UNIVERSITY OF TECHNOLOGY SYDNEY

Real Estate Asset Pricing – Evidence from Australian and US Real Estate Investment Trusts (REITs)

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Doctor of Philosophy

under the supervision of

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Certificate of Originality

I, Bingyang Ye, declare that this thesis is submitted in fulfilment of the requirements for the award of the degree of Doctor of Philosophy, in the School of Built Environment of the Faculty of Design, Architecture and Building at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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List of Abbreviations

Abbreviation	Definition
A-REIT(s)	Australian Real Estate Investment Trust(s)
AD	Asia Developed
AMEX	American Stock Exchange
APT	Arbitrage Pricing Theory
ARCH	Autoregressive Conditional Heteroskedasticity
ARFIMA	Autoregressive Fractionally Integrated Moving Average
ASX	Australian Securities Exchange
AUD	Australian Dollar
BTM	Book-to-Market Ratio
CAPM	Capital Asset Pricing Model
CIQ	Capital IQ
CMA	Conservative Minus Aggressive (in Fama-French Five-Factor model)
COVID-19	Coronavirus (2019) Pandemic
CRSP	Centre for Research in Security Prices
DCC	Dynamic Conditional Correlation
DSGE	Dynamic Stochastic General Equilibrium
EGARCH	Exponential Generalised Autoregressive Conditional Heteroskedasticity
EMH	Efficient Market Hypothesis
EPRA	European Public Real Estate Association
FE	Fixed Effects
FF	Fama-French (Three-Factor model)
FFO	Funds From Operations
FIEGARCH	Fractionally Integrated Exponential Generalised Autoregressive Conditional Heteroskedasticity
FIGARCH	Fractionally Integrated Generalised Autoregressive Conditional Heteroskedasticity
FRED	Federal Reserve Economic Data (US)
FTSE	Financial Times Stock Exchange
FY	Fiscal Year
GARCH	Generalised Autoregressive Conditional Heteroskedasticity
GFC	Global Financial Crisis
GICS	Global Industry Classification Standard
GRS	Generalised Regime Switch

Abbreviation	Definition
HHI	Herfindahl-Hirschman Index
HML	High Minus Low (value factor in Fama-French model)
ICAPM	Intertemporal Capital Asset Pricing Model
IPO	Initial Public Offering
MPT	Modern Portfolio Theory
MSCI	Morgan Stanley Capital International
MSDR	Markov-Switching Dynamic Regression
MTB	Market-to-Book ratio
NAREIT	National Association of Real Estate Investment Trusts (US)
NASDAQ	National Association of Securities Dealers Automated Quotations (US)
NBER	National Bureau of Economic Research (US)
NCREIF	National Council of Real Estate Investment Fiduciaries (US)
NOI	Net Operating Income
NPI	National Property Index
NYSE	New York Stock Exchange
OLS	Ordinary Least Squares
PACX	Pacific Exchange
QE	Quantitative Easing
RBA	Reserve Bank of Australia
REIT(s)	Real Estate Investment Trust(s)
RMW	Robust Minus Weak (in Fama-French Five-Factor model)
RPIR	Residential Property Index Return
SBIC	Schwarz's Bayesian Information Criterion
SIRCA	Securities Industry Research Centre of Asia-Pacific
SMB	Small Minus Big (size factor in Fama-French model)
SVAR	Structural Vector Autoregression
TRTH	Thomson Reuters Tick History
UK	United Kingdom
UMD	Up Minus Down (momentum factor in Fama-French model)
US	United States
USD	United States Dollar
VAR	Vector Autoregression
WRDS	Wharton Research Data Services

Abstract

This thesis identifies several gaps in the existing literature on Real Estate Investment Trusts (REITs) in Australia, including limited research on returns and volatilities of listed real estate in Australia, a lack of broad research into the magnitude of return and connection between REITs and stock markets across time, and the varying degree of efficiency or inefficiency of the REIT market. By addressing these gaps, this research provides valuable insights for investors in the Australian market.

This research seeks to investigate three key aspects of REIT beta, which measures the sensitivity of REIT returns to stock market movements: whether the variation in REIT beta across different industry sectors leads to differential levels of beta; how REIT beta fluctuates under varying market conditions, particularly during market downturns with high volatility; and the connection between the financial and accounting attributes of REITs and their beta. By understanding these factors, investors can better assess the risks and returns associated with REITs and make more informed investment decisions.

This study is guided by three conceptual frameworks: Modern Portfolio Theory (MPT), Markov regime-switching models, and the firm-level drivers of beta. The first framework provides a fundamental context for understanding and analysing the risk and return characteristics of REITs. The second framework assumes a constant transition probability between one regime and another, and that the endogeneity parameter is constant. The third framework is rooted in the

notion that financial ratios offer valuable insights into a company's underlying financial health and its potential to deliver future returns.

This analysis uses data from S&P Capital IQ Pro and WRDS CRSP platforms, including Australian and US equity REITs from 2000 to 2021. Financial data from the stock markets of both countries is collected. For each Australian REIT (A-REIT), time series data and asset transaction records are gathered. To analyse market factors, Fama-French size and value factors are calculated for the A-REITs. By splitting A-REITs into specialised and diversified groups, this research further investigates the diversification benefits of each type of REIT. Herfindahl-Hirschman Indices (HHI) are constructed for each A-REIT as another level of diversification based on asset type transactions. The regimes of Australian stock and REIT markets are identified, and diversification benefit is analysed with regime consideration. At the firm level, financial ratios are calculated for all REITs. For US REITs, three liquidity measures are constructed: turnover ratio, absolute return, and spread ratio. Finally, sector analysis is performed for both Australian and US REITs.

The empirical results show that REITs are generally less risky than the major stock market index in Australia. Specialised REITs have 14.0% lower beta than diversified REITs, meaning they have higher risk-adjusted returns and provide diversification benefit. This is because specialised REITs are exposed to different property sectors, which have different risk–return characteristics. The relationship between REIT returns and stock market returns is asymmetric for normal regimes and crisis regimes in Australia, with REITs being more sensitive to changes in interest rates and economic growth during crises. The diversification benefit of specialised REITs only exists during normal market periods in the regime analysis, highlighting the importance of identifying regimes for investors when making investment decisions. Firm-level factors such as size and yield are positively associated with US REIT performance, while firm illiquidity influences REIT performance negatively. A-REIT sector betas are generally lower than US REIT sector betas and these two markets demonstrate different sector performance.

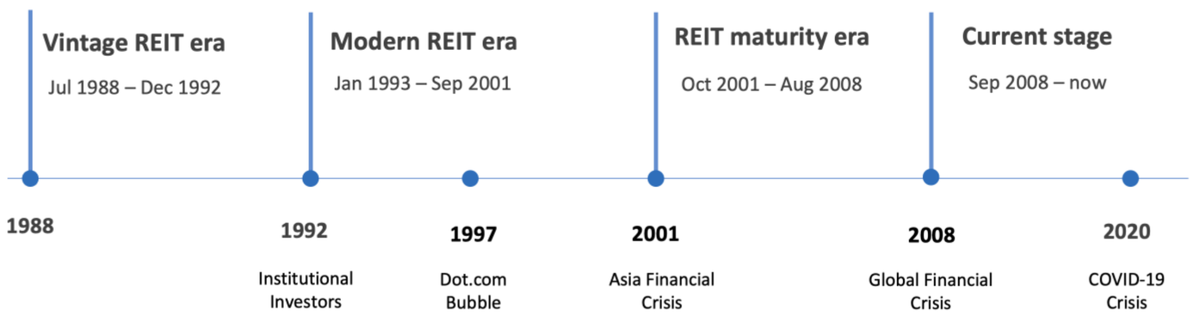
Chapter 1 **Introduction**

1.1 Overview

It is widely acknowledged that property is important as an investment class, but the illiquid nature of direct real estate makes such investment less attractive to investors. REITs are listed companies specialising in property investment. To qualify as a REIT, they must fulfill specific criteria, such as the distribution of a significant portion of their earnings to shareholders through dividends. A-REITs constitute approximately 5.62% of the global REIT market, which spans 75 countries (EPRA, 2024). In Australia, the total listed real estate sector accounts for 6.75% of the domestic stock market, with A-REITs comprising 95.01% of this sector (EPRA, 2024). Valued at A$144.5 billion in 2023 (Statista, 2023), A-REITs are a significant asset class, offering investors access to more liquid real estate investments and diversification benefits, while requiring lower capital commitments compared to direct real estate ownership..

As shown in Fig. 1-1, the REIT market has seen different development stages with distinct features. Before 1992, the REIT market was dominated by microcap stocks and lack of investor attention (Aguilar et al., 2018; Jirasakuldech et al., 2006; Shen, 2020), while in later years, mid-cap and large-cap REITs emerged and the REIT market has seen continued expansion globally in both developed and emerging regions. Therefore, a better understanding of the financial performance of REITs is of great importance to investors' portfolio construction and investment decisions.

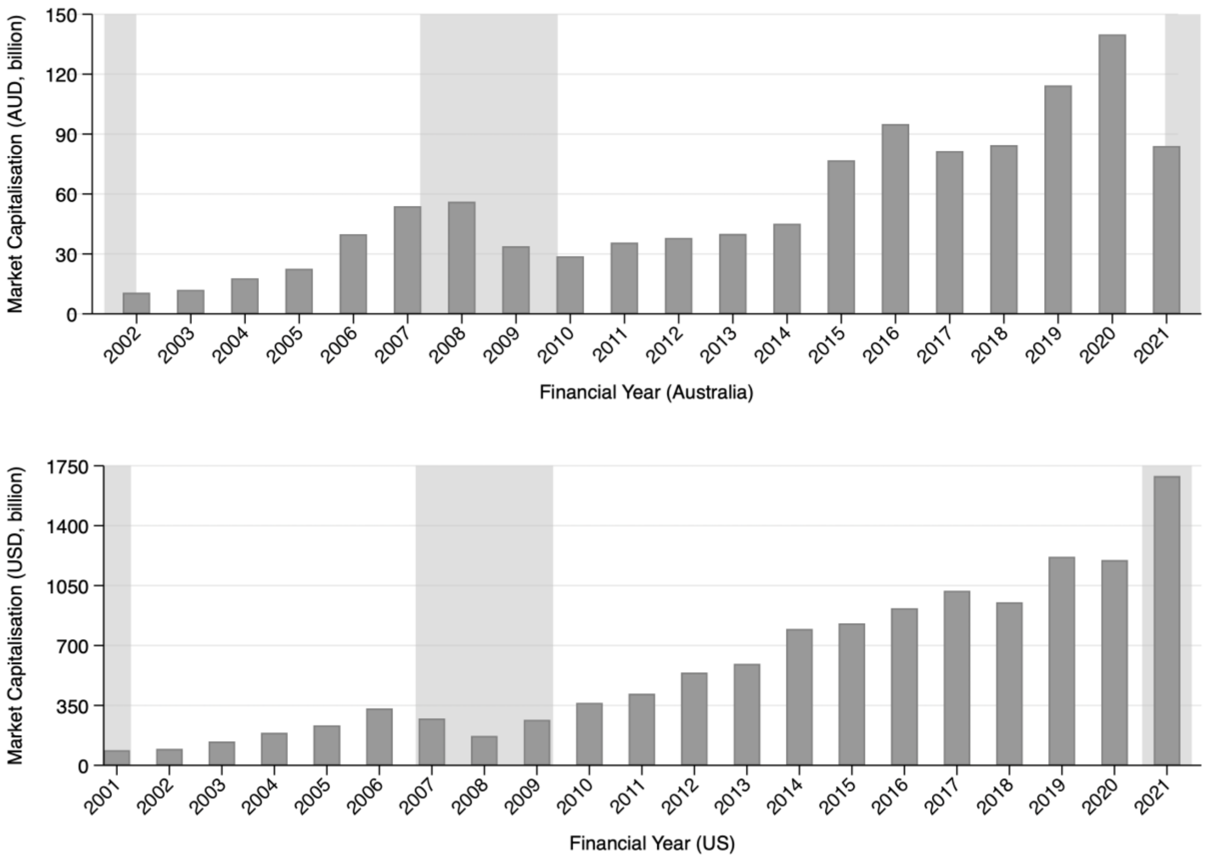
Fig. 1-1. REIT eras



Despite the extensive research on REIT investment strategy, few studies have focused on property type diversification and firm-level characteristics in pricing REITs. For instance, while REITs offer diversification benefits over a three-year "long horizon" period in the US and UK, it remains unclear how the volatility of the real estate securities market correlates with the capital market in Australia due to the absence of sector-level data (Hoesli & Oikarinen, 2012).

Fig. 1-2 illustrates that while Australia has a greater number of small-cap REITs, US REITs are mostly mid-cap and large-cap stocks, necessitating different investment strategies for the two markets. While some studies consider liquidity in their analysis but not firm structure (Hoesli et al., 2017), other research suffers from a small sample size of only 77 US REITs (Rehse et al., 2019), resulting in a pricing model that offers limited explanatory power for REIT returns. Thus, this study offers a more comprehensive investment strategy for portfolio diversification by considering property type diversification benefit, market condition and firm-level features along with liquidity measures, thereby reducing the potential for biased outcomes.

Fig. 1-2. US and Australia REIT market capitalisation



Note: The crises areas are shaded with light grey: 2000–2001 dot.com bubble, 2007–2009 global financial crisis and 2021 COVID-19 pandemic. Australian Financial Year ends in June, US Financial Year ends in December. Data source: S&P CIQ Pro (2000–2021).

REOCs is another type of listed property companies that does not necessarily seek rental income but can be capital gain. REOCs don't have to abide by the asset requirement to be qualified as a REIT, therefore don't enjoy the tax benefit that REIT have. REITs can engage in real estate development by forming joint venture partnerships with private developers. These distinctions can influence investor preferences based on their financial goals and risk tolerance.

In addition to the listed sector, the private property sector is another component of the property market, including unlisted property syndicates and wholesale unlisted funds. Unlisted property syndicates operate within the private property sector and are primarily income-driven, favouring secure, long-term leases, such as 10-year agreements with tenants like the Australian Taxation Office (ATO). These syndicates typically focus on industrial and office properties, as they outsource much of their operations, avoiding the complexities of managing numerous retail tenants. With limited resources for market research and leasing, they tend to concentrate on sectors that offer greater stability and require less operational involvement.

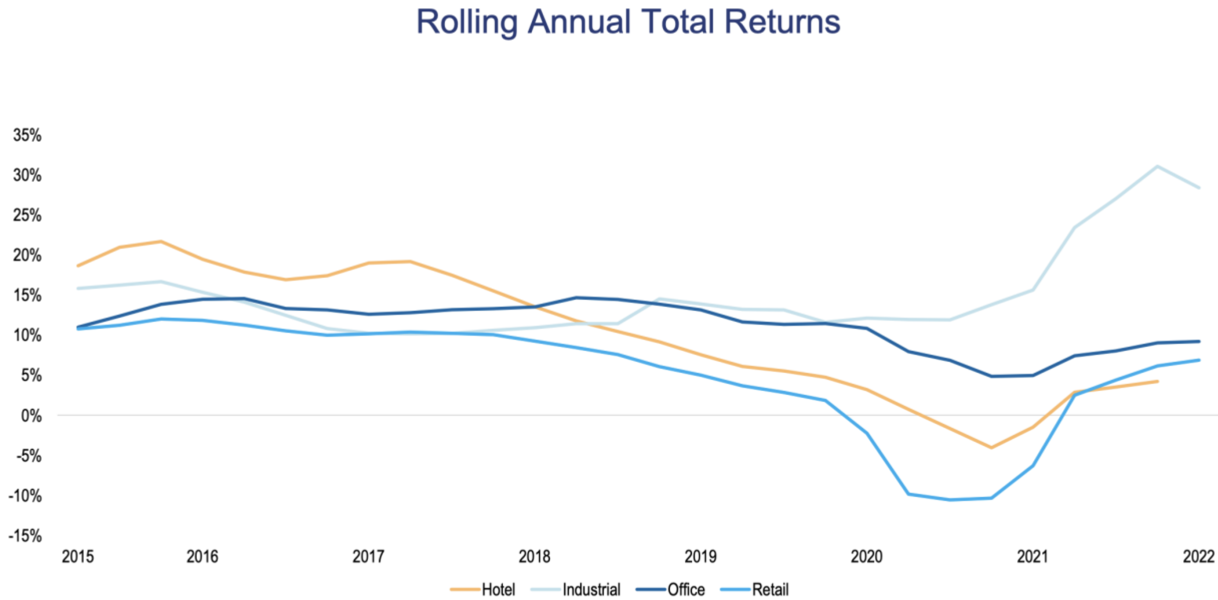
Wholesale unlisted funds are another major player in the private property investment space. These funds include large institutional investors such as insurance companies, superannuation funds, offshore entities like the Norwegian Future Fund, and sovereign wealth funds from Germany and the Netherlands. These institutions allocate a portion of their investments to real estate, either by directly purchasing properties or by investing in wholesale funds, which are often closed-ended. These funds are highly capitalised and search globally for opportunities, partnering with reputable managers to achieve targeted returns. Typically, they involve a small group of four to five investors, leading to transactions often referred to as "club deals." These funds seek high-quality, A-grade properties and maintain modest gearing levels between 10% and 30%. Their focus is on long-term growth, targeting capital gains through property acquisitions or developments, with investment horizons of 10 to 15 years. The funds are externally managed and usually invest in traditional property asset classes.

While many global markets are recovering in 2024, Australia's slowdown is deepening. The Australian commercial real estate market saw significant value declines in Q2 2024, with the

Property Council of Australia/MSCI Australia Annual Property Index reporting a downturn with total return of -3.7% for FY2023–24, which was led by a steep fall in capital growth (-8.5%) and the worst since 2009 (Property Council of Australia, 2024). According to Property Council of Australia (2024), Once the top-performing asset class, the industrial sector's performance has weakened, posting a total return of 0.1%, down from 23% two years ago, with capital growth falling to -4%.

The office sector has been hardest hit, experiencing a total return of -9.3%, and capital losses of 13.6%, with cumulative losses exceeding those of the Global Financial Crisis at 22% (Property Council of Australia, 2024). Office sector experienced a structural change in the demand for office space due to the impact of Covid-19 crisis that brought work from home and hot desking trends. However, the retail sector recorded a positive total return of 2%, supported by an income return of 6% despite negative capital growth (-3.8%) (Property Council of Australia, 2024), which is signalling a modest recovery for retail sector. Figure 1-3 shows that the hotel and retail sectors display a high correlation over this period. However, as noted by the recent commercial trends by Property Council of Australia (2024), these two sectors have shown divergent performance from 2023 to 2024.

Fig. 1-3. A-REIT return by sector (2000–2022)



Source: The Property Council of Australia/MSCI Australia All Property Annual Index (MSCI, 2022)

To provide a more comprehensive analysis for a more accurate investment strategy regarding real estate portfolio performance, this research focuses on the period of 2000 to 2021 when a more mature market is present. It contributes to REIT research in several ways. It considers the return sensitivity and volatility of REIT and non-REIT stock by employing the capital asset pricing model (CAPM) and the autoregressive conditional heteroskedasticity (ARCH) model. Much of this work has not previously been applied to the latest Australian data.

This study also contributes to understanding and improving the explanatory power of the traditional asset pricing model by incorporating the REIT investment property type, thereby providing another perspective for real estate fund managers to construct their own portfolio of a mix of specialised A-REITs and gain diversification benefits compared to purchasing diversified REITs. Specialised A-REITs focus the majority of their investments on one property sector, such as industrial or office. The property type diversification benefit remains statistically significant for explaining A-REIT returns when controlling for the Fama-French size and value factors in Fama-French three-factor model. The size factor (small minus big) quantifies the impact of a company's size on returns by subtracting the returns of larger firms from those of smaller ones. Similarly, the value factor (high minus low) reflects the return differential between firms with high and low book-to-market ratios.

Moreover, this research represents the latest robust regime-switch analysis of Australian REITs and stock markets. The impact of the COVID-19 crisis on REITs is also considered and compared to that of the global financial crisis (GFC) by using data from 2020 and 2021. This study fills the research gap of how crises shape regime shifts and change the diversification benefit in the REIT and stock markets in Australia. This also enables investors with a straightforward regime judgement of the REIT market to then adopt the corresponding strategy of holding more REITs during normal market states and reducing their REIT holdings during crises. These strategies are expected to outperform a simple buy-and-hold portfolio that contains REITs and non-REIT stocks in terms of maximising the diversification benefits based on different market states of REITs and non-REIT stocks.

The pooled regression models considering the firm-level financial and accounting features together with liquidity measures present a new direction for listed real estate research. It is essential to price the firm features since market capitalisation affects stock performance (Fama & French, 2012) and the liquidity of REITs is subject to both real estate and stock markets. Firm liquidity is a key driver of REIT performance, as REITs behave like direct real estate in the long run (Hoesli & Oikarinen, 2012, 2019), and the underlying properties are illiquid. In addition, this thesis presents an analysis of the US and Australian REIT markets, suggesting that US REITs carry higher systematic risks than A-REITs, and that sector performance varies between the two countries.

1.2 Research problems

This research investigates three critical aspects of REIT beta. First, it assesses whether the variation in REIT beta across different industry sectors leads to differential levels of beta. Second, the study aims to explore how REIT beta fluctuates under varying market conditions, particularly during market downturns and periods of high volatility. Finally, it seeks to understand the connection between REITs' financial and accounting attributes and their beta, providing valuable insights for investors in assessing risk and making informed investment decisions.

With the increasing size of listed real estate markets and their attractive performance, this research addresses some key issues that have not been fully examined in the listed real estate markets. Specifically, the common proxy for the market portfolio return in the CAPM model does not include REIT returns (Roll, 1977), which may lead to an incomplete understanding of REIT performance. While Glascock and Lu-Andrews (2018) studied the relationship between REIT beta and returns using traditional CAPM for US REITs from 1992 to 2014, their study predates REITs becoming a standalone sector in 2016[1]. Other recent research has focused on the impact of the COVID-19 pandemic on REIT returns (Milcheva, 2021), but lacks a longer-term perspective. As a result, there is a need for further examination of mainstream pricing models, such as CAPM and Fama-French factor models, specifically applied to REITs in different timeframes and market conditions.

[1] According to NAREIT, on 31 August 2016, S&P and MSCI classified listed equity REITs and other listed real estate companies as a separate sector in the Global Industry Classification Standard, moving them from the financial sector, reflecting the significant growth of the REIT market.

Further, previous studies mainly focused on the stock return volatilities in the US financial markets (Clayton & MacKinnon, 2003; Yang et al., 2012), leaving a gap in understanding the return volatility and linkages between the listed real estate market and the stock market in Australia. Additionally, the relationship between REITs and stock markets, particularly in terms of risk, may fluctuate under different market conditions, such as normal periods, crises, and economic booms. Furthermore, the efficiency of the Australian securitised real estate market appears to vary considerably across time, which may explain the inconsistent findings in earlier research (Su et al., 2012). This inconsistency highlights the need for a regime-switch analysis in the Australian REIT market, particularly in light of the growing involvement of institutional investors.

Finally, the extent to which financial characteristics influence risk exposure in the Australian REIT market remains unclear. It is essential to examine how firm-level factors, such as capital structure and liquidity, affect REIT performance. As the listed property sector continues to grow, understanding these dynamics becomes increasingly important for evaluating the drivers of REIT risk and return.

1.2.1 REIT beta

There is limited literature on returns and volatilities of listed real estate in Australia with most of the work restricted to United States markets. In Australia, there has not previously been any broad research into the magnitude of return volatilities and interconnectedness between the REIT and stock markets. There is persistence in the volatility of equity REITs at daily frequency, but the magnitude of such phenomenon is less than that in the S&P 500 index (Cotter & Stevenson, 2008). Thus, it is important to understand the returns and volatilities of REITs as another asset class compared to the financial market as a whole.

It is unknown how well the CAPM and Fama-French factor models are applied in REITs. Therefore, the research investigates the empirical accuracy of traditional asset pricing models in the listed real estate assets and investigates if REITs are similar to non-REIT stocks. The findings of previous research on the characteristics of the listed property market are that the market differs from common stocks and bonds due to the unique traits of both the underlying real estate assets and the structure of REITs. Some researchers concentrate on the risks and returns of REITs using the CAPM (Devaney & Weber, 2005), and others find evidence of trade-offs between return and variances (risks) of REITs (Zhou & Kang, 2011). The results of this research are of practical use to both investors and regulators, especially given the impact of the recent COVID-19 crisis that posed a structural shock to the whole real estate market.

The relationship between REITs and general stock market returns is relevant to the understanding that REITs are priced in the financial market and behave like direct properties in the long term (Hoesli & Oikarinen, 2012). However, the linkage of asset returns measured by the cointegration between listed real estate markets, such as REITs, and the stock market varies in different countries. In particular, Hoesli and Oikarinen (2012) used the Johansen (1996) trace test for cointegration between stock, REIT and direct real estate indices and adopted a vector-error-correction-model (VECM), a vector autoregressive (VAR) model and impulse response functions for the asset returns, but found no tight links of returns in the Australian markets even when including in the analysis the fundamental factors that affect returns.

1.2.2 Regime-switch consideration in the A-REIT market

Return and volatility characteristics in the REIT market tend to fluctuate across various market conditions. The growing REIT market and increasing investor interest in this sector have led to significant trading growth in recent years. However, the financial turmoil experienced by all assets from 2007 to 2009 shifted investors’ focus towards understanding return and volatility characteristics, which, if better understood, could have been leveraged to optimise the performance of portfolios containing both REITs and non-REIT stocks. Recent researchers have examined REIT returns within the framework of regime-switch models (Case et al., 2014; Case et al., 2012), while others have applied regime-switch models to investigate asset allocation of portfolios that include REITs and other assets (Sa-Aadu et al., 2010).

The economic cycle is a critical consideration in real estate investment. REIT returns are underpinned by both long-term real estate cycles and short-term financial market volatilities. In this thesis, the regime-switch method is used to investigate the REIT market, as fundamental drivers of REIT returns change over time in different phases of cycles. The REIT market might switch to a top regime during a bull market or stays in a stable regime if there are no significant shocks. The possibility of a REIT market jumping to a different regime is dependent on the current market state, real estate cycles and financial market volatilities. Moreover, the degree of efficiency or inefficiency of the Australian securitised real estate market varies considerably across time, which may explain why previous studies have varied results as they explored different periods (Su et al., 2012). Thus, a regime switch in the Australian REITs market marked by the development of institutional investor involvement is worth researching.

A financial crisis provides a unique opportunity to test the regime switch. The correlation between the Australian listed property market and the stock market remarkably increases during a market downturn (Newell & Acheampong, 2001). The 2007–2009 GFC changed institutional investment behaviour, as institutional investors continued to put capital in the more liquid REIT market during and after the crisis period (Das et al., 2015). Su et al. (2012) re-examined REIT market efficiency with an improved portmanteau test that overcomes the limitations of standard autocorrelation tests. They argue that market efficiency could also be reflective of regulatory changes such as financial market reform as a result of a financial crisis. This reform could also spill over to the securitised real estate market (Dell'Ariccia et al., 2012; Krinsman, 2007). Thus, the post-crisis period is often substantially different from the pre-crisis period due to new regulations, and financial and fiscal stimulations which may lead to a regime switch.

Therefore, it is essential to study if a financial crisis affects the volatility of the REIT market and capital market over time to help identify and establish the extent of the regime switch in Australia. Brauers et al. (2014) highlighted that an abrupt burst of the bubble tends to lead the cointegration tests to reject the null hypothesis of such change in the bubble, and therefore they used a complex system approach to identify rational bubbles in the US equity REIT market from 1989 to 2011. As a national economy could enter an environment of low interest rates due to a financial crisis, there is an overlap between the crisis and the spillover of risks. It is unknown how a financial crisis would influence the linkage between the REIT market and the general stock market in Australia.

1.2.3 Firm-specific risks and REIT beta in Australian and US markets

Previous studies have examined the drivers of REIT beta, but the results have been mixed. Some studies have found that firm-specific factors such as size (Alcock & Steiner, 2018; Highfield et al., 2021), leverage (Dogan et al., 2019; Pavlov et al., 2018), market-to-book ratio (Alcock & Steiner, 2018) and profitability (Bond & Xue, 2017; Glascock & Lu-Andrews, 2014b) are substantial drivers of REIT performance. Profitability predicts future REIT returns and leads to higher REIT returns (Glascock & Lu-Andrews, 2014b).

To consider firm-specific risks, this analysis uses a larger dataset of US REITs containing more than 138 equity REITs to avoid overfitting. Overfitting occurs due to noise, the restricted size of the training set, and the intricacy of classifiers. To mitigate this problem, the “data expansion” strategy suits complex models, involving the fine-tuning of hyperparameter sets with a substantial volume of data (Ying, 2019). In the US market, there are over 138 REITs with a combined market capitalisation exceeding US$1.69 trillion[2], which is approximately 20 times larger than the A-REITs market, comprising 31 REITs in this study. In this context, the study by Ying (2019) offers evidence supporting the use of US data for a more robust analysis of how firm characteristics influence beta and on the varying performance of REITs in different real estate sectors.

Liquidity and other firm-specific features are important considerations in financial asset pricing, especially in the real estate market where illiquidity of the underlying assets persists (Demirci et al., 2023; Richter, 2022). Prior research on REIT liquidity has largely overlooked the influence of underlying real estate market returns, despite their strong correlation with property values (Geltner et al., 2021). This study examines the long-term relationship between REIT beta and firm-level characteristics, including three liquidity measures: turnover ratio, absolute return and spread ratio. The study also incorporates residential market indices into the analysis to consider the long-run movement (Hoesli & Oikarinen, 2019).

REIT returns are asymmetric across market states from the regime-switch analysis and previous literature (Glascock & Lu-Andrews, 2018; Yang et al., 2012). To minimise such bias, this study employs the quantile regression proposed by Koenker and Bassett Jr (1978). Chen et al. (2012) used quantile regression to analyse the influence of monetary policy on REIT returns. Building on this approach, this study delves deeper into the investigation, examining how firm-specific

[2] Refers to US REITs included in this thesis, as of June 2021 from SP Global Capital IQ Pro

attributes affect REIT beta differently across each of the three quantiles (0.25, 0.50, 0.75) for each firm characteristic.

It is worth noting that each specific real estate subsector has unique attributes and varying levels of risk due to the nature of the underlying properties, but these sector-specific risks within REITs have not been thoroughly studied. To extend the research in section 1.2.1, this thesis conducts a detailed analysis of different sectors within the REIT market. It aims to understand the risks and returns associated with each specific sector, including office, retail, residential, industrial, healthcare, hotel and specialty properties as classified by the Global Industry Classification Standard (GICS). By using a large dataset with over 138 US REITs, the findings become more robust and reliable. Additionally, this research considers the impact of direct real estate investment and extends sector analysis to both the US and Australian markets.

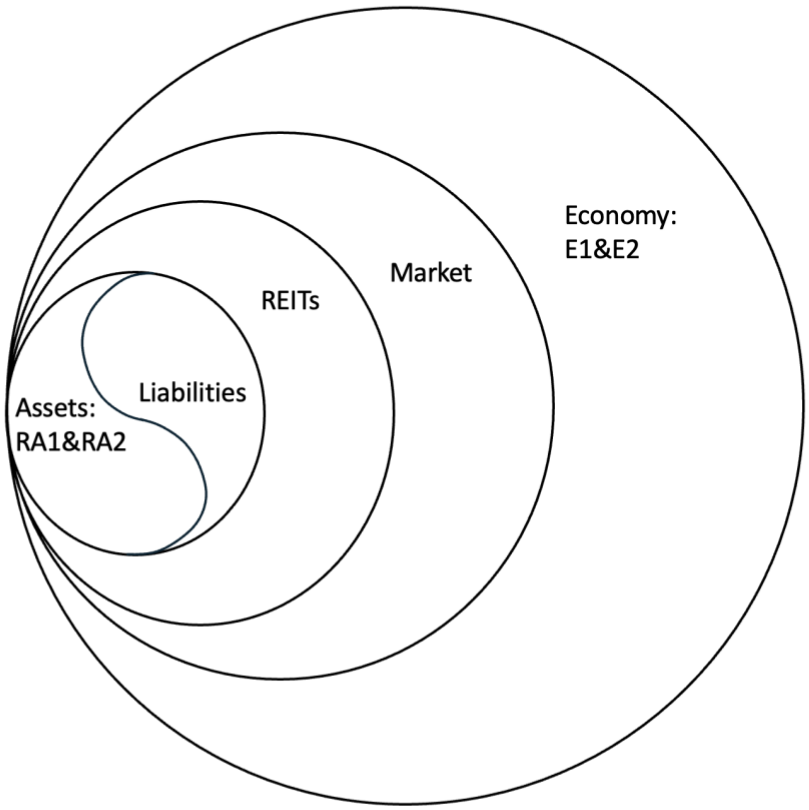
The study shares similarities with existing literature but distinguishes itself in the following aspects. First, in addition to the classic financial ratios such as size, leverage, market-to-book ratio, and profitability, this study highlights the importance of liquidity to REIT beta by incorporating three liquidity measures: turnover ratio, absolute return and spread ratio. Second, this study uses quantile regression to distinguish variations in firm-level drivers of beta across quantiles, thus reducing bias and heteroskedasticity associated with the regime-dependent REIT beta. Third, this study conducts sector analysis for US and Australian REITs, differentiating the risk levels of each property sector. This analysis offers valuable insights for investors aiming to identify sectors with the potential to outperform the broader market. Consequently, investors can adjust their investment portfolios to align with their risk preferences, thereby optimising their investment strategies.

1.3 Conceptual framework

Figure 1-4 illustrates the conceptual framework guiding this thesis. It underscores the vital role of REITs in the economy, systematic risk (E1) and market regimes (E2) represent the economic factors that significantly influence the performance and attractiveness of REITs to investors. Systematic risk refers to the general uncertainty in the stock market affected by economic factors such as supply and demand, which determine the price level in macroeconomy and impacts REIT performance. According to MPT, to maximise returns without taking too much risks, investors could allocate their investments across a range of assets (Markowitz, 1952), including those in different markets such as stocks and bonds in the capital market, as well as REITs in the listed real estate market. Property in the wider economy is seen as both an economic good and a type of financial asset (Ball et al., 1998), same the nature of REITs. REITs offer investors a chance to diversify their portfolios (RA1), because REITs own underlying brick-and-mortar assets that perform differently from stocks and bonds. This diversification potential, alongside firm level factors that reflects the financial strength of REITs (RA2), shapes the performance of REITs.

Market regimes (E2), on the other hand, represent the different economic situations like boom or recession, which affect REIT beta. Business cycles are frequently referred to as macroeconomic fluctuations (Ball et al., 1998), driving both stock and REIT markets' movements. As the time series of stock price is a good economic indicator for understanding the general market trends for real estate sector (Case, 1965), this thesis will investigate how REITs perform in different conditions of the stock market, using stock market regime shifts to examine the relationship between REIT and stock markets in booms and crises.

Fig. 1-4. Conceptual framework



Note: E1 is the first factor of the economy that affect REIT performance and stands for systematic risk, E2 is the second factor in play and represents market regimes. RA1 means the asset side of the REIT provides diversification benefit, RA2 means the second part of asset-level factors that shape REIT performance.

In Figure 1-4, there are various firm-level indicators of the financial strength from both the asset (RA1 & RA2) and the liability sides of a REIT. This thesis will focus on investigating the asset side driving factors of REIT performance. The financial ratios (RA2) of a REIT may explain individual REIT performance at the firm level. The analysis on the firm-specific features of REITs by looking into its assets provides a deeper understanding of the REITs market. Therefore, from economy level to market level and firm level within REIT market, this research focuses on explaining REIT beta in both macro and micro perspective.

To investigate these issues, the thesis is organised into three main chapters. Chapter 2 looks at REIT beta in the Australian market, which reflects how REIT performance relates to the broader stock market. Chapter 3 examines how different economic situations affect REIT performance, offering insights into how REITs behave in various market conditions. Finally, Chapter 4 studies what drives REIT performance at firm level, considering factors like leverage, yield and liquidity ratios. The specific chapter framework is as follow.

This research is guided by the three conceptual frameworks. First, the principles of MPT provide a fundamental framework for understanding and analysing the risk and return characteristics of REITs. It is based on the idea that investors can reduce the risk of their portfolios by diversifying their investments across a variety of assets (Markowitz, 1952). The CAPM, as articulated by Black (1972), relies on certain assumptions on investor beliefs, asset return distribution, investors' utility, and unrestricted trading. Lintner (1969) and Black (1972) underscore that relaxing or removing different assumptions may alter the CAPM. Further, the Efficient Market Hypothesis (EMH), posited by Fama (1970a), contends that market efficiency is determined by the extent to which prices reflect available information. Fama (1970a) distinguishes three forms of efficiency: weak, where information comprises only historical prices; semi-strong, where capital market prices adjust to all publicly available information; and strong, where specific investors lack monopolistic access to relevant information. The challenge in proving inefficiency lies in what

Fama (1970a) terms the “joint hypothesis problem”, asserting that any test of mispricing is intertwined with a model of discount rates, making definitive evidence challenging to establish.

Second, in a regime-switch model, the market state can switch from one regime to another through time, and the coefficients are regime-dependent and controlled by a finite state Markov chain. Markov regime-switching models assume a constant transition probability between one regime and another and assume the endogeneity parameter to be constant, which implies that the correlation between the underlying factor and time series is unchanged through time (Hamilton, 1989). The classic literature following Hamilton (1989) assumes that the regime shifts are exogenous regarding all realisations of the regression disturbance. The transition matrix in the regime-switch model assumes that the probability of a regime change depends on the past only through the value of the most recent regime.

Third, the relationship between firm-level financial ratios and risk and returns is rooted in the notion that financial ratios offer valuable insights into a company’s underlying financial health and its potential to deliver future returns. These financial ratios serve as valuable tools for evaluating a company’s effectiveness in managing capital structure (Alcock & Steiner, 2018; Dogan et al., 2019), improving returns (Hou & Van Dijk, 2019), and enhancing liquidity (Zhu & Lizieri, 2022). Firm-specific features such as size and trading volume, along with market-wide factors like property market liquidity, contribute to shaping REIT liquidity. This liquidity not only reflects market conditions but also conveys information about stock volatility and trading volume.

1.4 Research questions

According to MSCI, deal activity of the commercial property sector in Australia experienced a significant decline in 2023, plummeting by 48% to AU$39.6 billion (Lenaghan, 2024), which marks the biggest annual drop since the GFC. This decrease results from rising interest rates and different workplace demand in the Australian market. This research addresses critical concerns in listed real estate markets, attention on commercial real estate and funds in the media. Amidst these discussions, there's a growing imperative to reassess existing pricing models for REITs and their connections with the stock market. Key issues include the debate surrounding the suitability of conventional pricing models like the CAPM and Fama-French factor models for REITs, the limited comprehension of return volatility and linkage between listed real estate and stock markets across various market conditions (normal and crisis), and the investigation into firm-level determinants of REIT beta tied to firm characteristics. The overarching research question is: how do industry sector, market conditions, and financial and accounting attributes affect REIT beta?

Research question 1: How does REIT beta based on CAPM vary across industry sectors?

1a: How does REIT beta behave in the Australian context?

1b: What is the diversification benefit of specialised REITs compared to diversified REITs?

Research question 2: How does REIT beta change in response to varying market conditions?

2a: What is REIT beta under different regimes in Australia?

2b: Does the diversification benefit still exist in changing market conditions over time?

Research question 3: What is the relationship between the financial and accounting attributes of REITs and their beta?

3a: How will a firm's specific factors affect REITs' risk and return in the US?

3b: How does sector performance vary in Australia and the US considering detailed sector groups?

1.5 Research hypotheses

REITs which are publicly traded in the stock market can be viewed as financial assets and analysed by the CAPM. However, the model is insufficient in capturing the return features of REITs as measured by the magnitude of model coefficients. Previous literature on REIT pricing focuses on other factors, such as industry concentration (Zhang & Hansz, 2022), location of assets (Zhu & Lizieri, 2022) and market liquidity (Downs & Zhu, 2022). The REIT sector separates from the stock market while still tightly links to other asset classes, including gold and oil (Mensi et al., 2022). A substantial portion of current research is dedicated to analysing the US market. In contrast, this study prioritises the A-REIT market due to the limited existing knowledge about it. This thesis investigates the relationship between REITs and the broader stock market, the diversification advantages offered by REITs concerning stock market dynamics, and the characteristics that drive risk and return at the firm level. This research is guided by the following hypotheses:

Hypothesis 1: Under the CAPM assumptions, the risk adjusted return of REITs will be the same for diversified funds and specialised funds.

Hypothesis 2: REIT beta varies across different market regimes, and any differences between the two are likely local phenomena due to different market tastes.

Hypothesis 3: Firm-specific factors will affect REIT return and beta. The impact is different across different markets such as in the Australian and US stock markets.

1.6 Research significance

Existing research on REIT performance has limited focus on the drivers of beta, such as sector concentration, changing stock market regimes, and financial ratios. This thesis fills these research gaps in the understanding of REIT returns and beta in the Australian and US markets. It contributes to the literature on the application of the CAPM model to REIT analysis with classification of fund type, which can be used to assess the diversification benefit of REITs more accurately. It highlights the importance of identifying different market regimes when estimating REIT beta. It also outlines several firm-specific factors crucial to REIT performance, enabling investors to identify and invest in better-performing REITs.

Furthermore, this study explores the applicability of traditional asset pricing models like the CAPM and Fama-French factor models in the context of Australian REITs. These models have been used extensively, but they may not be directly applicable to REITs, which have unique characteristics compared to common stocks. This study categorises individual REIT firms into specialised REITs and diversified REITs, based on the sector diversification provided by S&P Capital IQ Pro which uses GICS and is modified based on asset managers' knowledge of the A-REIT market. Analysing 31 equity REITs in Australia from 2000 to 2021, the study reveals the potential for diversification and improved risk-adjusted returns in specialised REITs. The study shows that specialised REITs, which focus on one real estate sector, carry higher risks and lower returns compared to diversified REITs. This study has practical implications for investors seeking to optimise their portfolios, as they could achieve superior performance by constructing their portfolio in the Australian market. However, the findings pertain only to the Australian stock market.

Additionally, this research adapts the traditional CAPM to account for regime shifts, demonstrating how specialised A-REITs can offer diversification benefits during normal economic periods while highlighting potential challenges during crisis periods. The study helps with the understanding of the dynamics of the Australian REIT market, particularly how it can be described using a two-regime model. By employing regime-switch models, the research investigates the relationship between REIT returns and the broader stock market across different phases of economic cycles. The analysis shows that the previously found diversification benefit of specialised REITs only exists outside of crisis periods.

The regime-switch analysis highlights the potential regime shifts of the A-REIT market influenced by financial market volatilities as the crisis regimes of both markets overlap. The results indicate that Australian REITs perform poorly and are more volatile than the S&P/ASX-200-Financials-ex-A-REIT Total Return Index during crises, contributing to the understanding of the connections between these markets. This knowledge is particularly vital for investors and regulatory bodies, especially given the recent upheaval caused by the COVID-19 pandemic.

This research also emphasises the crucial role of liquidity in understanding REIT beta by expanding the analysis beyond traditional financial metrics to include three additional liquidity measures at the firm level. The inclusion of sector analysis for both US and Australian REITs provides valuable insights into the risk profiles of different property sectors, helping investors identify sectors with the potential to outperform the overall market and optimise their investment strategies. Overall, this research significantly contributes to the field of real estate investments by providing a comprehensive, nuanced and balanced perspective on REIT performance and its influencing factors.

1.7 Structure of the thesis

To examine the characteristics of REIT risks and returns under a regime-switch framework and take into consideration the drivers of REIT beta for Australian and US markets, the thesis is organised as follows.

Chapter 1 provides an overview of the REIT market, including its historical context, structure and various REIT types. It also discusses the global economic relevance of REITs and the advantages they offer investors. The chapter pinpoints three key research issues concerning the limited comprehension of REIT performance. Based on the research problems identified, the chapter develops research questions and hypotheses. The chapter concludes by outlining the importance of the research.

Chapter 2 investigates the relationship between the Australian listed real estate market and the stock market index. By splitting REITs into specialised and diversified groups, this chapter examines the benefits of diversification by investing in specialised A-REITs, which are REITs that concentrate their investments on a specific property type. The feature of REIT risks and returns explored in this chapter enable further analysis in the next chapter.

Chapter 3 explores the connection between REITs and stock markets in Australia, using regime-switching models to uncover the underlying dynamics. As fundamental drivers for REIT returns and volatilities change over different REIT eras, it is beneficial to analyse the features of REITs with a regime-switch analysis. With the clearer identification of REIT regimes (market states) and corresponding performance, Chapter 3 then assesses the diversification benefit of Australian REITs under different regimes. Furthermore, Chapter 3 explores the influence of crises on REIT returns, beta and the REIT–stock relationship. These insights can empower investors seeking to formulate regime-based investment strategies concerning REITs.

Chapter 4 analyses the impact of firm-level characteristics and liquidity on REIT beta using US equity REIT data. The prevailing body of research underscores the significance of financial ratios, such as size, leverage and liquidity, in influencing REIT performance. Given the illiquid nature of REIT underlying assets, a thorough examination of firm-level ratios is crucial for gaining a comprehensive understanding of REIT performance. This chapter tests firm-level features such as size, leverage, profitability, market-to-book ratio and three firm liquidity measures against REIT returns and beta. The study also includes a sector analysis of both the US and Australian REIT markets, with a detailed ranking of risk levels in each property sector.

Chapter 5 summarises the main findings of the research and discusses the contribution of the thesis to the existing body of knowledge on REITs, highlighting the originality and significance of the research findings. It also identifies potential directions for further research.

Chapter 2 **Beta and diversification benefit of Australian REITs**

2.1 Background

This study focuses on the continued expansion and increasing importance of the Australian REIT market, which is the sixth-largest global REIT market. The A-REIT market has seen rapid development since institutional investors started seeking yields from REITs in the early 1990s and became more mature from 2001 as 13 more A-REITs emerged from 2000 to 2009. A-REITs offer benefits of regular income, tax deferred contributions, liquidity and diversification. Diversified REITs were the popular form of REIT in the early stages of A-REITs, while in recent years, specialised REITs have seen a rapid growth through the form of sector-specific A-REITs and niche property investments in non-traditional sectors such as manufactured homes, healthcare, childcare, data centres and storage (Grant Berry, 2021).

Australia has a well-developed financial market with established regulations and systems. However, the real estate market is less liquid than the financial market, as information asymmetry, high transaction costs, and heterogeneity exist. REITs, on the other hand, grant access to the high yield of the real estate market and the desirable features of financial market products. Globally, REITs have grown at around 17% annually from 2007 to 2014, primarily driven by equity REITs (McKinsey, 2015). Australia has the second-largest REIT market in Asia and is considered a near mature market with a ten-year average yield of 5.2% (Savills, 2019). Despite the importance of this market to investors, regulators and academics, the A-REIT market is one of the least researched areas. Pricing of REITs requires systematic risk measures which are provided in this study.

The dynamic properties of REIT volatilities have been studied by researchers. Real estate is a long-term investment, and its volatility is smaller than that of the stock market. Since REITs are a real estate asset priced in the financial market, the returns of the securitised real estate market are expected to be less volatile than returns of the financial market. Liow, Ho, Ibrahim and Chen (2009) found that the volatilities of the real estate securities market and the broader stock market tend to change in the same direction at the same time. This finding applies to the individual countries of Hong Kong, Japan, Singapore, the UK and the US, as well as the three regional markets of the Americas, Asia and Europe. When compared to the volatility of the S&P 500 index, the volatility of equity REITs displays persistence over time but of different magnitude, and this phenomenon in equity REITs is significantly linked to the trading volume from 1999 to 2003 (Cotter & Stevenson, 2008).

A lower volatility of stock prices reduces the impact of inaccurate predictions from a majority herd as shown by the two experiments conducted in Sweden (Andersson et al., 2014). There is a steady increase over time in the proportion of volatility not accounted for by stock, bond or real estate related factors, and can be explained by the ownership of larger-cap REITs in the US in the 1990s (Clayton & MacKinnon, 2003). Previous study shows that stocks, bonds, unsecuritised real estate, market cycles, sector-specific factors and ownership structure are the essential drivers of REIT return (Clayton & MacKinnon, 2003).

GPT Group is one of Australia's largest REITs and operates as a fund manager, with $34 billion in assets under management (GPT, 2024). As an internally managed REIT, GPT earns funds management fees from three underlying funds in office, retail, and industrial sectors. The management is overseen by its own corporate team. The GPT Wholesale Office Fund offers investors exposure to high-quality office assets in major Australian office markets, while the GPT Wholesale Shopping Centre Fund provides access to premium Australian retail assets. A stapled security, in this context, consists of a unit in a Trust and a share in a Company that are bound together, meaning they cannot be transferred or traded separately. For listed securities like GPT, these are quoted on the ASX as "stapled securities." GPT investors hold one General Property Trust unit and one GPT Management Holdings Limited share, which are "stapled" together and jointly traded on the ASX under the code "GPT". The trust side of GPT owns the balance sheet assets, making it asset-heavy and the primary vehicle considered by banks when lending to GPT. The corporation side is the active entity responsible for operations. GPT operates as a hybrid REIT, generating income both from fees and from gains in its balance sheet assets.

In the A-REIT market, investors can be classified as either passive or active. Passive investors, such as index funds managed by Barclays and Vanguard, play a significant role. These funds closely mirror the index, for example, Barclays reports an index return of 11%, meaning they replicate the index exactly. If the index acquires 2% of Goodman, the fund buys 2%, no more or less. This passive approach is attractive due to low transaction costs, typically around 3 to 4 basis points, and Vanguard offers similarly low fees, sometimes as little as 12 basis points, aiming to attract a broader investor base by providing cost-effective options. The focus is on accumulating capital through large-scale, low-cost investments.

In contrast, domestic investors typically take an active approach to A-REITs. Major players in this space include First Sentier, Deutsche Bank, Macquarie, Pendal, and Resolution. These investors actively manage their portfolios, making strategic decisions about when and where to invest in A-REITs. On a global scale, active investors like Fidelity (Boston), Cohen & Steers (New York), GIC, and PGGM (Amsterdam) are also prominent in A-REIT investments. These investors allocate capital to Australia as part of a broader, globally diversified strategy, with investments in markets such as Japan and Singapore. For instance, they might invest in Goodman for growth and GPT for more passive exposure, reflecting a diversified approach based on market conditions.

Domestic general equity investors view A-REIT as a defensive asset class, alongside other defensive investments such as BHP or CSR. A-REIT are seen as low-risk due to stable rental income and low gearing, which reduces the likelihood of significant losses. While these investors generally prefer growth assets like Telstra or major banks, they may shift to AREITs when growth markets underperform, using them as a temporary defensive strategy.

Retail investors, often referred to as "mum and dad" investors, represent a smaller, passive segment in the AREIT market. These investors typically favour secure investments such as DXI or Waypoint REIT, which focus on service stations and offer stable income through regular distributions. Although their impact on the broader market is limited, their investments are valued for security and reliable returns.

In summary, larger institutional investors tend to favour non-listed property funds or direct property investments, allowing them to gain real estate exposure through experienced fund managers while avoiding the volatility of the stock market associated with listed property. Smaller institutional investors, with lower assets under management and less experience in property, are more likely to invest in listed property via A-REITs. While larger investors also hold A-REITs, their exposure is usually limited compared to their non-listed property investments, with A-REITs often considered part of their broader equity portfolio rather than a core real estate holding.

2.2 Literature review

Modern portfolio theory (Markowitz, 1952), CAPM and the arbitrage pricing theory (APT) (Roll & Ross, 1980) are the traditional quantitative models that underpin the rational expectations-based models. Chan et al. (1990) adopted the two mainstream approaches towards REIT pricing, using both the multifactor arbitrage pricing model and CAPM to evaluate returns from equity REITs. When CAPM was used to estimate REIT returns, the actual returns were higher than what was predicted by the model. This phenomenon, known as excess returns, does not occur when using a multifactor model (Chan et al., 1990). Similar to Connor and Korajczyk (1986) and (Titman & Warga, 1986)'s method with stock return data, Chan et al. (1990) regressed REIT excess returns on the excess returns of a portfolio whose returns are perfectly correlated with predefined factors in the multifactor model. Chan et al. (1990) found three common underlying drivers of both REITs and stock returns: the variations in the risk, term structure and unexpected inflation. REITs are therefore not a hedge against unexpected inflation as it negatively influences the returns.

Real estate assets are typically held for long-term investments with stable rental incomes. Therefore, the return volatilities in the listed real estate market are mainly derived from the change of required discount rate in the capital market. As a result, the returns of the real estate market are expected to be less volatile compared to the general stock market. Liow et al. (2009) found that the conditional volatilities of these two markets tend to change in the same direction at the same time in Hong Kong, Japan, Singapore, the UK and the US. This is not surprising as the linkage is the change of discount rate from the capital market. A positive relationship is also found between real estate securities market conditional volatilities and correlations, where the correlation between the two market returns is higher if one market has increased volatility (Liow et al., 2009). Volatility of stock returns is time-varying and there exists asymmetric transmissions of stock return volatilities between different countries (Liow et al., 2005). The analysis conducted by Chung et al. (2016) is primarily concerned with the GFC period from 2007 to 2009, and the authors found evidence of a negative relationship between REIT implied volatility and current REIT returns as well as between REIT implied volatility and future REIT returns, reporting that current REIT implied volatility signals future REIT stock volatility.

Equity REITs exhibit persistent volatility at a daily frequency, but the extent of this long-term memory is lower compared to the S&P 500 index (Cotter & Stevenson, 2008). This phenomena of persistence in volatility but not in returns is a common finding in financial economics, and is referred to as long memory in finance literature (Cotter & Stevenson, 2008). Using FTSE data, Zhou and Kang (2011) extended the study of Cotter and Stevenson (2008) and compared the forecast results of long-memory models (ARFIMA, FIGARCH) with short-memory models (GARCH, stochastic volatility models) and asymmetric models (EGARCH, FIEGARCH), and found that the long-memory models dominate over other models over different forecast horizons (1, 5, 10, 15, 20, 25 days) and subsamples defined by financial crises breakpoints.[3] Then Zhou (2017) argued that the reduced form model realised volatility outperforms the GARCH models in predicting the

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[3] ARFIMA (Fractionally Integrated Autoregressive Moving Average Model), FIGARCH (Fractionally Integrated Exponential GARCH), EGARCH (Exponential GARCH), FIEGARCH (Fractionally Integrated GARCH)

daily volatility of REITs in Australia, Hong Kong, the UK and the US from 2008 to 2014. However, the relationship between the magnitude of return volatilities in REITs and stock markets in Australia is unknown for the more recent years.

The strong linkage between REIT returns and their underlying real estate factor is verified by a number of researchers (Chiang et al., 2006; Hoesli & Oikarinen, 2012; Lee, 2008). The predictability goes from REITs to direct real estate sequentially when real estate shocks occur in the US, the UK (Hoesli & Oikarinen, 2012) and Australia (Hoesli & Oikarinen, 2012; Lee, 2008). Hoesli and Oikarinen (2012) examined whether securitised real estate returns reflect direct real estate returns or general stock market returns and found empirical evidence that the long-term REIT market performance is substantially more tightly related to direct real estate performance than to general stock market returns. This is in accordance with Chiang et al. (2006). Based on strategies from Fama and French (1993), Chiang et al. (2006) built a zero-cost REIT-mimicking portfolio to capture information in REIT prices, namely SMB (small-minus-big in terms of capitalisation), HML (high-minus-low, book-to-market ratio), and UMD (up-minus-down, momentum) strategies and found that the market beta of the REIT-mimicking portfolio they built converged with the market beta of the National Council of Real Estate Investment Fiduciaries (NCREIF) property index, which measures the unleveraged private commercial real estate returns. The mimicking portfolios constructed with firms from the REIT industry have better explanatory power than directly using the Fama-French three-factor model (Chiang et al., 2006). Small capitalisation REITs are less cointegrated with the stock market (Yunus, 2012).

The REIT market has three distinctive eras (Aguilar et al., 2018; Jirasakuldech et al., 2006; Shen, 2020). The REIT and non-REIT stock correlation in the pre-modern era (July 1978 – August 1991) was between 59% and 76%, declined abruptly in the modern era marked by increased institutional investors (August 1991 – September 2001), and rose again in the era after the inclusion of REITs in broad stock market indices such as S&P 500 starting from October 2001 (Case et al., 2012). Moreover, higher beta REITs earn remarkably lower risk-adjusted returns than lower beta REITs only in the REIT era after 1993 (Shen et al., 2020).

It is essential to delve into the underlying drivers behind the volatilities of the REITs, direct real estate, and the capital market to understand the linkages among these markets. Hoesli and Oikarinen (2012) and Yunus (2012) used impulse response functions to investigate the relationship between securitised property markets, stock markets and macroeconomic variables in Australia , the UK and the US. More mature REIT markets are more integrated with the stock market and macroeconomic fundamentals (Yunus, 2012). Nevertheless, Yunus (2012) used data from 1990 to 2007, but the exclusion of the post-GFC period fails to capture the macroeconomic fundamental drivers for securitised real estate prices, such as economic sentiment in Hoesli and Oikarinen (2012) that looks at future growth of the economy. Table 2-1 summarises recent literature on REIT beta as follows.

Table 2-1. Summary of the most recent literature on REIT beta

Author & Year	**Topic**	**Notes**	**Data periods**	**Country**
Glascock and Lu-Andrews (2018)	Static and asymmetric beta estimation	Significant and positive systematic beta-return relation exists in both static and conditional CAPM models	1992–2014	US
Hoesli and Oikarinen (2019)	REITs, stock and direct real estate	REITs behave like stocks in the short run but more like direct real estate in the long run	1998–2017	Europe, UK, US, Asia-Pacific
Lin et al. (2019)	Sector-specific A-REITs	Sector-specific A-REITs offer superior risk-adjusted returns and improved portfolio diversification	2000–2018	Australia
Boudry et al. (2020)	Diversification benefit of REIT common and preferred stock	REIT preferred stock suits risk-averse investors by mitigating risk and offering a unique risk–return profile	1992–2012	US
Shen et al. (2020)	Beta anomaly of risk adjusted returns	High-beta REITs have lower risk-adjusted returns, which could be explained by institutional investors' preference for these riskier assets	1982–2017	US
Feng et al. (2021)	Geographical diversification	REITs with higher levels of transparency benefit from geographic diversification	2010–2016	US
Milcheva (2021)	Regional COVID-19 risk factors	Unlike Asia, US firms with higher pandemic exposure experienced greater performance declines	2019–2020	US, Asia
Zhu and Lizieri (2022)	Location risk modelled by local beta	Diversifying investments across different geographical locations lowers risks	1978–2015	US

2.3 Data and methodology

2.3.1 Data and summary statistics

This chapter focuses on whether property-type diversification could explain A-REIT performance. The study scope of this question is limited to the equity REITs listed on the Australian Stock Exchange that invest in Australian properties.[4] REIT performance is measured using the Total Return Index from Standard & Poor's Capital IQ Pro (S&P CIQ) and price index from Data Stream. The three Fama-French factors are constructed using the S&P/ASX-200 Index, firm-level financial data are from S&P CIQ, and minor adjustments are based on hand-collected data from financial reports and presentation documents on individual company websites. The Herfindahl-Hirschman Index is constructed using asset type information of historical transactions from S&P CIQ. The dummy variable for a specialised REIT uses the firm-level definition from S&P CIQ.

For preliminary beta testing, this thesis uses the time series of the S&P/ASX-200 price index and the S&P/ASX-200 A-REIT price index from DataStream. The study period is from 31 March 2000[5] to 22 January 2021. Return is calculated using the log difference of the first and last trading day values of the week/month/quarter, and daily return is calculated using the log difference of the last and current trading day values. Australian residential housing median sale price and dividend

[4] Direct property and unlisted property fund data are excluded due to uncertain availability and infrequent trading, often resulting in smoothed or lagged transaction data. As a result of these data limitations, neither direct property nor unlisted property fund data have been used.

[5] The starting date March 2020 is used for the empirical analysis because a measure of REIT returns — the S&P/ASX-200 A-REIT Price Index — is available as of that date.

payments files of REIT firms are from SIRCA database and CoreLogic. The data of the Property Council/MSCI Investment Performance Index for aggregate and subsector direct real estate index is not found in Thomson Reuters Tick History (TRTH) via Refinitiv platform. The proxy for the risk-free rate in the Australian market is the Reserve Bank of Australia (RBA) cash rate[6]. For analysing A-REIT beta over time, during each financial year, only REITs with a full non-missing time series are included in the analysis for that year to ensure that the coefficients represent all REITs. Missing values in REITs could be attributed to during the period where the REIT has not emerged or has delisted. The REITs with missing values in each financial year are excluded in the analysis so that the coefficients do not underweight the returns of those REITs with missing values.

It might not be appropriate to compare REIT–stock correlations across different literature, because the indices used and the return frequencies chosen are different (Case et al., 2012). Therefore, this thesis investigates returns on daily, weekly, monthly and quarterly frequency to compare and provide an overall picture of REIT and stock markets.

The natural log difference of the price indices is used to generate returns. For weekly, monthly and quarterly frequencies, this thesis uses the beginning of the period trading day value and end of the period trading day value. Annual frequency data is excluded in the summary of preliminary results as it is not ideal. Weekly and monthly frequencies are more often used in the existing literature.

[6] https://www.rba.gov.au/statistics/cash-rate/, accessed 25 July 2020.

Table 2-2 presents the descriptive statistics regarding the index returns. In the Australian market, the volatilities of the REIT index returns are higher than the volatilities of the stock index returns at daily, weekly, monthly and quarterly level. Both REIT and stock index returns exhibit significant kurtosis as depicted by the values that are larger than 1, whereas only the skewness of the REIT index return indicates a substantially skewed distribution.

Table 2-2. Summary statistics of Australian REIT and stock market index returns

	Daily		**Weekly**		**Monthly**		**Quarterly**	
	A-REIT	ASX200	A-REIT	ASX200	A-REIT	ASX200	A-REIT	ASX200
No. of observations	5,300	5,300	1,060	1,060	243	243	81	81
Mean	-0.0002	0.031	0.022	0.036	-0.025	0.015	0.018	0.031
Std. deviation	3.266	2.557	1.385	1.008	0.656	0.479	0.277	0.202
Skewness	-1.297	-0.745	-1.705	-0.684	-3.278	-1.404	-2.915	-0.821
Kurtosis	16.877	9.050	17.121	4.377	21.047	5.481	12.183	1.069

Note: A-REIT is the S&P/ASX-200 A-REIT price index, and ASX200 is the S&P/ASX-200 price index. Data source: Data Stream (March 2000 – January 2021).

2.3.1.1 Risk-free rate and market index

Risk-free proxies include the Reserve Bank of Australia (RBA) cash rate target, monthly 10-year Australia government bond yields[7] (July 1969 – May 2021) and monthly Australia 90-day bank bill rates from FRED (April 2001 – April 2021). These three interest rates are selected because the risk-free rate is usually considered as the safest investment. The RBA cash rate is available for each historical change on that day, and a monthly average of the cash rate is used for monthly empirical analysis. The RBA cash rate is employed as the proxy for the risk-free rate, because the

[7] See https://fred.stlouisfed.org, Long-Term Government Bond Yields: 10-year: Main (Including Benchmark) for Australia, Percent, Monthly, Not Seasonally Adjusted

short-term interest rates are commonly used in previous literature as it drives both real estate and stock market returns (Chan et al., 1990; Hoesli & Oikarinen, 2012), and regression results show more consistency with a yearly robustness check than using 90-day bank bill rates.

Figure 2-1 illustrates the monthly values of risk-free rates over time. In the early 2000s, both rates remained relatively stable, fluctuating around 0.45%. They reached their peak in 2008 before experiencing a decline to below 0.3% in 2009, coinciding with the period of the GFC. Subsequently, they increased from 2010 to 2012 and gradually decreased to below 0.15% from mid-2016. Between 2019 and 2021, both the RBA cash rate and the 90-day bank bill yield plummeted to an exceptionally low level, approaching zero during the COVID-19 pandemic.

Fig. 2-1. Risk free rates: RBA cash rate and Australia 90-day bank bill yield

Note: Monthly yields are the per annum figure divided by 12. Data source: RBA, Fred (2000–2021).

2.3.1.2 REITs data

For factor models, the time series of daily Total Return Index is retrieved from S&P CIQ. This thesis uses returns on daily, monthly and yearly (financial year) frequency to compare and confirm the capital asset pricing model in the Australian REIT market. REIT risk premium is the log difference for each of the REIT Total Return Indices, then minus the risk-free rate of the RBA cash rate. It is estimated at daily, weekly, monthly and quarterly frequency. Market risk premium is the log difference returns of the S&P/ASX-200 Total Return Index, minus the risk-free rate of the RBA cash rate. It is estimated at daily, weekly, monthly and quarterly frequency.

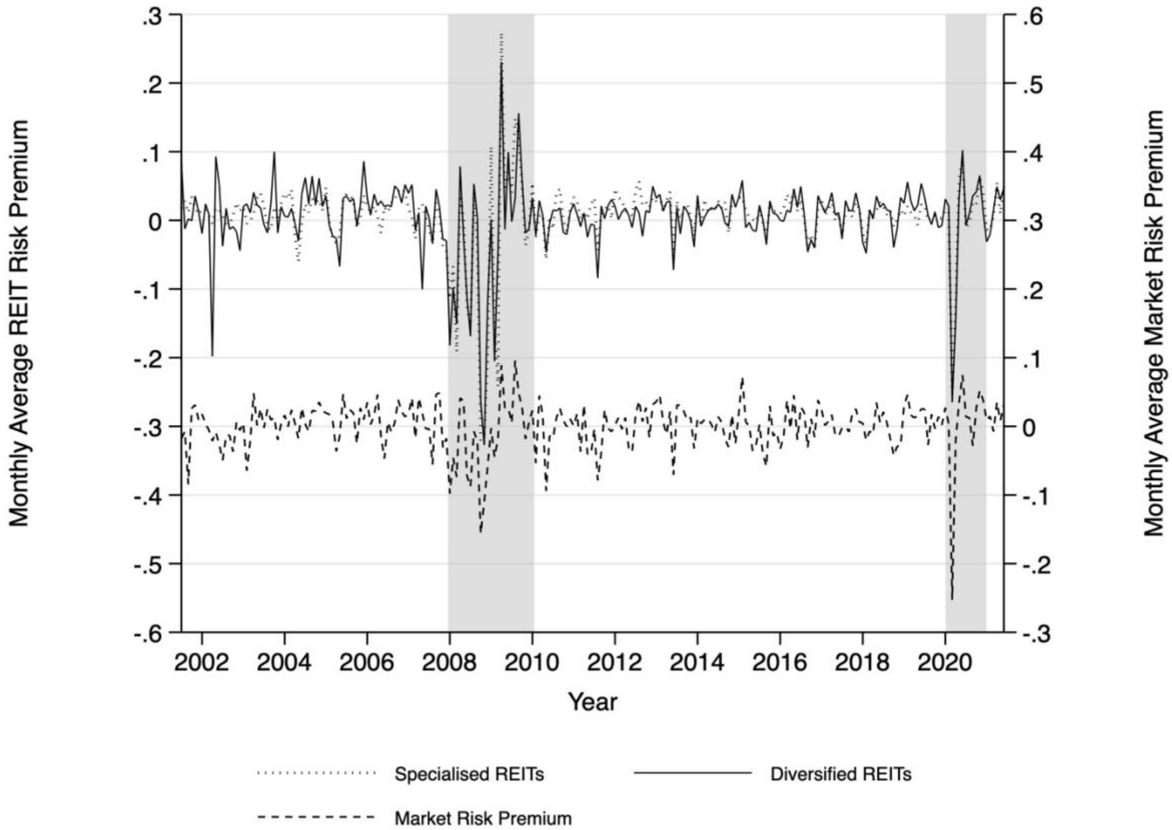
The A-REITs included in this analysis are identified by their unique S&P Capital IQ ID, which remains constant despite any changes in the names of the trusts. While REITs may be delisted due to factors such as failures or mergers, this issue has been tested and the results are not presented here to maintain brevity. To ensure data consistency, these REITs, along with those investing in offshore properties, are not considered in the subsequent analysis. Specifically, eight A-REITs are omitted from the analysis (Agricultural Land Trust, Aims Property Securities Fund, Ante Real Estate Trust, Blackwall Property Trust, Folkestone Education Trust, Viva Energy REIT, Unibail-Rodamco-Westfield, SHPCTR, and Australasia Property Group Stapled Unit).

For monthly returns, this thesis compares two methods of calculation and chooses to use the average monthly method rather than computing returns using end-of-month trading day values of each month. This is because the average monthly method is less affected by the calendar effect, such as the week-of-month effect that causes abnormal returns (Zhang et al., 2017). The average monthly returns are natural log differences of the average values of the index of the current and last month. For the three factors in the Fama-French three-factor model, the data library provided by Kenneth French is used for Australia but there is no separate dataset for the REIT market.[8] Therefore, the size and value factors are constructed using accounting data from Standard & Poor's Capital IQ Pro (see Appendix C).

A-REITs are classified into two categories: specialised and diversified. This is based on S&P CIQ classification of their investment focus using GICs definitions with corrections based on suggestion from Australian fund manager. Figure 2-2 shows the average monthly risk premium of diversified A-REITs, specialised A-REITs and average monthly market risk premium using the S&P/ASX-200 Index. REIT risk premium and stock market risk premium generally move in the same direction. The grey shaded areas specify the GFC and COVID-19 pandemic periods.

[8] See "International Research Returns - Data Country Portfolios formed on B/M, E/P, CE/P, and D/P". http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#Developed

Fig. 2-2. Average risk premium of specialised and diversified A-REIT



Note: Monthly returns are the log difference of the monthly averages of Total Return Index values, then minus the RBA cash rate to calculate risk premium. Market risk premium uses S&P/ASX-200 Total Return Index and RBA cash rate. Data source: S&P CIQ (2000–2021).

The returns of diversified REITs are more volatile than specialised REITs, particularly before the GFC. As depicted in Figure 2-2, during the GFC period, A-REIT risk premium were more volatile than the stock market, as depicted by the wider range between minimum and maximum average monthly risk premium of A-REITs. From 2008 to 2009, the stock market risk premium was between -0.2 and 0.1, whereas the A-REIT risk premium had a low of -0.33 and a high of 0.27. Specialised REITs outperformed diversified REITs from 2010 to 2013 but underperformed diversified REITs in 2019.

One possible reason for the superior returns of specialised REITs from 2010 to 2013 is that the "other" sector delivers higher returns than the industrial, retail and office sectors. Moreover, subsector performance accounts for the deterioration in the relative return performance of specialised REITs. The Property Council/MSCI Investment Performance Index shows that from 2013, property in the industrial sector outperforms other sectors, while retail and other sectors deliver low returns. Furthermore, as 10 out of the 26 specialised REITs in Australia focus on the retail sector, the relative underperformance of specialised REITs in 2019 may result from the decreasing returns of the Australian retail sector. In 2013, there were 11 specialised REITs and six of them were in the retail sector. Among the 10 diversified REITs in 2013, three REITs focused on industrial investments, and only one concentrated on retail. Consequently, specialised REITs underperform diversified REITs in general because of the poor relative return in retail (McCallum, 2021). In addition, the shift in subsector performance might result from business cycles and economic regime change.

The detailed A-REITs information is listed in Appendices A and B. The analysis does not disaggregate the sub-sectors into more specific categories such as office, retail, or industrial due to concerns about sample size and potential overfitting when multiple dummy variables are introduced. While sub-sector performance was tested in Chapter 4, including these variables would compromise the statistical validity of the model due to the limited number of A-REITs in each category. Moreover, The study's primary objective is to assess the overall diversification benefits of A-REITs based on their broader investment focus, rather than analysing the behaviour of individual sub-sectors. As such, the current classification provides a more consistent basis for examining the research question.

The A-REITs sector yield was under the impact of "taper tantrums" from 22 May to 24 June 2013, as shown by the sharp decrease of returns in 2013 in Figure 2-2. Taper tantrum was a collective panic after investors learned that the US would put breaks on its quantitative easing program. There was a sharp rise in bond yield, whereas bond and equity prices slumped. A-REITs underperformed the banking sector by 10% before this event as real yield rose but outperformed the banking sector by 6.1% during the post-event period in 2014 when real yield declined (Macquarie, 2021). A-REIT returns are leveraged returns, and each firm may have different debt levels. Therefore, firm-level financial data should be included as additional controls in further research.

2.3.1.3 Financial data

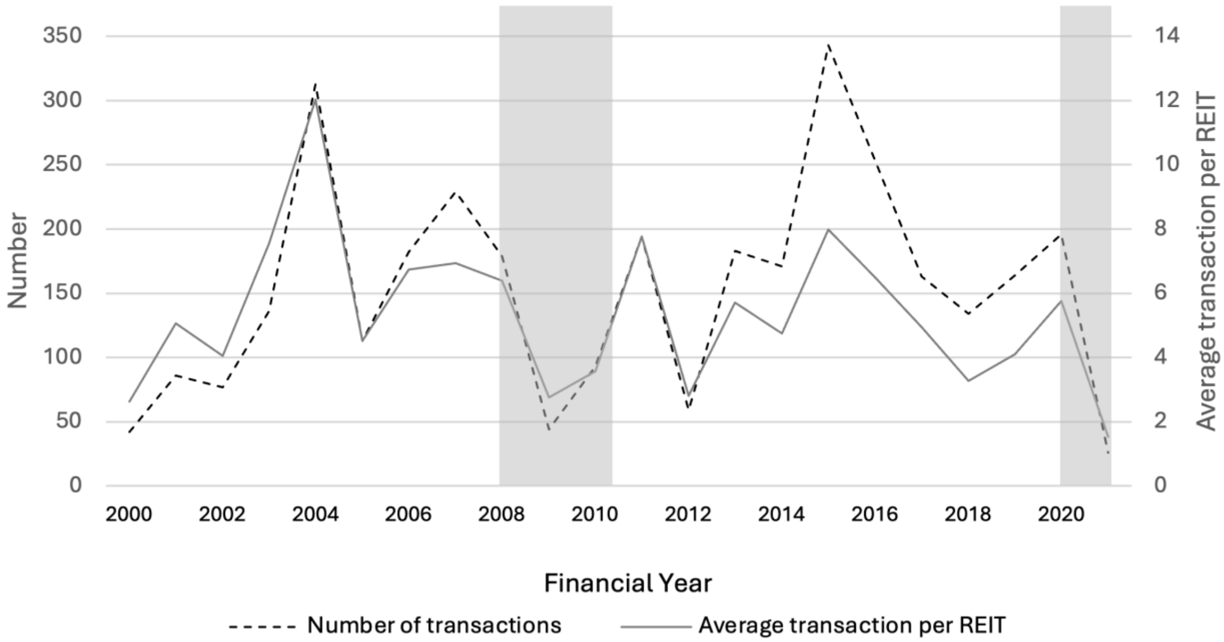
This thesis uses a sample comprised of fund-level data for the 38 A-REITs obtained from Standard & Poor's Capital IQ Pro (Former S&P Global Market Intelligence), including the financial data and historical property transaction data as identified and classified into property type categories by the source. Using customised annual balance sheet templates prepared by the Standard & Poor's customer service team and Excel add-ins from Standard & Poor's Capital IQ Pro, data is collected and processed to build a static profile of the property type and portfolio diversification for each REIT. A survivor bias may exist, which calls for additional caution in the interpretation of the test results.

Financial data of REITs such as market capitalisation, debts and assets conform to Australian and US financial year definitions. In Australia, the financial year is from 1 July to 30 June the following year. For instance, the 2021 financial year is 1 July 2021 to 30 June 2022. In the US, the financial year is the same as calendar year. International REITs data is also collected from S&P CIQ for further research on an international comparison. While REITs have existed since the 1970s, the sample period of April 2000 to June 2021 is the most relevant for current A-REIT investors.

Definition of the focus property type of funds is also collected from S&P CIQ. REITs are defined as diversified REIT, office REIT, residential REIT, industrial REIT, hotel REIT or specialty REIT. This definition, together with historical property transactions, is then used to classify the funds into two groups: diversified REITs and specialised REITs. To improve the A-REIT profiles of underlying assets, the plan is to manually collect financial report data from 2000 to 2021 to supplement asset level information not provided by S&P CIQ to build a time-varying profile. This profile is supplemented by items related to sector-specific assets, such as book value and the number of assets in the annual financial reports and financial results presentation documents from the company websites of the REITs in Chapter 4.

Figure 2-3 depicts the total and average historical property transactions of A-REITs in each financial year.

Fig. 2-3. A-REIT historical asset transactions by financial year



Note: This includes all transaction for both purchase and sales in four types (current properties, sold properties, development properties and planned acquisitions). Data source: S&P CIQ (2000–2021).

The average number of transactions per REIT in the Australian market is at a higher level than the previous year in financial years 2004, 2011, 2015 and 2020 and declines significantly in crisis times such as 2009 and 2021. REITs trade assets more actively in normal periods, as asset value deviates from intrinsic value and the market is more illiquid during crisis periods. The total number of transactions in the Australian REIT market was the highest in 2015, and this could be attributed to the nine new REITs entering the market and building up their portfolios during 2013 to 2015.

2.3.1.4 Herfindahl-Hirschman Indices

This thesis uses the HHI to measure a fund's diversification. HHI is calculated for each A-REIT as a measure of diversification based on firm-level transactions in different property types. For example, if a REIT invests in only one property type, which is industrial REIT, then its HHI will be

1, which means 100% of the transactions are in one kind of asset. A lower HHI means more diversification on asset type for a REIT, for example, a value of 0.25 for number weighted HHI means the REIT has same number of transactions in each of the four different property types that are transacted. Regarding value weighted HHI of 0.25, the interpretation is that the REIT has same total price after aggregating transactions in each of the four different property types that are transacted.

Following Anderson et al. (2015), Dennis and Sohan (1995) and Holder (1993), this thesis constructs the number-weighted and value-weighted Hirschman-Herfindahl Index for each A-REIT firm with available historical asset transactions. The assets are further classified in historical transactions into five property types, based on the 13 categories of primary property type for each asset from Standard & Poor's Capital IQ Pro. The traditional Herfindahl-Hirschman index (HHI) is based on four property types: office, industrial, residential and retail. However, it is inappropriate to classify specialty property as any of the four types. The four main property types are from the literature, and the thesis uses "other" as the fifth property type to include specialty property such as data centres, medical facilities, self-storage and student accommodation. Specialty properties offer higher yields and perform well across the economic cycle.

Following Rhoades (1993), I construct the firm-level number-weighted and value-weighted Herfindahl-Hirschman Indices (HHI) based on all available historical transactions of A-REITs collected in December 2020. Currently, there is only one HHI value for each firm over the entire study period of historical transactions, including the following four transaction types: current properties, sold properties, development properties and planned acquisitions. Number-weighted HHI is calculated using asset numbers in each property sector. Value-weighted HHI is calculated by acquisition price, if not stated otherwise. I measure diversification by HHI for REIT j based on five property types defined by GICS embedded in the S&P CIQ dataset. More specifically,

$$Herfindahl - Hirschman\ Index\ (HHI)_i = \sum_{j=1}^{n} p_i^2$$

(2-1)

in which p_i is the proportion of a REIT's assets invested in property type j, in this case, n is five for number-weighted and value-weighted HHI and refers to the following five property types: office, industrial, residential, retail and other. To simplify the analysis, I convert the nine property types from the initial data to five property types. "Industrial" includes self-storage, "retail" includes hotel and the "other" property type includes healthcare, specialty and multiuse. p_i is derived using historical acquisition price for value weighted HHI. The higher the HHI, the more concentrated the firm investments in terms of property types. HHI is a continuous variable between 0 and 1. A value of 1 indicates a specialised A-REIT, and a value close to 0 indicates an A-REIT with a diversified portfolio across property sectors. A higher HHI value means a higher concentration of REIT investments in terms of property type. The detailed values of HHI are attached in Appendices A and B.

Some data is less frequently available because it reflects underlying economic or financial variables that change slowly. In contrast, models like CAPM rely on high-frequency data to capture daily market movements. Time-varying HHI is less favoured in this study due to the incomplete REIT transaction data, including missing transaction dates and buy/sell prices in S&P Capital IQ Pro. Consequently, the HHI remains time-invariant throughout the sample period. This index, which measures market concentration based on assets or market shares, is typically static and calculated quarterly or annually. Despite its infrequent calculation, HHI provides valuable context for models using daily data by blending static and dynamic inputs.

2.3.2 Methodology

This chapter uses CAPM (Lintner, 1965; Sharpe, 1964) Fama-French three-factor model (Fama & French, 2012), Dimson (1979) and Scholes and Williams (1977) methods to measure beta. CAPM and Fama-French three-factor model consider beta as a constant value, while Dimson beta and Scholes-Williams beta incorporate different values of beta that contains information from last period and one period forward.

2.3.2.1 Capital Asset Pricing Model

CAPM is a classical asset pricing model in finance literature, which is applied to the listed real estate stocks in this study to examine the REIT return. Following Sharpe (1964) and Lintner (1965), I employ the CAPM as the first step to calculate the asset beta. This step is fundamental to the whole research since it provides key information about REIT betas as an asset class. In particular, it is essential to determine if REIT beta is above or below 1. This study also investigates how REIT beta changes over time, in different market states as well as in different REIT eras, and if CAPM is appropriate in pricing REIT returns.

Sharpe (1964), Lintner (1965) and Mossin (1966) set the foundation of CAPM, then Fama (1970b) and Merton (1973) expanded the classical CAPM from a static model to an intertemporal model (ICAPM) with specification of a multiperiod horizon for the investor. Merton (1973) considered the maximisation of consumer-investor behaviour when they are given a changing investment opportunity set. However, factors like wage income and goods with fluctuating prices are not incorporated in the ICAPM model. Black (1976) then included the short-run speculative factors to examine the effect of disequilibrating shocks on individual behaviour as well as the consequent market performance, assuming rational expectations and gradual price adjustments. Market efficiency is positively related to the speed of price adjustments, and Fama (1970a) defined three levels of market efficiency: weak-form, semi-strong, and strong-form efficiency. Grossman and Stiglitz (1980) corrected the efficient market hypothesis to include the cost of collecting and analysing market sensitive data.

In addition, Breeden (1979) extended the multi-beta continuous-time model in Merton (1973) by using single-beta on aggregate consumption instead of the market portfolio. This aggregate consumption measure allows a broader coverage of the true consumption variable than does coverage of a true market portfolio by the market portfolio measure. Furthermore, given the joint distribution of returns and aggregate consumption, it is easier to test and apply the model with the single-beta, which is relative to a specific variable.

CAPM is the earliest asset pricing model and perhaps the most widely accepted. The CAPM estimates the sensitivity of the returns of a portfolio to market risk, symbolised by the beta coefficient (β). Following Sharpe (1964), Lintner (1965) and Mossin (1966), the CAPM is generally stated as the following:

$$\mathrm{E}\left(R_{i,t}\right) = R_{f,t} + \beta * \left(R_{m,t} - R_{f,t}\right) + \epsilon_{i,t} \tag{2-2}$$

where $\mathrm{E}(R_{i,t})$ denotes the expected rate of return on asset *i* at time t, $R_{f,t}$ is the risk-free interest rate, $R_{m,t}$ is the expected rate of return on the market portfolio, β measures risk or asset price beta and ϵ_t is the residual term. The risk premium of portfolio i is linearly associated with the risk premium (market return above risk-free return).

The CAPM is a mathematical model that uses market data and assumes that investors are rational. But empirical evidence undermines the underlying assumptions and limits its application, as shown in the Sharpe (1964), Lintner (1965) and Black (1972) versions. Major academic studies are now using one or more of a multifactor model (Fama & French, 2015), the Carhart four-factor model (Carhart, 1997) and a long-run model using VAR. CAPM is the pillar of asset pricing, although later many studies repudiated the empirical value of CAPM (Fama & French, 1992, 1996; Roll, 1977). Although CAPM denotes a complete representation of risk, it does not include the human element, i.e., the investor behaviour from which the data is generated is not considered. For example, there is evidence that residuals from CAPM have explanatory power for investor sentiments (Apergis & Rehman, 2018).

More recent researchers have focused on the time variation of return correlation between REIT and stock (Case et al., 2012), while others concentrate on asymmetric beta and its relationship with returns (Glascock & Lu-Andrews, 2018). Case et al. (2012) showed that REIT–stock correlation was high before 1991, falling from the end of 1991 to 2001, then increased after September 2001. REITs with higher downside betas deliver higher average returns, but the upside betas are irrelevant in the beta–return relationship (Glascock & Lu-Andrews, 2018). Glascock and Lu-Andrews (2018) first examined static unconditional beta in the traditional CAPM framework with modification from Pettengill et al. (1995), then tested conditional betas in the downside risk framework from Bawa and Lindenberg (1977). Glascock and Lu-Andrews (2018) reported that both REITs and REIT portfolios with higher betas enjoy higher positive returns when the realised market returns are above risk-free rates and suffer from more negative returns when realised market returns are below risk-free rates.

2.3.2.2 Fama-French factor models

Different from the one-factor CAPM, Fama and French (1993) proposed a three-factor model and posited that expected returns can be explained by the market risk premium, the difference between the returns on small and large capitalisation portfolios (SMB, small minus big), and the difference between the returns on high and low book-to-market portfolios (HML, high minus low). The three-factor model is as follows:

$$REIT\ risk\ premium_{i,t} = \alpha_i + \beta_i * Risk\ premium_{m,t} + s_t * SMB_t + h_t * HML_t + \epsilon_{i,t} \quad (2\text{-}3)$$

in which $REIT\ risk\ premium_{i,t} = R_{i,t} - R_{f,t}$, REIT risk premium is REIT return minus the risk-free rate, similarly, $Risk\ premium_{m,t} = R_{m.t} - R_{f,t}$. Although the Fama and French factors are direct and are applied increasingly in empirical work, substantial disagreement exists about the risk factors. There are three aspects of critiques concerning the validity of the model in Fama and French (1993): mistaken investor overreaction for the effect of size or book-to-market factor (Lakonishok et al., 1994), using common phenomena in financial markets as a pricing factor (Ferson et al., 1999), and neglecting other important factors (Novy-Marx, 2013; Titman et al., 2003). Novy-Marx (2013) and Titman et al. (2003) point out that equation (2-3) is incomplete because its three factors do not explain the variation in average returns related to profitability and investment. Based on this recommendation, Fama and French (2015) then proposed a five-factor model, adding profitability and investment factors to the three-factor model, and subsets of the factors to explain the returns on portfolios of stocks created to yield large spreads:

$$REIT\ risk\ premium_{i,t} = \alpha_i + \beta_i * Risk\ premium_{m,t} + s_t * SMB_t + h_t * HML_t + r_t * RMW_t + c_t * CMA_t + \epsilon_{i,t} \quad (2\text{-}4)$$

The coefficients of the five factors are β_i, s_t, h_t, r_t, and c_t, which correspond to the following variables: the difference in returns between a value-weighted market portfolio and a risk-free return, between a portfolio of small stocks and a portfolio of big stocks in terms of market capitalisation (SMB), between high and low book-to-market ratio (B/M)[9] stocks (HML), between portfolios of stocks with high and low robustness in terms of profitability (RMW, robust minus weak), and between portfolios of stocks with conservative and robust investment companies

[9] B/M ratio is the book value of equity divided by market value of equity.

(CMA, conservative minus aggressive) (Fama & French, 2015). Conservative investments for REIT firms, for instance, are Australian supermarkets like Woolworths or Coles that produce steady income flows because they provide daily necessities. Fama and French (2015) claimed that SMB, HML, RMW and CMA themselves are not state variables but diversified portfolios that specified assortments of exposure to unknown state variables, which in turn contribute to risk premiums that are not justified by the general market factor. Averages of monthly percent risk premium for value-weighted (VW) portfolios formed on different sorts of size, B/M, OP and Inv are examined, sorted by NYSE breakpoints for small and big stocks (Fama & French, 2015).

Fama-French size (SMB) and value (HML) factors are calculated using REITs' risk premium. SMB measures the return difference between small and big firms. HML measures the return difference between overvalued firms and undervalued firms based on the market-to-book ratio. Both factors are estimated at annual frequency.

A similar study by Hou et al. (2015) tested a four-factor model that includes factors similar to market risk premium, SMB, RMW and CMA without justifying the exclusion of HML in the model in the US from 1972 to 2012. They compared the performance of their four-factor model to that of the CAPM, the Fama-French three-factor model, and the Carhart (1997) four-factor model, which adds a momentum factor. Hou et al. (2015) mainly focused on explaining the returns associated with anomaly variables outside the factors they use. Moreover, the value-weighted portfolios from univariate sorts of each variable in Hou et al. (2015) are composed of big stocks, aside from the size effect, whereas the limitations of asset pricing models are primarily in small stocks (Fama & French, 1993).

Recent applications of Fama-French factor models in the REIT market seek to improve the classic model by controlling for traditional factors and including other factors, such as idiosyncratic risk (Ooi et al., 2009; Ro & Ziobrowski, 2011), investor sentiment (Lin et al., 2009) and reporting transparency (Dempsey et al., 2012). Ooi et al. (2009) demonstrate that the size and book-to-market equity ratio factors become insignificant when accounting for the idiosyncratic risk of each REIT firm, but the momentum factor is still robust with the inclusion of idiosyncratic risk. On the other hand, Ro and Ziobrowski (2011) compared abnormal returns of diversified and specialised REITs with CAPM and the Fama-French three-factor model with momentum factor in the US from 1997 to 2006. They found that, compared to diversified REITs, REITs specialising in one property type bear higher market risks but do not provide higher margins. In addtion, Lin et al. (2009) controlled for conventional variables in the Fama-French three-factor model to test for investor sentiment in the US from 1994 to 2005, and stated that the independent variables in the model better explain the successful REITs than the less successful REITs. Dempsey et al. (2012) showed evidence of the negative relationship between REIT performance and the financial opacity of financial statements in US REIT firms, and the residual opacity has incremental explanatory power for returns beyond the factors in Fama and French (1992, 1993).

2.3.2.3 Dimson beta and Scholes-Williams beta

REITs are illiquid because of the underlying property, therefore, they might be thinly traded. Consequently, there may exist a lag in the linkage between A-REITs and the stock market. To address this issue of nonsynchronous trading, this study adopts the Dimson beta and the Scholes-Williams beta for robustness checks. The Dimson beta accounts for the scarcely traded scenarios and employs a transactions time assumption, implying that the return for a security on a day when it trades is the change between the last trade of that day and the last trade on the most recent day it traded. (Dimson, 1979). Meanwhile, the Scholes-Williams beta uses a closing time assumption, which means that the return for a security on a day when it trades is the difference between the closing price of the day and the closing price of the most recent day on which the security traded (Scholes & Williams, 1977). Following Hollstein et al. (2020) and Dimson (1979), add the g lagged market returns:

$$REIT\ risk\ premium_{i,t} = \alpha_i + \sum_{g}^{0} \beta_{1,g} * Risk\ premium_{m,t+g}$$
$$+\beta_2 * Spe_i + \sum_{g}^{0} \beta_{3,g} * Spe_i * Risk\ premium_{m,t+g} + \epsilon_{i,t}$$

(2-5)

in which $g = -4, \ldots, -1, 0$, and $Risk\ premium_{m,t-g}$ depicts the current period market risk premium and four lagged market risk premiums, using a 252-trading day rolling window. Dimson beta is then given by:

$$\beta_{DS} = \frac{\sum_{g}^{0} \beta_{1,g}}{1 + 2\varrho}$$

(2-6)

in which $g = -4, \ldots, -1, 0$, ϱ represents the autocorrelation of the market risk premium, which is also calculated with the 252-day rolling window. For standard error:

$$SE_{DS} = \sqrt{\frac{\sum_g^0 se_g^2}{1 + (2\varrho)^2}}$$

(2-7)

Following Scholes and Williams (1977), this study first estimates three betas: lead beta, historical beta and lagged beta using the 252-trading day rolling window:

$$REIT\ risk\ premium_{i,t} = \alpha_i + \beta_{1,g} * Risk\ premium_{m,t+g} + \beta_2 * Spe_i + \beta_{3,g} * Spe_i * Risk\ premium_{m,t+g} + \epsilon_{i,t}$$

(2-8)

in which $g = -1, 0, 1$, and three regressions are performed respectively. Then, based on results from equation (2-8), the Scholes-Williams beta is calculated:

$$\beta_{SW} = \frac{\sum_g^1 \beta_{1,g}}{\varrho}$$

(2-9)

in which $g = -1, 0, 1$, ϱ represents the first-order autocorrelation of the market risk premium.

2.4 Results

2.4.1 REIT beta testing

This study uses the CAPM and ARCH(1) model to investigate the return sensitivity of REITs and stocks. The calculation using covariance is also used to verify the CAPM outputs. Unit root tests for the price indices and their returns are also performed. The unit root results suggest that the daily index returns of REITs and stocks are I(1) whereas the weekly, monthly and quarterly index returns are I(0), which means that the two time series are non-stationary on a daily basis but stationary on weekly, monthly and quarterly frequencies. Market anomalies that arise from the data frequency are considered by assessing daily, weekly, monthly, quarterly and annual data with model outputs. Table 2-3 lists the models for examining REIT and stock returns.

Table 2-3. Model specifications

1. CAPM	$\boldsymbol{R_{i,t} = R_{f,t} + \beta * (R_{m,t} - R_{f,t}) + \epsilon_{i,t}}$
2. REIT return autocorrelation	$R_{i,t} = \alpha_i + \beta_4 * R_{i,t-1} + \epsilon_{i,t}$
3. Stock return autocorrelation	$R_{m,t} = \alpha_i + \beta_5 * R_{m,t-1} + \epsilon_{i,t}$
4. Test residual from Model 2 (ARCH(1))	$\epsilon_{i,t}^2 = \alpha_i + \beta_6 * \epsilon_{i,t-1}^2$
5. Test residual from Model 3 (ARCH(1))	$\epsilon_{i,t}^2 = \alpha_i + \beta_7 * \epsilon_{i,t-1}^2$
6. Beta - by covariance calculation	$\beta = \frac{cov(R_i, R_m)}{Var(R_m)}$

The relative changes of beta values from daily interval to quarterly interval can easily be seen in Table 2-4. Standard error is shown in parentheses below each beta estimate in Table 2-4 for Models (1) to (6) and by covariance calculation. Model (6) shows the by covariance calculation for market beta, and the values increase as the intervals become longer, such as from daily to weekly. The interval effect is straightforward for REIT and stock returns as shown by the daily, weekly, monthly and quarterly beta values. This is in line with the finance literature (Smith, 1978). The beta estimates in the CAPM model (Model (1)) also exhibit a similar pattern.

Table 2-4. Beta in one-factor models using different data frequency

Frequency	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Daily	0.818*** (0.013)	0.0254 (0.014)	-0.063*** (0.014)	-0.627*** (0.115)	0.505*** (0.012)	0.818
Weekly	0.838*** (0.033)	-0.205*** (0.030)	-0.038 (0.031)	0.136*** (0.030)	0.276*** (0.030)	0.838
Monthly	0.962*** (0.063)	0.102 (0.064)	0.110* (0.064)	0.134** (0.064)	0.291*** (0.062)	0.965
Quarterly	1.004*** (0.104)	0.226** (0.111)	0.026 (0.113)	0.131 (0.112)	0.158 (0.112)	1.007

*Note: Column (1) refers to CAPM, Columns (2) and (3) refer to REIT and stock autocorrelation testing, Columns (4) and (5) refer to residual testing from the autocorrelation models, Column (6) is beta calculation by covariance for verification. See Table 2-3 for detailed model specifications. Risk premium is calculated using the log difference of the specified trading day values of the frequency in Column (1), then minus the risk-free rate (RBA cash rate). Using the RBA cash rate shows similar results for Column (2) as using Australian government bond yields for the risk-free rate. * p<0.05, ** p<0.01, *** p<0.001.*

In Table 2-4 Model (2), only the weekly beta estimate is negative, which might result from the mean-reverting characteristic of REIT index returns. The beta estimate in Model (4) is the largest for weekly frequency. In Models (4) and (5), the beta estimates are highly significant. However, the beta of the REIT residuals squared from the last period is higher than that of the stock. Therefore, given a similar level of market shock, the REIT market is more volatile than the stock market on daily, weekly and monthly intervals, but the stock market is more volatile than the REIT market on a quarterly basis. Moreover, the beta estimates of residuals from Model (2) on last period return of REIT are negative and also less than 1, implying that REIT stocks are low risk assets that could provide diversification benefits.

As shown in the output of ARCH(1) Models (4) and (5) in Table 2-4, for weekly, monthly and quarterly intervals, the positive betas mean that a larger error in the previous period implies a larger variance today for both REIT and stock returns. In addition, REITs have brick-and-mortar assets and are supposed to be less volatile than stocks in the long run. This is verified by the smaller beta estimates of REIT returns compared to stocks on a weekly, monthly and quarterly basis. In particular, the REIT return betas are about 50% of the betas of stock returns for weekly and monthly intervals.

For the daily interval in Table 2-4, the volatilities of REIT and stock returns exhibit different features. The negative parameter in Model (4) suggests that a larger error at previous trading day means a smaller variance in REIT returns today, signifying a correction. In contrast, the positive parameter indicates that a larger error at previous trading day results in larger variance in stock returns today, implying intraday momentum. However, in absolute value, volatility of REIT returns is larger than that of stock returns, suggesting that REITs are more sensitive to market movements than stocks. There are two possible explanations. First, there exists a different return pattern on a weekly basis for stocks, implying that they deviate from market efficiency (Gutierrez & Kelley, 2008; Pan et al., 2013; Rodriguez et al., 2014). This might apply to REITs because of the unique feature of underlying real estate assets while being listed on the stock market, and the market overreaction that needs time for information adjustment over the weeks. Aguilar et al.

(2018) found examples of both persistence and mean reversion in the returns of individual REITs in the US market and showed that many REITs are not efficiently priced at any given point in time. Second, there is evidence of asymmetric beta of REITs (Chiang et al., 2004; Glascock & Lu-Andrews, 2018; Yang et al., 2012). REIT portfolios with higher betas have more positive returns when the realised market returns exceed risk-free rates and more negative returns when the realised market returns fall below risk-free rates (Glascock & Lu-Andrews, 2018). Yang et al. (2012) contend that default spread and stock market volatility drive the conditional correlations between REITs, stocks and bonds. Nevertheless, the predictive power of default spread for conditional correlations between markets increases after 2007, whereas that of the stock market volatility decreases (Yang et al., 2012).

Holding REITs as the only asset in the portfolio is unfavourable for investors since REITs are more volatile than general stocks, especially in the shorter term. The volatility feedback effect (time-varying risk premium) might explain the higher sensitivity of REIT stocks compared to the common stocks. If volatility is priced, an expected surge in volatility would foster the required rate of return, which in turn causes an instant plunge in the stock price to give room to higher future returns (Bollerslev et al., 2006). On the other hand, Yang et al. (2012) captured the stronger asymmetric volatility feature of REIT returns relative to stock returns, and attributed it to their high levels of leverage instead of the volatility feedback effect. This coincides with the leverage effect found in property stock returns (Liow et al., 2005). REIT firms seek funding from the debt market due to its special requirements of company operations to qualify as a REIT and enjoy the tax shield benefit. Therefore, REITs might not be the optimal hedging tool for stocks during market downturns.

The selection of frequency in implies trade-offs between granularity and noise reduction. Daily data offer high granularity but may contain noise due to short-term fluctuations and market volatility. Monthly and quarterly data provide smoother trends but may overlook important short-term patterns. Weekly frequency provides a balance between data granularity and noise reduction, allowing for the capture of medium-term trends while minimising excessive noise inherent in daily data. To examine the time-varying beta calculation on a weekly level, Table 2-5 divides the whole data period into two subperiods to look at the differences in beta.

Table 2-5. Subperiod beta in one-factor models using weekly data

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Whole period:	0.838***	-0.205***	-0.038	0.136***	0.276***	0.838
Apr. 2000 – Jul. 2020	(0.033)	(0.030)	(0.031)	(0.030)	(0.030)	
Subperiod 1:	0.916***	-0.026	0.043	0.120**	0.267***	0.993
Apr. 2000 – Dec. 2010	(0.050)	(0.041)	(0.042)	(0.042)	(0.041)	
Subperiod 2:	0.731***	-0.104**	-0.148***	0.252***	0.163***	0.662
Jan. 2011 – Jul. 2020	(0.043)	(0.045)	(0.044)	(0.043)	(0.044)	

*Note: Column (1) refers to CAPM, Columns (2) and (3) refer to REIT and stock autocorrelation testing, Columns (4) and (5) refer to residual testing from the autocorrelation models, Column (6) is beta calculation by covariance for verification. Risk premium is calculated using the log difference of the first and last trading day values of the week, then minus the risk-free rate (RBA cash rate). Using the RBA cash rate shows similar results for Model (2) as using Australian government bond yields for the risk-free rate. * p<0.05, ** p<0.01, *** p<0.001.*

Table 2-5 illustrates that the CAPM beta in Model (1) in subperiod 1 (from 2000 to 2010) is substantially higher than in subperiod 2 (2011 to 2020). This is also true for betas in Model (6), the by covariance calculation output. Moreover, the sign of the autocorrelation feature of stock index return also changes from positive in subperiod 1 to negative in subperiod 2. As subperiod 1 in Table 2-5 includes the GFC period, clearly it is necessary to define different regimes such as the GFC and use corresponding parameters for the asset pricing models. It is also evident that the extent of the autocorrelation and volatility increases for both REIT and stock index returns in subperiod 2, as seen in the betas of Models (2) to (5). This property suggests that the volatility of weekly returns is more dependent on the previous week's values in subperiod 2, and this can be modelled using a regime-switching model that considers similar variance in a same market state.

The day-of-the-week effect is straightforward as shown in Table 2-6. The Monday effect of REIT returns exists in the US (Chan et al., 2005) and the Wednesday anomaly of the stock market is present in Australia (Zhang et al., 2017). Institutional holdings could explain the outperformance of REITs on Mondays in the US (Chan et al., 2005), but the weekly and annual calendar effects are less significant for REITs than for non-REIT stocks (Subrahmanyam, 2007).

Table 2-6. Day-of-the-week effect of beta in one-factor models using weekly data

Weekly	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Mon to Fri	0.838*** (0.033)	-0.205*** (0.030)	-0.038 (0.031)	0.136*** (0.030)	0.276*** (0.030)	0.838
Mon to Mon	0.856*** (0.032)	-0.130*** (0.031)	-0.015 (0.031)	0.328*** (0.029)	0.435*** (0.027)	0.856
Average of Daily Return in the week	0.818*** (0.013)	0.025 (0.014)	-0.063*** (0.014)	0.134** (0.064)	0.291*** (0.062)	0.965

*Note: Column (1) refers to CAPM, Columns (2) and (3) refer to REIT and stock autocorrelation testing, Columns (4) and (5) refer to residual testing from the autocorrelation models, Column (6) is beta calculation by covariance for verification. Risk premium is calculated using the log difference of the trading day values specified in Column (1), then minus the risk-free rate (RBA cash rate). * p<0.05, ** p<0.01, *** p<0.001.*

2.4.2 Specialised funds beta vs diversified funds beta

REITs employ varied strategies for constructing their portfolios. While REITs like Charter Hall Group, GPT, and Mirvac diversify their investments across multiple property types, others such as Goodman and Scentre Group concentrate on specific property sectors, namely industrial and retail, respectively. In this section, the objective is to investigate the performance differences between specialised and diversified funds. To explore the performance distinctions between specialized and diversified funds, this section incorporates one-factor models, Fama-French three-factor models, and yearly REIT beta values.

2.4.2.1 One-factor model

To examine Research question 1b regarding the diversification benefit of specialised REITs compared to diversified REITs, one factor regressions are performed including a dummy variable that classifies the type of REITs into two groups of specialised and diversified funds. This section presents the results of how REIT types affect the beta, and the dummy variable is tested with different definitions of specialisation level, using the number-weighted and value-weighted diversification index HHI constructed from asset-based transaction records.

Table 2-7 presents one-factor model results of A-REITs with different definitions of specialisation level, using the *specialised* variable, number-weighted HHI and value-weighted HHI.

Table 2-7. One-factor models of A-REITs with specialised dummy

***Spe_i* definition**	**(1) S&P CIQ**	**(2) S&P CIQ**	**(3) Number-weighted**	**(4) Number-weighted**	**(5) Value-weighted**	**(6) Value-weighted**
Dependent variable: $REIT\ risk\ premium_{i,t}$						
$Risk\ premium_{m,t}$	0.517*** (0.005)	0.595*** (0.007)	0.524*** (0.005)	0.678*** (0.011)	0.526*** (0.005)	0.795*** (0.013)
Spe_i *(yes=1; no=0)*	0.0002 (0.000)	0.0002 (0.000)				
HHI_i			0.0005** (0.000)	0.0005** (0.000)	0.0004* (0.005)	0.0004* (0.000)
$Spe_i * Risk\ premium_{m,t}$		-0.140*** (0.010)				
$HHI_i * Risk\ premium_{m,t}$				-0.260*** (0.017)		-0.403*** (0.018)
Constant	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Number of REITs	35	35	34	33	33	33
R-squared	0.100	0.102	0.104	0.107	0.105	0.109
Observations	101,923	101,923	99,820	99,406	97,934	97,934

*Note: Daily returns are the natural log differences of the individual REIT Total Return Index, and daily risk premium are winsorised at 1%. Market returns are the natural log differences of the S&P/ASX-200 Index. Monthly returns are the natural log differences of the monthly average values of the index between the current and last month index. RBA cash rate is the proxy for the risk-free rate to calculate risk premium. In Models (3) – (6), due to the data limit of historical property transactions to construct the Hirschman-Herfindahl Index (HHI), HHI is a continuous variable at the firm level. Number-weighted HHI is based on the number of assets in each of the five property types defined by GICS: industrial, office, residential, retail and other. Value-weighted HHI is based on the acquisition price of the asset in the five property types; the book value of asset in the acquisition year is used where the acquisition price is not available in the transaction record. APN Property Group Limited is excluded as the index stopped on 2 April 2001, and this analysis focuses on 2002 to 2021. Irongate Group and Garda Property Group are excluded due to a lack of data. RNY Property Trust and US Masters Residential Property are excluded as their investment focus is on the US. Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

In Table 2-7 Column (1), without consideration of the interaction effect between specialised and market risk factor, the REIT beta is 0.517. This implies that a 1% decrease in the broad stock market will lower REIT return by 0.517%. Specialised REITs earn 0.0171% higher daily returns than diversified REITs in the whole study period of 2000 to 2021, although this difference is statistically insignificant. Comparing Columns (1) and (2), specialised REITs carry 14% lower risk than diversified REITs, as shown by the significant and negative interaction term between the specialised dummy variable and market risk premium. After adding the interaction term in Column (2), the beta of specialised REITs is 0.595–0.140 = 0.455, suggesting a lower sensitivity to the stock market when accounting for the interaction effect than in Column (1).

As shown in Columns (3) to (6) of Table 2-7, replacing the specialised binary variable with a continuous diversification measure HHI, both number-weighted and value-weighted HHI are significantly positive, suggesting that higher concentration REITs carry approximately 0.049% higher daily returns. As specialised REITs tend to have the majority of real estate assets in one property type, resulting in a higher HHI, this result is similar to Columns (1) and (2) using the specialised variable. In addition, I check both models with and without the interaction term between market risk premium and HHI. The interaction term between HHI and market risk premium is strongly significant at the 1% level for both number-weighted and value-weighted HHI models, implying that high concentration REITs carry 26.0 to 40.3% less systematic risk than low concentration REITs. The number of observations in Columns (3) and (6) is smaller because it is subject to data availability regarding historical asset transactions at the firm level.

2.4.2.2 Fama-French three-factor model

Table 2-8 presents the empirical results for the Fama-French three-factor model with the specialisation variable in different definitions.

Table 2-8. Three-factor models of A-REITs with specialised dummy

Spe_i **definition**	**(1)** **S&P CIQ**	**(2)** **Value-weighted HHI median**	**(3)** **HHI 30th and 70th quantiles**	**(4)** **HHI quantiles excluding HHI=1**
Dependent variable: $REIT\ risk\ premium_{i,t}$				
$Risk\ premium_{m,t}$	0.580***	0.573***	0.606***	0.646***
	(0.007)	(0.007)	(0.007)	(0.008)
Spe_i	0.0001	0.0002	0.0002	0.0000
(yes=1; no=0)	(0.000)	(0.000)	(0.000)	(0.000)
$Spe_i * Risk\ premium_{m,t}$	-0.151*	-0.168***	-0.231***	-0.181***
	(0.010)	(0.010)	(0.012)	(0.013)
SMB_t	-0.105***	-0.104***	-0.165***	-0.195***
	(0.005)	(0.005)	(0.006)	(0.007)
HML_t	0.045***	0.044***	-0.010	0.009
	(0.004)	(0.004)	(0.006)	(0.006)
Constant	0.000**	0.000**	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Number of REITs	35	34	21	17
R-squared	0.112	0.116	0.139	0.167
Observations	97,563	95,460	61,971	52,514

*Note: Daily returns are the natural log differences of the individual REIT Total Return Index, then minus the RBA cash rate to calculate risk premium. Market returns are the natural log differences of the S&P/ASX-200 Index, then minus RBA cash to calculate risk premium. Daily risk premium is winsorised at 1%. SMB presents the difference between a portfolio of small stocks and a portfolio of big stocks, HML presents the difference between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks. Column (1) uses adjusted definition for specialised variable based on S&P CIQ. Column (2) uses definition for the specialised variable based on value-weighted HHI median value of 0.7005, where Specialised equals 1 if the firm HHI is above the median and 0 otherwise. Column (3) uses definition for specialised variable based on value-weighted HHI 30th and 70th quantile values, where Specialised equals 1 if the REIT has an HHI value that is in the top 30% (higher than 0.8757) and equals 0 if the value is in the bottom 30% (lower than 0.5263). Column (4) uses the definition for the specialised variable based on the recalculated 30th and 70th quantile values of the value-weighted HHI excluding the specialised REITs (exclude REITs with HHI values of 1), where Specialised equals 1 if the REIT has an HHI value that is in the top 30% (higher than 0.8121), and equals 0 if the value is in the bottom 30% (lower than 0.5083). For the Specialised definitions using 30th and 70th percentile values, the group between 30th and 70th is removed from the analysis. APN Property Group Limited is excluded as the index stopped on 2 April 2001, and this analysis focuses on 2002 to 2021. Irongate Group and Garda Property Group are excluded due to a lack of data. RNY Property Trust and US Masters Residential Property are excluded as their investment focus is on the US. Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

In Table 2-8 Column (1), market risk, size and value factors are all statistically significant when the specialised dummy variable uses an adjusted definition from Standard & Poor's Capital IQ Pro. The coefficients of the market factor are 0.580 and -0.151, respectively, which means that when the general stock market changes by 1%, specialised and diversified REIT returns will change by 0.429% and 0.580%, respectively. The size factor has a coefficient of -0.105, suggesting a 10.5% higher return for REITs with larger firm size, measured by market capitalisation. The value factor has a parameter of 0.0455, implying that REITs with higher book-to-market values earn 4.5% higher returns.

To check the different definitions of the specialised dummy variable in Columns (2) to (4), Spe_i is redefined using the relative value of HHI for each firm by comparing it to the median, 30th and 70th quantile values, and 30th and 70th quantile values (excluding specialised REITs), respectively. Using value-weighted HHI for the classification based on median HHI value of 0.7005, $\mathrm{Specialised_i}$ takes a value of 1 for REITs with HHI above the median and 0 otherwise. For definition based on the 30th and 70th quantile values of value-weighted HHI, Spe_i equals 1 if the REIT has an HHI value that is in the top 30% (higher than 0.8757), and equals 0 if the value is in the bottom 30% (lower than 0.5263). For definition based on 30th and 70th quantile values of value-weighted HHI and excluding the specialised REITs (exclude REITs with HHI=1), $Specialised_i$ equals 1 if the REIT has an HHI value that is in the top 30% (higher than 0.8121), and equals 0 if the value is in the bottom 30% (lower than 0.5083). The value factor becomes insignificant in Columns (3) and (4).

In Column (2) of Table 2-8, the Fama-French three factors are statistically significant at the 1% level and have similar signs and values in Column (1). The coefficients of the market factor and the interaction term are 0.573 and -0.168, respectively, which means that when the general stock market changes by 1%, specialised and diversified REIT returns will change by 0.405% and 0.573%, respectively. The size factor has the same value of coefficient as in Column (1), standing at -0.104, suggesting a 10.4% higher return for REITs with larger firm size. The value factor has a parameter of 0.0443, which is very close to the value in Column (1), implying that REITs with higher book-to-market value earn 4.43% higher returns on average. The explanatory power of the interaction term between specialised dummy and market factor remains robust in the presence of Fama-French size and value factors. The results in Column (2) present evidence of the positive influence of property type concentration on REIT risk reduction, controlling for the market, size and value factors. Using a redefined specialised variable based on the median HHI value of the 34 A-REITs, the interaction term between the specialised variable and market factor is more statistically significant than the original definition.

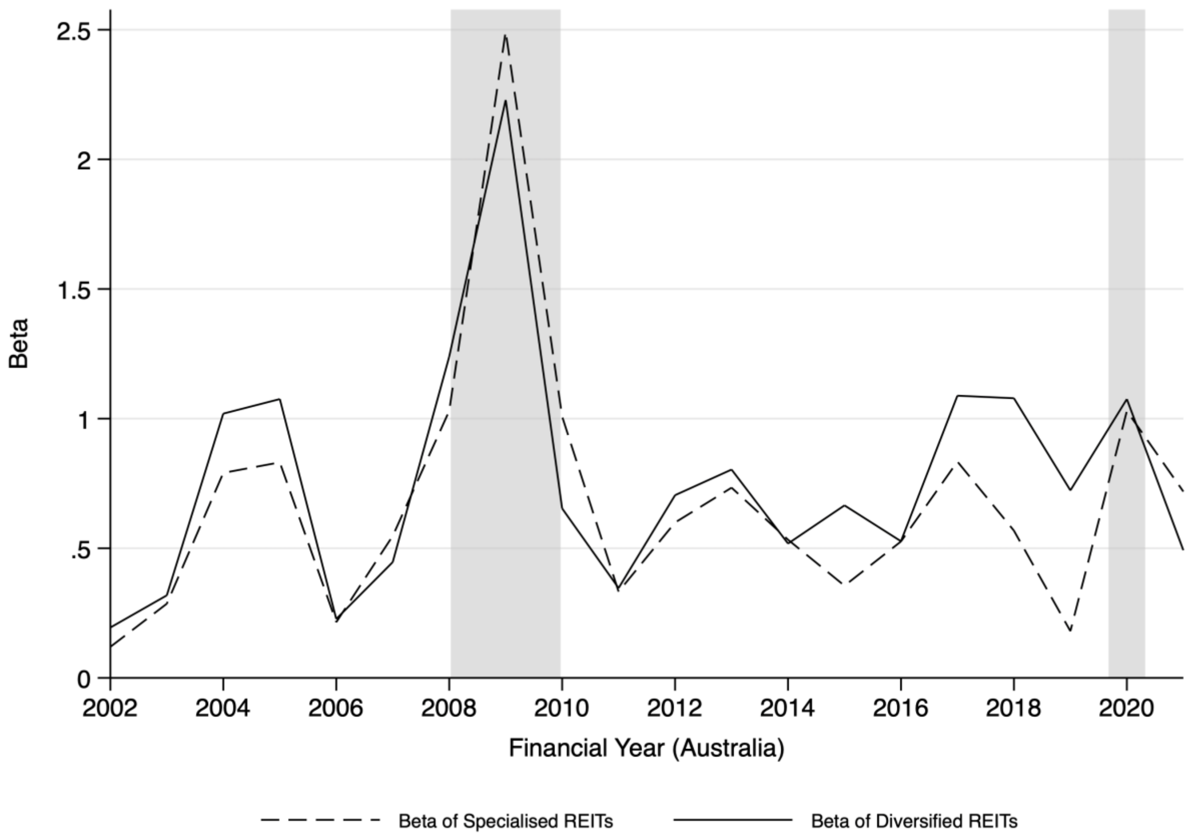
In Table 2-8 Columns (3) and (4) that use the definition of specialised based on the 30^{th} and 70^{th} quantile values of HHI, the inferior risk feature of diversified REITs is even more evident as diversified REITs carry 18.1% to 23.1% higher risks controlling for the market, size and value factors. This result suggests that a heavily concentrated portfolio carries less risk than the more equally allocated portfolio of REITs in terms of property type. This finding justifies the grounds for further research in constructing a time-varying HHI and incorporating more fund-level data for a more accurate and dynamic analysis to uncover what drives such superior returns and lower risks in specialised REITs.

As shown by the results in Table 2-8, A-REITs of bigger size (measured by market value) earn higher returns than smaller REITs. A-REITs with a higher book-to-market ratio earn higher returns than REITs with a lower book-to-market ratio. The signs of the three factors in all four models are in accordance with Milcheva (2021), who studied the impact of COVID-19 on listed real estate companies with Fama-French and Fama-MacBeth models using a similar dataset. Comparing the beta in Column (3) to Column (1), diversified REITs carry about 0.026% higher risks when excluding the group of REITs in the range of 30^{th} and 70^{th} quantile values of HHI. Moreover, diversified REITs carry 0.066% higher risks when further excluding the specialised REITs with an HHI value of 1 and are more sensitive to the size factor in Column (4). These findings confirm the importance of portfolio concentration by property type in explaining the risks and returns of REITs. The specialised dummy variable is insignificant in the three-factor model. Regardless of how the property-type concentration dummy variable is defined, diversified REITs carry 15.1 to 16.8% higher risks than specialised REITs as shown in Columns (1) and (2) in Table 2-8.

2.4.2.3 REIT beta dynamics

This section examines balanced panels of A-REITs for each Australian financial year from 2002 to 2021. Figure 2-4 shows the trend of the monthly betas of specialised and diversified A-REITs over time from financial year 2002 to 2021.

Fig. 2-4. Beta of specialised and diversified A-REIT

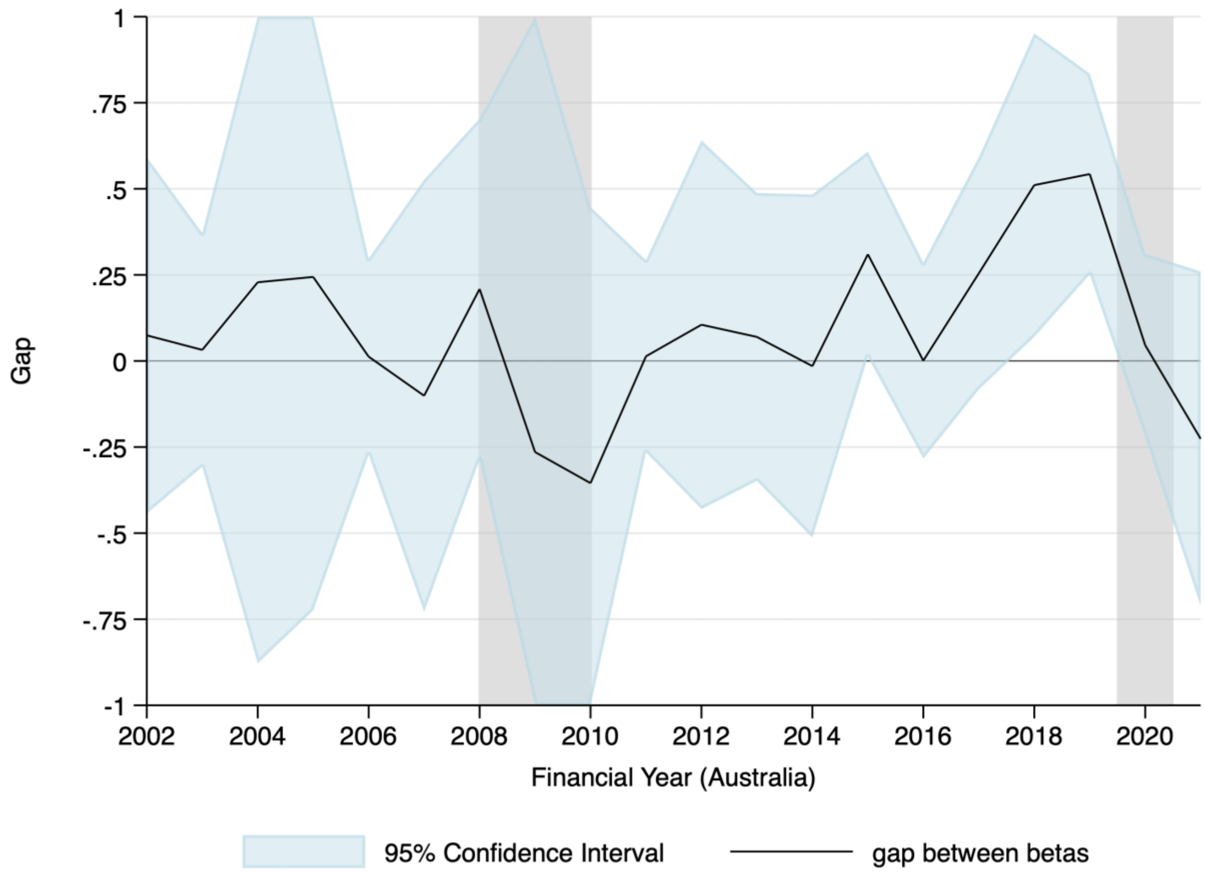


Note: Monthly returns are the log difference of the monthly averages of Total Return Index values, then minus the RBA cash rate to calculate risk premium. Market risk premium uses the S&P/ASX-200 Total Return Index and RBA cash rate. GFC and COVID-19 crises periods are shaded in grey. Data source: S&P CIQ (2000–2021).

In Figure 2-4, the betas of specialised REITs fluctuate around 0.6 in normal market conditions when returns are high and volatilities are low. The line of specialised REIT betas lies below the beta of diversified REITs except for crises times in 2009 and 2021, indicating a slightly higher sensitive return for specialised REITs in a volatile market. Specialised REITs only have beta values higher than 1 in years 2008, 2009, 2010 and 2020, which are the GFC and COVID-19 pandemic periods. In general, diversified REITs present higher beta than specialised REITs, implying that the returns of diversified REITs are more sensitive to changes in systematic risks. Both specialised and diversified REITs have beta values above 2 during the GFC period, consistent with the high downturn betas in existing literature (Ang et al., 2008).

Fig. 2-5 depicts the change in the gap between the monthly betas of diversified and specialised A-REITs from financial year 2002 to 2021 using monthly returns. Specialised REITs are more sensitive to the changes in the financial market during crisis times, whereas diversified REITs are more sensitive during normal periods. A higher gap means diversified REITs are more sensitive to the market factor than specialised REITs. The gap is negative during the GFC and COVID-19 pandemic crisis periods, whereas it mostly stays positive in normal periods, suggesting a more sensitive specialised REIT during crisis times. This phenomenon is in line with the diversification benefit of diversified REITs because the subsector-specific risks were higher for specialised REITs during the GFC, as office and industrial sectors underperformed all other subsectors in the Australian real estate market shown by the MSCI Performance Index.

Fig. 2-5. The gap between monthly betas of specialised and diversified A-REIT



Note: Monthly returns are the log difference of the monthly averages of Total Return Index values, then minus RBA cash rate to calculate risk premium. Market risk premium uses S&P/ASX-200 Total Return Index and RBA cash rate. GFC and COVID-19 crises periods are shaded in lines. Data source: S&P CIQ (2000–2021).

For the COVID-19 crisis in financial year 2020, the higher beta of specialised REITs may result from the shut-down of brick-and-mortar retail and hotel businesses and the restrictions of work from home that hit the office sector. The new entry of more specialised REITs around 2014 and 2015 may also explain the specialised REIT return, such as Scentre Group (retail), Aventus Group (retail), Arena REIT (social infrastructure) and GDI Property Group (office). For the increase in the gap in 2015, a robustness check is conducted on the effect of new entrants on beta by comparing the coefficients of the interaction term before and after excluding the new entrants of specialised

REITs in 2014 and in 2015 separately. Excluding new entrants has a negligible effect on the gap between diversified REIT beta and specialised REIT beta. Therefore, new REITs did not increase the difference in betas of diversified and specialised REITs.

2.4.3 Robustness check

Any study of correlation is subject to the way the sample is organised and defined in the analysis. To enhance the robustness of the previous results, I examine the empirical analysis by constructing different frequencies (daily and monthly), different classifications of specialised dummy and different timeframes (break down to yearly). The robustness results show that the findings are not confined only to the historical time periods, frequency and grouping examined.

2.4.3.1 One-factor model: Dimson beta and Scholes-Williams beta

Table 2-9 reports the Scholes-Williams beta in Column (2) and Dimson beta in Column (1). For the whole analysis period, the Dimson beta and Scholes-Williams beta for A-REITs are 0.904 and 0.727 in Columns (1) and (2), respectively, which are closer to the value of 1 than using the previous OLS method. This is because these two methods include more information about the stock market. The results imply that A-REITs move along with general stock market trends but are still less volatile than the market.

Literature generally supports the methods proposed by Dimson and Scholes-Williams, which are generally considered to be more sophisticated and comprehensive than other approaches (Hollstein et al., 2020; Howard et al., 2022) as they incorporate more information from a wider range of periods. This has led to doubts about the validity of the diversification benefits suggested by the CAPM, prompting further research in this area.

Table 2-9. One-factor models of Dimson beta and Scholes-Williams beta

	(1) **Dimson**	**(2)** **Scholes-Williams**
Dependent variable: $REIT\ risk\ premium_{i,,t}$		
$Risk\ premium_{m,t}$	0.904** (0.087)	0.727** (0.087)
Spe_i *(yes=1; no=0)*	0.0000 (0.001)	0.0000 (0.001)
$Spe_i * Risk\ premium_{m,t}$	-0.134 (0.133)	-0.182 (0.133)
Constant	0.000 (0.000)	0.001 (0.000)
Number of REITs	35	35
Observations	93,687	73,587

*Note: This table reports the mean values of the time series of beta. Daily returns are the natural log differences of the individual REIT Total Return Index, and daily risk premium are winsorised at 1%. Market returns are the natural log differences of the S&P/ASX-200 Total Return Index. RBA cash rate is the proxy for the risk-free rate to calculate risk premium. The adjusted definition for specialised variable based on S&P CIQ is used. APN Property Group Limited is excluded as the index stopped on 2 April 2001 and this analysis focuses on 2002 to 2021. Irongate Group and Garda Property Group are excluded due to a lack of data. RNY Property Trust and US Masters Residential Property are excluded as their investment focus is on the US. R-squared is not reported because the method used to calculate beta involves multiple regressions for one beta value. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

2.4.3.2 One-factor model: Different frequency and yearly windows

In addition to the subperiod robustness checks, I test the beta of diversified and specialised REITs with yearly windows from 2002 to 2021 as an alternative frequency to the overall panel regressions using daily and monthly data controlling for firm fixed effects. This provides a yearly perspective for the one factor results in 2.4.2.1. The monthly and daily results with breakdowns into each financial year are presented in Tables 2-10 and 2-11, respectively. For each year, only firms with a full year of observations are included to test the models and document the breakdown of beta values.

Table 2-10 presents the results using daily data. The time period is presented in two sections: from 2002 to 2011, and 2012 to 2021. In Table 2-10, the daily betas of specialised REITs fluctuate around 0.515 in periods excluding the crisis years FY2008–2010 and FY2020. The daily beta of specialised REITs increased to 0.863 in 2008 and to 0.856 in 2020, suggesting higher sensitivity of REIT returns to the changes in the stock market. The difference in beta values for crisis years implies that the REIT returns are slightly more sensitive to the broad stock market movements during the COVID-19 pandemic in 2020 (0.856) than during the GFC (0.754 to 0.863).

The coefficients of the firm-level specialised dummy variable in Table 2-10 show that specialised REITs have statistically significant higher returns at the 1% level than diversified REITs in 2002, 2010, 2011, 2012, 2014 to 2018 and 2020, while diversified REITs have statistically significant higher returns at the 1% level in 2006, 2008 and 2021. The signs of the coefficients are inconsistent for crisis periods, which explains the insignificant result of the coefficient of the specialised dummy variable in the previous panel regressions. However, specialised REITs have lower beta than diversified REITs except for 2002 and 2006. Therefore, specialised REITs generally have higher risk-adjusted daily returns. The firm fixed effects are all strongly significant at the 1% level, suggesting more controls at the firm level.

Table 2-10. Yearly one-factor models of A-REITs using daily data

FY	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Dependent variable: $REIT\ risk\ premium_{i,t}$										
$Risk\ premium_{m,t}$	0.200**	0.283***	0.383	0.470**	0.262**	0.483***	0.863***	0.851***	0.754***	0.514***
	(0.050)	(0.035)	(0.284)	(0.148)	(0.079)	(0.098)	(0.046)	(0.107)	(0.112)	(0.091)
Spe_i	0.001***	0.000***	0.000	0.000	-0.001***	0.000	-0.002***	0.000	0.000***	0.001***
(yes=1; no=0)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Spe_i *$	0.037	-0.082	-0.098	-0.135	0.088	-0.097	-0.187	0.018	-0.060	-0.069
$Risk\ premium_{m,t}$	(0.082)	(0.052)	(0.364)	(0.204)	(0.112)	(0.189)	(0.141)	(0.230)	(0.199)	(0.150)
Constant	0.001***	0.001***	0.000	0.000	0.001***	0.000**	-0.001***	-0.001***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Number of REITs	8	8	10	12	14	15	15	16	16	16
Number of Observations	2,000	2,024	2,540	3,035	3,528	3,720	3,750	4,016	4,016	4,016
FY	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Dependent variable: $REIT\ risk\ premium_{i,t}$										
$Risk\ premium_{m,t}$	0.527***	0.627***	0.618***	0.678***	0.601***	0.425***	0.544***	0.418***	0.856***	0.683***
	(0.087)	(0.088)	(0.086)	(0.087)	(0.072)	(0.070)	(0.095)	(0.052)	(0.093)	(0.101)
Spe_i	0.001***	0.000	0.000**	0.000***	0.000***	0.000***	0.001***	0.000	0.000***	-0.001***
(yes=1; no=0)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Spe_i *$	-0.110	-0.130	-0.220	-0.249*	-0.197*	-0.061	-0.235*	-0.180*	-0.217	-0.195
$Risk\ premium_{m,t}$	(0.152)	(0.133)	(0.129)	(0.114)	(0.095)	(0.089)	(0.107)	(0.069)	(0.109)	(0.115)
Constant	0.000	0.000**	0.000***	0.000***	0.001***	0.000***	0.000***	0.000***	0.000***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Number of REITs	16	17	21	27	28	31	34	35	36	38
Observations	4,000	4,284	5,313	6,858	7,112	7,843	8,568	8,820	9,180	9,652

*Note: For each year, only firms with a full year of observations are included to test the models and document the breakdown of beta values. Daily risk returns are the natural log differences of the individual REIT Total Return Index, then minus RBA cash rate to calculate risk premium. Market returns are the natural log differences of the S&P/ASX-200 Total Return Index, then minus RBA cash rate to calculate risk premium. REIT risk premium is winsorised at 1%. The adjusted definition for specialised variable based on S&P CIQ is used. APN Property Group Limited is excluded as the index stopped on 2 April 2001 and this analysis focuses on 2002 to 2021. Irongate Group and Garda Property Group are excluded due to a lack of data. RNY Property Trust and US Masters Residential Property are excluded as their investment focus is on the US. Standard Error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

Table 2-11 presents the results using monthly data. The time period is presented in two sections: from 2002 to 2011, and 2012 to 2021. In Table 2-11, the beta values are statistically significant at the 1% level from FY2008 to 2020. From FY2002 to 2010, although the number of REITs increased from 8 to 16, there is still a smaller number of REITs in the early 2000s compared to the decade from 2011.

Table 2-11. Yearly one-factor models of A-REITs using monthly data

FY	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Dependent variable: $REIT\ risk\ premium_{i,t}$										
$Risk\ premium_{m,t}$	0.181 (0.146)	0.303 (0.141)	1.018** (0.309)	1.054* (0.355)	0.241*** (0.048)	0.441 (0.212)	1.344*** (0.126)	2.210*** (0.368)	0.707*** (0.128)	0.343*** (0.074)
Spe_i *(yes=1; no=0)*	0.003** (0.001)	-0.007*** (0.001)	0.004 (0.005)	0.007 (0.006)	-0.020*** (0.002)	-0.004 (0.006)	-0.027*** (0.003)	0.001 (0.021)	-0.011* (0.004)	0.026*** (0.000)
$Spe_i *$ $Risk\ premium_{m,t}$	-0.062 (0.213)	-0.032 (0.152)	-0.271 (0.524)	-0.273 (0.428)	-0.004 (0.130)	0.039 (0.313)	-0.224 (0.228)	0.220 (0.804)	0.326 (0.371)	0.009 (0.132)
Constant	0.015*** (0.001)	0.016*** (0.001)	-0.009* (0.003)	-0.009 (0.005)	0.015*** (0.001)	0.008 (0.004)	-0.014*** (0.002)	0.016 (0.010)	0.013*** (0.001)	-0.009*** (0.000)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Number of REITs	8	8	10	12	14	15	15	16	16	16
Number of Observations	96	96	120	144	168	180	180	192	192	192
FY	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Dependent variable: $REIT\ risk\ premium_{i,t}$										
$Risk\ premium_{m,t}$	0.762*** (0.161)	0.785*** (0.172)	0.476** (0.129)	0.647*** (0.116)	0.504*** (0.099)	1.153*** (0.137)	1.209*** (0.206)	0.732*** (0.121)	1.100*** (0.104)	0.604** (0.159)
Spe_i *(yes=1; no=0)*	0.006* (0.002)	0.006 (0.003)	-0.009** (0.003)	0.004*** (0.001)	0.001** (0.000)	-0.007** (0.002)	0.015*** (0.002)	0.006*** (0.001)	-0.009*** (0.001)	-0.017** (0.005)
$Spe_i *$ $Risk\ premium_{m,t}$	-0.130 (0.266)	-0.048 (0.217)	0.031 (0.251)	-0.280 (0.141)	0.013 (0.134)	-0.276 (0.175)	-0.542* (0.233)	-0.546** (0.144)	-0.046 (0.134)	0.240 (0.270)
Constant	0.003 (0.001)	0.000 (0.003)	0.007*** (0.002)	0.005*** (0.000)	0.012*** (0.000)	-0.007*** (0.001)	-0.017*** (0.002)	0.004** (0.001)	-0.005*** (0.001)	0.015*** (0.003)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Number of REITs	16	17	21	27	28	31	34	35	36	38
Observations	192	204	252	324	336	372	408	420	432	456

*Note: For each year, only firms with a full year of observations are included to test the models and document the breakdown of beta values. Monthly returns are the natural log differences of the monthly average values of the individual REIT Total Return Index, then minus RBA cash rate to calculate risk premium. Market returns are the natural log differences of the monthly average values of S&P/ASX-200 Total Return Index, then minus RBA cash rate to calculate risk premium. REIT risk premium is winsorised at 1%. The adjusted definition for specialised variable based on S&P CIQ is used. APN Property Group Limited is excluded as the index stopped on 2 April 2001 and this analysis focuses on 2002 to 2021. Irongate Group and Garda Property Group are excluded due to a lack of data. RNY Property Trust and US Masters Residential Property are excluded as their investment focus is on the US. Standard Error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

As showed in Table 2-11, the limited number of firms might explain the insignificant betas in the early 2000s. In FY2008 to 2009, the monthly betas of specialised REITs are larger than 1 with values of 1.344 and 2.210, suggesting that specialised REIT returns are more sensitive during the GFC. The beta value of specialised REIT at 2.43 (=2.21+0.22) in 2009 means that the specialised

REIT returns drop by 2.43%, given a 1% decrease in the stock market. The coefficient of the specialised dummy variable is positive for seven years out of the 2011 to 2019 period, suggesting higher returns of specialised REITs outside of crisis periods, and lower returns during crises.

The interaction term between the specialised dummy variable and market risk premium is negative except for 2007, 2009 to 2011, 2014, 2016 and 2021 in Table 2-11. These coefficients are insignificant in most of the years. The sign of the coefficient of the interaction term suggests that diversified REITs carry higher risks than specialised REITs in 13 years out of the 20-year study period despite showing no significance in most years. The firm fixed effects are all strongly significant at the 1% level, suggesting more controls at the firm level. Overall, the results in Tables 2-10 and 2-11 demonstrate similar results that specialised REITs carry lower risks and have higher risk-adjusted returns than diversified REITs.

2.4.3.3 Three-factor model: Year fixed effects

To consider time fixed effect in the Fama-French three-factor model, following Torres-Reyna (2007), I add time fixed effect to equation (2-4). Because the one factor model is focused on exploring the diversification benefit of specialised funds and diversified funds and does not consider other factors, Fama Frech three-factor model is used to examine if the same benefit exists and robust to the size and value effects. A Wald test on the time effect confirmed that the year effect needs to be accounted for in the Fama French three-factor model with time fixed effect. The test result for fixed effect is insignificant. Because the F value is 0 and less than 0.05

in the Wald test, I reject the null that the coefficients for all years are jointly equal to zero. Therefore, time fixed effects are needed in this case.

Table 2-12 presents the results of the A-REIT pooled regression with Fama-French factors, controlling for year fixed effect. Financial year 2002 is used as the base reference group, and 2000 and 2001 are excluded because the size and value factors have no values in those financial years.

Table 2-12. Three-factor model of A-REITs with year fixed effect

	(1)	**(2)**
Dependent variable: $REIT\ risk\ premium_{i,t}$		
$Risk\ premium_{m,t}$	0.580*** (0.007)	0.576*** (0.007)
Spe_i *(yes=1; no=0)*	0.000113 (0.000)	
$Spe_i * Risk\ premium_{m,t}$	-0.151* (0.010)	-0.138*** (0.010)
SMB_t	-0.105*** (0.005)	-0.107*** (0.005)
HML_t	0.045*** (0.004)	0.043*** (0.004)
Constant	0.000** (0.000)	0.000 (0.000)
Number of REITs	35	35
R-squared	0.112	0.114
Observations	101,923	97,563
Year FE	N	Y

*Note: Column (1) is the baseline model, Column (2) controls for year fixed effects. Daily returns are the natural log differences of the individual REIT Total Return Index, and daily risk premium are winsorised at 1%. Market returns are the natural log differences of the S&P/ASX-200 Index. RBA cash rate is the proxy for the risk-free rate to calculate risk premium. In Column (2), specialised dummy is omitted because of collinearity, as new specialised REITs entered the market in 2003, 2005, 2011, 2012, 2014, 2015, 2017, 2019 and 2020. The adjusted definition for specialised variable based on S&P CIQ is used. APN Property Group Limited is excluded as the index stopped on 2 April 2001 and this analysis focuses on 2002 to 2021. Irongate Group and Garda Property Group are excluded due to a lack of data, RNY Property Trust and US Masters Residential Property are excluded as their investment focus is on the US. Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

Compared to the weakly significant interaction term between market factor and specialised dummy variable (-0.151) in Column (1) in Table 2-12, the coefficient is strongly significant (-0.138) at the 1% level in Column (2), indicating that specialised REITs carry 13.8% lower systematic risk than diversified REITs on average. The coefficients of the interaction variable demonstrate findings similar to those of the one-factor model (-0.140) described in section 2.4.2.1. However, Table 2-12 presents a higher R-squared value of 0.112 instead of 0.102, attributed to the strong significance level of the size and value factors. In Column (2), year fixed effects of 2008 and 2021 are statistically significant at the 1% level, suggesting approximately -0.32% and -0.31% influence of the GFC and COVID-19 pandemic on A-REIT returns, respectively. Therefore, a subperiod robustness check could use 2008 as the GFC and 2020 as the COVID-19 periods. This provides grounds for applying regime switch. The Spe_i dummy variable is omitted because of collinearity with year fixed effect.

2.4.3.4 Three-factor model: Different time periods

Spanning a time period of 2000 to 2021, the data is split into four periods of distinct economic conditions based on the robustness check of year fixed effect: a pre-crisis period of relatively high growth (2000 to 2007), the GFC period of disruption and contraction (2008), a post-GFC period of relatively low growth (2009–2019) and a COVID-19 pandemic period with economic downturn (2020–2021).

In Table 2-13, the market factor using the S&P/ASX-200 Index and RBA cash rate as an overall indicator for market conditions is significantly positive in all periods and increased from 0.431 before 2008 to 0.577 after 2008. This rise may be explained by the increased integration between the A-REIT sector and the overall equity market. Moreover, the coefficients of the market factor are higher during the crisis periods, standing at 0.599 and 0.591 respectively for the years 2008 and 2020 to 2021, revealing a strengthened effect of systematic market risk towards A-REIT returns. The higher beta could be because when market conditions are unfavourable, property asset values and rental returns from tenants exhibit more similar trends as the stock market than normal periods. The interaction term between the market factor and the specialised dummy variable loses significance in 2008 but decreases to -20.9% during 2009 to 2019 compared to -7.21% in the pre-GFC period. From 2009 to 2019, specialised REITs carry 20.9% lower risks than diversified REITs, controlling for the size and value factors. This is consistent with the previous finding of specialised REIT diversification benefit during normal market times. From 2020 to 2021, the interaction term has a value of -11.9%, suggesting that specialised REITs still carry fewer risks than diversified REITs.

Table 2-13. Subperiod three-factor models with specialised dummy

	(1) **2000–2021**	**(2)** **2000–2007**	**(3)** **2008**	**(4)** **2009–2019**	**(5)** **2020–2021**
Dependent variable: REIT $risk\ premium_{i,t}$					
$Risk\ premium_{m,t}$	0.580*** (0.007)	0.431*** (0.020)	0.599*** (0.032)	0.577*** (0.010)	0.591*** (0.020)
Spe_i *(yes=1; no=0)*	0.0001 (0.000)	0.0000 (0.000)	0.0003 (0.001)	0.0001 (0.000)	-0.0004 (0.000)
$Spe_i * Risk\ premium_{m,t}$	-0.151* (0.010)	-0.072* (0.010)	-0.071 (0.047)	-0.209*** (0.013)	-0.119*** (0.023)
SMB_t	-0.105*** (0.005)	-0.188*** (0.013)	-0.021 (0.021)	-0.139*** (0.007)	0.097*** (0.023)
HML_t	0.046*** (0.004)	-0.080*** (0.010)	-0.059*** (0.018)	0.081*** (0.006)	0.340*** (0.018)
Constant	0.000** (0.000)	0.000 (0.000)	-0.003*** (0.000)	0.000*** (0.000)	0.001*** (0.000)
Number of REITs	35	16	16	34	34
R-squared	0.112	0.062	0.141	0.097	0.0252
Observations	97,563	17,041	3,888	65,555	8,976

*Note: Column (1) is the whole study period, Column (2) is a part of cycle, Column (3) is crisis, Column (4) is next cycle, Column (5) is the recent cycle of the COVID-19 pandemic. Daily returns are the natural log differences of the individual REIT Total Return Index, and daily risk premium are winsorised at 1%. Market returns are the natural log differences of the S&P/ASX-200 Index. RBA cash rate is the proxy for the risk-free rate to calculate risk premium. The adjusted definition for specialised variable based on S&P CIQ is used. APN Property Group Limited is excluded as the index stopped on 2 April 2001 and this analysis focuses on 2002 to 2021. Irongate Group and Garda Property Group are excluded due to a lack of data. RNY Property Trust and US Masters Residential Property are excluded as their investment focus is on the US. Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

The R-squared values are low in Table 2-13. According to Shalizi (2015), the R-square statistic does not provide a reliable measure of goodness of fit, as it can be influenced by the deviation of the explanatory variable. A model can have a low R-square value while still offering a strong explanatory capacity. In this study, the focus is not on achieving a high R-square value, but on identifying the marginal effects related to beta, as opposed to the overall explanatory power of the model.

Overall, the coefficient of the size factor is -10.5% for the whole study period, which suggests that size, as measured by market capitalisation, is positively correlated with A-REIT returns. The negative value of the coefficient of the size factor is in accordance with the finding of Highfield et al. (2021), who point out that the REIT industry is slowly moving away from both cost and revenue efficiency over time, but larger REITs still enjoy comparative advantages over smaller REITs in both revenue (production) and costs in the US from 2001 to 2015. Contrary to the findings by Milcheva (2021), who stated that listed real estate companies in Asia developed regions have negative coefficients for the market, size and value factors during the COVID-19 period (24 January 2020 to 21 April 2020), but have positive coefficients in the pre-COVID period (1 November 2019 to 22 January 2020). The difference could be due to the inclusion of Japanese REITs in the analysis and not purely focused on Australia. As for listed real estate firms in the US, the coefficients of the three Fama-French factors stay positive before and during the COVID-19 period (Milcheva, 2021).

2.5 Summary

2.5.1 Economic impact

The economic impact of the specialised dummy variable is huge despite the fact that the coefficients are insignificant. The coefficients of the interaction term between the specialised dummy variable, adjusted from S&P CIQ, and market risk premium are strongly significant in one-factor regressions at the 1% level and weakly significant in the Fama-French three-factor model at the 10% level. This implies considerable risk-reduction benefit by adding specialised REITs to an existing portfolio containing non-REIT stocks. Also, the diversification benefit still exists after adding the size and value factors. The coefficients of the interaction term between HHI-based specialised dummy variables and market risk premium are also strongly significant in the Fama-French three-factor model. In addition, the beta value is around 0.5. Beta measures the sensitivity of an asset's returns relative to the overall market, with a beta of 1 indicating that an asset moves in line with the market. A beta smaller than one indicates that A-REITs experience lower volatility compared to the general stock market. This is in line with the defensive play favoured by REIT investors in terms of reducing portfolio risks.

Out of the three Fama-French three-factor models based on median and 30^{th} and 70^{th} quantile of HHI values from the Australian REITs, the model using the median value of HHI to redefine specialised REITs shows better performance as the three factors and the interaction term are all strongly significant at the 1% level. Therefore, the specialised definition based on the Herfindahl-

Hirschman Indices from the historical asset transactions is a more precise implication of the property-type concentration status for A-REITs at the firm level than the adjusted S&P CIQ definition. The higher the degree of concentration in terms of property type, the lower systematic risks that REITs will carry. As there are many small-cap REITs in Australia, the daily beta is smaller than the monthly beta.

The robustness check of subperiods shows that specialised REITs carry lower risks during the GFC and COVID-19 pandemic crises. There are diversification benefits in investing in specialised REITs during normal market conditions, meaning outside of the GFC and COVID-19 pandemic crisis periods. Therefore, investors could allocate their portfolios strategically based on the market regime. Moreover, size matters. Investors will receive higher returns by investing in larger market capitalisation REITs. One possible reason is that bigger REITs benefit from economies of scale, confirming the importance of the size factor as stated in previous literature. The value factor (HML) has a small coefficient of 0.0442 for the whole study period of 2000 to 2021, indicating that the high book-to-market ratio is also a favourable trait when selecting REITs. The empirical analysis with balanced panel regression testing shows that specialised REITs deliver 0.015% slightly higher returns and carry 14% fewer risks than diversified REITs, controlling for the Fama-French size and value factors. Therefore, investors that seek to add real estate exposure through REITs should invest in specialised REITs to enhance portfolio performance. Based on empirical analysis and robustness checks, this study accepts the hypothesis that specialised REITs have higher risk-adjusted returns than diversified REITs.

2.5.2 Conclusion

This chapter presents evidence of the positive influence of property-type concentration on A-REIT risk reduction controlling for the Fama-French market, size and value factors. This chapter answers Research question 1 regarding REIT beta across industry sectors based on CAPM. Specialised REITs have lower beta than diversified REITs, which means that specialised REITs are less sensitive to the changes in the broader stock market. Specialised REITs also have less volatile and higher risk-adjusted returns than diversified REITs. This could be attributed to the expertise in a specific property type that helps managers earn superior returns when they restrict themselves to investments in that specific type of property (Geltner et al., 2001). These findings provide guidance for investors in the Australian REIT market in that asset allocation to A-REITs with higher property type concentration adds value to the performance of a portfolio that contains stocks and provides diversification.

Hypothesis 1, which posited that Under the CAPM assumptions, the risk-adjusted return of REITs will be the same for diversified funds and specialised funds, is rejected by the findings in this chapter. The data analysis shows that diversified REITs carry 14% to 16.8% higher risks than specialised REITs. These results are statistically significant and robust to how the property-type concentration dummy variable is defined, based on HHI calculated from historical asset transactions or S&P CIQ definition. The explanatory power of the interaction term between the specialised dummy and market factor remains robust in the presence of Fama-French size and value factors. Sub period analysis shows that specialised REITs are more sensitive to the changes in the financial market during crisis times, whereas diversified REITs have higher betas during normal periods. The examination of Hypothesis 1 adds to existing knowledge of the A-REIT market by providing insights of the superior performance of specialised REITs compared to diversified REITs. Therefore, investors could improve the risk profile of their portfolios by constructing their own portfolio of specialised REITs rather than investing in diversified REITs and allocating more weight to specialised REITs in non-crisis periods.

The monthly betas of specialised and diversified REITs are higher than 1 during the GFC and COVID-19 pandemic periods and are less than 1 in normal times. This is in line with literature as betas during downturns are always higher (Ang et al., 2008). The low beta may suggest that real estate investments have less systematic risk than the capital market during normal market conditions. Diversified funds have higher beta as diversification implies a higher degree of systematic risk. This thesis also confirms the security market line in the Australian REIT market as both specialised and diversified REITs have upward-sloping security market lines in normal times, excluding the financial years 2008 and 2009. Australian REITs with a larger size in terms of market capitalisation and a higher book-to-market ratio are also associated with higher returns.

Chapter 3 Regime-switch consideration in Australian REIT market

3.1 Background

The correlation between stock market returns and REIT returns has been examined using a linear approach in Chapter 2. However, REIT returns exhibit regime-dependent behaviour (Demiralay & Kilincarslan, 2022). The Markov-switching model, which can capture both long-term trends and discrete switches in the data (Baharumshah et al., 2017), provides a more in-depth understanding of the A-REIT market regimes. This chapter aims to provide a clearer analysis on the dynamic connectedness (short run and long run) between the A-REIT market and the stock market, especially during periods of steady and unstable regimes.

REITs have caught investors' attention because of the maturing market in recent decades. However, the crises that hit all assets from 2007 to 2009 and the COVID-19 pandemic have shifted investors' interest on return and volatility characteristics that, if better comprehended, might have been used to maximise performance of portfolios containing REITs and non-REIT stocks. Abundant literature has captured the dynamic REIT volatilities with ARCH models and different versions of GARCH models (Cotter & Stevenson, 2008; Jirasakuldech et al., 2006; Zhou & Kang, 2011). Recent researchers have also examined REIT returns under the framework of regime switch (Case et al., 2014; Case et al., 2012; Lizieri et al., 2012), and others apply regime-switch models to investigate asset allocation of portfolios with REITs and other assets (Sa-Aadu et al., 2010). Furthermore, there is growing interest in conducting analysis of the behavioural biases in the REIT market, such as animal spirits (Akerlof & Shiller, 2009; Fama, 2014; Shi & Kabir, 2018), as the volatility spillover between REITs and stock markets is unexamined and with the special feature of REIT stocks with underlying brick-and-mortar assets.

To examine the characteristics of REIT returns and volatilities with a regime-switch framework, the thesis is organised in three separate chapters. This chapter investigates the volatility transmission between the Australian listed real estate market and the stock market. It also explores the regime-dependent nature of REIT returns, thereby contributing to a deeper understanding of REIT beta. Chapter 2 highlighted the significant impact of market conditions on REIT returns. The characteristics of REIT returns and volatility examined in Chapter 2 pave the way for a deeper exploration of regime switching in the REIT market. This chapter studies the relationship between REIT returns and market regimes by comparing the two-regime and three-regime models in REITs and stock markets. As fundamental drivers for REIT returns and volatilities change over different REIT eras, it is clearer to analyse the features of REITs with a regime-switch analysis. This chapter also considers the impact of crises on REIT returns and volatilities and the REIT–stock relationship and the design of regime-dependent investment strategies for investors interested in REITs.

3.2 Literature review

This thesis adopts a regime-switch approach to explore the time-varying price behaviour of REITs. Considering the classification of REIT eras from researchers, this study defines REIT eras as five periods: 2000 to 2007, the GFC, 2008 to 2020, the COVID-19 crisis, and the post-COVID period Regimes of booming periods and recovery periods are also considered. With the transition matrix of defined regimes, one could form a reasonable expectation of the possibility of one regime change to another, such as the chance of a switch from a booming market regime to a crisis regime if given the current market state as a bull market. Therefore, the identification of regimes is valuable for both policymakers and investors.

There are distinct REIT eras, therefore it is essential to price REITs in each era accordingly to the identification method from regime switch. From Jirasakuldech et al. (2006, p. 110), “we segment the data into two subperiods: before and after 1991. This breakdown is chosen because it is often argued that the new REIT era begins in 1992, marked by the Kimco IPO and changes to the rules regarding institutional ownership”. Similarly, Shen (2020) defined the vintage REIT era as from July 1988 to December 1992, and the REIT maturity era as from October 2001 to August 2008. In addition, the Fama-French three-factor model performs well for the pricing of US REITs prior to 1993 (Chiang et al., 2006), implying a structural change in 1992. This is in accordance with Aguilar et al. (2018), who noted that the modern REIT era began in 1993. It is sensible to use data from early 1990 onwards to examine REIT pricing efficiency given the REIT maturation in the early 1990s (Aguilar et al., 2018; Hoesli & Oikarinen, 2012), yet this thesis aims to scrutinise the market dynamics in different subperiods of REIT development, including the pre-maturation era for REITs. Shen (2020) concluded that the distress anomaly in the REIT market results from market mispricing, including the development of institutional ownership and volatility in the general stock market (Shen, 2020).

There is confirmation empirically about modelling REIT returns with the consideration of different REIT eras (regimes). Case et al. (2012) first incorporated the REIT regime shift that occurred in the early 1990s in their DCC-GARCH (Dynamic Conditional Correlation Generalised Autoregressive Conditional Heteroskedasticity) model, Case et al. (2014) then proposed that the Markov regime-switch techniques are better than the ARCH models when studying the time-varying returns of REITs, non-REIT stocks and bonds during the period 1972–2009 in the US, and found that REITs and non-REIT stocks can be described by two states, featuring high (low) conditional returns and low (high) volatility. Following Engle (2002), Case et al. (2014) added a structural break dummy variable in the DCC-GARCH model to cater to the two REIT eras while modelling the heteroskedastic shocks in a regime of changing volatilities. Sa-Aadu et al. (2010) used a two-regime framework (Hamilton, 1989) to study the portfolio allocation implications of the differences in the portfolio properties of eight asset classes (small cap stocks, medium/large cap stocks, government bonds, corporate bonds, international stocks, commodities, precious metals and equity REITs) in the US.

Aside from the above papers, a strand of research has emerged that focuses on using regime switch to model real estate returns. There is evidence of the regime-switching model as a better fit than autoregressive models for explaining time-varying volatility real estate returns (Chen & Shen, 2012; Lizieri et al., 2012). Chen and Shen (2012) found that the duration of the high-volatility regime is relatively short, typically lasting for only a few months. This suggests that REIT returns are relatively volatile in the short term, but that the volatility tends to revert to normal levels relatively quickly. Lizieri et al. (2012) used a regime-switching model that allows for the possibility that real estate returns can switch between two regimes: a high-volatility regime and a low-volatility regime. They found that the unsmoothed returns are more volatile than the smoothed returns and suggest that investors who focus on the recent past may be underestimating the true volatility of real estate returns (Lizieri et al., 2012). Chang et al. (2011) used a VAR (Vector Autoregressive) model and considered the regime-switching probability when analysing the effect of monetary policy and term structure on different asset returns in the US from 1975 to 2008, including REITs, stocks and bonds.

There is extensive literature on the application of regime switch in the macroeconomy and the stock market. To evaluate the market states of the macroeconomy, the regimes assessed are tightly linked to the business cycle in Hamilton (1989). Gao et al. (2020) applied the Markov-Switching GARCH (MS-GARCH) to study the volatilities of NASDAQ and S&P 500 indices. Regime-switch behaviour is studied with different focuses, such as regime switch of exchange rates that rejects the random walk hypothesis (Engel, 1994; Engel & Hamilton, 1990), the difference of interest rate between two maturities that is attributed to inflation during a stable interest rate regime (Ang et al., 2008), and volatility regimes with a Generalised Regime Switch (GRS) that incorporates the GARCH model in Gray (1996). Strong regime-switch evidence is also found in the stock market (Balcilar et al., 2015; Tu, 2010), and Hamilton and Susmel (1994) proposed a regime-switching ARCH (Autoregressive Conditional Heteroskedasticity) model that could be applied to stock market return.

Apart from fundamental macroeconomic factors, significant events such as crises contribute to changes in the market dynamics of REITs and stocks. Hoesli and Oikarinen (2012) examined the GFC related lead–lag relationships between REITs and stock markets and found that the REIT market predicted the recent crisis and recovery. Stock market and equity REIT returns are positively correlated regardless of the state of the market (Chen et al., 2012). Also, REIT returns are mainly independent of shocks in the direct real estate market and stocks (Hoesli & Oikarinen, 2012). In times of crisis, there tend to be drastic changes in monetary policy. Monetary policy negatively affects equity REIT returns on condition that investors have low expectations of real estate price increments (Chen et al., 2012). Liow et al. (2005) controlled for the regime shifts of the 1997 financial meltdown and 2001 terrorist shock in the Asian and European markets and investigated the short-run and long-run relationship in six listed property markets (Australia, Hong Kong, Japan, Singapore, United Kingdom and the United States).

It is crucial to study how financial crises affect the volatility of REITs and financial markets over time to identify the periods of the regime switch. Gupta et al. (2019) found that regime-specific interest rate spread shocks and monetary policy shocks explain over 60% of return variations during 2013 to 2016. Additionally, Haas and Liu (2018) argued that accounting for regime-switching correlations is more important than accounting for the dynamics of individual volatilities when modelling the dynamic correlation between the MSCI World index and FTSE EPRA/NAREIT Global returns. Using an endogenous regime-switching model, Benigno et al. (2020) found that different macroeconomic shocks are more important for different historical crisis episodes and different phases of a given episode. They also identify three financial crises: the debt crisis (1981–1983), the Mexican peso crisis (1994–1996), and the GFC (2007–2009).

The direction of volatility spillover between REITs and other assets may vary depending on the market regimes (Mensi et al., 2022). The post-crisis reform could also spill over to the securitised real estate market (Dell'Ariccia et al., 2012). As the economy could enter a low-interest-rate environment due to a financial crisis, there is an overlap between the crisis and the spillover effect. Mensi et al. (2022) examined spillovers in global markets with a Markov-Switching VAR model and found that A-REITs are the least immune to spillovers from oil prices compared to Italy and Hong Kong REITs. Price spillover between REITs, gold and oil in Australia differs between high and low volatility regimes (Mensi et al., 2022). In the low volatility regime, the oil and gold markets have a greater impact on REITs than REITs have on oil and gold, while in the high volatility regime, REIT prices contribute to the fluctuations of oil prices (Mensi et al., 2022).

Recent studies focusing on the real estate sector have provided valuable insights into the stylised facts of regime switching. There are diverse impact of news-based uncertainties on returns of sector-specific US REIT indices (Demiralay & Kilincarslan, 2022), and the drivers of REIT returns change under different regimes (Gupta et al., 2019; Mensi et al., 2022). Therefore, it is important to examine the drivers of REIT returns separately for each regime. Using linear and non-linear regime-switching models, Demiralay and Kilincarslan (2022) showed that residential REITs are least sensitive to uncertainties while office and hotel REITs are most sensitive to the uncertainty index during market downturns.

In addition to the application to real estate (Gupta et al., 2019) and commodities (Liu & Lee, 2021; Mensi et al., 2022), regime-switching models have been extensively used in financial economics to investigate return patterns of cryptocurrencies (Huang et al., 2021). Based on identifying intraday extreme behaviours from regime-switching analysis of the crude oil market, Liu and Lee (2021) addressed the importance of implementing volatility forecasting by incorporating intraday realised measures into a mixed data sampling approach. These recent works demonstrate the ongoing relevance and applicability of regime-switch models in understanding complex economic phenomena and informing decision-making in various domains.

Table 3-1. Summary of literature on regime-switch model of REITs

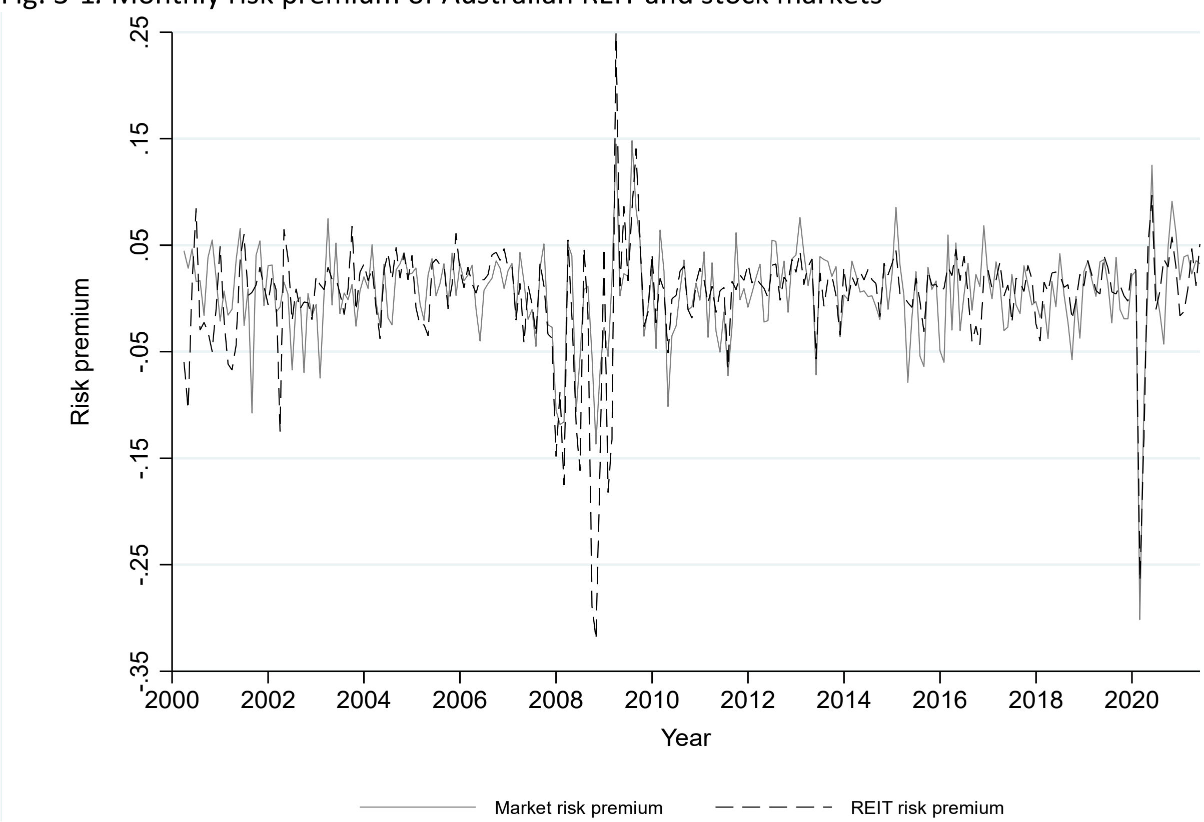
Author & Year	**Model**	**Notes**	**Data periods**	**Country**
Hamilton (1988)	Develops regime-switch model	Term-structure of interest rates holds when considering regime changes	1962–1987	US
Satchell and Lizieri (1997)	Threshold Autoregressive model	High and low interest rate regimes exist based on a one-month lag; regime-switching models are more robust to changes in the correlation between prices and real interest rates	1975–1995	UK
Sa - Aadu et al. (2010)	Hamilton regime-switch; Hansen and Jagannathan (1991) Volatility Bound	Investigate portfolio properties of real estate in different market conditions	1972–2008	US
Chang et al. (2011)	Three-variate time-varing SVAR(p), impulse response function	Comparing REITs, housing and stocks	1975–2008	US
Case et al. (2014)	Multivariate Markov switching, ARCH, GARCH	Apply Markov switching to REITs, stocks and bonds to study the joint returns of these assets	1972–2009	US
Gupta et al. (2019)	Change-point vector autoregressive (VAR) model	Overly relied on monetary policy to correct REIT bubbles and should notice aggregate supply shocks	1972–2016	US
Benigno et al. (2020)	Workhorse Markov-switching dynamic stochastic general equilibrium (DSGE)	To model the occasionally binding borrowing constraint as engodgenous regime-switching process, as opposed to the non-binding regime	1980–2016	US
Demiralay and Kilincarslan (2022)	Non-linear Markov regime-switching model	REIT returns are sector-dependent and sector-dependent	1990–2020	US
Mensi et al. (2022)	Follows Diebold and Yılmaz (2014), Markov-switching VAR	Price-switching spillovers are time-varying, REITs are net contributors in high-volatility regime compared to gold and oil	2016–2022	Asia-Pacific, Europe, UK, US

3.3 Data and methodology

3.3.1 Data

This chapter uses the same financial and returns data from SP CIQ Pro as in Chapter 2 from 3 April 2000 to 30 June 2021. To consider the regime changes in pricing models for Australian stock and REIT markets, the regime probabilities over time are examined first. As shown in Figure 3-1, there are high volatility periods in 2007 to 2009 and in 2020. It would be realistic to assume that the variance in this high volatility state differs from the variance in the low volatility state.

Fig. 3-1. Monthly risk premium of Australian REIT and stock markets



Note: Monthly returns are the log difference of the monthly averages of Total Return Index values, then minus RBA cash rate to calculate risk premium. Market risk premium uses the natural log differences of the monthly average values of the S&P/ASX-200 Financials-ex-A-REIT Total Return Index. RBA cash rate is the risk-free rate proxy.

The S&P/ASX-200-Financials-ex-AREIT Total Return Index is the proxy for Australian stock market regimes. The log difference of this monthly return index series is used, and the RBA cash rate is subtracted to derive the market risk premium. A time series of average monthly risk premium of REITs from 2000 to 2021 is used for determining A-REIT regimes. First, I calculate daily returns of each REIT using the log difference of the REIT Total Return Index, and minus the RBA cash rate to get the REIT daily risk premium. Then I calculate the simple average of the sum of daily risk premium of each REIT in each month to compute the average monthly risk premium for the overall A-REIT market.

A monthly return times series is calculated due to the unavailability of the S&P/ASX-200-AREIT Total Return Index from 2016 to 2021. Another factor is that REIT monthly returns exhibit greater stability, making them more suitable for a regime-switching model. This stability allows the model to identify consistent regimes over extended periods, contributing to a more reliable and meaningful outcome, as opposed to frequent switching between regimes over a short span of days.

3.3.2 Methodology

3.3.2.1 Markov-switching dynamic regression models

The Markov-switching dynamic regressions model is a statistical model that is used to analyse the behaviour of a time series that may switch between different regimes. A Markov-switching dynamic regression (MSDR) is performed with switching variances in each state with 20 iterations with a switching variable of lagged stock market index, for two-regime and three-regime switching scenarios. This method enables fast adjustment after a change in state, and is often applied on monthly or daily data (StataCorp, 2021). Based on these regressions, probabilities of each state at a given time are predicted for each scenario.

The specification of the MSDR model is:

$$R_t = \mu_G + \alpha u_t + \beta_G v_t + \epsilon_G \tag{3-1}$$

where R_t is the dependent variable, μ_G is the regime-dependent intercept in regime $G(j), j = 0,1,\ldots,j$. u_t and v_t are vectors of exogenous variables that may include lags of R_t, α is constant across regimes, β_G changes across regimes, and ϵ_G is an i.i.d. error that follows a normal distribution, $\epsilon_G \sim N[0, \sigma_G^2]$. For each $j = 0,1,\ldots,j$ in $G(j)$, there is a corresponding volatility σ_n, which defines the volatility of R_t in regime j.

Based on Hamilton (1994) these regimes are produced by an aperiodic, irreducible and ergodic first-order Markov chain:

$$\text{Prob}\;(G_t = j|\{G_j\}_{j=1}^{t-1}, \{y_j\}_{j=1}^{t-1}) = \text{Prob}(G_t = j|G_{t-1} = i) = p_{ij}$$

(3-2)

where p_{ij} is the generic $[i,j]$ element of the $\mathrm{i} \times \mathrm{j}$ transition matrix $S, i = j$. S determines the evolution of the Markov chain:

$$S = \begin{pmatrix} p_{11} & \cdots & p_{i1} \\ p_{12} & \cdots & p_{i2} \\ \vdots & \ddots & \vdots \\ p_{1j} & \cdots & p_{ij} \end{pmatrix}$$

(3-3)

in which, for $j = 2$ in regime $G(j)$:

$$P[G_t = 1|G_{t-1} = 1] = p_{11}, P[G_t = 2|G_{t-1} = 1] = p_{12} = 1 - p_{11},$$

$$P[G_t = 1|G_{t-1} = 2] = p_{21}, P[G_t = 2|G_{t-1} = 2] = p_{22} = 1 - p_{21;}$$

(3-4)

for $j = 3$ in regime $G(j)$,

$$P[G_t = 1|G_{t-1} = 1] = p_{11}, P[G_t = 2|G_{t-1} = 1] = p_{12}, P[G_t = 3|G_{t-1} = 1] = p_{13} = 1 - p_{11} - p_{12},$$

$$P[G_t = 1|G_{t-1} = 2] = p_{21}, P[G_t = 2|G_{t-1} = 2] = p_{22}, P[G_t = 3|G_{t-1} = 2] = p_{23} = 1 - p_{21} - p_{22},$$

$$P[G_t = 1|G_{t-1} = 3] = p_{31}, P[G_t = 2|G_{t-1} = 3] = p_{32}, P[G_t = 3|G_{t-1} = 3] = p_{33} = 1 - p_{31} - p_{32},$$

(3-5)

where p_{12} denotes the transition probability to regime 2 at t $(G_t = 2)$, given that the market was in regime 1 at $t-1$ $(G_{t-1} = 1)$. p_{11}, p_{22}, p_{33} represent the situation that the market stays in the same regime from $t-1$ to t. Therefore, every row in equation (3-3) should sum up to 1.

Ergodicity suggests the existence of a stationary vector of state probabilities τ that obey $\tau = S'\tau$. Irreducibility suggests that $\bar{\xi} > 0$, which means that all unobservable states are possible. S is unknown and unobserved in reality, $\bar{\xi}$ therefore can be estimated with knowledge on S given by the information set.

As suggested by Demiralay and Kilincarslan (2022), the expected duration of each regime can be obtained from the transition probabilities:

$$E(D_{nn}) = 1/1 - p_{ij}$$

(3-6)

in which $E(D_{nn})$ presents the expected duration of the regime when $P[G_t = j|G_{t-1} = i] = p_{ij}$, p_{ij} denotes the probability of when the market continues to be in the same regime from $t-1$ to t.

3.3.2.2 Smoothed probabilities

Regime-switching models gain enhanced accuracy and utility by employing smoothed probabilities to filter out data noise, uncover underlying trends, and pinpoint periods of varying return volatility. As Zhu et al. (2017) emphasise, an effective Markov regime-switching model should accurately differentiate between regimes and produce reliable smoothed probabilities. Consider $\tau_{t|T}$, in which $t < T$ represents the vector of conditional probabilities $\text{Prob}\,(G_t = j|\{G_j\}_{j=1}^{t-1}, \{y_j\}_{j=1}^{t-1})$. The smoothed probabilities are calculated with the following algorithm (Kim, 1994) by iterating from $t = T-1, T-2, \ldots, 1$:

$$\tau_{t|T} = \tau_{t|t} \circledcirc \left\{S'\left(\tau_{t+1|T}(\Gamma)\tau_{t+1|t}\right)\right\} \tag{3-7}$$

where (Γ) denotes element-by-element division. The estimates of p_{ij} are displayed in the results section. The process of tackling the complications from $\sum_{j=1}^{s} p_{ij} = 1$ by approximating functions of p_{ij} and standardising p_{is} for $j \in \{1,2,\cdots,s-1\}$ is written as:

$$p_{ij} = \frac{\exp\,(-\eta_{ij})}{1 + \exp(-\eta_{i1}) + \exp(-\eta_{i2}) + \cdots + \exp\,(-\eta_{i,s-1})} \tag{3-8}$$

$$p_{is} = \frac{1}{1 + \exp(-\eta_{i1}) + \exp(-\eta_{i2}) + \cdots + \exp\,(-\eta_{i,s-1})}$$

(3-9)

Then, Schwarz's Bayesian information criterion (SBIC) values from the model results are used as the criteria to choose between the two-regime and three-regime models. Lower SBIC values indicate a better trade-off between model fit and model complexity (Schwarz, 1978). Therefore, a lower SBIC is preferred because it suggests a model that provides a good fit to the data while keeping the number of parameters in check. By selecting the model with the lowest SBIC among a set of candidate models, it is possible to find the model that best explains A-REIT performance while avoiding unnecessary complexity. This helps to reduce the risk of overfitting and improves the generalisability of the model to unseen data.

3.3.2.3 Pooled regressions with regime dummy variables

Based on the previous stock market regime analysis using the major stock market index as the regime definition, I run the following pooled regressions for REITs:

$$\begin{aligned} R_{i,t} - R_{f,t} = {} & \alpha_i + \beta_1 * Risk\ premium_{m,t} + \beta_2 * Spe_i + \beta_3 * Spe_i * Risk\ premium_t \\ & + \beta_4 * Regime_{i,t} + \beta_5 * Risk\ premium_{m,t} * Regime_{i,t} \\ & + \beta_6 * Spe_i * Regime_{i,t} + \beta_7 * Spe_i * Risk\ premium_{m,t} * Regime_{i,t} + \epsilon_{i,t} \end{aligned}$$

(3-10)

in which $REIT\ Risk\ premium_{i,t} = R_{i,t} - R_{f,t}$ is the risk premium for REITs, $Risk\ premium_{m,t}$ is the market risk premium, $Regime_{\mathrm{i},t}$ is a categorical variable indicating the market regime status based on the estimated regime probabilities of stock market, with the normal regime as the base category. There is one regime dummy variable in pooled regression for two-regime scenario, depicting normal and crisis regimes. There are two regime dummy variables for three-regime scenario, differentiating normal and not normal regimes, then crisis and boom regimes. $\beta_4, \beta_5, \beta_6$ and β_7 are vectors of regime coefficients. I test two regime scenarios, one is for the two-regime analysis (normal and crisis) and another is a three-regime analysis (normal, crisis, and boom).Spe_i is the dummy variable for specialised, $\varepsilon_{i,t}$ is the residual term.

After analysing the performance of A-REITs under the framework of regime switching, Fama-French size and value factors are included to further analyse the impact of these factors:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_1 * Risk\ premium_{m,t} + \beta_2 * Spe_i + \beta_3 * Spe_i * Risk\ premium_{m,t} + \beta_4 * SMB_t$$
$$+\beta_5 * HML_t + \beta_6 * Regime_{i,t} + \beta_7 * Risk\ premium_{m,t} * Regime_{i,t} + \beta_8 * Spe_i * Regime_{i,t}$$
$$+\beta_9 * Regime_{i,t} * SMB_t + \beta_{10} * Regime_{i,t} * HML_t + \beta_{11} * Regime_{i,t} * Spe_i * Risk\ premium_{m,t} + \epsilon_{i,t}$$

(3-11)

in which $Regime_{i,t} * SMB_t$ depicts the influence of the size factor in each regime, $Regime_{i,t} * HML_t$ depicts the influence of the value factor in each regime. For the two-regime scenario, $Regime_{i,t} = 1$ means crisis regime. In this case, $(\beta_4 + \beta_9)$ is the coefficient of the size factor, $(\beta_5 + \beta_{10})$ is the coefficient of the value factor, $(\beta_3 + \beta_{11})$ is the coefficient of the interaction term between Spe_i and market risk premium in the crisis regime.

3.4 Results

3.4.1 Regime probabilities and choice of regime

To address research question 2 outlined in section 1.4 regarding the behaviour of REIT beta under evolving market conditions, Markov regime-switching models are estimated under the assumptions of two and three volatility regimes separately. To identify the regimes, the sigma coefficients that represent volatility estimates as defined by standard deviation are used for each regime. Specifically, a high value of sigma implies a high volatility regime, and a low value of sigma implies a low volatility regime. Typically, a high volatility regime depicts crisis periods, whereas a low volatility regime characterises normal or boom market periods. The results are as follows.

This section presents the results of the analysis of Markov-switching dynamic regressions for the Australian real estate investment trust (A-REIT) market. These results provide the foundation for further analysis when the A-REIT market is divided into different types of REITs in the following section.

Table 3-2 documents the MSDR results comparing two-regime and three-regime scenarios of Australian stock and A-REIT markets. Columns (1) and (2) display the results with market risk premium as the dependent variable, considering a one period lag of market risk premium. Columns (3) and (4) illustrate results using REIT risk premium as the dependent variable, considering the impact of current period market risk premium. The two-regime model is favoured over the three-regime model because the two-regime model has a lower SBIC value.

Table 3-2. MSDR of market and A-REIT risk premiums with switching variances

Dependent variable:	**(1)** $\boldsymbol{Risk\ premium_{m,t}}$	**(2)** $\boldsymbol{Risk\ premium_{m,t}}$		**(3)** $\boldsymbol{REIT\ risk\ premium_{t}}$	**(4)** $\boldsymbol{REIT\ risk\ premium_{t}}$
Panel A: Normal regime					
$Risk\ premium_{m,t-1}$	0.095 (0.072)	0.001 (0.000)	$Risk\ premium_{m,t}$	0.355*** (0.041)	0.278*** (0.066)
Constant	0.008* (0.003)	0.017*** (0.003)	*Constant*	0.010*** (0.002)	0.015*** (0.002)
Panel B: Crisis regime					
$Risk\ premium_{m,t-1}$	0.282 (0.152)	0.741 (0.545)	$Risk\ premium_{m,t}$	1.097*** (0.134)	1.324*** (0.205)
Constant	-0.010 (0.012)	-0.022 (0.021)	*Constant*	-0.030** (0.010)	-0.035** (0.012)
Panel C: Boom regime					
$Risk\ premium_{m,t-1}$		0.348*** (0.068)	$Risk\ premium_{m,t}$		0.811*** (0.078)
Constant		-0.015* (0.001)	*Constant*		-0.009 (0.012)
Observations	254	254		254	254
SBIC	-3.494	-3.389		-4.191	-4.175
Number of REITs				35	35

*Note: The stock market regimes are based on the market risk premium, considering switching variances. The A-REIT market regimes are based on the market risk premium, considering switching variances. REIT risk premium is the averages of log difference of each REIT's Total Return Index and the RBA cash rate. Market risk premium is based on the log difference of S&P/ASX-200-Financials-ex-A-REIT Total Return Index and RBA cash rate. SBIC value is reported as R-squared is not in the output of MSDR. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

Columns (1) and (2) in Table 3-2 show that when taking into consideration switching variances of the market, the autocorrelation effect of time series market data becomes less of a concern in two-regime analysis. The results of the two-regime model in Column (1) indicate that the regime-dependent constants affect the market risk premium in the normal regime as the constant is large (0.75%) and significant in Panel A, but the coefficients of lagged market risk premium are not significant in Panels A and B. Column (1) shows the results for the two-regime model. The coefficient of the lagged market risk premium in the crisis regime (28.2%) is two times higher than in a normal regime (9.5%), although the lagged market risk premium has no statistically significant impact on the market risk premium in both the normal and crisis regimes. Column (2) displays the results for the three-regime model. In Panel C, the lagged market risk premium affects the market risk premium in the boom regime as the constant is large and significant in the boom regime, but the coefficients of lagged market risk premium are insignificant in other regimes.

After checking the market risk premium in different regimes, it is important to investigate the impact of stock market regime on A-REITs. This study uses stock market risk premium to identify the turning points of A-REIT risk premium employing the Markov-switching models. Columns (3) and (4) in Table 3-2 present the MSDR results of REIT risk premium with switching impacts from the stock market risk premium. Comparing the two regimes in Column (3), the normal period market risk premium (1.097%) has three times the impact on average REIT returns during a crisis regime as in the normal regime (35.5%). This finding confirms the result of subperiod analysis in Chapter 2 Section 2.5.2. The volatility of market risk premium in the crisis regime amounts to three times the volatility in a normal period. Therefore, combining the volatility rise and the increase in magnifying impact from market risk premium, average REIT returns are more volatile than the stock market in general, during crisis periods.

Despite the slightly lower SBIC value, which does not favour a higher number of regimes, the three-regime analysis provides a sense of how increasing the number of regimes affects the results of the analysis. It is worth noting that when adding a boom regime into consideration in Table 3-2 Column (4), the coefficient of the market risk premium in the boom regime (81.1%) is three times the value in the normal regime. The coefficient 0.811 is smaller than 1, indicating that in booming stages of the stock market, A-REITs co-move with the general stock market but to a lesser extent. The standard deviation of A-REIT beta in the boom regime is 0.078. This is slightly higher than the value of 0.066 in the normal regime, but not as high as the value of 0.205 in the crisis regime. The results of this analysis suggest that the returns of A-REITs are more volatile in the boom and crisis regimes than in the normal regime. This is likely because the boom and crisis regimes are characterised by more extreme events, such as rapid increases or decreases in asset prices.

The results of the analysis in this section indicate that the A-REIT market can be divided into two regimes: a normal regime and a crisis regime. The normal regime is characterised by higher returns and lower standard deviation, while the crisis regime is characterised by lower returns and higher standard deviation. The findings of this section provide a valuable foundation for further analysis of the A-REIT market. In the following section, the A-REIT market is divided into different types of REITs in order to assess how the different types of REITs have performed in different regimes. The findings of this analysis have implications for investors who are considering investing in A-REITs. Investors should be aware that the returns of A-REITs are more volatile in the boom and crisis regimes, and they should adjust their investment strategies accordingly.

Table 3-3 reports the regime persistence for the two-regime and three-regime Markov-switching process for the stock market based on Columns (1) and (2) in Table 3-2. It clearly shows the existence of two volatility regimes in the stock market. In Table 3-3 Panel A, both regimes in the two-regime model are highly persistent with posterior probabilities of 90.2% and 97.9%. The crisis regime has high volatility (sigma) while the normal regime has lower volatility with values of 0.077 and 0.031, respectively. The expected duration is 47.8 months for the normal regime and 10.16 months for the crisis regime.

Table 3-3. Matrix of regime-switch probabilities of monthly stock market risk premium

State	**1 (normal)**	**2 (crisis)**	**3 (boom)**	**Sigma**	**Expected duration estimate (months)**
Panel A: Two-regime					
1 (normal)	0.979	0.021	-	0.031	47.80
2 (crisis)	0.092	0.902	-	0.077	10.16
Panel B: Three-regime					
1 (normal)	0.448	0.160	0.392	0.024	1.81
2 (crisis)	0.000	0.116	0.884	0.093	1.13
3 (boom)	0.987	0.013	0.000	0.033	1.00

Note: The stock market regimes are based on the market risk premium, considering switching variances. The numbers are based on the results of columns (1) and (2) in Table 3-2.

Panel B in Table 3-3 shows the three-regime model results. The three regimes with different volatility levels (sigma) can be interpreted as representing normal, crisis and boom stock market regimes. The crisis regime has higher volatility of 0.093 than the value in Panel A (0.077). The boom regime is persistent in maintaining the same boom regime with posterior probabilities of 98.7%. In contrast, the normal regime and crisis regime have lower probabilities of staying in the same regime with values of 44.8% and 11.6% respectively. The sigma value is 0.024 for the normal regime, 0.093 for the crisis regime, and 0.033 for the boom regime. The expected durations of the normal, crisis and boom regimes are 1.81 month, 1.13 month and 1 month, respectively.

Table 3-4 reports the regime probabilities for the two-regime and three-regime Markov-switching process for the REIT market based on Columns (3) and (4) in Table 3-2. It distinctly shows the presence of two volatility regimes in the A-REIT market.

Table 3-4. Matrix of regime-switch probabilities of monthly A-REIT market risk premium

State	**1 (normal)**	**2 (crisis)**	**3 (boom)**	**Sigma**	**Expected duration estimate (months)**
Panel A: Two-regime					
1 (normal)	0.973	0.027	-	0.019	37.18
2 (crisis)	0.098	0.902	-	0.070	10.25
Panel B: Three-regime					
1 (normal)	0.872	0.004	0.124	0.015	1.54
2 (crisis)	0.047	0.936	0.017	0.073	9.21
3 (boom)	0.317	0.045	0.638	0.025	8.04

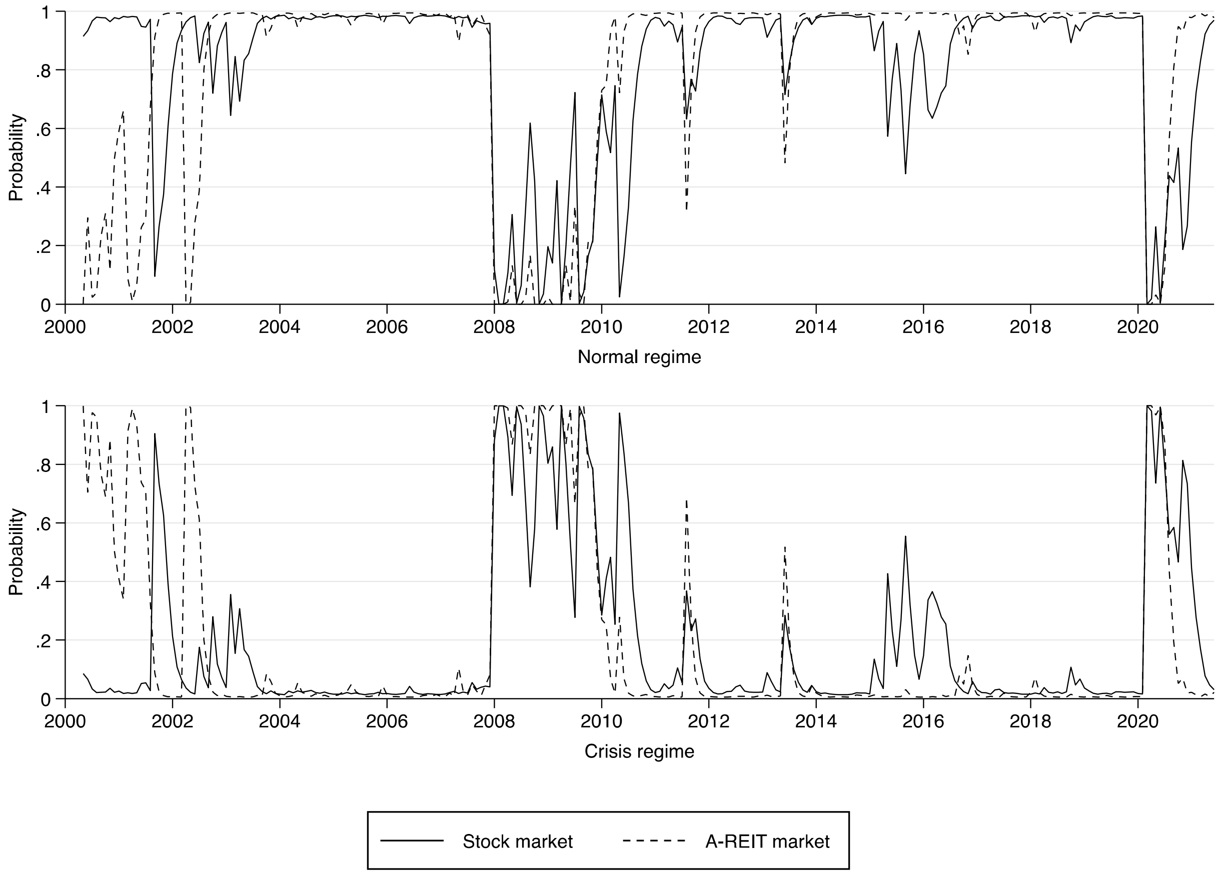
Note: The A-REIT market regimes are based on the REIT risk premium, considering switching variances. The numbers are based on the results of columns (3) and (4) in Table 3-2.

According to the two-regime model presented in Panel A of Table 3-4, the probability of remaining in the crisis regime is 90.2% once the crisis has begun. Given a normal regime in the current month, the probability of remaining in a normal regime for the following month is 97.3%. The probability of transitioning from the normal regime to the crisis regime is 2.7%, while the probability of shifting from the crisis regime to the normal regime is 9.8%. The sigma in the normal regime for A-REITs is 0.019, 39% lower than that of the stock market in the two-regime scenario (0.031). Conversely, the sigma in the crisis regime for A-REITs is 0.070, 10% lower than that of the stock market (0.077). This means A-REITs are less volatile than stocks during normal regimes.

Panel B of Table 3-4 reveals that both the normal and crisis regimes exhibit a strong tendency to persist, with probabilities of 87.2% and 93.6%, respectively. The boom regime exhibits a high probability of persistence (63.8%) and a lower probability of transitioning to the normal regime (31.7%). The expected durations for the normal and crisis regimes in A-REITs are similar to those of the stock market, at 37.18 months and 10.25 months, respectively. The expected duration for the normal regime in A-REITs is 10 months shorter than that of the stock market. The sigma value for the crisis regime of A-REITs (0.073) is 21.5% lower than that of the stock market (0.093), and the sigma values for the normal (0.15) and boom (0.025) regimes are 37.5% lower and 24.2% lower, respectively. This implies higher volatility of A-REITs during a crisis regime compared to the normal regime of the A-REIT market. The expected duration for the normal regime in A-REITs is 1.54 months, slightly shorter than that of the stock market. The durations for the crisis and boom regimes in A-REITs are 9.21 and 8.04 months, respectively, both significantly longer by at least 7 months compared to the corresponding regimes in the stock market. This suggests A-REITs stay in crisis and boom regimes longer than the stock market does.

Figure 3-2 displays the probabilities of the Australian stock market and REIT market for the two-regime model. Overall, the A-REIT market aligns with the stock market as the A-REIT market line follows the stock market line. The A-REIT market was under development and displayed poor continuity in the duration of each regime in the early 2000s. Therefore, it is better to use the more stable stock market regimes for analysis. The GFC period from 2008 to 2010 and the COVID-19 pandemic period from 2020 to 2021 are defined as a crisis regime. The outbreak of the COVID-19 pandemic has switched both the stock market and A-REIT market from a stable to a volatile regime. The results indicate that the probability of the A-REIT market being in the normal regime has increased in recent years. This suggests that the A-REIT market is becoming more mature and stable.

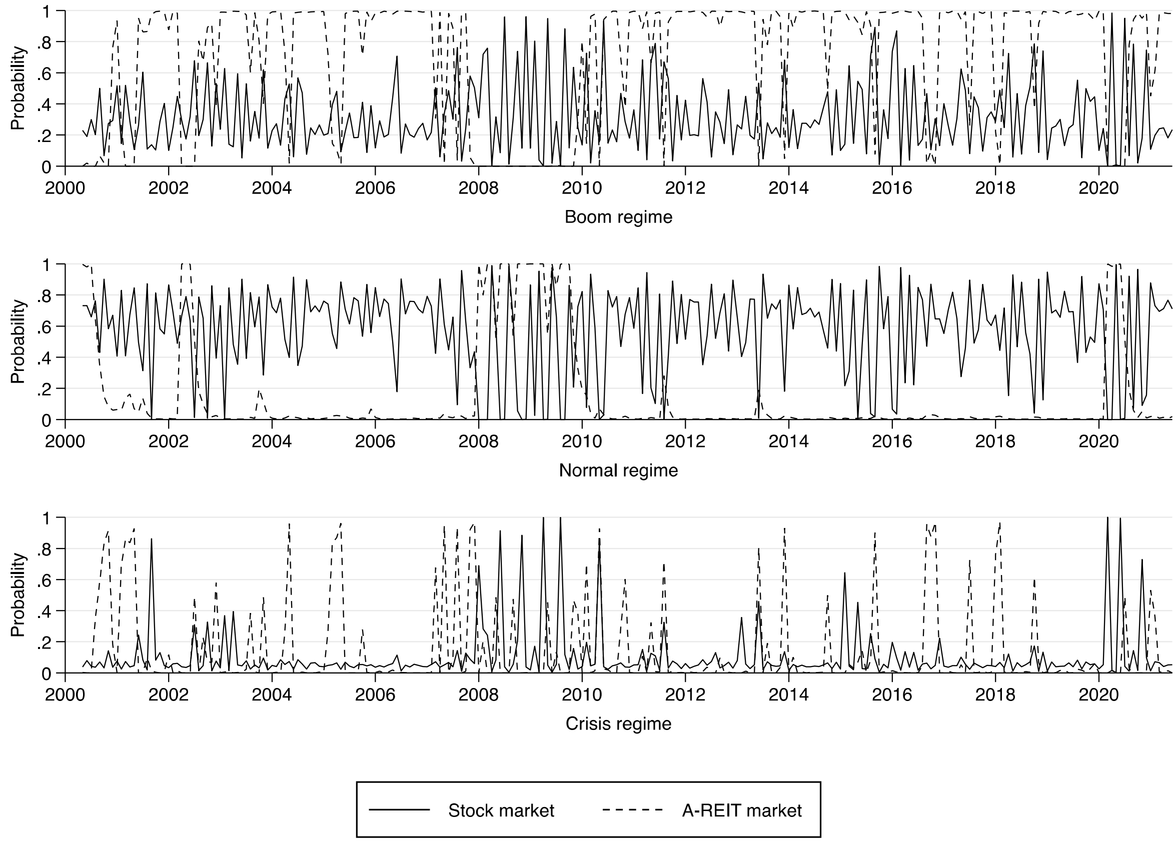
Fig. 3-2. Two-regime distribution of Australian stock and REIT market risk premium



Note: The stock market regimes are based on the market risk premium, considering switching variances. The A-REIT market regimes are based on the calculated return premium, considering switching variances.

Figure 3-3 presents the regime-probabilities for the three-regime model of the Australian stock market and REIT market. The difference between regimes is defined by the variance of each risk premium (sigma) in Tables 3-2 and 3-3. According to data from FRED (2022), the 2001 crisis lasted for five months, while the Global Financial Crisis spanned 38 months, both of which correspond closely to the durations observed in Figure 3-2.

Fig. 3-3. Three-regime distribution of Australian stock and REIT market risk premium



Note: The stock market regimes are based on the market risk premium, considering switching variances. The A-REIT market regimes are based on the calculated return premium, considering switching variances.

As shown in Figure 3-3, for the stock market, the three regimes have less evident differences in terms of probability distribution from 2008 to 2010, and the expected duration of each regime is shorter and less stable in the three-regime distribution. For the A-REIT market, the normal and boom regimes are not clearly separated with sharp probabilities. Therefore, a two-regime analysis is more suitable for Australia. Further, the rationale is that A-REITs as listed stocks are subject to the impacts of the stock market in the short-term as previously found in literature. To examine the performance of A-REITs with respect to the regimes of the stock market, this thesis uses the regime of the returns of the S&P/ASX-200-Financials-ex-REIT Total Return Index.

3.4.2 Pooled regressions

The MSDR analysis in section 3.4.1 presents the regime-switching analysis using a simple average of all REIT returns, which does not provide insights into the cross-sectional understanding of regime-dependent beta. Therefore, pooled regression is performed with dummy variables of different regimes for further examination of REIT beta in different regimes. The results are depicted in Table 3-5.

In Column (1) of Table 3-5, the default regime is the normal regime, the interaction term between the specialised dummy variable and market risk premium is significant (-11.0%), suggesting that specialised REITs carry lower risks than diversified REITs. In the crisis regime in Column (1), the coefficient of the dummy variable $Crisis\ regime_t$ is significant and negative (-1.9%), indicating that REIT monthly returns are 1.9% lower during crises times regardless of the focus of investment property type (specialised or diversified). The interaction term $Crisis\ regime_t * Market\ risk\ premium_t$ measures the beta, which is significant during the crisis regime with a high value[10] of 1.05. This implies higher systematic risk of REIT performance during the crisis periods of the Australian stock market. Therefore, return is lower but risk is higher during a crisis for all A-REITs.

[10] 0.383+0.669, the sum of coefficients for market risk premium

Table 3-5. One-factor pooled regressions with stock market regimes

	(1) **Two regimes**	(2) **Three regimes**
Dependent variable: REIT $risk\ premium_{i,t}$		
Panel A: Normal regime		
$Risk\ premium_{m,t}$	0.383***	0.349***
	(0.042)	(0.046)
Spe_i *(yes=1; no=0)*	0.005	0.005
	(0.003)	(0.005)
$Spe_i * Risk\ premium_{m,t}$	-0.110*	-0.127*
	(0.039)	(0.054)
Panel B: Crisis regime		
$Crisis\ regime_t$	-0.019***	-0.028**
	(0.003)	(0.010)
$Crisis\ regime_t * Risk\ premium_{m,t}$	0.669***	0.617***
	(0.074)	(0.086)
$Crisis\ regime_t * Spe_i$	0.002	0.005
	(0.007)	(0.011)
$Crisis\ regime_t * Spe_i * Risk\ premium_{m,t}$	0.029	0.081
	(0.120)	(0.118)
Panel C: Boom regime		
$Boom\ regime_t$		0.007
		(0.005)
$Boom\ regime_t * Risk\ premium_{m,t}$		0.727***
		(0.141)
$Boom\ regime_t * Spe_i$		-0.003
		(0.007)
$Boom\ regime_t * Spe_i * Risk\ premium_{m,t}$		-0.078
		(0.195)
Constant	0.006	0.007
	(0.003)	(0.005)
Observations	5,011	5,011
R-squared	0.291	0.268
Number of REITs	35	35
SE Clustered by firm	Y	Y

Note: The stock market regimes are based on the market risk premium, considering switching variances. REIT risk premium is based on the log difference of each REIT's Total Return Index and RBA cash rate. Market risk premium is based on the log difference of S&P/ASX-200-Financials-ex-A-REIT Total Return Index and RBA cash rate. Spe_i *is the dummy variable that classifies A-REITs into two groups based on asset focus, which equals 1 for specialised REITs and 0 otherwise. Regime dummy variables include Boom regime and Crisis regime, which equals 1 if true and 0 otherwise, the base group is normal regime. Overall R-squared is reported. Standard error in parentheses.*
** p<0.05, ** p<0.01, *** p<0.001.*

The coefficient of the interaction term between crisis regime and the specialised dummy in Table 3-5 Column (1) is positive but insignificant with a value of 0.2%, suggesting that specialised fund returns are not much different from returns of diversified funds. These two types of funds offer similar returns during crisis. The three-way interaction term is positive but insignificant with a value of 2.9%, implying that specialised REITs carry higher risks than diversified REITs in a crisis regime. Overall, the two types of funds perform similarly during a crisis period. Diversified funds do not provide additional diversification benefit, but specialised funds outperform diversified funds during normal periods, which supports the previous finding.

As shown in Panel B in Table 3-5, Column (2), specialised REITs carry higher risks than diversified REITs in the crisis regime, compared to the normal regime in Panel A. The coefficient of the interaction term between regime and risk premium is significant and negative (-2.8%), indicating that REITs have 2.8% lower returns and carry 61.7% higher risks in the crisis regime. This suggests that specialised REITs are more exposed to risk than diversified REITs in times of crisis. On the other hand, in the boom regime in Panel C, REITs have similar returns as in the normal regime, with a small and insignificant difference of 0.7%, but carry 72.7% higher risks. The coefficient of the three-way interaction term is insignificant and positive, indicating that specialised REITs carry lower risks than diversified REITs in the boom regime. This suggests that specialised REITs are less exposed to risk than diversified REITs in times of economic prosperity.

After investigating how the stock market regimes affect REIT returns, it is also important to look at whether REITs perform differently in A-REIT market regimes. Table 3-6 presents the pooled regression results with A-REIT market regimes. Panels A and B in Column (1) of Table 3-6 denote that specialised REITs lose their diversification benefit during crisis as the beta changes from 0.287 (=0.409–0.122) to 1.375 (=0.409+0.805+0.161). Panel B in Column (1) of Table 3-6 illustrates that, during crisis regimes in the A-REIT market, A-REITs exhibit statistically significant lower returns (-0.001).

In Column (2) of Panel A in Table 3-6, specialised REITs have a similar beta value (0.282) in the normal regime, as compared to Column (1) Panel A. However, the diversification benefit of REITs during normal regimes becomes insignificant (15.1%) under the three-regime scenario. As demonstrated in Panel C of Column (2), A-REITs realise statistically significant higher returns (0.001) during boom regimes in the A-REIT market. Panel B in Column (2) of Table 3-6 depicts that specialised REITs have higher beta of 1.405 (=0.433+0.782+0.190) during crises. Panel C in Column (2) indicates that specialised REITs have a beta of 0.375 (0.433–0.058+0.043) during a boom regime.

Table 3-6. One-factor pooled regressions with A-REIT market regimes

	(1) **Two regimes**	(2) **Three regimes**
Dependent variable: REIT $risk\ premium_{i,t}$		
Panel A: Normal regime		
$Risk\ premium_{m,t}$	0.409*** (0.045)	0.433*** (0.086)
Spe_i *(yes=1; no=0)*	0.001 (0.000)	-0.000 (0.000)
$Spe_i * Risk\ premium_{m,t}$	-0.122* (0.057)	-0.151 (0.145)
Panel B: Crisis regime		
$Crisis\ regime_t$	-0.001*** (0.000)	-0.000 (0.000)
$Crisis\ regime_t * Risk\ premium_{m,t}$	0.805*** (0.099)	0.782*** (0.102)
$Crisis\ regime_t * Spe_i$	0.000 (0.000)	0.000 (0.000)
$Crisis\ regime_t * Spe_i * Risk\ premium_{m,t}$	0.161 (0.152)	0.190 (0.171)
Panel C: Boom regime		
$Boom\ regime_t$		0.001*** (0.000)
$Boom\ regime_t * Risk\ premium_{m,t}$		-0.058 (0.096)
$Boom\ regime_t * Spe_i$		0.000 (0.000)
$Boom\ regime_t * Spe_i * Risk\ premium_{m,t}$		0.043 (0.141)
Constant	0.000*** (0.000)	-0.001*** (0.000)
Observations	4,835	4,835
R-squared	0.268	0.279
Number of REITs	35	35
SE Clustered by firm	Y	Y

*Note: Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001. Data source: Standard & Poor's Capital IQ Pro, from 3 April 2000 to 30 June 2021.The A-REIT market regimes are based on the market risk premium, considering switching variances. REIT risk premium is based on the log difference of each REIT's Total Return Index and RBA cash rate. Market risk premium is based on the log difference of S&P/ASX-200-Financials-ex-A-REIT Total Return Index and RBA cash rate.* Spe_i *is the dummy variable that classifies A-REITs into two groups based on asset focus, which equals 1 for specialised REITs and 0 otherwise. Regime dummy variables include Boom regime and Crisis regime, which equals 1 if true and 0 otherwise, the base group is normal regime.*

Table 3-7 shows the results of a pooled regression with Fama-French factors included in the model. In Column (1) of Table 3-7, the coefficients of the interaction variables between specialised REITs and market risk premium are -12.2% for the normal regime and -13.3% for the crisis regime. The reason for insignificance could be the change of data frequency from daily to monthly, the small sample size of REITs due to data limitations of the A-REIT market, and overfitting. Despite the economic insignificance, specialised REITs bear lower systematic risk in the normal regime.

As depicted in Panel B of Table 3-7 Column (1), the coefficient of the size factor for the crisis regime is negative and statistically significant (-18.1%) when considering separating the normal and crisis regimes. This is in line with previous research, where firms with larger size (market capitalisation) earn higher returns. The value factor is negative and insignificant in the normal regime (-8.9%), whereas it is strongly significant in the crisis regime (69.0%). A positive value factor means that a stock has a low book-to-market ratio. These results imply that A-REITs that are undervalued relative to their book value perform better than overvalued ones in a crisis regime. Adding a boom regime to the model leads to multicollinearity and is therefore excluded in this table.

Table 3-7. Three-factor pooled regressions with stock market regimes

	(1) Two regimes	**(2) Three regimes**
Dependent variable: REIT $risk\ premium_{i,t}$		
Panel A: Normal regime		
$Risk\ premium_{m,t}$	0.331***	0.430***
	(0.050)	(0.074)
Spe_i *(yes=1; no=0)*	0.0002	0.0002
	(0.000)	(0.000)
$Spe_i * Risk\ premium_{m,t}$	-0.122	-0.147
	(0.070)	(0.103)
SMB_t	-0.292**	-0.247*
	(0.099)	(0.098)
HML_t	-0.089	0.007
	(0.053)	(0.057)
Panel B: Crisis regime		
$Crisis\ regime_t$	0.001**	-0.001
	(0.000)	(0.000)
$Crisis\ regime_t * Risk\ premium_{m,t}$	0.416**	0.457***
	(0.133)	(0.100)
$Crisis\ regime_t * Spe_i$	0.002	-0.0001
	(0.007)	(0.001)
$Crisis\ regime_t * Spe_i * Risk\ premium_{m,t}$	-0.011	0.131
	(0.158)	(0.174)
$Crisis\ regime_t * SMB_t$	-0.181*	0.035*
	(0.073)	(0.133)
$Crisis\ regime_t * HML_t$	0.690***	0.241**
	(0.114)	(0.081)
Panel C: Boom regime		
$Boom\ regime_t$		0.001***
		(0.000)
$Boom\ regime_t * Risk\ premium_{m,t}$		0.168
		(0.097)
$Boom\ regime_t * Spe_i$		-0.0002
		(0.003)
$Boom\ regime_t * Spe_i * Risk\ premium_{m,t}$		-0.080
		(0.133)
$Boom\ regime_t * SMB_t$		-0.295*
		(0.073)
$Boom\ regime_t * HML_t$		0.777***
		(0.127)
Constant	0.000*	0.000*
	(0.000)	(0.000)

Observations	4,628	4,628
R-squared	0.348	0.318
Number of REITs	35	35
SE Clustered by firm	Y	Y

*Note: Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001. Data source: Standard & Poor's Capital IQ Pro, from 3 April 2000 to 30 June 2021. The A-REIT market regimes are based on the market risk premium, considering switching variances. REIT risk premium is based on the log difference of each REIT's Total Return Index and RBA cash rate. Market risk premium is based on the log difference of S&P/ASX-200-Financials-ex-A-REIT Total Return Index and RBA cash rate.* Spe_i *is the dummy variable that classifies A-REITs into two groups based on asset focus, which equals 1 for specialised REITs and 0 otherwise. Regime dummy variables include Boom regime and Crisis regime, which equals 1 if true and 0 otherwise, the base group is normal regime.*

There are a few reasons why undervalued stocks might have higher returns. One reason is that undervalued stocks are more likely to be bought by investors who are looking for value. These value investors are willing to pay a higher price for undervalued stocks because they believe that the stocks are worth more than their current price. Another reason why undervalued stocks might have higher returns is that they are more likely to experience positive earnings surprises. This is because undervalued stocks are often ignored by investors, which means that they are less likely to be priced in.

Column (2) in Table 3-7 displays the pooled regression results when considering boom regime. Panel A of Column (2) depicts the normal regime and shows that the coefficient of market risk premium is strongly significant (0.430), which is slightly higher than the value (0.331) in Panel A of Column (1). Compared to Column (1), the coefficient of specialised variable of normal regime in Column (2) remains the same at 0.0002 and insignificant. The coefficient of interaction term between specialisation dummy and market risk premium remains negative (-0.147). SMB is weakly significant with a similar value (-0.247) to Panel A of Column (1). HML is insignificant and has a small positive coefficient of 0.007.

Panel B of Column (2) in Table 3-8 exhibits the results in crisis regime. REIT beta is 0.457 higher in crisis regime than in normal regime as shown by the coefficient of the interaction variable between market risk premium and regime coefficient. The negative and small coefficient (-0.001) of specialised dummy suggests that specialised REITs do not earn higher return than diversified REITs during crisis. The positive coefficient of three-way interaction variable between specialised dummy and market risk premium within crisis regime (0.131) also confirms the higher risk of specialised REITs in crisis regime. SMB is weakly significant and positive (0.035) while HML is moderately significant (0.241). The coefficients of HML in Panel B of both Columns (1) and (2) are positive and significant, suggesting that the Fama-French value factor is important during crises.

Panel C in Column (2) of Table 3-7 depicts the boom regime results. Compared to normal regime, REITs are earning statistically significant 0.001 higher risk premium, and carry 0.168 higher risks. The coefficients for interaction variables between specialised dummy and boom regime dummy (-0.0002), between specialised dummy and market risk premium (-0.080) are all insignificant, the latter suggests that specialised REITs carry 8% lower risk in boom regime compared to normal regime. The SMB and HML factors in boom regime are statistically significant with coefficient values of -0.295 and 0.777. Comparing Columns (1) and (2), the HML factor plays a more important role outside of normal regime, which means that the risk premium difference between

REITs with high and low book-to-market ratios could explain REIT returns during crisis and boom regimes.

3.4.3 Robustness check

Chapter 2 found that the time series data exhibit autocorrelation in REIT and stock returns. Therefore, it is necessary to perform a robustness check of lagged variables in the Markov-switching models. The one-period lags of the average REIT risk premium and the market risk premium are considered in the robustness check of regime-switching models for both two-regime and three-regime scenarios. Section 3.5.1 takes into account the impact of the market risk premium on the REIT risk premium, as well as the influence of the one-period lag of the average REIT risk premium. Section 3.5.2 examines the importance of the one-period lag of the market risk premium on the REIT risk premium in models with different numbers of regimes.

3.4.3.1 Markov-switching dynamic regressions with lag of market risk premium

Table 3-8 shows that the one-month lag of the market risk premium does not have a statistically significant impact on the average REIT risk premium in all regimes and different regime models. The coefficients of the market risk premium remain strongly significant in all regimes, and the values in the crisis regime are about three times the size of those in the normal regime. This is consistent with the original findings, which did not include the one-month lag of the REIT risk premium, suggesting that the effect of the market risk premium on the average REIT risk premium is not sensitive to the inclusion of this lagged variable.

Table 3-8. MSDR of average A-REIT risk premium with lag of A-REIT market risk premium

	(1) **Two regimes**	**(2)** **Three regimes**
Dependent variable: $Average\ REIT\ risk\ premium_t$		
Panel A: Normal regime		
$Risk\ premium_{m,t}$	0.353***	0.243***
	(0.041)	(0.043)
$Risk\ premium_{m,t-1}$	0.0154	0.067
	(0.041)	(0.041)
Constant	0.010**	0.016**
	(0.002)	(0.002)
Panel B: Crisis regime		
$Risk\ premium_{m,t}$	1.062***	1.271***
	(0.141)	(0.229)
$Risk\ premium_{m,t-1}$	0.143	0.180
	(0.144)	(0.219)
Constant	-0.027**	-0.032**
	(0.010)	(0.012)
Panel C: Boom regime		
$Risk\ premium_{m,t}$		0.776***
		(0.067)
$Risk\ premium_{m,t-1}$		0.061
		(0.071)
Constant		-0.006
		(0.005)
Sigma 1	0.019	0.073
Sigma 2	0.068	0.019
Sigma 3		0.068
Observations	254	254
SBIC	-4.186	-4.116

*Note: Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001. Data source: Standard & Poor's Capital IQ Pro, from 3 April 2000 to 30 June 2021. The A-REIT market regimes are based on the stock market risk premium, considering switching variances. REIT risk premium is based on log difference of each REIT's Total Return Index and RBA cash rate. Market risk premium is based on the log difference of S&P/ASX-200-Financials-ex-A-REIT Total Return Index and RBA cash rate. Regime dummy variables include Boom regime and Crisis regime, which equals 1 if true and 0 otherwise, the base group is normal regime. SBIC value is reported as R-squared is not in the output of MSDR.*

3.4.3.2 Pooled regressions with A-REIT regimes

In this section, the regime-switch model is applied to further investigate if Fama-French factors with switching variances have impacts on REIT performance. As depicted in Table 3-9, the Fama-French factors are examined in different regimes.

Panel A of Column (1) in Table 3-9 denotes the normal regime of the A-REIT market in a two-regime scenario. The beta of specialised REITs and diversified REITs are 0.361 and 0.230 (=0.361–0.131), respectively. The size factor (-31.6%) is statistically significant, while the value factor (-10.0%) is insignificant in a normal regime. Panel B of Column (1) in Table 3-9 displays the crisis regime of the A-REIT market. The beta of specialised REITs increases to 0.750 (0.230+0.470+0.050), which is at a similar level as diversified REITs (0.700=0.230+0.470). This implies the disappearing diversification benefit of specialised REITs during crisis, which is consistent with previous analysis in Section 3.4.2. The size factor (-0.514=-0.316-0198) becomes weakly significant whereas the value factor (0.564=-0.1+0.664) is strongly significant in the crisis regime.

Table 3-9. Three-factor pooled regressions with A-REIT market regimes

	(1) Two regimes	(2) Three regimes
Dependent variable: $REIT\ risk\ premium_{i,t}$		
Panel A: Normal regime		
$Risk\ premium_{m,t}$	0.361***	0.378***
	(0.045)	(0.089)
Spe_i *(yes=1; no=0)*	0.000	0.000
	(0.000)	(0.000)
$Spe_i * Risk\ premium_{m,t}$	-0.131*	-0.148
	(0.061)	(0.142)
SMB_t	-0.316**	-0.205
	(0.101)	(0.161)
HML_t	-0.100	-0.304***
	(0.056)	(0.092)
Panel B: Crisis regime		
$Crisis\ regime_t$	0.000	0.002***
	(0.000)	(0.000)
$Crisis\ regime_t * Risk\ premium_{m,t}$	0.470***	0.454***
	(0.120)	(0.128)
$Crisis\ regime_t * Spe_i$	0.000	0.000
	(0.000)	(0.000)
$Crisis\ regime_t * Spe_i * Risk\ premium_{m,t}$	0.050	0.066
	(0.145)	(0.167)
$Crisis\ regime_t * SMB_t$	-0.198*	-0.312**
	(0.085)	(0.112)
$Crisis\ regime_t * HML_t$	0.664***	0.871***
	(0.108)	(0.143)
Panel C: Boom regime		
$Boom\ regime_t$		0.002***
		(0.000)
$Boom\ regime_t * Risk\ premium_{m,t}$		-0.055
		(0.095)
$Boom\ regime_t * Spe_i$		0.000
		(0.000)
$Boom\ regime_t * Spe_i * Risk\ premium_{m,t}$		0.034
		(0.137)
$Boom\ regime_t * SMB_t$		-0.139
		(0.121)
$Boom\ regime_t * HML_t$		0.276***
		(0.076)
Constant	0.000**	-0.001***
	(0.000)	(0.000)
Observations	4,628	4,628
R-squared	0.358	0.371
Number of REITs	35	35
SE Clustered by firm	Y	Y

*Note: The A-REIT market regimes are based on the REIT risk premium, considering switching variances. Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

Panel A of Column (2) in Table 3-9 reveals similar beta of specialised REITs (0.230=0.378–0.148) in the normal regime of the A-REIT market with consideration of three regimes. The size factor becomes insignificant (-20.5%), whereas the value factor is strongly significant (-30.4%). Specialised REITs carry higher risk in a crisis regime (0.750=0.230+0.454+0.066) and lower risk in a boom regime (0.209=0.230-0.055+0.034), compared to a normal regime. As indicated by the positive coefficients of the interaction term between the specialised dummy and REIT market risk premium in crisis (0.066) and boom (0.034) regimes, specialised REIT betas are higher than diversified REIT betas outside of the normal regime. The Fama-French value factor is statistically significant in both crisis and boom regimes in the three-regime model as illustrated in Column (2) of Panels B and C of Table 3-9, with values of 0.567 (=-0.304+0.871) and −0.028 (=-0.304+0.276), respectively.

Considering the findings in Columns (1) and (2) of Table 3-9, it is noteworthy to focus on the value factor’s dependence on regimes. Investors might observe variations in REIT returns across different regimes when making selections based on the value factor.

3.5 Summary

3.5.1 Economic impact

The analysis results provide essential insights and valuable implications for investors and asset managers in terms of regime identification and investment management. The pooled regression model with regime dummy variables suggests that investment strategies should be adjusted based on stock market regimes. This means that investors should make different investment decisions depending on whether the stock market is in a boom or a crisis regime. Government policymakers and investors should also make decisions with consideration of economic regimes. The regime shifts of the financial market have a different impact on the A-REIT market, in that during crisis regimes, A-REITs become more volatile than the Australian stock market index. This means that A-REITs are riskier during a crisis, and investors should allocate their portfolios accordingly.

The findings of this study contribute to the understanding of the interrelationships between REITs and the stock market and provide guidance for portfolio diversification and risk management strategies under dynamic market conditions. The study also confirms the diversification benefits of investing in specialised REITs during normal market periods. This is because specialised REITs are less correlated with the stock market than diversified REITs. However, during the GFC and the COVID-19 pandemic, REITs performed worse than the stock market. The beta of REITs more than doubled from 0.383 during normal regimes to 1.052 in crisis regimes. This is because REITs are more sensitive to changes in interest rates and economic growth, which were both volatile during these crises. Therefore, investors should assign their portfolio weights in a timely manner based on the stock market regimes and increase holdings for REITs when the stock market is identified as relatively stable.

The pooled regression with regime and Fama-French factors shows that the value factor has a significant impact on specialised REITs during crisis regimes. This suggests that the effects of size and value factors may not be the main drivers of REIT risk and returns during normal times, but value REITs stand out during crises. The separate robustness checks with lag of market risk premium and lag of average REIT risk premium show that REIT performance is not affected by the last period market condition and last period average REIT performance. This could be attributed to the regimes already included general information of the last period stock and REIT markets.

3.5.2 Conclusion

The findings of this chapter address the research question 2 outlined in Chapter 1, exploring how REIT beta changes in response to varying market conditions, particularly under different regimes in Australia. Through the application of the Markov regime-switching model, this study has demonstrated that REIT beta indeed varies significantly across different market regimes. The use of Markov-switching dynamic regression (MSDR) models and pooled regressions with regime-based dummy variables provide evidence of asymmetric effects of REIT risk premium to bull and bearish stock market conditions. This aligns with Hypothesis 2, supporting the statement that REIT beta behaves differently in response to distinct economic and market conditions.

The volatility of the stock market has a significant impact on the returns of equity REITs (Shen, 2020), and empirical evidence supports the use of regime-switching models in modelling REIT returns. By characterising distinct volatility regimes in the stock market when modelling the relationship between REITs and stock markets, investors can gain valuable insights into potential shifts between normal and crisis regimes (Haas & Liu, 2018), enabling them to anticipate market behaviour transitions. Real estate researchers have defined distinct REIT eras (Aguilar et al., 2018), emphasising the importance of pricing REITs with consideration of regimes. Additionally, it is crucial to analyse historical real estate returns rather than focusing solely on recent data when using the regime-switching method (Lizieri et al., 2012).

The application of Markov-switching models extends beyond REITs (Demiralay & Kilincarslan, 2022; Mensi et al., 2022), commodities (Liu & Lee, 2021), and economics (Benigno et al., 2020). These studies show that these models provide better insights into the dynamics of returns during different market conditions, contributing to a deeper understanding of volatility spillovers, the impact of financial crises, and the drivers of returns across diverse sectors. The relevance and applicability of regime-switch models are evident in recent works, underlining the models' ongoing role in enhancing comprehension of complex economic phenomena and informing decision-making across various fields.

Previous research on the relationship between REIT returns and stock market conditions has been limited. This chapter contributes to the existing body of knowledge by modelling REIT returns under the framework of regime-switching. The analysis results demonstrate that the correlation of REIT returns with stock market returns is dependent on the market regime. The relationship between REIT returns and stock market returns is asymmetric. This means that REIT returns are more sensitive to declines in stock market returns than they are to increases. This is in line with existing study (Mensi et al., 2022). The two-regime analysis suggests that REITs are more volatile than stocks during a crisis regime, but not during a normal regime. This is because REITs are more sensitive to changes in interest rates and economic growth, which are both more volatile during a crisis regime. Adding the number of regimes further reveals evidence of such magnifying volatility during market downturns. This means that the volatility of REIT returns is even higher during a crisis regime with multiple regimes.

The main findings of this chapter illustrate significant asymmetric dependence of REIT returns under different general stock market conditions. This finding has important implications for investors who are considering investing in REITs. Investors should be aware that REITs are more volatile than stocks during a crisis regime, and that they should adjust their investment strategy accordingly. For example, during a crisis regime, investors may want to reduce their exposure to REITs, or may want to invest in some REITs, such as industrial REITs, that are less sensitive to changes in interest rates and economic growth.

The findings of this study also contribute to the understanding of the interrelationships between REITs and the stock market and provide guidance for portfolio diversification and risk management strategies under dynamic market conditions. Further research could explore panel Markov-switching which allows more precise regime determination. Overall, this chapter provides valuable insights for investors and asset managers who are considering investing in REITs. Investors should carefully consider the economic regime when making investment decisions and be aware of the risks associated with investing in REITs.

Chapter 4 **Firm-specific risks and REIT beta in Australian and US markets**

4.1 Background

REIT liquidity is critical to REIT performance because the underlying assets are illiquid, and REIT liquidity is influenced by a variety of firm-level and market factors. Understanding these factors is crucial to pricing and understanding REIT performance. Firm-specific elements like the size and trading volume of a REIT (Richter, 2022) and market-wide factors, such as property market liquidity (Downs & Zhu, 2022), all play a role in shaping REIT liquidity. Moreover, it is important to recognise that REIT liquidity not only reflects market conditions but also conveys information about stock volatility and trading volume through the bid–ask spread ratio (Cannon & Cole, 2011). This underscores the significance of further research to include firm-level liquidity measures in REIT pricing.

Profitability is also a crucial aspect to consider in the analysis, as it affects the significance of size effects in stocks (Hou & Van Dijk, 2019). This linkage, in turn, is vital for pricing REIT returns and identifying the key drivers of REIT performance. Glascock and Lu-Andrews (2014a) also confirm the importance of profitability, showing that gross profit remains statistically significant for explaining cross-sectional REIT returns when controlling for size and momentum factors.

The US and Australian REIT markets, two of the world's largest and most mature REIT markets, exhibit key differences that warrant deeper analysis based on property subsectors. The US REIT market is known for its diversity, encompassing a wide range of property sectors, including niche ones like energy infrastructure and outdoor advertising, with greater exposure to the residential sector. In contrast, Australian REITs are more concentrated in the commercial property sector. Liquidity levels further differentiate the two markets, with the US REIT market being more liquid due to larger exchanges and higher trading volumes compared to Australian REITs. These disparities underscore the need for firm-specific measures as well as sector-specific analysis when considering investments in these distinct REIT markets or globally.

Previous studies, including those by Alcock and Steiner (2018) and Dogan et al. (2019), highlight the significance of leverage as a key determinant of REIT performance. Alcock and Steiner (2018) emphasise that leverage, in conjunction with systematic risk, is the primary driver for REITs' downturn performance. However, the role of leverage varies between the United States and Australia. In the US, there are no specific leverage restrictions, but there is a payout requirement mandating at least 90% of operating income be distributed as dividends, with a 4% excise tax applying if less than 85% of operating income was distributed (EPRA, 2016b). Conversely, in Australia, there are leverage restrictions, but no minimum distribution requirement concerning operating income, although general thin capitalisation rules may apply (EPRA, 2016a). Dogan et al. (2019) underscore that these differing regulations have a significant impact on REIT capital structure, with leverage restrictions playing a more crucial role in determining capital structure for Australian REITs.

In addition to the understanding of REIT financials, for REIT investors, subsector analysis holds great importance for REIT performance. It allows investors to identify REIT sectors expected to perform well and to diversify their portfolios effectively across various REIT sectors. Given the fragmentation and illiquidity in the real estate market, which is especially pronounced in the US with 50 states, diversifying away sector-specific risk is a challenging task. Sector-specific factors are pivotal in determining REIT returns (Clayton & MacKinnon, 2003). Furthermore, sector concentration in the US REIT market significantly impacts REIT returns and risk levels, as evidenced by (Zhang & Hansz, 2022).

This thesis investigates the specialised REITs as one group regarding the performance relative to diversified REITs in Chapter 2. This chapter expands on the diverse realm of specialised REITs by offering a detailed sector-wise analysis of the REIT market. It delves into the risks and returns associated with each specific sector, while also examining their respective market sizes. These sectors encompass various categories, such as office, retail, residential, industrial and hotel. Sector analysis is important because it can help investors to identify sectors that are likely to outperform the overall market. Therefore, this chapter conducts a sector analysis for a better understanding of REIT performance.

4.2 Literature review

There is abundant research on how firm-specific factors drive REIT performance through capital structure. For instance, leverage adjustment in anticipation of market changes could alleviate financial distress (Alcock & Steiner, 2018), and size, profitability and payout ratio are all significant determinants of REIT capital structure (Dogan et al., 2019). Dogan et al. (2019) found that country-specific factors such as legal requirements and macroeconomic conditions are also significant determinants of REIT capital structure. Specifically, REITs in countries with higher payout requirements tend to have higher leverage (Dogan et al., 2019). This is because REITs are required to pay out a larger portion of their earnings as dividends, which reduces their ability to retain earnings and reinvest in the business.

REIT beta performs differently during market downturns (Glascock & Lu-Andrews, 2018), and beta is driven by firm liquidity (Anthonisz & Putniņš, 2017). Anthonisz and Putniņš (2017) found a strong effect of "downside liquidity risk", which is an asymmetric beta where stock liquidity is especially sensitive to negative market returns. Furthermore, Glascock and Lu-Andrews (2018) examined REIT beta in relation to up and downside risk, which refers to market returns that are higher (up) and lower (downside) than the risk-free rate using Treasury bond yields. Specifically, they found that REITs with higher downside betas, meaning they are more sensitive to market downturns, had higher average returns, while upside betas are insignificant. This suggests that REIT investors tend to be more concerned about losses than gains (Glascock & Lu-Andrews, 2018), and that this difference in perception is important for understanding the risk–return trade-off.

Cai and Zhang (2011) also found a significantly negative effect of the change in leverage ratio on the portfolio returns.

REIT liquidity is affected by the underlying property market through liquidity (Downs & Zhu, 2022), which is a key driver of beta (Zhu & Lizieri, 2022). Downs and Zhu (2022) examined the relationship between property market liquidity and REIT liquidity. They measured property market liquidity using the turnover of property transactions and the number of property listings, and measured REIT liquidity with the bid–ask spread and trading volume. Downs and Zhu (2022) found that REITs in areas with more liquid property markets tend to have more liquid stocks. This is because REITs in more liquid property markets can more easily sell their underlying assets, which makes them more attractive to investors. Zhu and Lizieri (2022) found that the property market beta is more related to real estate market-related factors such as supply elasticity, market size and liquidity. They found that the risk associated with the location of the assets has been priced in REIT returns. This means that investors in REITs that are exposed to more volatile property markets demand a higher return. They also found that the impact of local real estate market risk on REIT returns is greater for REITs that are more specialised. These studies justify further examination of sector analysis for the REIT market.

Another recent research study on REIT liquidity suggests that despite the benefit of lower liquidity risk because of the payout requirements, REITs are more liquid than other types of real estate investments, such as direct real estate ownership and private REITs, but are less liquid than stocks and bonds (DiBartolomeo et al., 2021). DiBartolomeo et al. (2021) examined the liquidity risk of real estate investment trusts (REITs) in the US from 1980 to 2015. They found that REITs are more liquid than private real estate investments, such as direct real estate ownership and private REITs. They also found that the price impact of trades is greater for REITs than for other types of financial assets. This means that investors may have to pay a higher price to buy REITs and sell them at a discount because of liquidity.

Size and profitability are essential drivers of REIT returns. Hou and Van Dijk (2019) found that the size effect, which is the tendency of smaller stocks to outperform larger stocks still holds, even after controlling for a variety of factors that have been shown to explain the size effect in the past. They found that profitability shocks, which are unexpected changes in profitability, play an important role in explaining the size effect. Specifically, Hou and Van Dijk (2019) found that the smallest decile of stocks outperforms the largest decile of stocks by an average of 1.6% per month, and is more sensitive to profitability shocks than the largest decile of stocks. This outperformance is statistically significant and persists even after controlling for a variety of factors, including market beta, book-to-market ratio, momentum, and investment factor exposures.

Profitability is a crucial factor to consider in this analysis because it is related to other firm-specific variables and is the source of dividend payments under the REIT structure. Profitability influences the size effects in stocks (Hou & Van Dijk, 2019), and gross profit remains significant when controlling for size and momentum factors in REIT pricing (Glascock & Lu-Andrews, 2014a). Hou and Van Dijk (2019) adjusted for the price impact of profitability shocks and found a robust size effect in the cross-section of expected returns after the early 1980s. REIT profitability is usually measured by Funds From Operations (FFO), which corrects the amortisation for a more realistic real estate income measurement. Rental NOI is also a good measure of REIT profitability because it is a direct measure of the cash flow that the REIT generates from its operations. Cash flow is essential for REITs to pay dividends and to invest in new properties.

It is important to consider the underlying real estate market returns when analysing REIT performance, as previous research has shown that these two markets are closely aligned in the long run (Hoesli & Oikarinen, 2019). Previous study on REIT liquidity has not considered underlying real estate market returns, despite their high correlation with property values (Geltner et al., 2021). Geltner et al. (2021) used REIT data to predict market fundamentals and found that their estimates of property values are correlated with traditional property market data at a correlation coefficient of 0.95. This chapter aims to fill the research gap, as underlying real estate market returns are an important factor to consider when analysing REIT performance, along with firm-specific factors and liquidity measures.

Table 4-1 provides a comprehensive literature summary for this chapter on how various firm-specific factors, including size, value, leverage, profitability, book to market ratios, liquidity and other features, influence REIT returns. The research spans different countries and time periods, shedding light on the intricate relationships between these financial variables and investment outcomes.

Table 4-1. Summary of literature on firm-level drivers of stock returns

Author & Year	**Factor**	**Notes**	**Data periods**	**Country**
Roll (1984)	Roll's Spread Ratio Size	Strong and negative relation between estimated spread and size, firm size is also negatively related to trading cost	1963–1982	US common stocks listed on the New York Stock Exchange (NYSE)
Amihud and Mendelson (1986)	Amihud's ratio	Negatively correlated with returns	1963–1982	US common stocks listed on the NYSE, AMEX, and NASDAQ
Amihud (2002)	Amihud's illiquidity measure	Positively associated with returns, applied in cross-sectional data and over time	1963–1997	Firms listed on the NYSE, AMEX, and NASDAQ
Cai and Zhang (2011)	Leverage	Leverage negatively affects return	1975–2002	US
Fama and French (2012)	Size Value	Stock returns generally decrease with size and increase with value	1989–2011	US, UK, Europe, and Asia-Pacific
Anthonisz and Putniņš (2017)	Liquidity	Liquidity positively correlated with returns	1962–2011	US
Apergis and Rehman (2018)	Book to market	B/M ratio positively correlated with returns, but turns negative when considering Sentiment index in the CAPM	1995–2015	US
Fall et al. (2019)	Liquidity	Liquidity positively correlated with returns	2006–2014	All common firms listed on the NASDAQ
Hou and Van Dijk (2019)	Size	Positive size factor after adjusting for profitability shocks post 1980s	1963–2014	US
Ball et al. (2020)	Book to market	B/M ratio positively correlated with returns, mostly from the retained earnings to market ratio	1964–2017	US

Author & Year	**Factor**	**Notes**	**Data periods**	**Country**
Amihud and Noh (2021)	Amihud-Noh illiquidity measure	Positively associated with returns and robust to Fama-French and Carhart factors, illiquidity premium is weaker in more recent years and is concentrated in smaller and less liquid stocks	1955–2016	US, UK, Canada, Europe and Asia-Pacific
Kogan et al. (2022)	Profitability	Profitability positively correlated with returns, CAPM fails to explain expected returns on profitability factor	1958–2011	US

4.3 Data and methodology

The focus of this chapter is whether firm-level characteristics could explain A-REIT performance. The study scope of this question is limited to equity REITs listed on the Australian Stock Exchange that invest in Australian properties, and equity REITs in the US. REIT performance is measured using the Total Return Index from Standard & Poor's Capital IQ Pro (S&P CIQ). Firm-level financial data is from S&P CIQ Pro and Wharton Research Data Services, Center for Research in Security Prices (WRDS CRSP).

4.3.1 Data and definitions

Table 4-2 outlines the variable definitions of the original data and the finance and accounting variables used in the analysis. It provides the databases listed in the source. Further definitions and explanations are provided by the corresponding database (see Appendix D).

Table 4-2. Variable definitions

Variable	Definition	Unit	Data frequency	Source
Total assets	Total assets as reported	USD or AUD, billions	Annual	SP CIQ
Total debt	The aggregate unpaid principal balance owed under financial obligations to other parties	USD or AUD, billions	Annual	SP CIQ
Market capitalisation	Value of all issues of common equity	USD or AUD, billions	Annual	SP CIQ
Book equity	Total assets minus Total debt	USD or AUD, billions	Annual	SP CIQ
Rental net operating income (Rental NOI)	Total rental revenue, net of property operating expense, excluding the effect of depreciation and amortisation	USD or AUD, billions	Annual	SP CIQ
S&P500	Total Return Index for US stock market	Index	Daily	SP CIQ
S&P/ASX-200-Financials-ex-REIT	Total Return Index for Australia stock market	Index	Daily	SP CIQ
Federal funds rate	Risk-free proxy for US	Number	Daily	FRED
RBA cash rate	Risk-free proxy for Australia	Number	Daily	Reserve Bank of Australia
NCREIF Property Index (NPI)	National index of unleveraged composite total return for private commercial real estate properties held for investment purposes only	Index	Annual	Statista
S&P CoreLogic Case-Shiller 20-City Home Price NSA Index	Home price index for US using a three-month moving average	Index	Monthly	FRED
Residential Property Price Index	Weighted average of residential property performance of eight major cities in Australia	Index	Quarterly	Australian Bureau of Statistics
Share volume	The total number of shares of a stock sold on day 1	Number	Daily	WRDS CRSP

Variable	Definition	Unit	Data frequency	Source
Shares outstanding	The number of publicly held shares, recorded in thousands	Number	Daily	WRDS CRSP
Closing bid	The price offer by market participant to buy a stock	USD or AUD	Daily	WRDS CRSP
Closing ask	The price offered by market participant to sell a stock	USD or AUD	Daily	WRDS CRSP
Closing price or Bid/Ask average	The closing price for a trading day, or the negative value of bid/ask average if the closing price is not available on any given trading day	USD or AUD	Daily	WRDS CRSP

The calculation of returns and firm-level financial features including size, leverage, profitability and liquidity is generated from data listed in Table 4-2. The firm-level variables are winsorised at 99%. For liquidity ratios, turnover ratio measures firm liquidity, and the absolute return and spread ratio measure firm illiquidity. Detailed definitions of the variables from the databases are provided in Appendix D. The calculation process is described as follows:

- Average REIT risk premium

  First calculate the REIT risk premium for each REIT on each day, then add up the REIT risk premium on each day and take the average value. Because some REITs do not exist on some of the days, this time series may be skewed to the REITs that are listed early with the total return index starting from the beginning of the analysis period in year 2000. This is used for a robustness check. Estimated at daily frequency.

- ln(total assets) (Size)

  Natural log of Total assets. It is an approximate measure for firm size. To improve the interpretability of the coefficients, scale the data by dividing the original values by 1,000. This reduces the number of trailing zeros after the decimal point, making it easier to compare the coefficients and understand their relative importance. Estimated at annual frequency.

- Total debt/Total assets (Leverage)

  Measures firm leverage. Scale the data by dividing the original values by 10. Estimated at annual frequency.

- Rental NOI/Total assets (Yield)

  Measures the ability to produce cash flows based relative to asset value. Rental net operating income is chosen as the profitability measure due to data availability for both the United States and Australia. Scale the data by dividing the original values by 10. Estimated at annual frequency.

- Market capitalisation/Book equity (MTB)

  Market capitalisation/(Total assets – Total debt). It is the market-to-book ratio that represents how the market values the company’s assets compared to the asset value on the company’s balance sheet. The 5,215 negative observations which have negative book value of equity are excluded from the analysis. Scale the data by dividing the original values by 1,000. Estimated at annual frequency.

- Turnover ratio

  Trading volume/Shares outstanding. The 18 outliers with extreme values are excluded from analysis for the sample period 2000 to 2021. The ratio is adjusted using the past 20-trading day ratio for each stock. Estimated at daily frequency.

- Absolute return

  |Daily Return|. Captures the impact of trading due to the level of illiquidity. Estimated at daily frequency.

- Spread ratio

  $(Bid - Ask)/(Bid + Ask)/2$, measures the magnitude of illiquidity relative to stock trading price. Estimated at daily frequency.

- Return squared

  $(REIT\ risk\ premium)^2$, measures the magnitude of illiquidity due to return volatility. Estimated at daily frequency.

Table 4-3 presents the summary statistics of firm-level financial and accounting variables for the US in the analysis. It is calculated by pooling all the individual firms in the analysis. For example, in the case of REIT risk premium, pool the values from all firms together in the analysis period from January 2000 to June 2021, then observe the statistical metrics of the aggregate data.

Table 4-3. Summary statistics of US REIT variables for analysis on daily basis

Variable	No. of Obs	Mean	Std. Dev.	P5	P95	Min	Max
REIT risk premium	611,926	0.00024	0.04	-0.03	0.03	-3.35	4.38
Average REIT daily risk premium	1,032,080	0.00039	0.02	-0.02	0.02	-0.22	0.14
Risk premium (market)	1,103,404	0.00021	0.01	-0.02	0.02	-0.13	0.11
Size	630,092	0.00	0.00	0.00	0.00	-0.01	0.00
Leverage	630,092	0.05	0.02	0.02	0.07	0.00	0.12
Yield	615,487	0.01	0.00	0.00	0.01	0.00	0.03
MTB	596,187	0.00	0.00	0.00	0.00	0.00	0.05
Yearly beta	2,375	0.82	0.50	0.11	1.69	0.00	3.57
Absolute returns	611,926	0.01	0.03	0.00	0.05	0.00	4.38
Turnover ratio	549,605	0.01	0.01	0.00	0.02	0.00	0.18
Spread ratio	503,802	0.00	0.02	0.01	0.02	0.24	5.13

Note: The size, leverage, yield and MTB variables are scaled down and therefore have small values of summary statistics.

In Table 4-3, comparing REIT risk premium to stock market risk premium, REITs are more volatile than the major stock market trends with implications from the standard deviation values at 0.04 and 0.01 respectively. The standard deviation of leverage is relatively large with a value of 0.02, which indicates that there is a significant amount of variation of US REITs' debt level. The mean of yield is positive with a value of 0.01 (scaled down from 0.07). The standard deviation is relatively small, which suggests that there is a relatively small amount of variation in the yield level of US REITs. The mean value of leverage is 0.05 (scaled down from 0.49), implying that US REITs have high levels of leverage.

Table 4-3 shows the US REIT liquidity levels. The high standard deviation of 0.03 for absolute returns is three times the value of the mean, representing a cross-section liquidity difference. By contrast, the standard deviation for turnover ratio is small with a value of 0.01, close to its mean value. The spread ratio and the absolute returns have high maximum values (4.38 and 5.13 respectively) and relatively high standard deviation (0.02 and 0.03 respectively), suggesting further examination of how these liquidity ratios explain REIT risk premium.

Table 4-4 provides a correlation matrix illustrating the relationships among various firm-level accounting and financial variables of US REITs. These correlations range from -0.31 to 0.33, denoting the degree of association between the attributes. Most of the firm characteristics exhibit relatively low correlations despite being statistically significant, indicating their independence from one another.

Table 4-4. Correlation table of US REIT yearly variables

	$\mathbf{Size_{i,t}}$	$\mathbf{Leverage_{i,}}$	$\mathbf{Yield_{i,t}}$	$\mathbf{MTB_{i,t}}$	Turnover $\mathbf{ratio_{i,t}}$	Absolute $\mathbf{return_{i,t}}$	Spread $\mathbf{ratio_{i,t}}$
$Size_{i,t}$	1.00						
$Leverage_{i,t}$	0.17***	1.00					
$Yield_{i,t}$	0.13***	0.17***	1.00				
$MTB_{i,t}$	0.10***	0.23***	0.33***	1.00			
$Turnover\ ratio_{i,t}$	-0.16***	-0.04***	0.07***	0.06***	1.00		
$Absolute\ return_{i,t}$	0.00**	0.04***	-0.03***	-0.06***	-0.31***	1.00	
$Spread\ ratio_{i,t}$	0.29***	0.01***	-0.06***	0.06***	-0.06***	-0.06***	1.00

*Note: * p<0.05, ** p<0.01, *** p<0.001.*

Table 4-4 shows that the largest positive correlation is between the MTB and the yield ratio (0.33), suggesting that as the market-to-book ratio increases, so does the profitability level of US REITs. In essence, this implies that market expectations for future growth and profitability are associated.

Notably, in Table 4-4, larger REITs display higher leverage (0.17 correlation), enhanced yields (0.13 correlation), elevated future growth expectations (0.10 MTB correlation) and increased trading activity (-0.16 turnover ratio correlation) compared to smaller peers. Additionally, the correlation coefficient between size and spread ratio has a value of 0.29, which suggests bigger firms may have higher return spreads. The spread ratio exhibits minimal relationships with other variables, with the coefficients falling within a narrow range of -0.06 to 0.06. Turnover ratio and absolute return have a correlation value of -0.31, which means they contain similar information of illiquidity. Beyond turnover ratio, absolute return exhibits minimal associations with other factors, as its correlation coefficients hover around zero, ranging from -0.06 to 0.04.

In summary, Table 4-4 demonstrates that these firm characteristics exhibit relatively weak to moderate correlations. While several control variables have moderate correlation coefficients around 0.30 (and -0.31), each attribute provides unique information. This table offers initial insights into REIT firm-level characteristics, underscoring the need for further in-depth investigations to reveal their significance and practical implications for REIT beta.

4.3.2 Methodology

This chapter uses pooled regression with financial variables to measure the impact of firm-level factors on REIT risk premium. Sector analysis focuses on the performance of REITs in various sub sectors of US and Australian REIT markets. Quantile regression is also performed as a detailed analysis of how different quantiles of each variable have different effects as a robustness check.

4.3.3 Pooled regressions with financial variables

To examine the impact of firm-specific features on returns, I run the following pooled regressions for REITs with size, leverage, profitability, market-to-book equity ratio and liquidity ratios:

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_m * Risk\ premium_{m,t} + \cdot\, \beta\mathcal{F} + \beta_{n+1} * RPIR_t + \epsilon_{i,t}, \qquad (n = 4)$$

(4-1)

in which $R_{i,t} - R_{f,t}$ is the risk premium for REITs, $Risk\ premium_{m,t}$ is the stock market risk premium using the corresponding stock market inde4x as described in Table 4-2 in section 4.3.1, in this case, $n = 4$ in $\mathcal{F}_{i,j,t}$, $(\, i = 1, \ldots 152, j = 1, \ldots, n)$ represents the following financial ratios: $Size_{i,t}$, $Leverage_{i,t}$, $Yield_{i,t}$, and $MTB_{i,t}$, β is a vector of coefficients $[\beta_1, \beta_2, \ldots, \beta_n]$, $\mathcal{F}$ is a vector where each component of the vector is $\mathcal{F}_{i,j,t}$ for a given *i* and *t*, there's a varying *j from 1 to n*, and $\cdot\, \beta\mathcal{F} = \beta_1\mathcal{F}_{i,1,t} + \beta_2\mathcal{F}_{i,2,t} + \cdots + \beta_n\mathcal{F}_{i,n,t}$. Residential property index return $(RPIR_t)$ is included to proxy for the direct property investment returns as measured in the housing market.

A separate pooled regression with the interaction variables is also conducted to find out if the basic firm features have an impact on risks. Based on equation (4-1) with the four control variables on firm features, I then estimate the following model that includes the interaction terms of firm features and market risk premium, as follows:

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_m * Risk\ premium_{m,t} + \cdot \beta\mathcal{F}$$
$$+ \cdot \beta'\mathcal{F} * Risk\ premium_{m,t} + \beta_{n+1} * RPIR_t + \epsilon_{i,t},\ (n = 4)$$

(4-2)

$\cdot\, \beta'\mathcal{F} * Risk\ premium_{m,t} = \beta_1'\mathcal{F}_{i,1,t} * Risk\ premium_{m,t} + \beta_2'\mathcal{F}_{i,2,t} * Risk\ premium_{m,t} + \cdots + \beta_n'\mathcal{F}_{i,n,t} * Risk\ premium_{m,t}$, β' is another vector of coefficients $[\beta_1', \beta_2', \ldots, \beta_n']$ and $\mathcal{F}_{i,j,t} * Risk\ premium_{m,t}$ is the interaction variable between control variables of firm and market risk premium. The next step is to include three different measures of trading liquidity (i.e., turnover ratio, absolute return and spread ratio) one by one to test the liquidity impact on REITs' risk premium in the following pooled regressions.

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_m * Risk\ premium_{m,t} + \cdot \beta\mathcal{F}$$
$$+ \cdot \beta'\mathcal{F} * Risk\ premium_{m,t} + \beta_{n+1} * RPIR_t + \epsilon_{i,t},\ (n = 5, 6, 7)$$

(4-3)

Equation (4-3) specifies three separate equations with $n = 5, 6\ or\ 7$, respectively. Each of these equations add one more liquidity measure and its interaction variable with market risk premium each time. The three liquidity factors are $Turnover\ ratio_{i,t}$, $Absolute\ return_{i,t}$, and $Spread\ ratio_{i,t}$. For example, the first liquidity ratio to include is $Spread\ ratio_{i,t}$, which measures the proportion of bid–ask spread of firm stock price in stock price, where the larger the ratio, the more illiquid a stock is. The interaction variable, $Spread\ ratio_{i,t} * Risk\ premium_{m,t}$, is also included to examine the effect of spread ratio on firm risk level.

After that, I regress the accounting factors on each REIT's annual beta to find out which control variables are more important to explain the risk level of REITs:

$$REIT\ annual\ beta_{i,t} = \alpha_{i,t} + \cdot \beta \mathcal{F} + \epsilon_{i,t},\ (n = 7) \tag{4-4}$$

in which all the control variables are included.

4.3.4 Quantile regressions with financial variables

At different quantiles, the coefficients of financial variables may have different results. Unlike traditional least squares regression, which focuses on estimating the conditional mean, quantile regression allows for the estimation of the entire conditional distribution. This can be particularly useful when the distribution of the dependent variable is skewed (Machado & Silva, 2019). In addition, quantile regression can be used to assess the impact of regressors on different parts of the conditional distribution. By estimating quantiles at different levels (e.g., 25th, 50th, 75th percentiles), quantile regression can reveal how the relationship between the independent and the dependent variables varies across different parts of the distribution. Moreover, the method proposed by Machado and Silva (2019) is particularly useful in settings where the conditional distribution of the dependent variable is heteroskedastic or where there are time-lagged effects or potential endogeneity. This method is well-suited for analysing REIT and stock returns, which are characterised by lagged effects.

As demonstrated in Table 4-4, the firm-level financial variables exhibit relatively weak to moderate correlations with each other. For example, there is a negative correlation of -0.49 between absolute return and turnover ratio. To assess the individual impact of each control variable more rigorously on REIT returns and risks, quantile regression can be used to estimate the impact on beta for different levels of financial variables, thus providing information of conditional distribution for each variable. Following Koenker and Bassett Jr (1978) and Machado and Silva (2019), the quantile regressions are performed:

$$\Omega_{i,t} = \alpha_i + \mathrm{M}_{i,t}^{'} + D_{i,t} * (\omega_i + \Psi_{i,t}^{'}\iota) \tag{4-5}$$

in which $\Omega_{i,t} = R_{i,t} - R_{f,t}$, α_i and ω_i capture the fixed effects, $i = 1,2,3 \dots, n$ as there are n firms, $M_{i,t} = \beta_m * Risk\ premium_{m,t} + \sum_{j=1}^{n} \beta_j * \mathcal{F}_{i,j,t} + \sum_{j=1}^{n} \beta_j' * \mathcal{F}_{i,j,t} * Risk\ premium_{m,t}$,

$(n = 1,2, \ldots ,7)$, $\mathrm{M}'_{i,t}$ is the transposed independent variables including market risk premium and one of the seven accounting variables $\mathcal{F}_{i,j,t}$. Ψ is a k-vector of known differentiable (with probability 1) transformations of the components of M with element ς given by $\Psi_{\varsigma} = \Psi_{\varsigma}(M)$, ς= 1,...,k, $\Pr\{\omega_i + \Psi'_{i,t}\iota > 0\} = 1$, $D_{i,t}$ are i.i.d. (across i and t), statistically independent of $\mathrm{M}'_{i,t}$, and normalised to satisfy the moment conditions, $\mathcal{F}_{i,j,t}$ is replaced by one of the following variables and estimate regressions corresponding to equation (4-3) for each variable: $Size_{i,t}$, $Leverage_{i,t}$, $Yield_{i,t}$, $MTB_{i,t}$, $Turnover\ ratio_{i,t}$, $Absolute\ return_{i,t}$, $Spread\ ratio_{i,t}$. There are a total of 21 regressions performed in this section. Equation (4-5) leads to:

$$\Gamma_{\eth}(\varpi|M_{i,t}) = (\alpha_i + \omega_i p(\varpi)) + \beta * \mathrm{M}'_{i,t} + \Psi'_{i,t}\iota p(\varpi)$$

(4-6)

The scalar coefficient $\alpha_i(\varpi) \equiv \alpha_i + \omega_i p(\varpi)$ is the quantile-ϖ fixed effect for firm *i*, which is also the distributional effect at ϖ. The distributional effect has varying influence across the areas of conditional distribution of Ω. Then estimate $p(\varpi)$ by $\widehat{\varpi}$, in

$$min_p \sum_i \sum_t \vartheta_{\varpi}(\hat{\epsilon}_{i,t} - (\widehat{\omega_\iota} + \Psi'_{i,t}\hat{\iota})\ \varpi)$$

(4-7)

where $\vartheta_{\varpi} = (\varpi - 1)EI\{E \leq 0\} + \varpi EI\{E > 0\}$ is the verification function.

Initial results and existing literature suggested that firm size and yield affect returns (Hou & Van Dijk, 2019). Therefore, further examination of how REITs with different quantiles in each of the accounting variables affect REIT risk and returns is conducted. The regression results for 25% (low), 50% (medium) and 75% (high) quantiles are reported in the robustness check in section 4.5.2.

4.3.5 Sector analysis

After analysing the performance of REITs with financial variables, dummy variables of the subsector of REITs are taken into consideration:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_1 * Risk\ premium_{m,t} + \beta_2 * \sum_{i=1}^{n} Sector_i + \beta_3 * \sum_{i=1}^{n} Sector_i * Risk\ premium_{m,t} + \epsilon_{i,t} \tag{4-8}$$

in which $\sum_{i=1}^{n} Sector_i$ $(n = 1,2,3,\ldots,7)$ depicts the influence of REIT subsector defined by the GICS, including hotel, specialty, diversified, healthcare, industrial, residential, office and retail, and the base group of the categorical dummy variable is hotel. Hotel is chosen so that all other dummy variables have a consistent sign of coefficients of the interaction variable for a more straightforward comparison. $\sum_{i=1}^{n} Sector_i * Risk\ premium_{m,t}$ depicts the influence of the subsector on the amount of risk that the corresponding type of REIT carries.

4.4 Results

4.4.1 Size, leverage, yield, MTB and trading liquidity

Table 4-5 presents the results of pooled regressions of US REIT risk premium with market risk premium, financial variables, liquidity ratios, and interaction variables of accounting and liquidity ratios from 2000 to 2021. The results in Column (1) show that the market risk premium is a significant predictor of REIT risk premium, with a coefficient of 0.956. This means that for a one percentage point increase in the market risk premium, REIT risk premium is expected to increase by 0.956%. The financial variables also have a significant impact on REIT risk premium. Leverage is strongly significant with a coefficient value of -0.010, suggesting that REITs with higher debt levels tend to have lower risk premiums. One possible reason is that REITs with higher debt levels are more sensitive to interest rate changes, which increases their risk.

The residential property index return is strongly significant with coefficient values range from 0.104 to 0.113 in Columns (1), (2) and (3). This suggests that REIT risk premium is positively correlated with the performance of the residential property market. This is likely because REITs and residential properties are both exposed to similar economic factors, such as interest rates and economic growth. Another explanation is that residential REIT is included in the analysis and its returns correlate with the residential market index return.

Table 4-5. Pooled regressions of US REIT risk premium with financial variables

	(1)	(2)	(3)	(4)	(5)
Dependent variable: REIT $risk\ premium_{i,t}$					
$Risk\ premium_{m,t}$	0.956***	0.903***	0.675***	0.456***	0.471***
	(0.029)	(0.091)	(0.102)	(0.062)	(0.060)
$Size_{i,t}$	-0.038	-0.068	-0.114	0.011	-0.043
	(0.066)	(0.066)	(0.143)	(0.105)	(0.114)
$Leverage_{i,t}$	-0.010***	-0.009**	-0.008*	-0.015	-0.014
	(0.003)	(0.000)	(0.003)	(0.008)	(0.008)
$Yield_{i,t}$	0.020	0.025	0.005	-0.008	-0.014
	(0.018)	(0.019)	(0.027)	(0.031)	(0.029)
$MTB_{i,t}$	0.089	0.062	0.057	0.105	0.097
	(0.051)	(0.048)	(0.043)	(0.058)	(0.063)
$Turnover\ ratio_{i,t}$			0.020	0.100*	0.101*
			(0.021)	(0.045)	(0.046)
$Absolute\ return\ _{i,t}$				0.159	0.160
				(0.103)	(0.105)
$Spread\ ratio_{i,t}$					0.0485
					(0.027)
$Size_{i,t} * Risk\ premium_{m,t}$		127.008***	45.197*	89.112***	83.205***
		(17.991)	(22.251)	(13.284)	(12.860)
$Leverage_{i,t} * Risk\ premium_{m,t}$		3.400	0.147	-0.354	-0.299
		(1.791)	(0.167)	(0.871)	(0.833)
$Yield_{i,t}\ * Risk\ premium_{m,t}$		-22.340**	-16.321*	-18.655***	-17.718***
		(7.840)	(7.211)	(4.233)	(4.098)
$MTB_{i,t} * Risk\ premium_{m,t}$		-24.762	-8.728	14.065	14.763
		(13.443)	(0.6.202)	(9.978)	(10.215)
$Turnover\ ratio_{i,t} * Risk\ premium_{m,t}$			-26.724***	6.153	6.445
			(2.062)	(3.682)	(3.685)
$Absolute\ return_{i,t} * Risk\ premium_{m,t}$				17.620***	17.654***
				(2.065)	(2.071)
$Spread\ ratio_{i,t} * Risk\ premium_{m,t}$					2.305**
					(0.752)
$RPIR_t$	0.113***	0.111***	0.104***	0.192**	0.188**
	(0.011)	(0.011)	(0.012)	(0.061)	(0.061)
Constant	0.001**	0.000*	0.000	-0.002	-0.001
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Observations	442,685	442,685	387,546	387,546	382,809
R-squared	0.188	0.198	0.277	0.425	0.429
Number of REITs	152	152	139	139	139
Year FE	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y
SE clustered by firm	Y	Y	Y	Y	Y

*Note: REIT risk premium is based on the log difference of each REIT's Total Return Index and US Federal Reserve Funds Rate. Market risk premium is based on the log difference of S&P 500 Total Return Index and US Federal Reserve Funds Rate. Residential property index returns (RPIR) are log differences of the values linearly interpolated from original frequency to daily value using S&P Case-Shiller 20-city house price index. Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

The interaction variables between size and the market risk premium and between yield and the market risk premium are statistically significant in Column (2) of Table 4-5. The coefficient of the interaction variable between size and the market risk premium is strongly significant with a value of 127.008, implying that REITs with bigger firm size carry higher market risks. Yield is significant and negative with a value of -22.340, meaning that REITs with higher rental income relative to their total assets tend to have lower risks. The coefficient values suggest that REITs are very sensitive to the changes in size and yield, as a one percentage point increase leads to a 127% and 22.34% reduction of risk, respectively. A higher yield signals healthier financial conditions, therefore reducing the level of systematic risks that a REIT carries.

In Column (3) of Table 4-5, the turnover ratio as a measure of illiquidity (takes a negative value of calculated turnover ratio) is insignificant, but its interaction variable with market risk premium is strongly significant with a value of -26.724. This large coefficient value also suggests that the risk level of REITs is very sensitive to the liquidity level. This implies that REITs with higher turnover ratios (more liquid), or those that are less difficult to trade, tend to have a low turnover ratio in this analysis and carry lower risks. This is likely because investors are more likely to sell off illiquid assets during periods of high market risk, which can further increase their risks. Another possible reason to explain the sensitivity of REITs to liquidity is the underlying properties of REITs, they are less liquid by nature as it takes more time to trade properties than stocks and bonds and may incur more costs such as brokerage and legal fees.

Comparing Columns (3) and (4) in Table 4-5, after including absolute return as another measure of illiquidity and its interaction variable with market risk premium, the interaction variable between turnover ratio and market risk premium changed from strongly significant in Column (3) to insignificant in Column (4). This suggests that absolute return is a better measure of illiquidity than turnover ratio, and the return variations contain information about liquidity as captured by turnover ratio. The coefficient of turnover ratio (0.100) is weakly significant. The coefficient of the interaction variable of turnover ratio and market risk premium is strongly significant with a value of 17.620, implying that more variations in REIT returns represent higher risks. The high value of this coefficient also suggests sensitivity. In addition, the variables for interaction between size and market risk premium (89.112) and yield and market risk premium (-18.655) become strongly significant in Column (4).

Comparing Columns (4) and (5) in Table 4-5, the market risk premium has statistically significant and similar values of coefficients at 0.456 and 0.471, respectively. After including spread ratio and its interaction variable with market risk premium as the third set of measures of illiquidity in Column (5), the interaction variables with market risk premium for both absolute return and spread ratio are statistically significant with values of 17.654 and 2.305, respectively. The results in Column (5) imply that these two liquidity ratios are effective controls for measuring illiquidity of REITs. The coefficients of the interaction variables with market risk premium for size (83.205) and yield (-17.718) both remained statistically significant in Column (5) with similar values to Column (4). The coefficients of the interaction variable between turnover ratio and market risk premium stayed insignificant.

4.4.2 REIT beta and firm features

Table 4-6 shows the results of the regression of REIT annual beta on firm features from 2000 to 2021. This table provides a more in-depth exploration of the relationship between accounting features and REIT beta.

Table 4-6. US REIT beta over financial variables

	(1)	**(2)**	**(3)**
Dependent variable: REIT annual beta			
$Size_{i,t}$	93.160*	75.227**	62.225*
	(36.421)	(28.563)	(26.577)
$Leverage_{i,t}$	3.202**	0.791	0.936
	(1.186)	(0.963)	(0.935)
$Yield_{i,t}$	14.097*	12.451*	13.967**
	(6.757)	(5.876)	(5.059)
$MTB_{i,t}$	-11.177*	-5.405	-6.437*
	(5.406)	(3.261)	(3.061)
$Turnover\ ratio_{i,t}$	-13.125**	-3.366	-2.126
	(4.574)	(3.242)	(2.997)
$Absolute\ return_{i,t}$		32.914***	35.947***
		(3.169)	(2.812)
$Spread\ ratio_{i,t}$			8.772***
			(2.395)
Constant	-0.075	-0.318***	-0.107
	(0.081)	(0.061)	(0.078)
Observations	1,617	1,616	1,616
R-squared	0.793	0.833	0.838
Number of REITs	138	138	138
Year FE	Y	Y	Y
Firm FE	Y	Y	Y
SE clustered by firm	Y	Y	Y

*Note: REIT risk premium is based on the log difference of each REIT's Total Return Index and US Federal Reserve Funds Rate. Market risk premium is based on the log difference of S&P 500 Total Return Index and US Federal Reserve Funds Rate. Beta is first obtained by the capital asset pricing model for each calendar year for each firm. For annual calculation, the mean value of daily trading volume and liquidity ratios per calendar year is used. Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

As depicted in Column (1) of Table 4-6, size and leverage exhibit statistically significant and positive impact on REIT beta. This implies that REITs characterised by larger firm size and higher leverage levels tend to have higher betas. Turnover ratio has a significant and negative coefficient (-13.125), indicating that REIT stocks that are more frequently traded have lower beta values.

The liquidity levels are substantial drivers in shaping REIT beta, as evident in the yearly beta regressions conducted on accounting features in Table 4-6. Columns (2) and (3) provide more insights, showing the strongly significant coefficients of the interaction variables between absolute return and market risk premium (32.914 and 35.947, respectively). Furthermore, the interaction variable between spread ratio and market risk premium in Column (3) demonstrates a strongly significant coefficient of 8.772. These findings underscore the significance of liquidity measures as crucial predictors of REIT beta.

REITs with higher absolute returns and larger spread ratios tend to have higher betas, and Table 4-6 highlights the sensitivity of beta to changes in absolute return. Leverage becomes insignificant when absolute return is added in Column (2) compared to Column (1). This change in significance may be attributed to the inclusion of leverage information within the liquidity variables. The results suggest that REIT betas are not solely determined by the overall stock market dynamics but are also influenced by REIT-specific factors, including size, rental income, market capitalisation, debt level, turnover ratio, absolute return and spread ratio. These results confirm the previous findings in Table 4-5.

4.4.3 Robustness check

4.4.3.1 Pooled regressions with standalone financial variables

Table 4-7 presents the pooled regression results of robustness checks with a standalone financial variable for each of the seven variables. Columns (1) to (7) are the regression results for seven separate regressions, with each regression containing only one financial variable.

Table 4-7. Pooled regressions of US REIT risk premium with standalone financial variables

	(1) Size	(2) Leverage	(3) Yield	(4) MTB	(5) Turnover ratio	(6) Absolute return	(7) Spread ratio
Dependent variable: REIT $risk\ premium_{i,t}$							
$Risk\ premium_{m,t}$	0.832***	0.680***	1.112***	1.000***	0.703***	0.402***	1.038***
	(0.024)	(0.108)	(0.091)	(0.042)	(0.0310)	(0.038)	(0.023)
$Financial\ variable_{i,t}$	-0.000	-0.001	0.004*	0.000	-0.011	0.052**	0.046***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.020)	(0.018)	(0.013)
$Financial\ variable_{i,t}$ $*\ Risk\ premium_{m,t}$	0.152***	0.533*	-2.408*	-0.036*	-25.710***	12.140***	2.343**
	(0.016)	(0.220)	(0.994)	(0.016)	(2.192)	(0.692)	(0.881)
Constant	0.001***	0.002***	0.001***	0.001***	0.001***	-0.000	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	470,010	470,010	459,829	466,989	471,123	542,673	465,087
R-squared	0.185	0.177	0.182	0.180	0.273	0.307	0.248
Number of REITs	152	152	152	152	144	165	144
Year FE	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y
SE clustered by firm	Y	Y	Y	Y	Y	Y	Y

*Note: REIT risk premium is based on the log difference of each REIT's Total Return Index and US Federal Reserve Funds Rate. Market risk premium is based on the log difference of S&P 500 Total Return Index and US Federal Reserve Funds Rate. Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

In Table 4-7 Columns (1) and (6), size and absolute returns also have strongly significant interaction variables with market risk premium, at 0.152 and 12.140 respectively. This result confirms the standalone effect of firm size and absolute returns on the amount of risk that REITs carry, as both variables are positively correlated with REIT riskiness. For the interaction variable of spread ratio and market risk premium, the coefficient is significant with a value of 2.343, indicating illiquidity increases the risk level of REITs. Tables 4-12 and 4-13 align with the findings presented in section 4.4.1, thereby offering valuable support for a robustness assessment.

4.4.3.2 Quantile regressions of firm-level features

Table 4-8 shows the regression results of the low, medium, and high quantiles (0.25, 0.50, 0.75). Based on each of the eight control variables and Fama-French size and value factors, there are eight individual regressions.

Table 4-8. The interaction term in quantile regressions of US REIT financial variables

	Quantile		
	(1) **0.25**	**(2)** **0.50**	**(3)** **0.75**
Dependent variable: REIT $risk\ premium_{i,t}$			
$Size_{i,t}$	0.158*** (0.003)	0.151*** (0.003)	0.145*** (0.003)
$Leverage_{i,t}$	0.541*** (0.027)	0.533*** (0.022)	0.524*** (0.027)
$MTB_{i,t}$	-2.483*** (0.001)	-2.406*** (0.001)	-2.330*** (0.001)
$Yield_{i,t}$	-0.035*** (0.113)	-0.035*** (0.092)	-0.037*** (0.001)
$Turnover\ ratio_{i,t}$	-25.26*** (1.416)	-25.71*** (1.112)	-26.16*** (1.387)
$Absolute\ return_{i,t}$	10.580 (55.640)	12.380 (65.610)	13.630 (103.400)
$Spread\ ratio_{i,t}$	2.954*** (1.121)	2.338** (0.917)	1.731 (1.166)
$Return\ squared_{i,t}$	34.180 (25.391)	27.100 (15.512)	19.900* (9.723)
Year FE & firm FE	Y	Y	Y

*Note: REIT risk premium is based on the log difference of each REIT's Total Return Index and US Federal Reserve Funds Rate. Market risk premium is based on the log difference of S&P 500 Total Return Index and US Federal Reserve Funds Rate. This table reports coefficients of the interaction between the financial variable and market risk premium from the 0.25, 0.50 and 0.75 quantile regressions for each of the financial variables in separate regressions for each variable, using daily data. Year fixed effects (fiscal year) and firm fixed effects are controlled. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

The quantile regression model estimates the conditional quantiles of the dependent variable, which is REIT risk premium. The three quantiles that are estimated are the 25th, 50th, and 75th percentiles. The 25th percentile represents the value of REIT risk premium below which 25% of the observations fall, the 50th percentile represents the median value of REIT risk premium, and the 75th percentile represents the value of REIT risk premium below which 75% of the observations fall. Across these quantiles, absolute returns and size factors are consistently and positively correlated with the systematic risk of REITs with strong significance in Table 4-8.

The interaction terms between each of the financial variables (excluding four liquidity ratios) and market risk premium have a statistically significant effect on the quantiles of the dependent variable (REIT risk premium). The coefficients for these five variables are positive and significant for all three quantiles. This indicates that the effect of the market risk premium on the quantiles of REIT risk premium is not constant across all values of size and leverage. For example, a one percentage point increase in the interaction term of size is associated with a 0.158% increase in the 25th percentile of REIT risk premium. Comparing Column (1) to Columns (2) and (3) in Table 4-8, the effect of size on the 25th percentile of REIT risk premium is larger than its effect on the 50^{th} (0.151) and 75th percentiles (0.145). This suggests that size has a more pronounced effect on the lower tail of the distribution of REIT risk premium.

For profitability measure, its risk reduction effect on the 25th percentile of REIT risk premium is more than that on the 75th percentile of REIT risk premium. In contrast, the turnover ratio has slightly more risk reduction impact on REITs with higher risk premium, comparing the 25th percentile (-25.260) to the 75th percentile of REIT risk premium (26.160). Because the interaction variable between absolute return and market risk premium is insignificant in these quantiles, a further check using return squared is presented. The interaction variables with market risk premium for both absolute return and return squared are insignificant.

4.4.3.3 Firm size and its impact on turnover ratio

Table 4-9 shows the outcome of a more detailed investigation on the turnover ratio, particularly its interaction with the market risk premium. This analysis is conducted in light of the observation that the interaction variable in Columns (4) and (5) of Table 4-5 becomes statistically insignificant compared to its state in Column (3), as discussed in section 4.4.1. The results in Table 4-9 show that REITs with different size have different liquidity levels. Turnover ratio has more impact on small cap REITs than big cap REITs in the US market.

Table 4-9. US REIT risk premium and turnover ratio – small cap and big cap

	(1) US – small cap	**(2) US – big cap**
Dependent variable: REIT $risk\ premium_{i,t}$		
$Risk\ premium_{m,t}$	0.611**	0.922***
	(0.031)	(0.049)
$Turnover\ ratio_{i,t}$	0.024	-0.087*
	(0.022)	(0.042)
$Turnover\ ratio_{i,t} * Risk\ premium_{m,t}$	-29.003***	-17.470***
	(2.144)	(3.649)
Constant	0.001***	-0.002
	(0.002)	(0.001)
Observations	364,915	106,208
R-squared	0.260	0.294
Number of REITs	137	143
Year FE	Y	Y
Firm FE	Y	Y
SE clustered by firm	Y	Y

*Note: Big cap stocks have market capitalisation values above USD 10 billion. Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

The results in Table 4-9 indicate varying liquidity levels among REITs of different sizes. Notably, the turnover ratio exerts a more pronounced influence on small-cap REITs (-29.0) in the US market compared to their large-cap (-17.5) counterparts. Small-cap REITs are more sensitive to illiquidity induced risks.

4.5 Sector analysis of US and Australian REITs

Previously, Chapter 2 examined the performance of REITs based on broad category. This section compares the sector performance of US and Australian REITs by splitting them into more detailed sector groups. Before the comparison between the two countries, the summary statistics of financial variables of A-REITs are presented in Table 4-10.

Table 4-10. Summary statistics of A-REIT variables for analysis on daily basis

Variable	No. of Obs	Mean	Std. Dev.	P5	P95	Min	Max
REIT daily risk premium	114,776	0.00024	0.02	-0.03	0.03	-1.03	0.62
Average REIT daily risk premium	148,172	0.00026	0.01	-0.01	0.01	-0.15	0.08
Market risk premium	235,532	0.00020	0.01	-0.02	0.02	-0.12	0.09
Size	104,776	0.57	1.32	-1.24	2.68	-2.30	3.71
Leverage	104,776	0.31	0.12	0.10	0.52	0.00	0.75
Yield	102,255	0.70	0.26	0.38	1.18	0.04	2.32
MTB	102,255	1.00	0.34	0.60	1.54	0.10	3.30
Yearly beta	206,096	0.00	0.01	-0.02	0.02	-0.21	0.18
Absolute returns	116,166	0.38	0.42	0.04	0.83	0.00	7.67
Turnover ratio	114,776	0.01	0.02	0.00	0.04	0.00	1.03
Spread ratio	40,356	-0.01	0.01	-0.02	0.00	-0.38	0.00

Table 4-10 illustrates the summary statistics of firm-specific financial variables for Australian REITs. The A-REIT risk premium has a lower standard deviation than the US REITs risk premium, as the standard deviation of the REIT daily risk premium is slightly higher in the US (0.04) than in Australia (0.02). Meanwhile, REITs in both markets on average have higher risk premium than market risk premium. The mean leverage is higher in the US (0.48 before scaling) than in Australia (0.31), which is consistent with previous research that Australia has lower leverage due to leverage limits (Dogan et al., 2019). The slightly higher mean value of yield in the US (0.71 before scaling down) compared to Australia (0.70) suggests that US REITs are more efficient in generating income from their properties. The mean of absolute returns is much higher in Australia (0.38) than in the US (0.01), indicating a more illiquid A-REIT market with more variations in returns.

Overall, the comparison of Tables 4-3 and 4-10 suggests that Australian REITs are riskier than US REITs, but they also offer the potential for higher returns. Investors should carefully consider their own risk tolerance and investment goals before investing in either market. This is likely due to several factors, including the different economic conditions in the two countries, the different regulatory environments, different market size and depth, and the different composition of the REIT subsectors in the two countries.

Table 4-11 demonstrates the number of REITs and the size of each sector in the US and Australian REIT markets as of June 2021. The table shows that the US REIT market is much larger than the Australian REIT market, with a total size of US$1.48 trillion compared to AU$111.64 billion. It also shows that the US REIT market is more diversified than the Australian REIT market. The largest sector in the US REIT market is the specialty sector, with 47% of the total market size, including REITs with an investment focus on towers for communications. The largest sector in the Australian REIT market is the diversified sector, with 43% of the total market size.

Table 4-11. Property sectors of US and Australian REIT markets

	US		Australia	
Sector	Number of REITs	Size (USD, billion)	Number of REITs	Size (AUD, billion)
Hotel	18	41.77	1	0.42
Office	24	114.26	3	1.68
Retail	37	196.59	8	24.84
Diversified	25	67.96	10	47.30
Healthcare	17	129.23	3	3.38
Specialty	35	699.98	3	3.16
Industrial	13	220.98	2	30.86
Residential	16	217.54	0	

Note: As of June 2021. Data Source: S&P CIQ Pro

In both the US and Australian REIT markets, the second largest sector is industrial, and the smallest sector is hotel by market size. Diversified A-REITs such as Mirvac conduct business in the residential sector, but there is no residential REIT in the Australian market. The US REIT market has a large residential sector comparable to the size of the US industrial sector. These differences in sector composition are likely due to various factors, including the different economic structures and property types based on the geography of the two countries. The US economy is more service-oriented, while the Australian economy is more resource-oriented. This is reflected in the relatively larger size of the healthcare and specialty sectors in the US REIT market, and the relatively larger size of the industrial and residential sectors in the A-REIT market.

Table 4-12 presents the results of the regression of US REIT risk premium on market risk premium, sector dummies, and interaction variables between the sector dummies and the market risk premium from 2000 to 2021. The results show that the betas are strongly significant with a value of 0.987 in Columns (1) and (2). This means that for every one percentage point change in the market risk premium, REIT risk premium is expected to change by 0.987% in the same direction.

The sector dummies are important predictors of REIT risk premium. All the sector dummies have significant coefficients, except for office. This means that REITs in all sectors except the office sector tend to have higher risk premiums than REITs in the hotel sector. The coefficient of market risk premium represents beta, and the base group of beta values measures hotel sector beta. The interaction variables between the sector dummies and the market risk premium are also strongly significant except for diversified and industrial REITs, which have moderate significance. This suggests that the impact of the sector dummies on REIT risk premium varies depending on each sector compared to the base group of hotel sector. For example, the coefficient of the interaction variable between the specialty sector dummy and the market risk premium is negative. This means that the impact of the specialty sector dummy on REIT risk premium is lower compared to the base group hotel REITs.

Table 4-12. Sector analysis of US and Australian REIT using daily data

	(1) US	(2) US	(3) US	(4) Australia	(5) Australia	(6) Australia
Dependent variable: REIT $risk\ premium_{i,t}$						
$Risk\ premium_{m,t}$	0.987***	0.987***	1.325***	0.480***	0.480***	0.448***
	(0.027)	(0.027)	(0.064)	(0.039)	(0.039)	(0.000)
Sector dummy (base = hotel)						
$Specialty_i$		0.000**	0.000***		0.000***	0.000***
		(0.000)	(0.000)		(0.000)	(0.000)
$Diversified_i$		0.002***	0.002***		0.000***	0.000**
		(0.000)	(0.000)		(0.000)	(0.000)
$Healthcare_i$		0.000***	0.001***		-0.000***	-0.000**
		(0.000)	(0.000)		(0.000)	(0.000)
$Industrial_i$		0.000***	0.001***		-0.000	-0.000*
		(0.000)	(0.000)		(0.000)	(0.000)
$Residential_i$		0.000***	0.000***			
		(0.000)	(0.000)			
$Office_i$		0.000	0.000**		-0.000***	-0.000***
		(0.000)	(0.000)		(0.000)	(0.000)
$Retail_i$		0.000***	0.000***		-0.000***	-0.001***
		(0.000)	(0.000)		(0.000)	(0.000)
$Specialty_i * Risk\ premium_{m,t}$			-0.437***			-0.165***
			(0.091)			(0.046)
$Diversified_i * Risk\ premium_{m,t}$			-0.338**			0.112*
			(0.109)			(0.046)
$Healthcare_i * Risk\ premium_{m,t}$			-0.395***			-0.072
			(0.099)			(0.116)
$Industrial_i * Risk\ premium_{m,t}$			-0.443**			0.194
			(0.137)			(0.144)
$Residential_i * Risk\ premium_{m,t}$			-0.552***			
			(0.096)			
$Office_i * Risk\ premium_{m,t}$			-0.263***			-0.166***
			(0.076)			(0.009)
$Retail_i * Risk\ premium_{m,t}$			-0.294***			0.014
			(0.077)			(0.076)
Constant	0.001**	0.000*	0.000	0.001*	0.001*	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	542,673	542,673	542,673	90,053	90,053	90,053
R-squared	0.190	0.190	0.194	0.092	0.092	0.096
Number of REITs	165	165	165	30	30	30
Year FE	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
SE clustered by firm	Y	Y	Y	Y	Y	Y

*Note: REIT risk premium is based on the log difference of each REIT's Total Return Index and risk-free rate. US Federal Reserve Funds Rate and RBA cash rate are used as a proxy for the risk-free rate for the US and Australia respectively. Market risk premium is based on the log difference of S&P 500 Total Return Index and S&P/ASX-200-Financials-ex-REIT Total Return Index for the US and Australia respectively, then minus the corresponding risk-free rate. Overall R-squared is reported. Standard error in parentheses. * p<0.05, ** p<0.01, *** p<0.001.*

Overall, the results of the regression suggest that the market risk premium and sector dummies are both important factors that influence the risk premium of US REITs. REITs in all other sectors tend to have higher risks than REITs in the hotel sector. However, the impact of the sector dummies on REIT risk level varies depending on the level of market risk.

Table 4-12 also demonstrates the regression results of A-REIT risk premium on market risk premium, sector dummies, and interaction variables between the sector dummies and the market risk premium from 2000 to 2021. The results show that the A-REIT has a strongly significant beta of 0.448 to 0.480. This means that for every one percentage point increase in the market risk premium, the Australian REIT risk premium is expected to increase by 0.480%.

In Column (6) of Table 4-12, the specialty and diversified sector dummies have positive coefficients, while the sector dummies for healthcare, industrial and retail all have negative coefficients. This means that REITs in the specialty and diversified sectors tend to have higher risk premiums than REITs in the hotel sector, while REITs in the healthcare, industrial and retail sectors tend to have lower risk premiums than REITs in the hotel sector. The interaction variables between the sector dummies and the market risk premium are strongly significant and negative for specialty and office, suggesting that these two sectors have relatively lower risks than the hotel sector.

The results of sector betas from Table 4-12 are calculated and ranked in Table 4-13. As an illustration, the beta value for US hotel REITs is derived from the market risk premium coefficient found in Column (3) of Table 4-12. On the other hand, the beta for US office REITs is calculated as the sum of the market risk premium coefficient (1.325) and the coefficient of the interaction variable between office and market risk premium (-0.263), resulting in a total of 1.062. A beta of 1.0 means that the security is expected to move in line with the market, while a beta of greater than 1.0 means that the security is expected to be more volatile than the market. US sector betas fluctuate around 1.0 whereas A-REIT sector betas are around 0.5, suggesting that A-REITs carry 50% less risk than US REITs. The table shows that the hotel sector has the highest beta (1.325) for US REITs. This means that REITs in the hotel sector are expected to be the most volatile in the US. Hotel, office, and retail REITs in the US are very volatile and will move more than the market index.

Table 4-13. Ranking property sectors by beta values from Table 4-12

Panel 1 – US REITs		**Panel 2 – Australian REITs**	
Sector	**Beta**	**Sector**	**Beta**
Hotel	1.325	Industrial	0.598
Office	1.062	Diversified	0.560
Retail	1.031	Retail	0.462
Diversified	0.987	Hotel	0.448
Healthcare	0.930	Healthcare	0.376
Specialty	0.888	Specialty	0.283
Industrial	0.882	Office	0.282
Residential	0.773		

By contrast, industrial REITs have the second-lowest beta in the US with a value of 0.882, whereas they have the highest beta for Australia with a value of 0.598. This implies A-REITs tend to move less than the major stock market. Office REITs are the least risky with a beta value of 0.282 in Australia although office REITs have the second-highest beta in the US. Diversified REITs have the second-highest beta in Australia, but they rank fourth in the US market. The residential sector has the lowest beta (0.773) for US REITs, implying that US residential REITs are expected to be the least volatile.

4.6 Summary

4.6.1 Economic impact

This chapter analysed the effects of firm-specific features on REIT performance with evidence of significant size, profitability and liquidity variables. The US and Australian REIT markets are similar in some ways and different in others. For commonalities, the market risk premium is a strongly significant predictor of REIT risk premium in both markets. In the US market, the coefficient of the market risk premium is 0.536, while in the Australian market, the coefficient ranges from 0.104 to 0.113. This means that for every 1% increase in the market risk premium, REIT risk premium is expected to increase by 0.536% in the US and by 0.104% to 0.113% in Australia.

Leverage is negatively correlated with REIT risk premium in both markets. In the US market, the coefficient of total debt/total assets is -0.001, while in the Australian market, the coefficient is -0.002. This suggests that REITs in both markets with higher debt levels tend to have lower risk premiums. One possible reason for this is that REITs with higher debt levels are more sensitive to interest rate changes, which can increase their risk. The residential property index return is positively correlated with REIT risk premium in the US market (0.113) and the Australian market (0.165). This suggests that REITs in both markets are positively correlated with the performance of the residential property market. REITs and residential properties are both exposed to similar economic factors, such as interest rates and economic growth.

The subsector performance of US REITs is different from Australian REITs. In the US, hotel REITs have the highest beta (1.325) and are much more sensitive to economic fluctuations than the industrial REITs with the highest beta (0.598) in Australia. However, A-REITs in the industrial sector are more volatile than US industrial REITs. Office REITs are the least risky sector in the Australian market, with a beta of 0.282, while residential REITs are the least risky sector in the US market, with a beta of 0.773. This suggests that office REITs in Australia are less sensitive to economic fluctuations than residential REITs in the US. Overall, the US REIT market is more volatile than the Australian REIT market. This could be due to the larger size of the US REIT market, the depth of the US capital market, the heterogeneity and diversity of the US property market, and the different regulations of the US economy.

Despite the higher betas, REITs in the US market tend to be more liquid than REITs in the Australian market. This is because the US REIT market is larger and more diverse than the Australian REIT market. REITs in the US market have higher yields than REITs in the Australian market. This could be attributed to the more mature US REIT market and its longer track record of profitability. It is important to note that there are various factors that can affect the liquidity and profitability of REITs, including the capitalisation of the REIT sector, the management team of REITs, and the overall economic environment. Therefore, investors who seek higher returns and liquidity with understanding of high volatility could consider US REITs as part of their portfolio.

Based on a CBRE report (Weinberg et al., 2022), 15% of US REITs are in the telecoms tower property sector, 15% are in residential, and 12% are in industrial properties. This stands in stark contrast to A-REITs, where tower properties are not securitised in the Australian REIT market. In addition, the structure and stability of the banking systems in the two countries also contribute to different performance in the US and Australia. In the US, the financial system has a large number of diverse financial institutions, including thousands of banks, which face significant challenges of regulations. Australia's banking system, with a concentration of four major banks, was relatively more stable during the GFC. The US capital market is less regulated than the Australian capital market in terms of financial derivatives, and as a result, the US market suffered more during the GFC than Australia did. Moreover, the US sector REIT betas reflect the market trends and the risk perception of investors. For global investors, understanding US REITs and their betas shows how volatile these assets are compared to A-REITs. This information is crucial for investors when making informed portfolio management decisions and overall risk management.

4.6.2 Conclusion

This chapter has highlighted the importance of firm-specific factors, especially firm-level liquidity measured by absolute returns and spread ratio, in evaluating the risk of REIT investments. Additionally, the subsector performance of the REIT market is important to risk and return determination with varying results in the US and Australia. For Australian REITs (A-REITs), the results suggest that the control variables and Fama-French factors are important determinants of the returns and risks of A-REITs. Investors can use the control variables and Fama-French factors to construct portfolios that meet their individual risk and return objectives. For example, investors who are looking for smaller, less risky REITs may want to consider those with lower SMB factors.

For US REITs, the ranking of property sectors by beta values has important implications. Investors who are looking for lower risk investments should consider investing in sectors such as the residential sector. Investors who are looking for higher returns may want to consider investing in the hotel sector or the specialty sector. However, these sectors are also expected to be more volatile. The ranking of property sectors by beta values can be used to construct portfolios that meet different risk and return objectives. It is important to note that the ranking of property sectors by beta values is based on historical data. It is possible that the betas of different sectors could change in the future. Additionally, the ranking of property sectors by beta values is only one factor that REIT investors should consider when making investment decisions. Other factors, such as the sector's fundamentals and the investor's own risk tolerance, should also be considered.

This chapter contributes to the academic research on REIT risk and return by providing evidence that firm-specific factors, such as firm-level liquidity measured by absolute returns and spread ratio, are important determinants of REIT risk. It also provides evidence that the subsector performance of the REIT market is important to risk and return determination, with varying results in the US and Australia. Additionally, investors can refer to the firm-specific variables and Fama-French factors to construct portfolios that meet their individual risk preferences and return objectives. Finally, the chapter provides evidence that the property subsectors have varying beta values, which has important implications for REIT investors.

Overall, this chapter provides valuable insights into the factors that REIT investors should consider when evaluating risk and return. By carefully considering firm-specific factors, subsector performance and beta values, REIT investors can make more informed investment decisions.

Chapter 5 **Summary and conclusions**

This chapter concludes the thesis. The following sections summarise the key findings of the empirical analysis, discuss the implications and contributions of the results, and suggest directions for future research.

5.1 Summary of the study

REIT beta is a complex phenomenon that can be affected by a variety of factors. This thesis investigated the drivers of REIT beta from three different perspectives: the diversification benefit of specialised A-REITs, A-REIT beta with regime-switch considerations, and firm-specific risks considering firm-level financial ratios in the US market.

Given the unexplored nature of A-REIT beta from a broad fund focus perspective, Chapter 2 explored the differential risk-adjusted returns between specialised and diversified REITs in Australia. By categorising REITs into these two groups, the hypothesis of the CAPM as a sufficient explanation of REIT returns was examined. Additionally, fund concentration based on the Herfindahl-Hirschman Index as an alternative method of splitting REITs into broad groups was considered. This index was constructed using property transaction records. Robustness checks were conducted using yearly windows on daily and monthly data, subperiod checks, Fama-French size and value factors, and Dimson and Scholes-Williams beta calculation methods. The subperiod analysis led to further exploration of beta in Chapter 3.

In light of the dynamic nature of A-REIT beta, Chapter 3 scrutinised the stock market and A-REIT market regimes to gain insights into how regimes are relevant to REIT beta. Using volatility level as the regime identification criterion, this chapter explored the performance of A-REIT beta under varying market conditions. Leveraging regime-switching analysis, the CAPM model was tested to assess the behaviour of A-REIT beta across different stock market regimes and A-REIT market regimes. The chapter also investigated whether the diversification benefits of specialised REITs persist during normal (boom) and crisis periods based on the market regimes.

In addition to the essential firm-level financial factors such as leverage, liquidity and size, Chapter 4 exploited US equity REIT data to rigorously examine the relationship between REIT beta and firm characteristics. As real estate is a relatively illiquid asset compared to general stocks, this in-depth examination explored the underlying determinants of REIT beta at the firm level with comprehensive fund-level liquidity consideration by calculating three different liquidity measures. Recognising the diverse nature of REITs and the potential sector-specific performance variations, this chapter also incorporated a sector analysis of both US and Australian REIT markets to show the differences. Quantile regression and splitting REITs into groups based on firm size were used to enhance the robustness of the findings.

5.2 Key findings for research questions

The empirical results show that REIT beta is less than 1, indicating that REITs are generally less risky than the major stock market index S&P/ASX-200-Financials-ex-A-REIT Total Return Index in Australia. In addition, specialised REITs have lower beta (0.140) and are robust (0.151) to the Fama-French size and value factors, implying the existence of a diversification benefit compared to diversified REITs. It means that specialised REITs have less volatile returns and higher risk-adjusted returns than diversified REITs. This finding suggests that property type concentration can help REITs reduce systematic risk and improve risk-adjusted returns. A potential explanation of such diversification benefit is that specialised A-REITs are exposed to different property sectors, which have different risk–return characteristics. The robustness check of Dimson and Scholes-Williams beta showed that the statistical significance of such diversification benefit disappears, but the negative sign of the coefficient stays the same. Therefore, more checks were performed.

Building on the analysis of A-REITs beta, this thesis further explored the regime-switch consideration in the Australian REIT market, as the beta is believed to vary across regimes. The findings suggest that the relationship between REIT returns and stock market returns is asymmetric for normal regimes and crisis regimes, which means the diversification benefit no longer exists during crises. The beta of REITs also undergoes a significant increase, more than doubling from 0.383 during normal regimes to 1.052 in crisis regimes. This heightened beta underscores the sensitivity of REITs to changes in interest rates and economic growth, factors that exhibit volatility during crises. Additionally, the findings indicate that specialised REITs are less correlated with the stock market than diversified REITs, and that they may outperform other REITs during normal periods. As a result, investors could allocate more to A-REITs during normal (boom) periods and less during crisis periods.

The study also examined how firm-level features drive US REIT beta, including size, leverage, yield, market-to-book ratio, turnover ratio, absolute return and spread ratio. The research demonstrated that firm-level factors such as size and yield are positively associated with US REIT performance, while illiquidity influences REITs negatively. This suggests that REITs with higher levels of firm-level liquidity are less risky investments. The sector analysis of both the US and Australian REIT markets illustrated the differences in sector performance between these markets. A-REIT sector betas are generally lower than US REIT sector betas. The analysis showed that hotel REITs have the highest beta in the US (1.325) while the industrial sector has the highest beta in Australia (0.598).

5.3 Contribution and policy implications

This thesis makes substantial contributions to the existing literature on estimating REIT beta using CAPM. It is one of the first studies to examine REIT beta in the Australian context and uses a comprehensive database from S&P CIQ Pro that surpasses those used in previous research. This enables the exploration of the diversification benefit of REITs comparing specialised and diversified REITs and analysing firm-level diversification by constructing an asset-based Herfindahl-Hirschman Index, which are unexplored in earlier studies. By focusing on this previously unexplored angle, the research not only fills a crucial gap in the literature but also offers valuable insights into the unique characteristics of REIT performance in Australia.

A pivotal finding emerges: specialised A-REITs offer a significant diversification benefit for investors, even after controlling for Fama-French size and value factors. This finding is important because it suggests that investors can reduce their portfolio risk by investing in specialised A-REITs and constructing their own diversified portfolio than buying diversified REIT stocks. The empirical result also means that A-REITs can be a valuable addition to build diversified portfolios instead of merely investing in stocks. Relying solely on either public or private funds is unlikely to fully capture the complete benefits of the asset class. REITs provide investors with targeted exposure to various property sectors and allow investors to build their own portfolio by investing in specialised A-REITs that focus on a specific subsector such as retail, office, specialty or industrial properties, enabling them to refine their risk profiles and enhance risk-adjusted returns. Despite the fact that it is a localised phenomenon of superior performance of specialised A-REITs, this finding enables global investors to have a deeper understanding of the Australian REIT market for better decision-making in terms of risk reduction and asset allocation.

Further, this thesis presents the difference in REIT beta in different market conditions and contributes to the understanding of regime changes in both stock and A-REIT markets. The study sheds light on the interconnectedness between REITs and the broader stock market, as their regimes tend to exhibit synchronised shifts over time. During a bull market, the diversification benefit of specialised A-REITs is more pronounced. However, in a bear market, the diversification benefit of specialised A-REITs may diminish or even disappear. Investors should therefore consider the current and future regimes when investing in the A-REIT market. During a normal (boom) market, investors may choose specialised A-REITs that provide exposure to property sectors with a higher likelihood of outperformance.

According to Ball et al. (1998), it is assumed that the estimated relationship derived from historical data will still exist in the future when using time series in real estate analysis. One method of forecasting involves assuming various scenarios for the independent variables. Therefore, the models employed in this thesis to analyse market conditions can be used for forecasting REIT performance by making assumptions regarding the present phase of the stock market within a business cycle. The findings offer guidance for portfolio diversification and risk management strategies under dynamic market conditions, emphasising the importance of regime identification and investment decisions tailored to prevailing economic conditions. For policy makers, the market indices of stock and REITs can be used as cycle indicators for identifying the market regimes for appropriate economic policy.

In addition, this research adds to the asset pricing literature of REITs by explicitly examining both traditional firm-specific risk variables and firm-level liquidity ratios when exploring the drivers of US REIT beta. The research extends beyond the classic financial ratio consideration of size, leverage, market-to-book ratio, and yield to incorporate three distinct liquidity measures: turnover ratio, absolute spread and spread ratio. These liquidity variables cover different aspects of firm-level liquidity, providing a comprehensive assessment of liquidity's impact on REIT investments and highlighting that US REITs have higher beta yet greater liquidity compared to A-REITs. Additionally, the empirical results from sector analysis on US and Australia REIT markets offer valuable guidance for global REIT investors, as the study reveals performance disparities across the same sector in these markets, emphasising the importance of market differences of REIT sectors.

Lastly, drawing on extensive datasets exceeding 700 types of financial and accounting data for Australia and the United States, this thesis screened and cleaned the data to construct specialised variables, the Herfindahl-Hirschman Index, Fama-French size and value factors for the A-REIT market, and firm-level financial ratios. Using extensive datasets and rigorous data analysis techniques, this thesis lays the groundwork for future research endeavours in REIT. By uncovering underlying mechanisms driving REIT beta and risk premium, it paves the way for the development of theories and models, enhancing the understanding of REIT investment dynamics and informing future policy decisions in the realm of real estate investment.

5.4 Research limitations

While this thesis makes noteworthy contributions to the understanding of REITs' beta, it is important to acknowledge the limitations to identify potential avenues for further research.

The availability of data is an external constraint of research, as the university discontinued its institutional subscription to the S&P Capital IQ Pro database due to the financial impacts of the COVID-19 pandemic. The data limitation at asset level for A-REITs within collected data also restricts research directions, as there are many missing items of property transactions that record detailed information such as the purchase and sale date and price for each firm when constructing the HHI variable. Additionally, due to the time limit of the degree and the heavy workload of data cleaning for more countries, the collected data of other countries was not fully used.

Constructing firm-level Herfindahl-Hirschman Indices (HHIs) using property transaction records is not only time-consuming but also hindered by the incompleteness of data from sources like S&P Capital IQ Pro. Attempts to gather more comprehensive data for A-REITs' time-varying firm-level portfolios with individual asset prices have proven challenging due to the inconsistent availability of complete records in company annual reports and results presentations. Additionally, the statistical terminology used to describe assets varies across firms, years and REIT maturity stages, further complicating the task of constructing consistent dynamic HHIs.

The thesis primarily used OLS regression and the CAPM as its primary model. However, the CAPM beta approach has been criticised for its limitations, such as its assumption of equal sensitivity to market downturns and upturns, as well as its sole reliance on current period information. Moreover, the linear relationship assumed between REIT returns and stock market returns may not accurately reflect market dynamics, particularly during different cycles. While the study attempted to address this issue by using a regime-switch method, incorporating non-linear models or additional variables could provide a more comprehensive and nuanced understanding of REIT performance.

Another constraint of this thesis lies in its exclusive focus on the diversification benefit of the Australian REIT market, which comprises a relatively limited number of REITs, primarily categorised as small-cap firms. The findings may not be directly applicable to other markets with different regulatory environments, economic conditions, or investor behaviour due to market heterogeneity. Furthermore, this thesis mainly examined the diversification benefit of A-REITs at the asset level. Fund-level factors such as the investment style of the REIT and investor sentiment were not considered.

While this study explored the asset side of REITs, it overlooked the liabilities side, which plays an equally crucial role in shaping a REIT's financial profile. Although leverage is considered as a factor influencing REIT beta, a comprehensive understanding of REITs demands a holistic examination of both asset and liability structures. The borrowing patterns of REITs are influenced by a complex interplay of local regulatory frameworks, economic cycles, and company-specific expansion and investment strategies. Neglecting the liabilities side could lead to an incomplete picture of the risk profile of REITs.

This thesis used a distinct set of seven firm-specific risk factors to explore the determinants of US REIT beta. While the findings reveal a significant association between firm-specific risks and REIT beta, additional relevant factors may remain unexplored. The findings could hold relevance for the US market due to the inherent heterogeneity and unique characteristics of real estate, particularly in terms of location, and demand further investigation in other REIT markets. The current scope of REIT beta analysis is limited to the US and Australia, suggesting that the results could be region-specific and necessitating validation across a wider range of REIT markets globally.

5.5 Further research directions

The constraints of this thesis suggest several potential avenues for further exploration to provide a comprehensive and nuanced understanding of REIT beta. To address data availability limitations, future studies could develop methods to enrich the existing dataset by incorporating additional relevant information. Creating a framework to standardise the statistical terminology used to gauge asset value would enable the consistent construction of dynamic HHIs.

In terms of modelling approaches, further research could use other models, such as a panel regime-switching model, to capture the complex and non-linear relationships between REIT returns, market performance and other factors. Exploring the time-varying nature of REIT performance across different market cycles would provide further insights. Investigating the impact of additional variables on REIT returns using non-linear models and assessing the relationship between REIT returns and stock market returns using a broader range of models would also provide valuable insights. Addressing the unique diversification challenges faced by retail investors disrupted by the recent pandemic would also provide valuable insights into the role of REITs in their asset allocation decisions. Some models are specifically designed to capture the patterns of return volatilities, such as the vector autoregressive models that can be used to analyse REIT volatilities.

While comparisons with other REIT markets such as the US and UK could provide additional context, the focus of this research is specifically on A-REIT due to their unique market dynamics and regulatory environment. The A-REIT market operates under different economic conditions and investment structures compared to the US, which limits direct comparability. However, the findings regarding diversification benefits within A-REIT may align with general trends observed in international REIT markets because global crises impact all REITs market, though further comparative analysis could be pursued in future research to explore these relationships more comprehensively.

Expanding the analysis to include other countries with varying regulatory environments, economic conditions, and investor behaviours would enable future research to evaluate the generalisability of the findings by comparing different REIT markets such as US and UK. Further research could also explore the behaviours of specific sub-sectors in greater depth using a larger dataset, and conduct comparisons of sub-sector performance across different REIT markets.

Examining the diversification benefit of REITs at the fund level with each REIT's investment strategy will enhance the understanding of the role of fund-specific characteristics in risk mitigation. Additionally, employing a broader range of firm-specific risk factors, such as investor utility and fund strategy, would provide a more nuanced understanding of the determinants of REIT beta. Future research could examine how REIT performance is driven by the risk–return profiles of different investor types.

Examining the efficiency of the REIT market, including its pricing mechanisms and transaction costs, evaluating REIT asset valuation methodologies, and analysing the strategies and behaviours of REIT market participants would provide valuable insights as the REIT market continues to evolve and new data and technologies emerge.

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Appendices

Appendix A: Summary of 35 A-REITs: HHI

Name	Listing Date	Market Capitalisation (AUD, billion)	Specialised=1 Diversified=0	Number-weighted HHI	Value-weighted HHI
Abacus Property Group	1/11/2002	2.96	0	0.199	0.569
ALE Property Group	1/11/2003	1.11	1	1	1
APN Convenience Retail REIT	1/07/2017	0.46	1	0.959	0.837
APN Industria REIT	1/12/2013	0.72	0	0.445	0.526*
Arena REIT	1/06/2013	1.24	1	0.792	.
Aspen Group	1/04/1991	0.16	0	0.201	0.301
Australian Unity Office Fund	1/06/2016	0.43	1	0.680	1
Aventus Group	1/10/2015	1.80	1	0.917	0.986
BWP Trust	1/09/1998	2.74	1	0.876	0.913
Carindale Property Trust	1/06/1999	0.31	1	0.500	1
Centuria Industrial REIT	1/12/2012	2.29	1	0.908	0.578*
Centuria Office REIT	10/12/2014	1.43	1	0.809	0.976
Charter Hall Group	1/06/2006	7.78	0	0.260	0.340
Charter Hall Long WALE REIT	1/11/2016	3.08	0	0.503	0.432
Charter Hall Retail REIT	1/11/1996	2.18	1	0.953	0.876
Charter Hall Social Infrastructure REIT	1/05/2003	1.32	1	0.740	1
Cromwell Property Group	1/02/1973	2.11	0	0.491	0.515
DEXUS	1/10/2004	11.44	0	0.382	0.413
Elanor Retail Property Fund	1/11/2016	0.15	1	0.802	1
GDI Property Group	1/12/2013	0.63	1	0.760	0.812
Goodman Group	1/02/2005	39.51	1	0.506	0.507
GPT Group	1/04/1971	9.73	0	0.298	0.286
Growthpoint Properties	1/07/2007	3.21	0	0.503	0.574
Home Consortium Ltd.	1/10/2019	1.58	1		
HomeCo Daily Needs REIT	21/11/2020	1.18	1		
Hotel Property Investments	1/12/2013	0.56	1	0.812	0.673*
Ingenia Communities Group	1/07/2004	2.13	1	0.472	0.680
Mirvac Group	1/06/1999	11.24	0	0.195	0.352
National Storage REIT	1/12/2013	2.86	1	1	1
Rural Funds Group	1/02/2014	0.90	1	1	1
Scentre Group	1/06/2014	14.22	1	0.912	1
Shopping Centres Australasia	1/11/2012	2.73	1	1	1
Stockland	1/04/1988	10.98	0	0.162	0.396
Vicinity Centres	1/12/2011	7.03	1	0.874	0.837
Waypoint REIT	1/08/2016	2.06	1	1	1

*Note. Annualised returns are monthly returns multiplied by 12. Listing dates are from ASX, accessed October 2021 (https://www2.asx.com.au/markets/trade-our-cash-market/asx-investment-products-directory/aREITs). ALE Property Group is adjusted from diversified REITs to specialised REITs using the "Primary Property Type" of the underlying assets and introduction from company website. * Value-weighted HHI is based on the acquisition price of the asset, and for some firms, the values are adjusted using data from corresponding company websites and financial year presentation documents. Property focus is based on the largest number of assets among all property types in each firm, in which social infrastructure includes residential properties with care service, healthcare and day care centres. For value-weighted HHI, Hotel Property Investments has an original value of 0.512, adjusted using planned acquisitions and acquisition cost for two hotels and one multiuse asset with one hotel value from the firm's FY2020 report. For Centuria Industrial REIT, the original value of value-weighted HHI is 0.519; data is manually collected from the book value stated on the firm's FY2020 report and asset type from S&P CIQ; it is close to 0.5 because of one specialty data centre asset worth 25% of the overall portfolio. For APN Industrial REIT, the original value of value-weighted HHI is 0.922, data manually collected from the book value and asset type stated on the company website as of 31 Dec 2020 with proforma inclusion of 3 assets. APN Property Group Limited is excluded as the index stopped on 2 April 2001, and this analysis focuses on 2002 to 2021. Irongate Group and Garda Property Group are excluded due to a lack of transaction data for underlying assets. RNY Property Trust and US Masters Residential Property are excluded as their investment focus is on the US. Data source: Standard & Poor's Capital IQ Pro as of 25 Dec 2020.*

Appendix B: Summary of 35 A-REITs: assets and returns

Name	Property Focus	No. of Assets Traded	Mean Daily Return (%)	Mean Monthly Return (%)	Mean Monthly Return (pa, %)
Abacus Property Group	office	88	0.0185	0.38	4.5
ALE Property Group	specialty	86	0.0646	1.33	16.0
APN Convenience Retail REIT	retail	95	0.0483	0.96	11.5
APN Industria REIT	industrial	34	0.0629	1.29	15.4
Arena REIT	social infrastructure	17	0.0842	1.73	20.7
Aspen Group	residential	55	-0.0789	-1.66	-20.0
Australian Unity Office Fund	office	10	0.0416	0.87	10.5
Aventus Group	retail	23	0.0576	1.15	13.9
BWP Trust	retail	90	0.0581	1.22	14.6
Carindale Property Trust	retail	2	0.0410	0.86	10.3
Centuria Industrial REIT	industrial	63	0.0651	1.35	16.2
Centuria Office REIT	office	28	0.0377	0.78	9.4
Charter Hall Group	retail	449	0.0543	1.12	13.4
Charter Hall Long WALE REIT	industrial	75	0.0394	0.83	10.0
Charter Hall Retail REIT	retail	125	0.0228	0.47	5.7
Charter Hall Social Infrastructure REIT	social infrastructure	13	0.0518	1.08	12.9
Cromwell Property Group	office	44	0.0862	1.81	21.8
DEXUS	industrial	236	0.0330	0.69	8.2
Elanor Retail Property Fund	retail	9	0.0197	0.23	2.7
GDI Property Group	office	15	0.0335	0.68	8.2
Goodman Group	industrial	58	0.0290	0.59	7.1
GPT Group	industrial	162	0.0144	0.30	3.6
Growthpoint Properties	industrial	76	0.0105	0.20	2.4
Home Consortium Ltd.	retail		0.1606	3.21	38.5
HomeCo Daily Needs REIT	retail		0.0548	1.07	12.8
Hotel Property Investments	hotel	58	0.0525	1.10	13.2
Ingenia Communities Group	social infrastructure	115	0.0187	0.38	4.5
Mirvac Group	residential	294	0.0228	0.47	5.7
National Storage REIT	self-storage	17	0.0582	1.24	14.8
Rural Funds Group	specialty (agriculture)	43	0.0947	1.92	23.1
Scentre Group	retail	44	0.0134	0.31	3.7
Shopping Centres Australasia	retail	112	0.0491	1.02	12.2
Stockland	social infrastructure	372	0.0328	0.69	8.2
Vicinity Centres	retail	106	0.0126	0.31	3.8
Waypoint REIT	specialty (fuel)	485	0.0265	0.53	6.4

*Note. Annualised returns are monthly returns multiplied by 12. Listing dates are from ASX, accessed October 2021 (https://www2.asx.com.au/markets/trade-our-cash-market/asx-investment-products-directory/aREITs). ALE Property Group is adjusted from diversified REITs to specialised REITs using the "Primary Property Type" of the underlying assets and introduction from company website. * Value-weighted HHI is based on the acquisition price of the asset, and for some firms, the values are adjusted using data from corresponding company websites and financial year presentation documents. Property focus is based on the largest number of assets among all property types in each firm, in which social infrastructure includes residential properties with care service, healthcare and day care centres. For value-weighted HHI, Hotel Property Investments has an original value of 0.512, adjusted using planned acquisitions and acquisition cost for two hotels and one multiuse asset with one hotel value from the firm's FY2020 report. For Centuria Industrial REIT, the original value of value-weighted HHI is 0.519; data is manually collected from the book value stated on the firm's FY2020 report and asset type from S&P CIQ; it is close to 0.5 because of one specialty data centre asset worth 25% of the overall portfolio. For APN Industrial REIT, the original value of value-weighted HHI is 0.922, data manually collected from the book value and asset type stated on the company website as of 31 Dec 2020 with proforma inclusion of 3 assets. APN Property Group Limited is excluded as the index stopped on 2 April 2001, and this analysis focuses on 2002 to 2021. Irongate Group and Garda Property Group are excluded due to a lack of transaction data for underlying assets. RNY Property Trust and US Masters Residential Property are excluded as their investment focus is on the US. Data source: Standard & Poor's Capital IQ Pro as of 25 Dec 2020.*

Appendix C: Fama-French factor construction

Size (SMB)

Based on small and big market values (MV), which is price per share at period end multiplied by common shares outstanding. Use the average returns of REITs with small MV minus the average returns of REITs with big MV.

Value (HML)

Based on high (top 30% inclusive) and low (bottom 30% inclusive) daily book-to-market (BTM) values, which is Basic book value per share divided by previously calculated MV. Use the average returns of REITs with high BTM minus REITs with low BTM values. A market-to-book ratio above one means that the company's stock is overvalued. A ratio below one indicates that it may be undervalued.

Size and value factor construction

To construct the size factor (smb), for each trading day, calculate the market value for each REIT with the following formula,

$$mv = share\ price * number\ of\ common\ shares\ outstanding \tag{C-1}$$

in which $share\ price$ is the daily stock price and the number of common shares outstanding is based on accounting information in each Australian financial year. For each trading day, calculate the simple mean of mv among REITs, and divide REITs into two groups subsequently. REITs belong to group "small" if their market value are higher than the simple mean of the market value of REITs and belong to group "big" otherwise. Then for each trading day, calculate the simple mean of stock return among REITs by two groups, small and big respectively. The daily size factor for REITs is the difference of simple mean of stock return between small and big size groups.

$$smb = smb\_small - smb\_big \tag{C-2}$$

To construct the value factor (hml), for each trading day, calculate the book to market value for each REIT with the following formula,

$$btm = \frac{book\ value\ per\ share}{share\ price} \tag{C-3}$$

For each trading day, calculate the 30th and 70th percentile of btm among REITs, and divide REITs into the following three groups: "high": btm is higher than or equal to the 70th btm value; "medium": btm is between than the 30th btm value and the 70th btm value (not inclusive); "low": btm is lower than or equal to the 30th btm value. For each trading day, calculate the simple mean of stock return among REITs by "high" and "low" btm groups, respectively. The daily value factor for REITs is the difference of simple mean of stock return between "high" and "low" groups.

$$hml = hml\_high - hml\_low \tag{C-4}$$

Appendix D: Data definitions from databases

Market capitalisation

Including convertible common stock on a one-to-one basis until the conversion window opens, and then at the conversion rate. If pricing is not available for secondary classes, the price of the primary class is applied.

FFO

As per the revised NAREIT definition for 2000, as reported by the company.

NCREIF property index

Including industrial, hotel, apartment, retail and office. All properties in the NPI have been acquired, at least in part, on behalf of tax-exempt institutional investors and held in a fiduciary environment. Property's return is weighted by its market value. Includes properties with leverage, but all returns are reported on an unleveraged basis. [11]

Excess return of REITs

Proxy for risk-free rate in the US is the Federal Funds rate and the RBA cash rate in Australia. Total Return Index is the total return of a security over a period, including price appreciation and the reinvestment of dividends, which are assumed to be reinvested at the closing Total Return price of the security on the ex-date of the dividend.

[11] https://www.ncreif.org/data-products/property/

S&P CoreLogic Case-Shiller 20-City Home Price NSA Index

Index levels are published with a two-month lag. Index performance is based on non-seasonally adjusted data. The index launch date is 18 December 2006. All information for an index prior to its launch date is hypothetical back-tested, not actual performance, based on the index methodology in effect on the launch date. Linearly interpolated from monthly to daily for regressions on daily basis in this thesis.

Residential Property Price Index – Weighted average of eight capital cities

Australian Bureau of Statistics, "Table 1. Residential property price index, index numbers and percentage changes", retrieved 2 March 2023. Series starts from Sep 2003 to Dec 2021. [12]

Share volume

The data source for NYSE/AMEX reports the number rounded to the nearest hundred. For example, 12,345 shares traded will be reported on the NASDAQ Stock Exchange as 12,345 and on the NYSE or AMEX exchanges as 12,300. Volume is set to -99 if the value is missing. A volume of zero usually indicates that there were no trades during the time period and is usually paired with bid/ask quotes in price fields. NYSE/AMEX volumes are the sum of volumes on all exchanges where that security traded that day.

[12] Index reference period for each index: 2011-12 = 100.0. [https://www.abs.gov.au/statistics/economy/price-indexes-and-inflation/residential-property-price-indexes-eight-capital-cities/dec-2021#data-downloads]

Closing bid

Bid is available both daily and monthly for all securities on the three major exchanges: NYSE, AMEX and NASDAQ. Bid prices for NASDAQ are handled a little differently than for NYSE/AMEX and outlined as follows:

NASDAQ

Bid is available for issues trading on the NASDAQ Stock Market during time periods when Bid or Low Price can contain the high price.

Since July 1980, NASDAQ has used the inside quotations as the closing bid and ask, with the close being at 4:00 pm Eastern time. The inside quotation is the highest bid and lowest ask for each trade date.

Bid is reported for all NASDAQ National Market securities since 1 November 1982 and for all NASDAQ securities since 15 June 1992, with the following exceptions due to source limitations (details excluded as it is for data unrelated to this research).

NYSE/AMEX

The bid for NYSE and AMEX securities is not the inside quotation, but the bid price from the last representative quote before the markets close for each trading date. Due to source limitations, only an unrepresentative quote was available on many days. These unrepresentative quotes showed very large spreads, frequently a bid of a penny and an ask of approximately double the price. These were usually posted by a market marker not on the primary listed exchange, who was required to post a quote but not interested in making a trade. From 1992 on, Bid and Ask were set to 0 when CRSP determined that the available quote was unrepresentative of trading activity, pending further research.

Bid data for NYSE are available from 31 December 1925 through the most currently completed month for securities when no closing price is available. Beginning 28 December 1992, a continuous series of bid data are available.

Closing ask

Ask is available both daily and monthly for all securities on the three major exchanges: NYSE, AMEX and NASDAQ. Ask prices for NASDAQ are handled a little differently than for NYSE/AMEX and outlined as follows:

NASDAQ

Ask is available for issues trading on the NASDAQ Stock Market during time periods when Ask or High Price can contain the high price.

Since July 1980, NASDAQ has used the inside quotations as the closing bid and ask, with the close being at 4:00 pm Eastern Time. The inside quotation is the highest bid and lowest ask for each trade date.

Ask is reported for all NASDAQ National Market securities since 1 November 1982 and for all NASDAQ securities since 15 June 1992, with the following exceptions due to source limitations. (details excluded as it is for data unrelated to this research).

NYSE/AMEX

The ask for NYSE and AMEX securities is not the inside quotation, but the bid price from the last representative quote before the markets close for each trading date. Due to source limitations, only an unrepresentative quote was available on many days. These unrepresentative quotes showed very large spreads, frequently a bid of a penny and an ask of approximately double the price. These were usually posted by a market marker not on the primary listed exchange, who was required to post a quote but not interested in making a trade. From 1992 on, Bid and Ask were set to 0 when CRSP determined that the available quote was unrepresentative of trading activity, pending further research.

Ask data for NYSE are available from 31 December 1925 through the most currently completed month for securities when no closing price is available. Beginning 28 December 1992, a continuous series of ask data are available.

Closing price or Bid/Ask average

The number in the price field has a negative sign to indicate that it is a bid/ask average and not an actual closing price. Please note that in this field the negative sign is a symbol and that the value of the bid/ask average is not negative.

If neither closing price nor bid/ask average is available on a date, *prc* is set to zero. In a monthly database, *prc* is the price on the last trading date of the month. The price series begins the first month-end after the security begins trading and ends the last complete month of trading.

If the security of a company is included in the Composite Pricing network, the closing price while listed on NYSE or AMEX on a trading date is the last trading price for that day on the exchange that the security last traded.

Similarly, highs, lows and volumes include trades on all exchanges on which that security traded. For example, if a stock trades on both the NYSE and the PACX (Pacific Stock Exchange), and the last trade occurs on the PACX, the closing price on that day represents the closing price on the PACX, not the NYSE. Price data for NASDAQ securities comes directly from the NASD with the close of the day at 4:00 pm Eastern Time. Automated trades after hours on NASDAQ are counted on the next trading date, although the volumes are applied to the current date. Daily trading prices for the NASDAQ National Market securities were first reported 1 November 1982. Daily trading prices for The NASDAQ Small Cap Market were first reported 15 June 1992. *prc* for NASDAQ securities is always a negative bid/ask average before this time. All prices are raw prices as they were reported at the time of trading.