bank credit to property market fluctuations. As a result, property market has become more detached from credit market. Conversely, equity markets, which respond more rapidly to changes in investor expectations and risk appetite, appear to mirror property market movements more closely. These structural and regulatory features help explain why the property-equity linkage is stronger than the property-credit relationship in Malaysia.

Another contribution of this paper lies in its integration of housing-related regulatory policy and macroeconomic regimes into the property–finance framework. The analysis reveals that the National Housing Policy 2018 has had a statistically significant long-term impact on property dynamics, while the Strata Management Act 2013 has exerted a more limited influence, highlighting the asymmetry in policy effectiveness. By disaggregating the sample into crisis and non-crisis periods, the study demonstrates that the strength and direction of inter-market relationships are regime-dependent, where GDP plays a stronger role during crisis periods, while the influence of the equity market intensifies during stable conditions. These findings reflect the procyclical nature of financial markets and underline the importance of context-sensitive policy design. Methodologically, this study adds value by combining time-domain econometric models with time-frequency analysis using wavelet coherence and PWC techniques. While the former provides estimates of average long- and short-run effects, the latter reveals how these relationships evolve over time and across investment horizons. The wavelet approach provides nuanced insights into episodes of convergence and divergence among markets, capturing shifts in co-movement intensity and direction that are often overlooked in traditional methods.

Notwithstanding its contributions, the study is subject to several limitations that open avenues for future research. First, the use of quarterly data may have limited its ability to capture high-frequency shocks or shifts in investor sentiment. Accordingly, future studies might consider weekly or monthly data for greater precision. Second, the policy variables were represented through binary dummies, which might not have fully captured the intensity, timing, or market interpretation of regulatory actions. Future research could incorporate an event study approach to more precisely model policy signalling effects. Third, while wavelet coherence offers nuanced view of time-frequency co-movements, its sensitivity to edge effects and its non-causal nature require cautious interpretation. These limitations were addressed by complementing the wavelet results with ARDL and VECM analyses, ensuring consistent verification across both time-domain and frequency-domain approaches. Future studies may incorporate additional causality-based or high-frequency techniques to further strengthen the understanding of market interdependencies. Additionally, this study focused on a single-country context due to its unique market structure – that is, as a bank-based economy with a socially significant property sector. Cross-country comparative studies – especially across other emerging markets – could test the generalisability of the wealth and credit-price effects in differing regulatory and financial development environments. Moreover, as environmental and sustainability considerations become increasingly central to real estate valuation and financing decisions, future work could integrate climate-related risks, green building initiatives, or environmental, social and governance investment flows into the property–finance narrative. In conclusion, this study offers a comprehensive and contextually rich understanding of the interdependencies between property and financial markets in Malaysia. By incorporating policy shifts, economic regimes, and time-frequency dynamics, it provides valuable insights for investors, policymakers, and regulators seeking to balance financial stability, housing affordability, and economic growth.

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