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Examining the Macroeconomic Determinants of Property Cycles in Australia

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This paper identifies the impact of macroeconomic determinants of commercial property investment and development markets in Australia. A Hodrick-Prescott (HP) filter is used to filter the cyclical components of commercial property investment and development time series. In order to identify the long-run relationships and short-run dynamics, coupled with causality between these factors and property cycles, the investment and development property cycles are analyed with respect to the movement of nine macroeconomic factors by using time series data from 1987 to 2016. The empirical results suggest that the Australian commercial property market is often in an overdemand situation rather than oversupply, which can be explained by the different patterns of the property cycles on the demand and supply sides. Property investment cycles are shorter and more volatile than development cycles at around 8-10 years and more than 20 years, respectively, since there is a larger elasticity of the macroeconomic factors that underlie the investment market with short-term dynamics, while the development cycle is mainly affected by such factors moderately in the long run. Both the investment and development markets are intensively affected by financing related variables rather than market-sentiment and economic-cycle related variables.

Keywords

Property Cycle, Property investment, Property development, ARDL, Macroeconomic forces.

1. Introduction

Property markets are subject to cycles of varying magnitudes and periodicity conditions, and have impact on the wider economy. Pyhrr et al. put forth an approach that conceptualizes property cycles to differentiate the demand and supply cycles coupled with their economic characteristics, of which the cyclic phases are defined based on the interaction of the supply and demand forces over time (Pyhrr et al., 1990). Pyhrr et al. also review the academic and practitioner literature on property cycles in a later study and highlight the importance of their understanding for financial and investment successes and failures (Pyhrr et al., 1999). The literature suggests that property cycles in different property markets have their individual characteristics that arise from the underlying asymmetry and heterogeneity. Research works that examine property cycles in the Australian property markets have mainly focuses on understanding the determinants of the development cycle (Higgins and de Valence, 2000), bubbles that underlie residential cycles (Wang et al., 2020) and the impact of property cycles on bank profitability (Zhu, 2005). Macroeconomic drivers are the underlying determinants of property cycles. Recent data at the national level show that investigations of commercial property cycles are still largely absent in the Australian context. This paper aims to provide insights into the patterns of property demand and supply cycles, in terms of investment and development cycles, coupled with their determinants in the macroeconomic context. Theoretically, an upswing in economic activity causes an uptick in the property market, thus leading to a decline in vacancy and increase in property prices. Increasing property prices spur the property investment market on the asset demand side which then leads to property development response on the supply side. Numerous studies have demonstrated that the demand and supply cycles of income producing property respond differently to cyclical changes in the overall macroeconomy, which reflects expectations of the future state of the property market, by both tenants and builders (Wheaton, 1987).

This paper provides empirical evidence on the macroeconomic causes of the cyclical movements of commercial property investment and development markets of Australia. The remainder of the paper is organized as follows: Section 2 presents a brief literature review. Section 3 describes the methodology. Section 4 discusses the results of the measurements of the investment and development cycles, coupled with their relationships with macroeconomic forces, and Section 5 concludes the discussion.

2. Literature Review

The literature on analyzing international property cycles is vast, spanning more than a century. Jadevicius et al. explore existing studies starting from the late 1900s, and conclude that in general, economic fluctuations have been the determinants of property cycles (Jadevicius et al., 2017). Triggered by the changing economic conditions in the recent past, the objective of studies that aim to understand property cycles is to prevent them from occurring again in the future. Modelling property cycles requires developments in theoretical understanding and analyses of economic cycles. Historical analyses of economic activities have subsequently identified different cycles. For instance, Kondratieff waves (K-waves), which are economic cycles that originate from technological innovation such as changes in production technology, have a longer cycle that ranges between 45 and 60 years. This longer cycle is part of a sinusoidal cycle that is consisted of four phases: expansion, peak, stagnation and recession (Narkus, 2012). The other generally accepted theory for economic cycles involves Kuznets swings (K-swings). Each K-swing lasts for about 20 years and is facilitated by demographic changes, spatial mobility and infrastructural investments (Tubadjia et al., 2016). Yet another type of economic cycle, the Juglar cycle, is a fixed business cycle of investment in equipment and technological structures with a length of six years. Then there are Kitchin cycles which are short business cycles of 4-5 years in duration and attributed to increased investment in output due to improved business climate, but this excessive production leads to drops in demand and prices and subsequently, the need to reduce output (Higgins and de Valence, 2000). When it comes to the property market, an early study on property cycles by Hoyt (1947) shows that the property markets in the United States (US) move as a predictable pattern supported by the interactions between unique local and national forces. These contribute to the dynamics in income returns from property, which are followed by fluctuations in capital value (Hoyt, 1947). Wheaton models the office property cycle in the US from both the demand and supply sides. The results suggest that there is a recurring twelve year cycle in property development determined on the basis of patterns in office building construction activities (Wheaton, 1987). Ball et al. state that the duration of a commercial property development cycle is approximately one decade, which is independent of the business cycle in the United Kingdom (UK) (Ball et al., 1998).

The interdependence of economic and property cycles has also been a subject of popular investigation in studies that focus on the UK and US as the main region of study. Theoretically, property cycles are influenced by economic cycles, in which the property cycle is more sensitive to economic fluctuations in the short to mid-term rather than the local conditions (Plattner, 1988). Hekman, however, finds that the adjustments in office market rents are a response to both local and national economic situations, and show a highly periodic performance at the national level (Hekman, 1985). Barras proposes a comprehensive model to examine the interactions among property development, the real economy and financial sector (Barras, 1994). The results indicate that property markets are subject to different cyclical influences of varying periodicity and major building booms occur when conditions such as a high demand, supply shortage and credit expansion coincide. According to the empirical results in Kling and McCue (1987), and McCue and Kling (1994), macroeconomics forces are capable of explaining for 60 percent of the dynamics of real estate cycles, among which the nominal interest rate is the strongest explanatory factor with a negative impact (Kling and McCue, 1987, McCue and Kling, 1994). Wheaton (1987) proposes that the employment growth rate has a significant influence on the office market. In a subsequent study, Barras specifically identifies the determinants of cyclical movements in property markets and finds that cyclical behaviour depends on five variables: the rate of output growth and depreciation, construction lag, combined transmission coefficient that links vacancy to development starts, and demand elasticity on the occupancy rate (Barras, 2005). Barkham uses seven macroeconomic indicators to model long-term property cycles, which comprise stock market indices, bond rates, rents, yields, real estate spreads over bonds, gross domestic product (GDP) growth, and national and international output gaps (Barkham, 2011). In more recent research, the impact of globalisation on property markets has been discussed, which further suggests that economic reasons underlie property market movements and interact with the property cycles as endogenous forces. The commonalities in office cycles reflected in the high correlation across international markets demonstrate the synchronization of economic factors that drive office markets in different regions (Stevenson et al., 2014, Barkham, 2012). Existing studies also point out that property cycles have been recurrent but show irregular dynamics with different leads and lags on economic cycles (RICS, 1994, Giannotti and Gibilaro, 2009).

Within the context of the Australian property market, most of the existing and recent studies focus on residential properties, in terms of the dynamics of housing prices, housing affordability and housing bubbles (Ma et al., 2018, Wong et al., 2019, Wang et al., 2020, Guest and Rohde, 2017). There are few studies that examine the cyclic nature of the property markets in Australia especially the commercial property markets, in which a large volume of the extant research tends to examine the interlinkages of market movements across different regions in Australia. Costello et al. examine the deviations of housing prices from fundamental prices during 1984 to 2008, coupled with the spillover effects of non-fundamental components of housing prices across capital cities in Australia (Costello et al., 2011). They point out that the New South Wales (NSW) market, as the largest market in Australia, produces the largest deviations and receives the largest spill overs. Akimov et al. investigate the housing market commonalities among eight metropolitan cities in Australia and find out that the two largest cities, Melbourne and Sydney, show similar cyclicality behaviour but differ from the other cities (Akimov et al., 2015). Valadkhani et al. examine the housing cycles of the four largest capital cities in Australia (Brisbane, Melbourne, Perth and Sydney) and propose a housing price model that includes variables like the interest rate, unit/apartment prices, unemployment rate, population, and rental returns (Valadkhani et al., 2016). The model forecasts that the housing prices in Melbourne and Sydney have a more volatile performance than the other two cities. Previous studies on Australian commercial properties often investigate their financial characteristics and performances such as the monetary instrument or indirect investment assets at the microeconomic level (Chikolwa, 2010, Rong and Trück, 2014).To the best of our knowledge, there is still a knowledge gap in the investigation of Australian commercial property cycles in the macroeconomic context. Only one recent study on property cycles, Hui and Wang, examine the cyclicality behaviours of securitized property markets in six countries and regions at the macro level (Hui and Wang, 2015). The results show that the Australian securitized market went through four complete cycles during 1990–2012, which experienced more cycles than the housing market in the same study period.

The features and triggers of property cycles vary across regions and sectors due to the underlying heterogeneity in factors that drive their property markets. A summary of the existing literature suggests that there are macroeconomic factors such as GDP, inflation, mortgage lending, and interest rates, bond yield, unemployment rate, and stock market returns, which impact property cycles. Most of the empirical evidence is drawn from commercial property cycle analyses which have used a range of different methodologies. Various sophisticated methodologies have been used to process the time series in the past century and analyse property cycles. In the early stages, cross-correlation functions (CCFs) have enabled the identification of leads and lags between two time-series. CCFs aim to test the order of fluctuations of two variables; in other words, the movement of one series tends to precede or follow the movement of another series. CCFs have been used to identify the triggers of cyclical activities behind commercial property markets (McGough and Tsolacos, 1995). Compared to CCFs, the vector autoregression (VAR) model has been predominantly used in the literature to model the interactions between macroeconomic forces and property cycles. The VAR model can evaluate the degree and direction of relevance among several related variables by capturing their linear interdependence in order to forecast the changes in the dependent variable (Gerlach and Peng, 2005, Filotto et al., 2018, Szweizer, 2018). In recent decades, a newly developed autoregressive method, the autoregressive distributed lag (ARDL) approach, has been proposed to test the long-run relationships and short-run dynamics that underlie multiple variables in time series models. This new approach coupled with its associated error correction model (ECM) is widely used to quantify and estimate the long term and short term effects of economic variables (Scott-Joseph and Turner, 2019, Onoja et al., 2017, Zheng et al., 2012). In this paper, the ARDL approach is used to model property cycles in Australia. The short-term dynamics and long-term relationships in property investment and development are modelled by using 9 macroeconomic variables, as discussed in the next section.

3. Methodology

The analysis in this paper covers the period of *1987-Q1 to 2016-Q4*. A thirty-year period is reasonable enough to explain the movement of property markets and identify cyclical movements. Property investment and property development are measured as the movements and fluctuations in the *Net Investment for All Direct Commercial Properties (NIN)* and *Total Value of Building Work Done (TVB)* over the past 30 years respectively. In terms of the property sectors, this study examines all of the sectors of commercial property which consists of retail, industrial and office. Property cycles are studied with regard to the cyclical movements of several exogenous macroeconomic factors that drive property markets. These factors are categorized as three types, namely economic-cycle related variables, financing related variables and market-sentiment related variables. Thus, this research intends to investigate the impacts based upon these three dimensions. Based on the existing literature, 9 macroeconomic variables are selected for analysis. All of the parameters and variables are evaluated in the same study period with property cycles at the national level in Australia. The details of all of the parameters and variables are shown in Table 1. Logarithmic transformation is applied for all of the variables to eliminate heteroscedasticity among them and test the elasticity between the reference cycles and macroeconomic forces.

In order to measure the cyclical movements of the property market in Australia, the Hodrick-Prescott (HP) filter, one of the most commonly used tools to study cyclicality, is used here to filter the raw time series of the two reference cycles (Hodrick and Prescott, 1997) into a trend and a cyclical component. That is, the HP-filter removes the cyclical components from the raw data to produce a time series without cyclical variations. The long-term trend is thus adjusted to sensitivity towards short-term fluctuations (Zhu et al., 2011). The equation of the HP-filter is written as:

$$\text{Min}\left\{\sum_{t-1}^{T} c_t^2 + \lambda \sum_{t=1}^{T}[(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})^2]\right\} \quad (1)$$

where c is the cyclical component, g is the trend component of any variable y, T is the number of samples of y, and λ is the smoothing parameter; where $y_t = c_t + g_t$. This process assumes a growth rate with a smooth trend which is chosen to minimize the accumulation of cyclical components over time. In this paper, the value of λ is assumed to be 1600 since the dataset is aggregated quarterly (McGough and Tsolacos, 1995).

This paper uses the ARDL approach coupled with the Granger causality test to identify the relationships and causality between macroeconomic variables and commercial property investment and development cycles in Australia. The ARDL cointegration approach is a newly developed cointegration procedure to measure the long-run equilibrium between series (Pesaran et al., 2001). The main advantage of using the ARDL over a conventional cointegration analysis is that the ARDL allows testing of the variables, which are integrated in both $I(0)$ and $I(1)$, rather than at the same difference level. Besides, the ARDL can also ignore the problem of endogeneity since ARDL models are free from residual correlation (Nkoro and Uko, 2016). Note that the variables need to be stationary to use this approach.

Table 1 Data Dictionary

	Category	Code	Definition
Reference Cycle	Demand	NIN	Net investment for all direct commercial properties
	Supply	TVB	Total value of building work done
Macroeconomic Forces	Economic-cycle related	CPI	Consumer price index inflation rate
		GDP	Real gross domestic product
		NUR	National unemployment rate
	Financing related	MLR	Mortgage lending rate
		LIRs	Long-term interest rates
		SIRs	Short-term interest rates
	Market-sentiment related	TIR	Total investment return index for all direct property assets
		SMI	Australia stock market index
		TBY	10-year bond yield

Note: Detailed definitions for NIN, TVB and TIR are provided in the appendix.

There are four steps in the ARDL approach. The first step is to test the stationarity of the time series. Only the variables that are stationary in *I*(0) or *I*(1) can be applied in the ARDL model. In previous research, the Augmented Dickey-Fuller (ADF) or Phillips-Perron (PP) tests are always used to test for the presence of unit roots in a series, which null hypothesis is the series has a unit root, in other words, the series is non-stationary. In this paper, the ADF test will be applied on all data to determine the unit roots in the series. The next step is to test the presence for cointegration among the variables in the unrestricted ARDL model. The conditional model can be written as Equation (2):

$$\begin{aligned}\Delta LnR_t = {} & \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta LnC_{t-i} + \sum_{i=1}^{n} \alpha_2 \Delta LnCPI_{t-i} \\ & + \sum_{i=1}^{n} \alpha_3 \Delta LnGDP_{t-i} + \sum_{i=1}^{n} \alpha_4 \Delta LnMLR_{t-i} + \sum_{i=1}^{n} \alpha_5 \Delta LnNUR_{t-i} \\ & + \sum_{i=1}^{n} \alpha_6 \Delta LnTIR_{t-i} + \sum_{i=1}^{n} \alpha_7 \Delta LnLIR_{t-i} + \sum_{i=1}^{n} \alpha_8 \Delta LnSIR_{t-i} \\ & + \sum_{i=1}^{n} \alpha_9 \Delta LnSMI_{t-i} + \sum_{i=1}^{n} \alpha_{10} \Delta LnTBY_{t-i} + \beta_1 LnC_{t-1} \\ & + \beta_2 LnCPI_{t-1} + \beta_3 LnGDP_{t-1} + \beta_4 LnMLR_{t-1} \\ & + \beta_5 LnNUR_{t-1} + \beta_6 LnTIR_{t-1} + \beta_7 LnLIR_{t-1} \\ & + \beta_8 LnSIR_{t-1} + \beta_9 LnSMI_{t-1} + \beta_{10} LnTBY_{t-1} + \sigma_t\end{aligned} \tag{2}$$

where Δ is the first difference operator; Ln is the log of the variables; R is the reference cycle; NIN or TVB depends on whether it is a property investment or development variable; n is the optimal lag of each variable; α_0 is the intercept, α_1 - α_{10} are the short-run coefficients, β_1 - β_{10} are the long-run coefficients; and σ_t is the white noise residual.

The cointegration can be tested by using bound *F*-statistics for a comparison with the critical bound values in a particular range. The determination of cointegration is based on the null hypothesis (H_0) in which long-run relationships do not exist, which means that the variables are not cointegrated. H_0 will be rejected when the *F*-statistic exceeds the upper critical value and the variables will be assumed to be cointegrated (i.e., H_0: $\beta_{1\text{-}10} \neq 0$). If the *F*-statistic is lower than the lower critical value, H_0 cannot be rejected (i.e., H_0: $\beta_{1\text{-}10} = 0$). If the *F*-statistic falls within the bound ranges, the result would be inconclusive.

If a cointegration relationship exists, the next step is to estimate the long-run relationships among the variables based on a selected ARDL model. In this stage, the Akaike information criterion (AIC) is used for the model selection in order to select the optimal lag lengths for the ARDL model. The model with the smallest AIC value is chosen. To estimate the long-run coefficient, the ARDL model can be written as:

$$LnR_t = a_0 + \sum_{i=1}^{n} a_1 LnC_{t-i} + \sum_{i=1}^{n} a_2 LnCPI_{t-i} + \sum_{i=1}^{n} a_3 LnGDP_{t-i} + \sum_{i=1}^{n} a_4 LnMLR_{t-i} + \sum_{i=1}^{n} a_5 LnNUR_{t-i} + \sum_{i=1}^{n} a_6 LnTIR_{t-i} + \sum_{i=1}^{n} a_7 LnLIR_{t-i} + \sum_{i=1}^{n} a_8 \Delta nSIR_{t-i} + \sum_{i=1}^{n} a_9 LnSMI_{t-i} + \sum_{i=1}^{n} a_{10} LnTBY_{t-i} + \varepsilon_t \quad (3)$$

where a_0 is the intercept, a_1 to a_{10} are the long-run coefficients; and ε_t is the white noise residual.

The short-run dynamics will also be calculated along with the long-run relationships by introducing an error correction (EC) term into the selected ARDL model. The unrestricted ARDL model will be reparameterized into the EC model (ECM). The ARDL-ECM estimates the short-run dynamics and the long run equilibrium in a single model. The representation of the ARDL-ECM equations of the two cycles are shown below:

$$\Delta LnR_t = b_0 + \sum_{i=1}^{n} b_1 \Delta LnC_{t-i} + \sum_{i=1}^{n} b_2 \Delta LnCPI_{t-i} + \sum_{i=1}^{n} b_3 \Delta LnGDP_{t-i} + \sum_{i=1}^{n} b_4 \Delta LnMLR_{t-i} + \sum_{i=1}^{n} b_5 \Delta LnNUR_{t-i} + \sum_{i=1}^{n} b_6 \Delta LnTIR_{t-i} + \sum_{i=1}^{n} b_7 \Delta LnLIR_{t-i} + \sum_{i=1}^{n} b_8 \Delta LnSIR_{t-i} + \sum_{i=1}^{n} b_9 \Delta LnSMI_{t-i} + \sum_{i=1}^{n} b_{10} \Delta LnTBY_{t-i} + \emptyset ECM_{t-1} + \omega_t \quad (4)$$

where b_0 is the intercept, $b_1 - b_{10}$ are the short-run coefficients, ECM_{t-1} is the error correction term; $\emptyset$ is the speed of adjustment; and ω_t is the white noise residual.

4. Empirical Results
4.1 Test for Stationarity of Time Series

The augmented Dickey-Fuller (ADF) unit root tests are applied on the data to establish the level of integration, for specifications for the i) intercept and trend, ii) intercept, no trend and iii) no intercept, no trend. The variables that fail to pass the unit root tests (the t-statistic less than the critical values in absolute terms) are differenced to see if they are stationary in the first order. Only the variables that pass the ADF tests in levels or first-differences can be regarded as stationary series to derive the ARDL model. The non-stationary variable will be rejected and filtered. The process suggests that the test should start with least restrictive model (including trend and intercept). If null is not rejected (i.e. the time series is unit root), then the model including intercept, but no trend, is tested. If this also does not reject the null, then the model with no intercept and trend is tested. The ADF tests indicate that LnNIN is stationary in specifications with (i) intercept and trend, and (ii) intercept, no trend. LnCPI is stationary in specification with (i) intercept and trend and (iii) no intercept and no trend. LnGDP is stationary in specification with (iii) no intercept and no trend. LnTBY and LnTIR are stationary with specification with (i) intercept and trend. The logarithms of NIN, CPI, GDP, TIR and TBY are stationary at level as per Enders (2014) process, while the remaining variables are stationary at first difference. This suggests that all of the variables can be used for the ARDL bounds testing approach to measure cointegration. The ARDL test indicates cointegration and the model can capture both long-run and short-run relations (Shrestha and Bhatta, 2018). All variables will enter the ARDL model at their levels (Shrestha and Bhatta, 2018).

4.2 Impacts on Property Investment Cycles
4.2.1 Cyclicality of Property Investment Market

The movements of the commercial property investment market that was separated into trend and cyclical components from 1987 to 2016 are shown in Figures 1 and 2 respectively. It is obvious that three peaks and three troughs are found in the long-term trend during the study period. The peaks in 1989-Q2, 1997-Q4 and 2007-Q2 show that the property investment demand peaked every 8.5 to 10 years with an increasingly pattern of decline. The troughs appear in 1992-Q2, 2002-Q1 and 2010-Q1, which mean that the investment demand quickly hit rock bottom every 8 to 10 years. The results suggest that the length of a property investment cycle in Australia should be around 8-10 years. Specifically, the magnitude of the investment cycles is linear before 2002 but severely fluctuates in the following years, which indicates that the property investment market in Australia has become more volatile in recent years.

Table 2 ADF Test Results

Variable	Level: *I(0)*			First-Difference: *I(1)*			Results
	Intercept and Trend	Intercept, No Trend	No Intercept, No Trend	Intercept and Trend	Intercept, No Trend	No Intercept, No Trend	
LnNIN	-6.356***	-6.365***	-0.358	-11.958***	-12.011***	-12.06***	*I*(0)
LnTVB	-3.330*	-1.618	0.254	-8.759***	-8.645***	-8.588***	*I*(1)
LnCPI	-4.017***	-2.599*	4.982***	-5.042***	-4.778***	-2.854***	*I*(0)
LnGDP	-1.943	-1.188	6.536***	-6.561***	-6.525***	-3.482***	*I*(0)
LnMLR	-2.888	-1.950	-1.345*	-5.403***	-5.423***	-5.339***	*I*(1)
LnNUR	-1.783	-1.380	-0.573	-4.654***	-5.423***	-4.692***	*I*(1)
LnTIR	-3.788**	0.514	1.814*	-2.946	-2.736*	-2.024**	*I*(0)
LnLIR	-3.408*	-1.042	-1.622*	-7.291***	-7.331***	-7.120***	*I*(1)
LnSIR	-3.294*	-1.489	-1.380	-6.086***	-6.101***	-5.981***	*I*(1)
LnSMI	-2.611	-2.601*	-0.171	-7.258***	-7.293***	-7.325***	*I*(1)
LnTBY	-3.640**	-1.214	-1.359	-8.314***	-8.329***	-8.282***	*I*(0)

Notes: *, **and *** represent significance at the 10%, 5% and 1% levels.

Figure 1 **Trend Components Based on Movement in the Property Investment Market (1987-Q1 to 2016-Q4)**

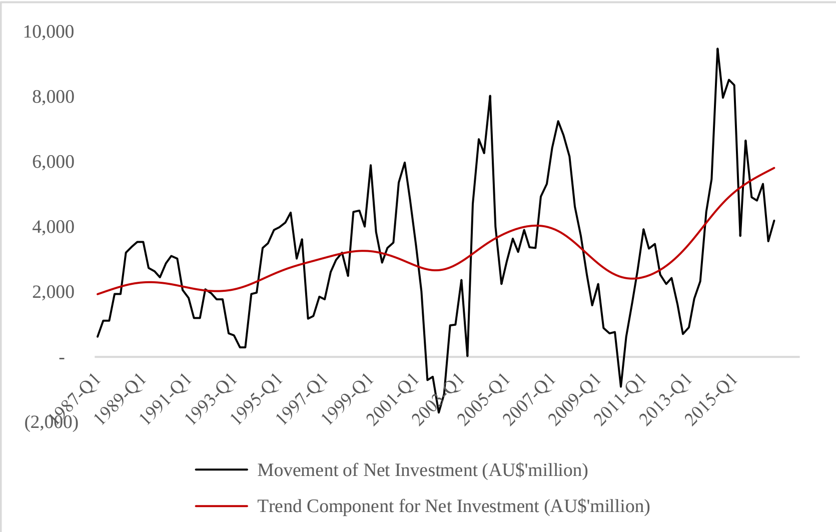
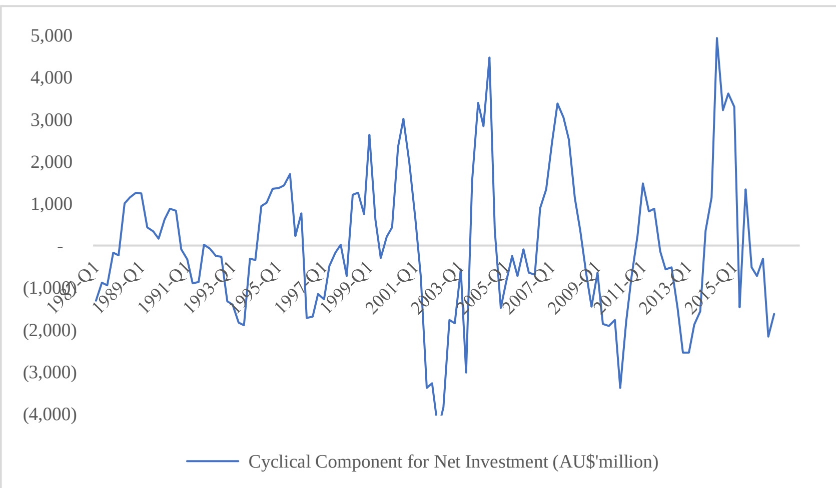


Figure 2 **Cyclical Components of Property Investment Market (1987-Q1 to 2016-Q4)**



4.2.2 Macroeconomic Factors Underlying Investment Cycles

To estimate the cointegration among the variables on the demand side, the property investment variable and 9 macroeconomic variables with a maximum of 4 lag lengths, namely one year, are included in the unrestricted model for Equation (2). The national unemployment rate (NUR) variable was removed from the model in order to pass the bound test. The results of the bound test (see Table 3) show that the *F*-statistic (12.773) is much larger than the upper bound (4.1) at the 1% level of significance, which demonstrates that the remaining variables are cointegrated and there is long-run equilibrium among the variables at the 1% significance level. Since cointegration among the variables is confirmed, the long-run coefficients will be estimated in the following step in accordance with Equation (3). According to the AIC result, the ARDL model with the smallest AIC value will be selected. The specification for the model for the property investment cycle is $ARDL^{NIN}(4,4,4,4,4,4,4,4,4)$. All of the explanatory variables have a lag length of 4 periods. The adjusted R^2 is 0.693, which means 69.3% of the variation of the investment cycle can be explained by using this model.

According to the long-run relationship coefficients shown in Table 4, only three of the selected macroeconomic variables have a long-run relationship with the reference cycle, among which the total investment return index for all direct property assets (TIR) shows the strongest correlation with the investment cycle with significance at the 1% level, followed by the mortgage lending rate (MLR) and 10-year bond yield (TBY) with significance at the 10% level. In the long-run, only the MLR has a negative relationship with the cycle; the others show a positive correlation. In terms of the long-run elasticity, the TIR is the most flexible variable in that a 1% increase in the MLR contributes to 3.8% decrease in property investment demand. The elasticity of the MLR and TBY is -3.5 and 1.4 respectively. Note that the consumer price index inflation rate (CPI), GDP, long-term interest rates (LIRs), short-term interest rates (SIRs) and Australia stock market index (SMI) have an insignificant effect on investment demand in the long-run. However, since the model fits the data well with R^2 at 0.69, these variables have not been removed and are further tested for the short-run dynamics in the following ECM.

Table 3 Bounds Test Result for ARDL Model of Investment Cycle

***F*-statistic**	**Significance**	**Lower bound *I*(0)**	**Upper bound *I*(1)**
12.77263***	1%	2.79	4.10
	5%	2.22	3.39
	10%	1.95	3.06

Notes: 1. *** represents significance at the 1% level.
2. NUR is removed from the model to pass the bound test.

Table 4 Long-Run Estimates for Investment Cycle

Variable	Coefficient	Standard Error	*t*-statistic	*p*-value
(Intercept)	131.016	59.007	2.220	0.030
LnCPI	0.004	4.774	0.001	0.999
LnGDP	-9.915	6.443	-1.539	0.129
LnMLR	-3.530*	1.794	-1.968	0.054
LnTIR	3.776***	1.108	3.409	0.001
LnLIR	-0.160	1.430	-0.112	0.911
LnSIR	0.108	0.827	0.131	0.897
LnSMI	-0.624	0.387	-1.612	0.112
LnTBY	1.405*	0.753	1.867	0.067
Adjusted R^2	0.693			

Note: *, **and *** represent significance at the 10%, 5% and 1% levels.

The next step is to reconcile the short-run dynamics with long run equilibrium of the macroeconomic forces that underlie the investment cycle. The associated ECM of the specified $ARDL^{NIN}$ model is determined to identify the EC term based on Equation (4). It can be observed from the $ARDL^{NIN}$-ECM results that R^2 is increased to 0.711, which indicates that this ECM can forecast the movements of investment cycles at a level of 71.1%. The details of the ARDL-ECM for investment cycles are given in Table 5. CPI, GDP, MLR, TIR, SIRs and SMI show short-run dynamics with the movement of an investment cycle with different lags, among which TIR and GDP appear to have an extremely large elasticity of around 20 and 10, respectively. After including the EC term, all of the macroeconomic forces increase their elasticity in the investment cycle in the short-run. The coefficient of the EC term shows the speed of adjustment towards equilibrium, in other words, how much of the disequilibrium in the previous period is being corrected (Nkoro and Uko, 2016). The negative EC coefficient (-0.9767) with significance at the 1% level in this model indicates convergence, which means that the short-run dynamics from the equilibrium in the current period adjust at an extremely fast rate of 97.67% from the previous period.

In order to analyze the direction of the impact between the macroeconomic forces and investment cycle, a Granger causality test is conducted. Since LIRs show insignificant impacts on the investment cycle both in the long-run and short-run, this variable will not be tested for Granger causality. The results (see Table 6) demonstrate that GDP, MLR, TIR and SIRs Granger-cause the changes of the investment cycle as the market signals. The strongest causations arise from TIR and GDP to the investment cycle at the 1% significance level, followed by the MLR and SIRs with significance at the10% level. Other variables have no causations with the investment cycle. Based on the results, GDP, TIR, MLR and SIRs are identified as the investment market signals in Australia.

Table 5 ARDL-ECM Results for Investment Cycle

Variable	Coefficient	Standard Error	*t*-value	*p*-value
ΔLnCPI	-1.383	7.395	-0.190	0.852
ΔLnCPI(-1)	-11.867*	6.751	-1.760	0.083
ΔLnCPI(-2)	-5.693	6.890	-0.830	0.412
ΔLnCPI(-3)	4.332	7.120	0.610	0.545
ΔLnGDP	-11.178*	5.915	-1.890	0.063
ΔLnGDP(-1)	-7.427	5.488	-1.350	0.181
ΔLnGDP(-2)	-1.264	5.350	-0.240	0.814
ΔLnGDP(-3)	-11.952**	5.652	-2.110	0.038
ΔLnMLR	2.126	1.622	1.310	0.194
ΔLnMLR(-1)	4.557**	1.794	2.540	0.013
ΔLnMLR(-2)	4.649***	1.705	2.730	0.008
ΔLnMLR(-3)	2.457	1.750	1.400	0.165
ΔLnTIR	-12.762*	7.057	-1.810	0.075
ΔLnTIR(-1)	18.400**	8.959	2.050	0.044
ΔLnTIR(-2)	23.224**	9.183	2.530	0.014
ΔLnTIR(-3)	-15.685*	8.010	-1.960	0.054
ΔLnLIR	-0.500	0.800	-0.620	0.534
ΔLnLIR(-1)	0.098	0.851	0.120	0.909
ΔLnLIR(-2)	0.495	0.846	0.580	0.561
ΔLnLIR(-3)	-0.754	0.799	-0.940	0.349
ΔLnSIR	-1.224	1.227	-1.000	0.322
ΔLnSIR(-1)	-1.355	1.195	-1.130	0.261
ΔLnSIR(-2)	-0.718	1.114	-0.640	0.522
ΔLnSIR(-3)	2.255**	0.990	2.280	0.026
ΔLnSMI	0.345	0.329	1.050	0.298
ΔLnSMI(-1)	0.778**	0.316	2.460	0.016
ΔLnSMI(-2)	-0.132	0.316	-0.420	0.677
ΔLnSMI(-3)	-0.278	0.304	-0.920	0.363
ΔLnTBY	0.231	0.270	0.860	0.395
ΔLnTBY(-1)	-0.302	0.313	-0.970	0.338
ΔLnTBY(-2)	-0.410	0.305	-1.340	0.184
ΔLnTBY(-3)	-0.333	0.263	-1.260	0.211
EC(-1)	-0.977***	0.084	-11.580	<2E-16
Adjusted R^2	0.711			

Notes: 1. *, **and *** represent significance at the 10%, 5% and 1% levels
2. Δ denotes the first difference operators.

Table 6 Granger Causality Results for Investment Cycle

Variable	H_0: Changes in the macroeconomic forces do not Granger-cause changes in investment cycle	
	F-statistic	*p*-value
LnCPI	1.96	0.11
LnGDP	4.97***	1.10E-03
LnMLR	2.20*	0.07
LnTIR	9.17***	2.30E-06
LnSIR	2.37*	0.06
LnSMI	1.75	0.15
LnTBY	0.74	0.57

Notes: 1. * and *** represent significance at the 10% and 1% levels.
2. GDP and LIRs are eliminated from the model.

4.2.3 Discussion

With respect to the market-sentiment related variables, the investment demand for property in Australia mainly depends on the performance of the property market itself and no Granger causal relationships are found in the stock and bond markets. The results of the ARDL model show that investment demand in the property market shares a common stochastic behavior with the bond market (TBY) in the long run and the stock market (SMI) with one quarter lags in the short run. However, these two markets show no causality with the investment market, which means that the market sentiments in the bond and stock markets will not transfer to the property market. Accordingly, the direct property investment market has operated as an independent investment market in Australia during the period of this study, partially due to the heterogeneity and the trading infrequency which results in inefficiency in the property market (Evans, 2004).The total investment return (TIR) shows procyclicality for the investment cycle in long run relationships as the most significant driver of demand. In the short run, the TIR has the highest elasticity at around 20 among all of the variables and drives property investment with two quarter lags. The elasticity of the TIR in the long run is 3.7. The result shows that in Australia, property investment market sentiment (investment performance) is the most significant market signal which is capable of affecting the market demand dramatically especially in the short run.

Unexpectedly, the linkages between property investment cycles and economic-cycle variables are not so clear in the long run in Australia. The GDP has a negative effect on property investment in the short run with a one-year lag. It appears that the depression of the economic environment will not affect the demand for commercial property investment. A previous study by (Anwer and Sampath, 1999) also obtains the same result. They determine the relationship between GDP and investment for 90 countries and find that these two variables have a negative relationship in Australia. One possible explanation for the result is that the property investment return has remained stable in Australia in recent decades (Cheong et al., 2008). According to the CBRE (Pierson, 2017), in Australia, foreign investment accounts for one-third of commercial property transactions as of 2016, which would dampen the impacts of local economic conditions to some extent. Property investment has become a vehicle to hedge against economic risks in Australia.

Interestingly, the financing-related variable, the MLR, appears to have inverse impacts in the long-run and short run relationships with two quarter lags. The MLR presents positive short-run effects on the investment cycle within three quarters, but translates into negative correlation in the long-run. As for policy makers, a contractionary monetary policy especially increasing the MLR is able to inhibit the property investment demand in the long run. However, such austerity measures will not cool down the property demand market immediately which will lag for nearly a year. SIRs affect investment cycles in the short run while LIRs have no correlation with the investment cycle. An increasing SIR would inhibit investment demand in the short-run one year later.

Above all, commercial property investment in Australia is relatively independent of the capital market and decoupled with economic conditions. This result is consistent with the previous literature which asserts that property investment demand in Australia will be less likely affected by local economic conditions or other domestic drivers due to large cross-border investment (Wong et al., 2019). From the policy perspective, the findings imply that the policies related to the regulation of foreign and cross-border investment in commercial property, coupled with the mechanisms that affect financing and gearing especially through the MLR and lending practices have significant impact on regulating or stimulating the investment market. Note that the effects of policies will not appear within a year.

4.3 Impacts on Property Development Cycle

4.3.1 Cyclicality of Property Development Market

The yearly value of property developments over time is presented in Figures 3 and 4. There is no visible cyclicality that appears in the long-term trend during this period due to the long wavelength of the supply cycle. Supplemented by the short-term fluctuations of the cycle, the results show that the property development market first peaked in 1990-Q1, followed by a decline in 1993-Q4 and then slightly recovered and remained stable for approximately 5 years. Then a continuous upward trend that achieves the second peak in 2010-Q2 is shown, which facilitates a stable pattern in the following years. Since there are two peaks and one trough involved in this pattern, it is reasonable to infer that the length of the property development cycle in Australia should be more than 20 years. The movements of the property development market have a steady and upward trend that are likely due to the continued strength of the property market, coupled with increasing complexity of the development procedures.

The longer waves of development cycles are possibly related to the complex procedures in the development activities such as the application of planning permits and building approvals, longer construction time, etc.

Figure 3 Trend Components Based on the Movements of Property Development Market (1987-Q1 to 2016-Q4)

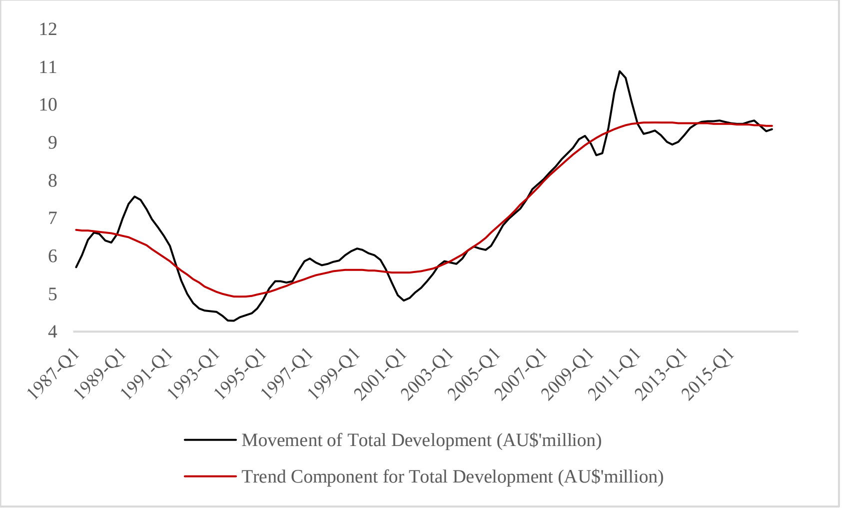
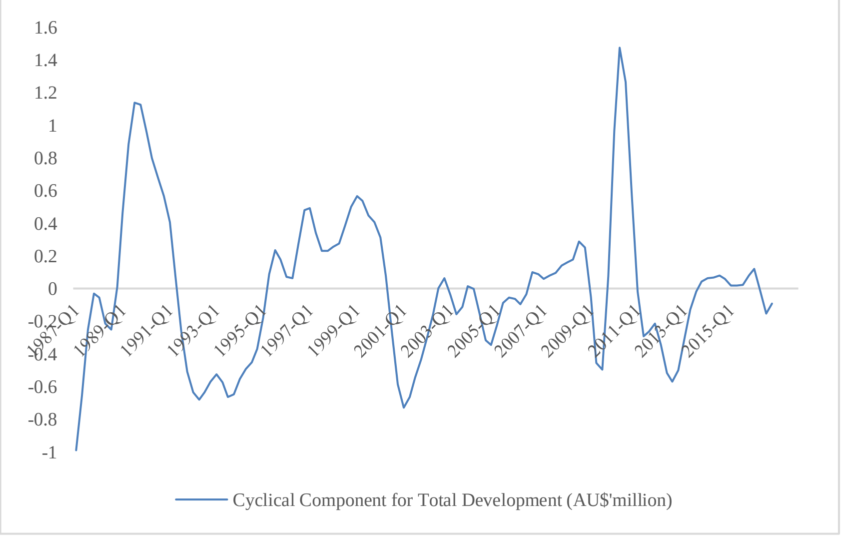


Figure 4 Cyclical Components of Property Investment Market (1987-Q1 to 2016-Q4)



4.3.2 Macroeconomics that Underlie Development Cycle

CPI, TIR and LIRs were eliminated from the model in order to pass the bound test. The result of the bound test (see Table 7) indicates that the *F*-statistic (4.0594) is larger than the upper bound (3.5) at the 5% significance level, which means cointegration exists and there is long-run equilibrium that underlies the remaining variables. The selected model for the development cycle is $ARDL^{TVB}(4,4,4,4,4,4,4)$ as per the smallest AIC value, with an extremely high adjusted R^2 at 0.999. The $ARDL^{TVB}$ model can explain the changes of the development cycle at a level of 99.9%.

The detailed long-run estimates are shown in Table 8. All of the significant variables have a small elasticity that is less than 1% and most of them show a negative relationship with the development cycle. NUR, SIRs and SMI are negatively correlated with the changes in the development cycle, MLR moves in the same tendency as the cycle. Even though GDP and TBY are insignificant in this model, all of the variables have been retained in the next step to estimate their short-run dynamics due to the validity of the model with a high adjusted R^2.

Table 7 Bounds Test Result for ARDL Model of Development Cycle

F-statistic	Significance	Lower bound *I*(0)	Upper bound *I*(1)
4.3147**	1%	3.15	4.43
	5%	2.45	3.61
	10%	2.12	3.23

Notes: 1.** represents significance at 5% level.
2. CPI, TIR and LIRs are eliminated from the model in order to pass the bound test.

Table 8 Long-Run Estimates for Development Cycle

Variable	Coefficient	Standard Error	*t*-statistic	*p*-value
Intercept	22.189***	8.077	2.747	0.007
LnGDP	-0.268	0.556	-0.481	0.632
LnMLR	0.596*	0.325	1.833	0.071
LnNUR	-0.915**	0.435	-2.101	0.039
LnSIR	-0.803**	0.366	-2.195	0.031
LnSMI	-0.516***	0.133	-3.891	2.04E-04
LnTBY	0.146	0.125	1.174	0.244
Adjusted R^2	0.999			

Notes:1.*, ** and *** represent significance at 10%, 5% and 1% levels.
2. CPI, TIR and LIRs are eliminated from the model in order to pass the bound test.

When it comes to the short-run relationship (see Table 9), the $ARDL^{TVB}$-ECM also performs well as reflected by the high adjusted R^2 of 0.914. GDP, SIRs, SMI and TBY show the short-run dynamics with the changes in property development cycle with various lags, among which the GDP is a synchronized factor with no lags. The elasticity of the variables to the property supply market is extremely small, which is under 0.5%, in the short-run compared with the demand market. The significant EC term (-0.062) further proves the presence of long-run equilibrium, which indicates that the short-run dynamics will deviate from the long-run relationship at a rate of -6.2%. The last step is to analyze the causality between the property supply market and macroeconomics. As shown in Table 10, the causations between the macroeconomic forces and development cycle are different with the results of the investment cycle. The dynamics of SIRs and MLR contribute to the fluctuations in the property supply market at a significance level of 1%, followed by the TBY and GDP at 10%. Hence, SIRs, MLR, TBY and GDP are identified as the development market indicators.

Table 9 ARDL-ECM Results for Development Cycle

Variable	Coefficient	Standard Error	*t*-value	*p*-value
ΔLnGDP	0.290**	0.127	2.27	0.025
ΔLnGDP(-1)	0.117	0.137	0.86	0.393
ΔLnGDP(-2)	0.000	0.137	0.00	0.998
ΔLnGDP(-3)	0.108	0.125	0.86	0.392
ΔLnMLR	0.021	0.039	0.54	0.590
ΔLnMLR(-1)	-0.048	0.041	-1.16	0.248
ΔLnMLR(-2)	-0.001	0.040	-0.03	0.980
ΔLnMLR(-3)	-0.019	0.040	-0.46	0.644
ΔLnNUR	-0.037	0.030	-1.24	0.219
ΔLnNUR(-1)	0.012	0.030	0.40	0.688
ΔLnNUR(-2)	-0.018	0.032	-0.55	0.582
ΔLnNUR(-3)	0.000	0.029	-0.01	0.990
ΔLnSIR	-0.024	0.028	-0.87	0.388
ΔLnSIR(-1)	0.060**	0.028	2.12	0.037
ΔLnSIR(-2)	0.001	0.027	0.02	0.983
ΔLnSIR(-3)	-0.040*	0.024	-1.66	0.100
ΔLnSMI	-0.006	0.008	-0.78	0.44
ΔLnSMI(-1)	0.022**	0.009	2.53	0.013
ΔLnSMI(-2)	0.008	0.008	0.93	0.355
ΔLnSMI(-3)	0.013*	0.008	1.66	0.100
ΔLnTBY	0.002	0.005	0.36	0.722
ΔLnTBY(-1)	-0.010*	0.005	-1.89	0.062
ΔLnTBY(-2)	-0.010*	0.005	-1.79	0.076
ΔLnTBY(-3)	-0.007	0.005	-1.31	0.195
EC(-1)	-0.062***	0.011	-5.75	1.20E-07
Adjusted R^2	0.914			

Note: *, **and *** represent significance at the 10%, 5% and 1% levels.

Table 10 Granger Causality Results for Development Cycle

Variable	H_0: The macroeconomic force changes do not Granger-cause the changes of the development cycle	
	***F*-statistic**	***p*-value**
LnGDP	2.21*	0.07
LnMLR	4.32***	2.80E-03
LnNUR	1.53	0.20
LnSIR	5.02***	9.60E-04
LnSMI	0.59	0.67
LnTBY	2.43*	0.05

Note: *, **and *** represent significance at the 10%, 5% and 1% levels.

4.3.3 Discussion

The development cycle establishes strong significant correlations with market-sentiment variables and the stock and bond markets. However, the result only finds a significant Granger causality from the bond market towards commercial property development activity in the short-run. It is different from the investment market in that the development market is not entirely independent on other capital markets, as reflected in the countercyclicality of the TBY with property supply in the short-run with extremely small elasticity at around -0.01 within one and two lags. This implies that the falling bond yield with one and two quarters lags is the short-term price signal for developers in Australia, however, this effect fails to transfer into the long term trend.

In terms of economic-cycle variables, NUR and GDP correlate with the development cycle but only GDP presents Granger causality as the market signal. Based on the results, the property development correlates to the economic cycle as revealed in the procyclicality of GDP. The GDP is the most sensitive variable, which affects the commercial property supply synchronously with no lags in the short run. This result is consistent with Barras (1994) in that an economic boom is always accompanied by booming building activities. The GDP has elasticity on the property development cycle of 0.3 in the short-run, but this impact does not transfer to the long-term effect.

Similar to the results of investment cycle, the development cycle is also significantly affected by the changes in financing related variables. The SIRs have both short-run and long-run relationships with the development cycle. It is worth noting that the elasticity of SIRs is smaller than 0.1 in the short-run but becomes larger in the long-run at -0.8 and is negative. The short-term impact of SIRs is inverted with different lag lengths. Stock market performance stimulates development as indicated by a positive coefficient of the SMI with one quarter lag, however, the effect inverts after three quarters lag. The MLR shows a positive correlation in the long-term with an elasticity of 0.6 but is insignificant.

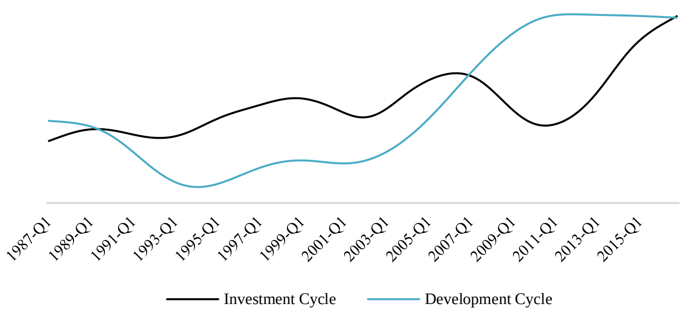
This paper establishes that the property development cycle is deeply impacted by macroeconomic determinants in the long run as revealed in their extremely small elasticity. Financing variables are the key factors since both the SIRs and MLR impact the property development market in the long term. From the perspective of policy, monetary policies that target interest rates will influence the supply of income producing properties. Increasing the SIRs can inhibit the overdevelopment of commercial property and prevent the underlying system risks, nevertheless, a high interest rate will also unfavorably affect economic growth. As for the impact of market-sentiment and economic-cycle related variables, the property development market in Australia is affected by both the SMI and NUR in the long run, however, these two variables fail to pass the Granger test, so they will not be considered as market signals. Policy makers can place emphasis on the decline in TBY and increase in GDP as the short-term market development stimuli.

4.4 Comparison of the Investment and Development Cycles

By comparing the pattern of investment and development cycles in Figure 5, it is obvious that the development cycle (supply cycle) is much longer than the investment cycle (demand cycle) and presents different movement patterns. In Australia, the commercial property market appeared to be overdemand from 1989 to 2007 for 18 years and then transformed into an oversupply situation for 9 years until 2016. Within the study period, the supply of commercial property for most of the time is not adequate enough to meet the demand requirements. Interestingly, the period of overdemand is twice as long as the period of oversupply. One possible reason for this difference is due to the different pattern of the demand and supply cycles coupled with the different impact factors that underlie the cycles. There are moderate long-run impact factors that influence the development cycle which extend the cycle length, while the investment cycle is more sensitive to the macroeconomic factors with short-run impacts that exacerbate the volatility.

In particular, when it comes to the property investment cycle, the length of each investment cycle is around 8-10 years with an increasingly volatile trend especially after 2000. Macroeconomic factors have a relatively large elasticity with the property investment cycle; most are around 2 to 20 in the short run dynamics and around 1 to 4 in the long run relationships. According to the empirical results, the property investment market is a relatively independent market, hardly impacted by market sentiment in other capital markets as well as overall economic conditions. In other words, commercial property direct investment in Australia is a good vehicle to hedge against the capital market and the overall economic risks. Among which, the changes in property investment return and GDP will produce great fluctuations in the demand cycle in the short-run. The investment demand is strongly affected by financial-related factors that are significantly correlated with the MLR and SIRs in the short-run.

Figure 5 Comparison of Investment and Development Cycles



The length of the development cycle is more than 20 years with a steady trend of increase, which is more than twice the length of the investment cycle. There are two possible reasons for the relatively stable cyclical fluctuations of the development cycle. The first reason is the length and complexities involved in the development procedures in Australia, such as the complicated planning process, the time taken to construct new dwellings, difficulty in the provision and funding of required infrastructures, as well as the cost of readying undeveloped land for construction and availability of suitable sites. Among them, local zoning and planning policies have played a significant role in the protracted supply side rigidities that underlie the development cycle (Reserve Bank of Australia, 2015). The second reason is that the property development market in Australia is marginally affected by the selected macroeconomic drivers in the short-run but deeply affected in the long run. Almost all of the macroeconomic factors have long term relationships with the development cycle. Similar to the investment cycle, the movement of the development cycle is also significantly caused by the changes of the financing-related variables as the profound market determinants.

5. Conclusion

According to the empirical investigation carried out in this research, most of the time within the study period the Australian commercial property market appears to be in overdemand with a time period that is twice as long as the oversupply situation. The length of the property investment cycle is much shorter and more volatile than the development cycle, of which the length of the investment cycle is around 8-10 years while the development cycle is more than 20 years. This paper estimates ARDL models to identify the determinants of property investment and development cycles. These determinants have been categorized as three factors, namely market-sentiment related, economic-cycle related and financing-related variables. These models will be particularly useful in the decision-making of an entry or exit point for income producing properties of investors and developers in different positions, which are deeply influenced by the upturn and downturn of the market cycles in macroeconomic contexts. They can also provide strategic implications for policy makers in Australia to regulate the demand and supply sides of commercial properties.

Based on the empirical results, the impact of macroeconomic factors that underlie the investment and development cycles are vastly different, and contributes to an imbalanced market in which the period of overdemand is much longer than that of oversupply. The selected macroeconomic factors show a relatively large elasticity on the property investment market reflected in the short-run dynamics. Such factors influence the development activities with moderate long run effects, which can be a possible explanation of the different patterns of the two cycles.

As for investors and developers, they need to consider that the various market signals depend on their different positions. Investors need to consider the long-term effects to gain higher long-term returns, for example, the MLR is a counter cyclical market signal for investors. Investors should also place emphasis on the local property investment market behaviour (return performance) and the fundamental characteristic of property itself, since the property market in Australia is a relatively independent market that is not relevant to other capital markets of the overall economy in the long-run. In other words, property markets in Australia involve fewer market risks and investors should focus on diversifying the non-market risks in investment portfolio decision-making. As per the developers, a falling GDP, but increase in investment return, MLR and SIRs are the first market signals of the rising demand as the development entry point in the short run. The market signals that follow for long-term development are the rising investment return and falling MLR. Note that since there is over demand in the property market in the long-run, developers are encouraged to establish their acquisition and develop strategies in more effective ways.

The key implications for policy makers are as follows. First, severe market imbalances encourage policy makers to optimize the planning process and development procedures. Empirical evidences show that there are lags in the ability of property supply to respond to changes in demand. Simplifying the planning process especially optimizing local zoning and planning policies are necessary for the Australian government to deal with protracted supply side rigidities.

Secondly, the establishment of short-term and long-term economic and financial strategies and policies will depend on the model itself. For short-term strategies, the movement of the demand and supply markets is related to the GDP, investment return, SIRs and TBY. For the long-term strategies, variables such as the investment return, MLR and SIRs should be considered as the prominent factors. Finally, the monetary policy adjustment mechanism, especially the leverage factors, as the most significant impact factors, should be used to regulate the property market in advance depending on the market cycle predictions. In an overdemand market, a contractionary monetary policy especially increases in the MLR can reduce property demand, however, such austerity measures will not cool down the property demand immediately but lag for around one year. In an oversupply market, an aggressive monetary policy such as cutting short-term interest rates to prevent overdevelopment in commercial property, will also take effect after around one year.

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Appendix

Data Dictionary (Detailed)

Code	Definition	Explanation/Measurement
NIN	Net investment for all direct commercial property	(Gross Purchase Prices + Part Purchase Costs + other Capital Expenditures) minus (Net Sale Receipts + Part Sale Receipts + Other Capital Receipts during the period)
TVB	Total value of building work done	Includes the costs of materials fixed in place, labour, and architect fees. Value of work done with chain volume measures; Total sectors (private and public) for non-residential properties.
TIR	Total investment return index for all direct property assets	Incorporates both capital and income elements, and is calculated as the percentage value change plus net income accrual, relative to the capital employed. Is recognized by the Global Investment Performance Standard (GIPS) set out by the Chartered Financial Analyst Institute as the standard composite measure of investment performance for all direct property assets.