EFFECTS OF REAL ESTATE CYCLES ON VALUATION OF
U.S. REAL ESTATE INVESTMENT TRUSTS (REITs)

by

Jeong Hwan Joo

B.B.A., Seoul National University, 1994
M.B.A., The University of Minnesota, 2006

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES
(Business Administration)

THE UNIVERSITY OF BRITISH COLUMBIA
(Vancouver)

July 2013

© Jeong Hwan Joo, 2013
Abstract

This study investigates the relation between accounting depreciation bias and equity valuation in a unique industry setting, Real Estate Investment Trusts (REITs). REITs report funds from operations (FFO), an industry standardized pro forma performance measure that is computed by excluding the depreciation expense of real properties from GAAP net income. Researchers have examined short-period samples and found inconclusive results on the relative ability of FFO and GAAP net income to explain the market value of equity. This dissertation attempts to explain their results by finding that depreciation expense, the largest reconciling item between FFO and net income, has different biases over the phases of real estate business cycles.

This study uses modeling techniques to develop an industry-specific valuation model for REITs. In this model, the difference between the valuation coefficients on FFO and depreciation expense captures accounting depreciation bias and varies over the phases of real estate cycles. This model presents a theoretical link between accounting depreciation bias and the relative ability of FFO versus net income to explain the market value of equity.

Using the REIT valuation model, this study empirically examines the impact of real estate cycles on accounting depreciation bias and on the relative ability of FFO and net income to explain the market value of equity. This study finds that FFO explains stock prices better than net income does in a market boom and that there is no significant difference in explanatory power between FFO versus net income in a market bust. Further results indicate that the valuation coefficients on FFO and depreciation expense have opposite sensitivities to a state variable that summarizes information on the real estate cycle phase during a year. These results partially reconcile the mixed results of prior studies across different time periods.
Preface

This dissertation is original, unpublished, independent work by the author, Jeong Hwan Joo.
# Table of Contents

Abstract .......................................................................................................................... ii
Preface ......................................................................................................................... iii
Table of Contents ........................................................................................................... iv
List of Figures ............................................................................................................... vii
Acknowledgements ..................................................................................................... viii
Chapter 1: Introduction ................................................................................................. 1

## Chapter 2: Background and Prior Literature ......................................................... 9

2.1 Introduction ............................................................................................................. 9
2.2 Overview of Real Estate Investment Trusts ......................................................... 12
2.3 Economic depreciation versus accounting depreciation ..................................... 14
    2.3.1 Economic depreciation of real estate ......................................................... 15
    2.3.2 U.S. GAAP for depreciation and impairment for real estate .................. 17
    2.3.3 Bias in depreciation expense and impairment loss for real estate .......... 19
2.4 Evolution of FFO as a pro forma performance measure for REITs .................... 22
2.5 Studies on the relative valuation usefulness of FFO and net income ............... 25
    2.5.1 Studies of REITs in the 1990s ................................................................. 25
    2.5.2 Studies of REITs in the 2000s ................................................................. 27
2.6 Relation between real estate cycles and relative ability of FFO and net income to
    explain equity value ......................................................................................... 29
    2.6.1 Real estate cycle theory ....................................................................... 29
    2.6.2 Relating real estate cycles to the results of prior REIT studies .......... 32
2.7 Conclusion ............................................................................................................ 37

## Chapter 3: Valuation Models for REITs ............................................................... 38

3.1 Introduction ........................................................................................................... 38
3.2 Valuation models with constant valuation weights ......................................... 42
    3.2.1 Cash flow dynamics (CFD) .................................................................. 44
    3.2.2 Cash flow valuation model ................................................................... 46
    3.2.3 Accounting relations for REITs ............................................................. 47
    3.2.4 The conditions for accounting bias ...................................................... 50
    3.2.5 Feltham and Ohlson (1996) model ....................................................... 52
    3.2.6 Relation between the Feltham and Ohlson (1996) model and the valuation models
        of prior REIT studies ............................................................................. 59
    3.2.7 Valuation model using FFO and depreciation expense ....................... 62
3.3 Valuation models with time-varying valuation weights ................................... 64
    3.3.1 The impact of market-level demand shocks on cash flows .................. 65
    3.3.2 Time-varying parameters of the cash flow dynamics for REITs ........ 69
## List of Tables

Table 1  Sample selection process ........................................................................................................ 140
Table 2 Summary statistics of a trimmed sample ..................................................................................... 142
Table 3 Spearman rank correlations ....................................................................................................... 144
Table 4 Estimation of the Feltham and Ohlson (1996) model ................................................................. 146
Table 5 Replicating a test of Fields et al. (1998) .................................................................................... 147
Table 6 Replicating a test of Kang and Zhao (2010) .................................................................................. 149
Table 7 Estimation of the modified Feltham and Ohlson (1996) model ................................................... 151
Table 8 Modified Feltham and Ohlson (1996) model with lagged book value of real property
        substituted for depreciation expense ................................................................................................ 153
Table 9 Effects of NAREIT (1999) regulations and discount rates on valuation weights ...... 154
Table 10 Estimating cash flow dynamics using consensus analysts’ forecasts of FFO ........... 156
## List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Economic depreciation of a real property</td>
<td>135</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Bias in the book value of real property</td>
<td>136</td>
</tr>
<tr>
<td>Figure 3</td>
<td>The cyclical pattern in the real estate market variables</td>
<td>137</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Impact of real estate cycles on the persistence of operating cash receipts</td>
<td>139</td>
</tr>
</tbody>
</table>
Acknowledgements

I am indebted to my co-supervisors Joy Begley and Sandra Chamberlain for their insightful comments, suggestions, and inspiration. I also appreciate the valuable insights and comments of Tsur Somerville, a member of my committee. I would like to thank Gerald Feltham for his teaching of valuation theory. This thesis would not have been possible without my wife, Kyung Dam Park, who has supported me throughout my Ph.D. program. I also appreciate my mother and my parents-in-law for their support, encouragement, and advice. Finally, I am thankful for my sons, Stephen and Stanley, for providing delight in my life.
Chapter 1: Introduction

In general, the valuation of an organization ought to move up or down with real economic depreciation (e.g., wear and tear) of assets. However, depreciation that is recorded in the accounting statements of an organization is likely to be a relatively poor proxy for economic depreciation. Real Estate Investment Trusts (REITs) provide a unique setting in which to study the relation between accounting depreciation bias and valuation. REITs record sizeable charges for the depreciation of real property because REITs must hold most of their assets in real property and earn the majority of their income by renting real property to others. Generally Accepted Accounting Principles (GAAP) requires real property that is not land, to be systematically depreciated over its useful life. Land is not depreciated. Depreciation expense for real property frequently exceeds the decline in the market value of real property during a period, inducing biases in GAAP net income and the book value of equity.

The belief that depreciation expense can be a conservatively biased charge for investing in real property has led the REIT industry to put forward funds from operations (FFO) as an alternative earnings measure to net income. FFO is a non-GAAP earnings measure; it is typically calculated as GAAP net income before depreciation expense and gains and losses on the sale of property. This study examines which measure, FFO or net income, performs better in explaining equity value and under what conditions. While prior research has examined which measure dominates during a particular sample periods, with mixed results, this study proposes that the relative ability of FFO and net income to explain equity value differs over the business cycle, due to differences in accounting bias.

Researchers who have studied specific sub-periods have found differing results on which performance measure, FFO or net income, better explains equity value. Studies
examining data for the 1990s do not find definitive evidence for the superiority of FFO versus net income in explaining equity value (Fields et al. 1998; Vincent 1999). In contrast, researchers studying data for the early 2000s report that FFO outperforms net income in that period (Baik et al. 2008; Kang and Zhao 2010). Baik et al. (2008) argue that a more precise specification for the calculation of FFO, provided by the National Association of Real Estate Investment Trusts (1999), enhanced the uniformity and reliability of FFO disclosure. They argue that this enhanced reliability enables FFO to explain equity value in the early 2000s better than in the 1990s. Kang and Zhao (2010) find evidence suggesting that real properties are over-depreciated. This, they argue, gives FFO stronger information content than net income.

These prior studies have looked at short sample periods and use differing valuation models to relate accounting numbers to equity values. These research design differences make it difficult to determine whether it is accounting depreciation bias or other factors that drive these empirical results about the relative ability of FFO and net income to explain equity value.

This study attempts to reconcile the REIT studies of the 1990's with those of the 2000's by using a REIT sample that is drawn from a longer time horizon, from 1995 until 2008, and by employing common valuation models across all time periods. An important aspect of this sampling design is that it allows me to examine the effects of real estate booms and busts on the relative ability of net income and FFO to explain equity values. This is the key contribution of this dissertation. My hypotheses draw on the insight that the market value of real property held by a REIT tends to appreciate when the demand for rental space increases, and it tends to depreciate when the demand for rental space decreases. While this implies that economic depreciation is varying across real estate booms and busts, accounting depreciation will not vary over these phases. Accordingly, I conjecture that REIT investors perceive depreciation
expense as more conservatively biased when they value equity in a market boom than when they value equity in a market bust. This study develops a REIT valuation model in which accounting depreciation bias varies over real estate booms and busts. Using this valuation model, my study examines the conjecture that accounting depreciation bias varies across real estate booms and busts, leading to variability in the ability of FFO versus net income to explain equity values across the phases of real estate cycles. To the extent that this idea is supported in my empirical analysis, this dissertation suggests a theory that brings together the conflicting results of prior studies.

Chapter 3 develops a valuation model for REITs by modifying a framework introduced by Ohlson (1995) and extended by Feltham and Ohlson (1996). Ohlson (1995) expresses the market value of equity as the book value of equity plus capitalized residual income, where residual income is an earnings measure minus a capital charge for the start-of-period book value of equity. He assumes that residual income diminishes over time; this in turn implies that the market value of equity is expected to converge to the book value of equity. His model is also expressed as a weighted average of capitalized earnings (less dividends) and the book value of equity, where the weight depends on the persistence of residual income. This alternative form has been widely used in numerous empirical studies, including Fields et al. (1998).

Feltham and Ohlson (1995, 1996) extend the Ohlson (1995) model by allowing for a permanent deviation of the market value of equity from the book value of equity. Feltham and Ohlson (1995) define accounting in operating assets as conservative if the book value of operating assets is, on average, less than the present value of the cash flows generated by past and current investments. Their model includes lagged operating assets to correct for
conservative bias in operating assets.\textsuperscript{1} They discuss research and development expenditures and depreciation expense as line items that create conservative bias in accounting. However, they do not formally incorporate these line items in the model. Feltham and Ohlson (1996) formalize accounting bias due to over-depreciation of capital assets (where the start-of-period book value of capital assets depreciates at a constant rate) and unrecorded positive NPV investment opportunities. To correct for bias due to over-depreciation of capital assets, they add the start-of-period book value of capital assets to the Ohlson (1995) model. To capture the unre corded positive NPV of investment opportunities associated with current investment, they add current investment to the Ohlson (1995) model.\textsuperscript{2}


For the valuation of a REIT, I set up two stationary Feltham and Ohlson (1996) models (hereafter, stationary FO96 models) that rely on two different accounting regimes for determining earnings, one for net income and the other for FFO. Each model also contains dividends, the book value of equity, the lagged book value of real property, and capital

\begin{footnotesize}

\begin{itemize}
    \item Zhang (2000) further elaborates conservative accounting in the Feltham and Ohlson (1995) model. He shows that under conservative accounting, capitalized earnings are a less biased indicator for equity value than book value on average and the weight on capitalized earnings relative to book value is a convex function of earnings growth.
    \item Several studies extend the Feltham and Ohlson (1996) model by formalizing conservative bias in line items in the financial statements. For example, Christensen and Feltham (2003, pp. 356-358) incorporates conservatism in R&D expensing into the Feltham and Ohlson (1996) model. Begley et al. (2006) model accounting conservatism inherent in loan loss provisions and unrecorded net present value of deposit taking in the banking industry.
\end{itemize}

\end{footnotesize}
investment. In Chapter 3 I show conditions under which the market value of a REIT can be stated equivalently, using either net income or FFO for the FO96 model. The conditions rely on cash flow dynamics, and on an accounting model that contains appropriate definitions of book value and appropriate controls for accounting biases. The analysis makes clear that, compared to the stationary FO96 models, the empirical models used in Fields et al. (1998) omit the variables that Feltham and Ohlson (1996) use to control for accounting bias.

One explanation for some variability in the findings of prior research is the omission of these variables in the research designs. However, the omission of controls for bias are unlikely to fully explain why prior REIT studies have found varying results in sub-periods regarding the relative explanatory power of net income and FFO for firm value. In particular, I show that the magnitude of bias varies directly with the persistence of cash receipts. If the persistence of cash receipts varies as real estate demand shocks impact construction and rents, the importance of depreciation bias will change the explanatory power of the two regression models across the phases of real estate cycles.

To help resolve the mixed results, my study further modifies the stationary FO96 models that uses net income and GAAP book values. In particular, my modified FO96 model allows valuation weights on net income components, i.e., FFO and depreciation expense, to vary over time. The simple non-stationary FO96 model is conducive to empirical estimation and will allow for tests of whether the difference between the coefficients on these income components varies with real estate cycles.

Accordingly, Chapter 4 carries out empirical tests of the theoretical models and explores whether the mixed results of prior studies are due to their inadequate control for accounting bias that is related to real estate cycles. The main tests proceed in two steps. I begin by testing
my hypothesis that the two stationary FO96 models with control variables for accounting bias have equal explanatory power. When I estimate these models, holding the coefficients fixed across the entire sample period, this hypothesis is not supported by the data. However, when I allow the coefficients to differ across different sub-periods that are formed to reflect when the real estate cycle is in a boom or a bust I find that during the bust periods the two models have equal explanatory power as predicted. It is during the boom times that the FFO model outperforms the net income model, indicating that the stationary FO96 net income model is unable to fully control for accounting depreciation bias. When I estimate the Fields et al. models for the same combined period and sub-periods, the results show similar cyclicality in the relative explanatory power of the FFO model versus the net income model. When taken together, these results suggest that the explanatory power of net income and FFO regressions are influenced by cycles, but that the accounting bias variables I have modeled in the stationary FO96 model are an incomplete explanation for the influence of cycles.

To further investigate the impact of real estate cycles on accounting bias across different periods, I test whether the coefficients on CFO (i.e., the largest component of FFO) and depreciation expense in the non-stationary FO96 model vary over real estate cycles. The results of estimating this model support my hypotheses that when an index summarizing information on the real estate cycle phase during a year is higher, the coefficient on CFO is higher (presumably due to greater persistence in cash flows) and that the coefficient on depreciation expense is lower (presumably due to less economic depreciation in asset values). This implies that the market is placing greater weight on CFO and less weight on depreciation expense when the real estate cycle phase is high, which helps to partially explain why the Fields et al. (1998) FFO model outperforms their net income model during boom periods, since the net income
model restricts CFO and depreciation expense to have equal weights.

Consistent with the results in Baik et al. (2008), I also confirm that the valuation coefficients on my two components for FFO (CFO and FFO-CFO) are higher in the period after the NAREIT (1999) clarified the definition of FFO in order to reduce the managerial discretion on the calculation of FFO. After controlling for the effect of this regulatory change, I continue to find that the market's valuation weight on CFO is higher when the real estate cycle phase is high, while at the same time, the weight on depreciation expense is reduced. These results suggest that both the business-cycle effect and the NAREIT (1999) effect contribute to the shift in the relative explanatory power of FFO and net income across different time periods.

The dissertation contributes to the literature in accounting in four ways. First, the theoretical model in Chapter 3 articulates the conditions in which a net income model and a FFO model drawn from Feltham and Ohlson (1996) can provide the same explanatory power for equity value. This theory clarifies that prior research drawing on both the early 1990’s and in the 2000’s should take care to include appropriate control variables for accounting biases.

This study also contributes to the valuation literature by incorporating real estate cycles into the Feltham and Ohlson (1996) model. Feltham and Ohlson (1996) formalize a constant relation between value and accounting depreciation bias. This study extends their model by allowing accounting depreciation to deviate from economic depreciation over booms and busts in the real estate market. While Ang and Liu (2001) allow valuation weights to change with time-varying interest rates and risk aversion, my model allows valuation weights to change with time-varying parameters in the dynamics of cash flows.

Third, this study provides a partial reconciliation of the mixed results of prior studies on the valuation usefulness of FFO and net income. Baik et al. (2008) propose that the NAREIT
(1999) regulation reduced managerial discretion in the calculation of FFO and enhanced the reliability of FFO disclosure, enabling investors to rely more on FFO. My study finds evidence suggesting that the real estate cycles and the NAREIT (1999) regulations both contribute to shifts in the relative explanatory power of FFO and net income across the sample periods used in prior studies.

This study also contributes to a better understanding of the relation between business cycles and the informativeness of earnings or earnings components by providing a contextual example of that relation in a unique setting. Wilson (1986), Bernard and Stobber (1989), Johnson (1999), and Jenkins et al. (2009) investigate the impact of business cycles on the information content of earnings or earnings components for non-financial firms. Their results are not based on a valuation model that formally links business cycles to the information content of earnings components. My study identifies a unique setting, namely REITs, where accounting depreciation bias plays a crucial role in differentiating a pro forma performance measure (FFO) from net income. In this setting, I find that the cyclicality in accounting depreciation bias influences the relation between stock prices and these two performance measures and interpret this finding in the context of the Feltham and Ohlson (1996) model.

The rest of this dissertation is organized as follows. Chapter 2 describes the institutional background of, and accounting for, REITs, and reviews literature on the relative ability of FFO and net income to explain equity value and real estate cycle theories. Chapter 3 develops a REIT valuation model. Chapter 4 uses the REIT valuation model to perform empirical tests for the cyclicity in the relative explanatory power of FFO and net income and in accounting depreciation bias. Chapter 5 summarizes the main findings and contributions of this study and provides suggestions for future research.
Chapter 2: Background and Prior Literature

2.1 Introduction

This chapter lays the foundation for the valuation models and research design choices that I present in Chapter 3. I begin by providing the institutional background for REITs, which includes the REIT business model, REIT accounting practices, and the rationale for the practice of valuing REITs based on pro forma earnings rather than on net income. I also review the prior REIT literature, focusing on how well FFO (a pro forma performance measure for REITs) and GAAP net income perform in explaining equity values. The chapter concludes by identifying avenues for the research I conduct in Chapters 3 and 4, including the idea of relating business cycles to the pricing weights applied to FFO and net income.

As noted in Chapter 1, in order to qualify as a REIT for tax purposes, an investment fund must invest most of its assets in real estate and earn the majority of its income from rentals. Accordingly, a REIT’s net income is reduced by a sizable GAAP depreciation charge (hereafter, depreciation expense) associated with the developed component of their real estate. REIT managers have argued that depreciation expense frequently exceeds economic depreciation, thereby making GAAP net income understate firm performance.

To overcome the alleged bias in net income reporting, National Association of Real Estate Investment Trusts (NAREIT, 1991) developed a non-GAAP performance measure, FFO, which excludes depreciation expense. Since then, most REITs have reported both net income and FFO in their annual reports. Although net income is a GAAP-required and -audited performance measure that is available to all investors, NAREIT and its member companies claim that FFO reflects firm performance more accurately than net income does (NAREIT

---

3 Many public companies have disclosed their earnings based on methodologies other than GAAP. Such non-GAAP earnings are frequently called “pro forma” earnings.
1996). Analysts and the financial media have largely accepted FFO as a standard industry performance measure, but some analysts have questioned its reliability (Martinez 1998 and Smith 2001).

Motivated by the debate over FFO among market participants, academic researchers have attempted to provide evidence on how effective FFO and net income are in providing valuation relevant information for investors. These studies benchmark the two measures based on their ability to explain levels of, or changes in, publicly traded equity values. However, they have produced mixed results regarding which of these two performance measures is closer to the long-term or short-term performance measures used by the market to value REITs.

While studies of other industries are relatively consistent in finding that pro forma measures outperform net income (e.g., Bradshaw and Sloan 2002), REIT studies examining the period prior to 2000 are inconclusive regarding whether FFO outperforms net income. For example, Fields et al. (1998) examine the sample period 1991–1995 and find that a regression of stock prices on FFO, the book value of equity, and dividends does not have significantly greater explanatory power than a similar regression based on net income, the book value of equity, and dividends. However, when they add depreciation expense and other charges to the FFO regression, these two additional variables have significant explanatory power. This latter result suggests that net income contains valuation-relevant information beyond the information in FFO. Vincent (1999) examines the period 1994–1996, regressing stock returns on FFO versus net income over long and short windows. She finds that whether or not FFO has greater information content than net income differs across return windows and also across proxies for expected earnings.

In contrast to this earlier work, recent studies examining REIT valuation in the period
after 2000 indicate that FFO outperforms net income in explaining stock prices and returns. For example, Baik et al. (2008) hypothesize that NAREIT’s clarification of the definition of FFO in 1999 improved the reliability of this measure, thereby enabling investors to rely on FFO for valuation with greater confidence. The authors find that stock prices are more strongly correlated with net income than with FFO for the period 1995–1999, while the opposite is true for the period 2000–2003, following the definition clarification (See their Table 2). They also find that, for the period following NAREIT’s (1999) guidance on the definition of FFO, the stock price response coefficient on FFO (conditional on net income) increases, while the response coefficient on net income (conditional on FFO) does not change significantly. Kang and Zhao (2010) hypothesize that FFO represents a firm’s performance better than net income does because accounting depreciation overstates economic depreciation. They examine this hypothesis for the period 2000–2005. During this period, they find that depreciation expense does not have significant incremental explanatory power for stock returns over and above that explained by FFO. They also find that accumulated depreciation has significant incremental explanatory power for stock prices over and above that explained by the book value of real property, suggesting that real property is over-depreciated.

The evidence in prior studies that rely on three- to six-year sample periods does not tell the full story regarding whether FFO is superior to net income in explaining equity value. The fitted valuation equations derived from short-period samples can deviate from long-term valuation relations. In particular, short-period sample estimates are not able to capture the impact of real estate business cycles on bias in accounting depreciation for a long sample period. Accounting standards require REITs to recognize depreciation expense as if the value of real estate declines systematically over time. However, the value of real property tends to
rise in a market boom and fall in a market bust. The demand shocks created by macroeconomic cycles, together with short-term supply inflexibility due to construction lags, may lead to cyclical changes in market rents and prices (Wheaton 1999). In addition, real estate companies tend to construct or improve buildings more in a market boom than in a market bust because of higher demand and lower financial constraints in a market boom than in a market bust. Therefore, FFO (that excludes depreciation expense) is likely to explain equity value better than net income (that includes depreciation expense) when the demand for real property is expanding. In contrast, FFO is less likely to explain stock prices and returns better than net income does when demand for real property is contracting.

The remainder of this chapter is organized as follows. Section 2.2 provides an overview of REITs. Section 2.3 describes accounting for real estate assets and contrasts accounting depreciation with economic depreciation. Section 2.4 describes how FFO has evolved as an alternative measure of REIT performance. The prior literature, on the relative ability of FFO and net income to explain stock prices and returns, is reviewed in Section 2.5. Section 2.6 reviews real estate cycle theories and discusses the potential impact of real estate cycles on the relative explanatory power of FFO and net income between the 1990s and the 2000s. Section 2.7 concludes the chapter.

2.2 Overview of Real Estate Investment Trusts

This section presents a brief summary of the institutional environment in which REITs operate. The investing, operating, and dividend policies pertaining to REITs are determined by both the nature of their assets (i.e., real estate) and by their tax status. These features provide a

4 Alternatively, if a positive demand shock in a boom drives overinvestment in real estate, this leads to a subsequent bust without depending on the incidence of negative demand shocks (e.g., Rajan 1994). Section 2.6.1 will explain this point in detail.
foundation for developing a valuation model for REIT equity in Chapter 3.

The U.S. Congress authorized REITs as an investment vehicle for real estate in the 1960s. The legislation enables average investors to own a variety of properties under professional management by investing in shares of publicly traded REITs, while enjoying a tax-preferred status relative to other corporate investments.

A REIT must distribute at least 90% of its taxable income as dividends to its shareholders in order to maintain REIT status. If a REIT meets this dividend requirement, such dividends are deducted from the REIT’s taxable income (Matheson 2008). This, in turn, avoids corporate taxes and leaves shareholders to pay taxes on the dividends they receive at their own individual tax rates. Consequently, a REIT is particularly attractive to low tax rate investors because it allows shareholders to obtain a relatively large and stable stream of after-tax dividend income. Because it is extremely costly for a REIT to retain more than 10% of its taxable income for reinvestment, it has limited ability to finance investments using internally generated funds. Instead, investments will normally be funded by issuing new equity or debt.

To be eligible for this favourable tax treatment and thus be classified as a REIT under the U.S. Internal Revenue Code, an investment fund must comply with an asset test and two income tests (Brody et al. 2008; Matheson 2008). These tests are designed to encourage REITs to make long-term investments in real property while deterring them from engaging in active trading of real property. The asset test requires a REIT to invest at least 75% of its assets in real estate assets (comprising real property, mortgages, and other REITs’ stocks), cash, or government securities. The first income test requires a REIT to derive at least 75% of all

---

6 In fact, in order to discourage REITs from actively trading in real property, 100% of any realized gain from immediately turning over newly invested properties to seek short-term profits is collected as a tax. To avoid such a tax, a property must be held for at least four years.
income (except for income from active trading of real estate) from real estate sources such as rental of real property or interest on mortgages. The second income test requires a REIT to earn at least 95% of all income (except for income from active trading of real estate) from passive investments, such as rents, interests, and dividends.

REITs fall into three categories based on asset composition: equity REITs, mortgage REITs, and hybrid REITs (i.e., REITs that are part equity REIT and part mortgage REIT). An equity REIT develops, owns and operates investment property, while a mortgage REIT makes loans and holds other securities backed by real estate collateral. Because the assets of equity REITs are highly concentrated in real property, their net income involves substantial building-related depreciation expense.\(^7\) The analysis in this study focuses on equity REITs because the primary purpose of this study is to examine the relation between equity value and alternative earnings metrics that include or exclude accounting depreciation.

### 2.3 Economic depreciation versus accounting depreciation

At the heart of the debate over whether FFO or net income is a superior measure of REIT performance is the question of whether depreciation expense reflects a true cost of holding real property for investment. In this section, I describe the concept of economic depreciation as it relates to real estate. I then discuss GAAP accounting for the depreciation of real property and the extent to which GAAP depreciation is likely to represent a biased estimate of economic depreciation. The concept of accounting depreciation bias is used as a foundation for developing a valuation model for REITs in Chapter 3.

---

\(^7\) According to Kang and Zhao (2010), depreciation expense for real estate amounts to about 15% of total revenues of equity REITs.
2.3.1 Economic depreciation of real estate

In this section, I discuss the general concept of economic depreciation derived from economic income. I then examine the economic depreciation of real estate as a special case.

The market value of an asset is typically regarded as the present value of the expected future cash flows generated by the asset, discounted at a cost of capital that is commensurate with the riskiness of such cash flows.\(^8\) Economic income generated by owning an asset for a period is equivalent to changes in the owner’s wealth resulting from owning the asset during that period. If the asset pays dividends to its owner, then the economic income for the period is equal to the dividends plus (minus) any increase (decrease) in asset value during the period.

Similarly, the value of real property is defined as the present value of expected future cash flows from the property. Economic depreciation of real property during a period is defined as the fall (or rise) in the value of the real property for that period.\(^9\) The value of real property is the combined value of the land and non-land components of the property. The two components are combined in rental activities to generate a stream of future cash flows over the economic life of the non-land component. Accordingly, the market prices of the two components are usually not separately observable. In this sense, it is not possible to observe the economic depreciation of these two components separately.

Figure 1 shows that, holding total investment in real property constant, various economic factors are expected to influence the value of developed real property. The value of a real property will decline over time as the non-land component of the real property physically

---

\(^8\) Theoretical finance typically considers the value of an asset to be equal to the expected future risk-adjusted cash flows from an asset discounted at the risk-free rate of interest. However, operationally risk-adjusted cash flows are not observable. Consequently, applied finance does not risk-adjust such cash flows, but instead adds a risk premium to the risk-free discount rate.

\(^9\) Historical cost depreciation does not precisely reflect economic depreciation. The International Financial Reporting Standards (IFRS) adopt fair-value accounting for investment property, which is similar to the concept of economic depreciation. Section 2.3.3 discusses fair-value accounting for investment property in detail.
deteriorates due to aging or use, or as it becomes functionally obsolete due to changes in construction technology or users’ tastes. The reduction of property value due to deterioration and obsolescence tends to occur at a greater rate as the property gets older. Long-term economic growth or demographic changes will shift the market demand for a property in both the short and long term. This shift in market demand changes the market value of the property in the long term. In addition, business cycles can expand or contract the market demand for rental space for multiple periods, driving cyclical changes in property value. (Section 2.6 explains the business-cycle effect in detail.)

Urban and land economics research has estimated the value of land as the price of a developed property minus the cost of replacing its building component with a new building of similar size and quality (Davis and Heathcote 2007). The quality of the building component of a property is assumed to reflect past deterioration and obsolescence. The replacement cost is assumed to be determined by the productivity of construction industry and the cost of basic materials but not by the economic factors for the demand for rental space. They find evidence suggesting that most of the variations in property value are attributed to variations in land value.

In a similar vein, Nichols et al. (2013) construct a land price index using the prices of land sales. In their paper, land sales refer to trades of vacant property or property with structures that will be demolished soon. They find evidence suggesting that land prices are more volatile than property prices and that property prices are more volatile when land represents a larger share of property value.

---

10 Researchers report a relation between demographic change and real estate demand. For example, Mankiw and Weil (1989) find that the U.S. Baby Boom in the 1950s and 1960s significantly increased the demand for housing between the ages of 20 and 30 in the 1970s and the 1980s.
2.3.2 U.S. GAAP for depreciation and impairment for real estate

This section discusses the capitalization of the costs of investments in real property and the periodic adjustment of such capitalized costs through the recognition of depreciation expense and impairment losses.

Accountants capitalize the initial costs of a variety of investments in real property, which constitute a REIT’s capital assets. Real estate investments include the acquisition of undeveloped land, the construction of a new property, the acquisition of a developed property, land improvements, building improvements, and tenant improvements. The costs of these investments are recorded as either non-depreciable assets (i.e., land) or depreciable assets (e.g., buildings, improvements, etc.). If a REIT constructs a building itself, the cost of land is added to the land account while the cost of construction is added to the building account. The cost of land consists of the total amount paid for the land and any costs needed to prepare the land for its intended use (e.g., the cost of demolishing an old structure if the land is acquired for new construction). In contrast, the expenditures incurred in building parking lots or in landscaping are recorded as depreciable assets called “land improvements” because parking lots or landscape improvements normally deteriorate over time. The purchase cost of a developed property is allocated to depreciable and non-depreciable components based on the estimated relative fair values of these components, because the market prices of these components are not separately observable. The costs incurred in substantially enhancing a building’s future service potential are recorded as a depreciable asset called “building improvements.”\footnote{Building improvements include expenditures for installing new roofing and replacing heating, ventilating, and air-conditioning systems.} In contrast, the costs of ordinary repairs, regular maintenance, and replacement of minor assets (e.g., changing drapes or carpets) are normally expensed immediately. The costs of improvements made by a
property owner to meet a tenant’s specific needs are capitalized and recorded as a depreciable asset called tenant improvements.

Depreciation expense systematically allocates the capitalized cost of depreciable assets (net of the assets’ estimated salvage values) over the estimated useful lives of the assets.\textsuperscript{12} In the income statement, depreciation expense matches the cost of using the assets for a period against the revenues the assets helped to generate during the same period. Salvage values are the estimated values of the assets at the end of their estimated useful lives. In practice, most REITs use straight-line depreciation to recognize depreciation expense associated with their non-land real estate assets.\textsuperscript{13} The straight-line method results in a balance sheet asset value that declines by a constant amount per year over the asset’s estimated useful life, although the structure of an older property typically deteriorates at a higher degree than that of a younger property does. The estimated useful life is typically 30–40 years for structures and 5–15 years for building improvements and land improvements.\textsuperscript{14} The estimated useful life for depreciating tenant improvements cannot exceed the life of the lease.

The costs associated with the successful negotiation of leases, both external commissions and internal direct costs, are also capitalized and amortized on a straight-line basis over the terms of the leases. These capitalized costs are referred to as deferred leasing costs and included in prepaid assets and other assets (Washington Real Estate Investment Trust Annual Report 2011, p.70). If an applicable lease terminates prior to the expiration of its initial lease term, the carrying amount of deferred leasing costs is written off to amortization expense.

\textsuperscript{12} U.S. GAAP does not specify the estimated usefulness life for individual asset. See the Financial Accounting Standards Board (FASB) Accounting Standards Codification 360-35: Property, Plant, and Equipment - Depreciation for detailed rules regarding depreciation.
\textsuperscript{13} I randomly select 76 firm-years for 15 REITs (1995–2006) and find that the straight-line method is used for all firm-years of this sample.
\textsuperscript{14} While US GAAP does not specify a maximum useful life for capital assets, industry practice is to depreciate structures over no more than 40 years.
U.S. GAAP does not depreciate the book value of land. Land is treated as an indefinite-lived asset because land is not subject to wear and tear and can be used as a site for a new building when the current building is no longer of value. Consequently, the book value of real property, the sum of the book values of land and non-land components, depreciates systematically over the estimated useful lives of the non-land components.

Under U.S. GAAP, REITs must perform impairment tests on real property if an economic event signals that the book value of the property might not be recoverable (FASB 2001). Impairment tests consist of a recoverability test and, when recoverable amount is less than carrying value, the measurement of impairment loss. The purpose of a recoverability test is to determine whether to record an impairment loss during a fiscal period. The property is determined to be impaired if its book value exceeds the sum of its undiscounted expected future cash flows. Once a real property is determined to be impaired, impairment loss is measured as the book value of the property less its fair value.

2.3.3 Bias in depreciation expense and impairment loss for real estate

There is an ongoing debate over whether accounting should be based on estimates of fair values or historical cost (which is typically more conservative) with respect to the valuation of assets and the recognition of income. Ideally, fair values would reflect the impact of an economic event on future cash flows. However, depending on the nature of the assets, fair values may be reliably determined for some assets (e.g., publicly traded securities), but may have to be subjectively determined for other assets (e.g., a unique company-specific asset). Conservative accounting refers to an accountant’s tendency to defer the recognition of gains but

---

15 A significant decrease in market price is an example of such an economic event.
16 If the market price of a property is available, it can be used as its fair value. Otherwise, the fair value of a property is estimated as the discounted sum of expected future cash flows generated by the property.
recognize anticipated losses in order to avoid overstating performance and financial position (Watts 2003). Fair values are conceptually more relevant to investment decisions but less reliable than historical cost (Ball 2006). U.S. GAAP requires the recognition of historical cost-based depreciation and impairment losses for commercial real property in pursuit of conservatism and prudence. I elaborate this point further below.

Depreciation expense can potentially overstate the economic depreciation of property for one of two reasons. First, in many cases, a well-maintained building can be used for rental activities for a considerable period following the end of the estimated useful life of the building. For example, a high-rise office tower tends to last longer than a century, making it virtually an indefinite-lived asset. In contrast, the estimated useful life of its building component is at most 40 years. The accelerated depreciation implied by a 40-year life can cause depreciation expense to overstate the economic depreciation of property.¹⁷ Second, depreciation expense does not reflect fluctuations in the value of property, even though the property can increase and decrease in value due to expected and unexpected shifts in market demand. If property (land and buildings) values are expected to appreciate over the long term, then depreciating buildings will lead to the understatement of the property values on the balance sheet and the overstatement of economic depreciation in the income statement.

The accounting for the impairment of real property can also contribute to conservatively biased net income (Beaver and Ryan, 2005; Roychowdhury and Watts, 2007). U.S. GAAP does not allow a company to recognize unrealized gains for real property. Thus, an impairment loss cannot be recognized until sufficiently large economic losses occur and wipe out all cumulative unrecognized unrealized gains. As a result, periodic unrealized gains and losses related to real

¹⁷ However, this overstatement of periodic economic depreciation due to the accelerated depreciation will end when the estimated useful life is over. During a period following the estimated useful life, a property will continue to depreciate, and depreciation expense will no more be recognized.
property are not recognized as they occur. However, unrealized losses are recognized in a more timely fashion than unrealized gains. In addition, U.S. GAAP does not permit the recognition of impairment reversals if the market value of the asset increases in a subsequent period.

Consequently, as shown in Figure 2, the book value of real property, which is reduced by the sum of past depreciation expense and impairment losses, is likely to understate the market value of real property over time. Such conservative bias, measured as the difference between the market and book values of real property, is expected to increase (decrease) over a period during which the market price of the property rises (falls).

The conservative bias in accounting depreciation based on historical costs has raised doubts among real estate practitioners about the usefulness of net income in communicating firm performance to investors (NAREIT 1996). This motivated the NAREIT and its member companies to develop the concept of FFO, which measures performance without deducting items related to depreciation of real estate assets (Poorvu and Cruikshank 1999, pp. 135–136).

In countries that account under the International Financial Reporting Standards (IFRS), accounting for investment properties differs from the U.S. accounting treatment. While U.S. GAAP requires historical cost accounting for real property, IFRS allows companies to use either historical cost or fair values to account for their investment properties. The cost option, much like the U.S. GAAP, is to carry investment property at cost less accumulated depreciation and any accumulated impairment losses. However, if a company uses the cost option under IFRS, the company must also disclose the fair value of its investment properties in its footnotes. Under the fair value option, the fair value of real property is reported on the balance sheet and unrealized changes in fair value are included in net income.

The U.S. standard setters, the Financial Accounting Standard Board (FASB), are in the
process of making many of U.S. standards closer to their IFRS counterparts. In this process, the FASB announced its proposal to require all REIT-type companies to report investment property on the balance sheet at fair value (FASB 2011).18 The FASB argues that the current IFRS provision for investment property reduces comparability between companies that have chosen different valuation options. In addition, for a company whose main business activity is not holding real property to earn rental income and capital gains, requiring fair value accounting is likely to be overly burdensome.

2.4 Evolution of FFO as a pro forma performance measure for REITs

This section discusses the rationale that led the REIT industry to develop funds from operations (FFO) as an alternative performance measure and how the regulatory efforts taken by the NAREIT and the SEC have influenced the disclosure of FFO.

The NAREIT and its member companies developed an industry-standard pro forma performance measure, FFO.19 FFO can be roughly measured as GAAP net income before extraordinary items, plus depreciation expense, minus gains (plus losses) on the sale of property. The NAREIT also required REITs to exclude the amortization of deferred leasing costs from FFO (NAREIT 2003). The NAREIT claims that FFO reflects firm performance more precisely than net income does. They argue that depreciation expense and amortization tends to overstate economic depreciation and that gains on the sale of property, which include accumulated depreciation for property sold, also tend to overstate economic gains on the sale of property. Most publicly traded REITs include FFO in their SEC filings and generally follow the guidelines recommended by the NAREIT.

---

18 The FASB issued this Exposure Draft on October 21, 2011 and received comments on it by January 5, 2012.
19 Pro forma earnings generally refer to earnings before any items that managers deem to be irrelevant to equity value. Pro forma earnings, sometimes also known as adjusted EBITDA, are not formally defined by GAAP.
The NAREIT has made efforts to enhance the uniformity and reliability of FFO disclosure. In particular, the NAREIT has provided definitions of FFO. The following paragraphs describe how the NAREIT’s definition of FFO has changed over time.\textsuperscript{20}

In 1991, the NAREIT initially defined FFO as net income (computed in accordance with GAAP), excluding gains (or losses) from debt restructurings and sales of property, plus depreciation expense. Reported FFO in this definition is based on beneficial interest in funds from operation generated by both consolidated and unconsolidated businesses.\textsuperscript{21} In this definition of FFO, depreciation expense includes the depreciation of the REIT’s own office buildings and improvements, and the amortization of deferred financing costs. However, these items are not directly relevant to the primary rationale for introducing the FFO measure, which is to avoid a net income bias stemming from a biased depreciation expense for investment property.\textsuperscript{22} In addition, the 1991 definition of FFO does not clearly stipulate whether FFO should include or exclude non-recurring items other than gains and losses on debt restructuring.

In 1995, the NAREIT clarified the definition of FFO and encouraged REITs to disclose a reconciliation of FFO with net income. First, NAREIT recommended that only depreciation expense for assets uniquely significant to the real estate industry should be excluded from FFO. Such assets include real property, capitalized leasing costs, and tenant improvements. Second, the NAREIT suggested that any significant non-recurring items should be excluded from FFO. This is intended to make the time series of FFO more persistent. Third, the NAREIT encouraged REITs, when reporting FFO in SEC filings, to include a reconciliation of FFO with

\textsuperscript{20} See Appendix A.1 for a summary for these changes in FFO definition.
\textsuperscript{21} Recall that GAAP net income of a REIT includes income from unconsolidated businesses (joint ventures and associates) through equity method, where income from unconsolidated businesses equals a REIT’s beneficial interest (e.g., 30\%) in GAAP net income generated by these unconsolidated businesses.
\textsuperscript{22} While an investment property is leased and resold to realize capital gains, a building used for the management and administration of an entire enterprise is customized for use by an entire company but not held for commercial leases and resale. Thus, the market price of this building on a stand-alone basis differs from its value to the enterprise in its day-to-day operations.
GAAP net income.

After the NAREIT issued the 1995 guidelines on FFO disclosure, some analysts and regulators questioned the uniformity and reliability of FFO (Martinez 1998). In particular, they criticized REIT managers for inflating FFO by classifying ordinary expenses incurred in a difficult business environment as non-recurring items. To reduce managerial discretion regarding the calculation of FFO, the NAREIT (1999) recommended that FFO should include all non-recurring operating results, except for extraordinary items defined under GAAP and gains and losses on property sales.23, 24

Even after the NAREIT issued the policy bulletin to clarify the definition of FFO in 1999, some analysts and news sources still questioned the reliability of FFO. For example, Starkman and Weil (2001) complain that there is no common definition of FFO. They also point out that FFO does not count expenditures spent to maintain buildings, or gains and losses on sales of property, which become important in the matured stage of an industry.25 For these reasons, some Wall Street investment banks began forecasting Earnings Per Share (EPS) rather than FFO as a primary performance measure for REITs (Smith 2001).

In 2002, the SEC began enforcing Regulation G to require all publicly listed firms, including REITs, to reconcile their non-GAAP measures with the closest GAAP measure (SEC 2003). Regulation G is designed to curb opportunistic disclosure of non-GAAP performance

23 Appendix A.2 shows an example of the reconciliation of net income to FFO, which follows the NAREIT’s (1999) definition.
24 The NAREIT listed the examples of non-recurring items that should be included in FFO—gains and losses on derivative and hedging arrangements, the costs of abandoned transactions, provisions for potential losses other than those related to depreciable property, merger integration and REIT conversion costs, the costs of unusual compensation or severance arrangements, and debt restructuring costs except for those defined as extraordinary under GAAP.
25 Starkman and Weil (2001) do not discuss the rationale for why capital maintenance and gains and losses on the sale of property are important in the matured stage of the REIT industry. I conjecture that capital maintenance expenditures increase with the age of property portfolio. Selling an older property is likely to generate greater gains than selling a younger property is because the book value of an older property contains more accumulated depreciation than the book value of a younger property does.
measures. In the course of enforcing Regulation G, the SEC requires publicly traded REITs to include in FFO non-recurring items as defined and clarified in 1999 by the NAREIT.\(^{26}\) In September 2003, the SEC prohibited REITs from excluding impairment loss from FFO (NAREIT 2003).

### 2.5 Studies on the relative valuation usefulness of FFO and net income

Researchers have found mixed results when they have examined whether FFO is more effective than net income in explaining equity value. These studies use a variety of research designs including regressing stock prices and return on FFO versus on net income. The studies focus on examining which measure is more useful over relatively short-period samples (e.g., three-to-six years). This section will summarize, in detail, the research designs and findings of such studies undertaken in the 1990s and the 2000s.

#### 2.5.1 Studies of REITs in the 1990s

Several REIT studies, which examine various samples from the early 1990s, find that the superiority of FFO over net income is contextual and varies by research design (Fields et al. 1998; Vincent 1999; Gore and Stott 1999). These findings do not uniformly support the REIT industry’s claim that FFO is more useful than net income for equity investors who seek information relevant to REIT performance.

Fields et al. (1998) perform tests looking at the relative ability of FFO versus net income to explain equity value for the period 1991–1995, with mixed results. On the one hand,

\(^{26}\) Frequently Asked Questions Regarding the Use of Non-GAAP Financial Measures (the ‘FAQ’), published on June 12, 2003 by the SEC, stipulates that Regulation G contemplates only the “funds from operations” measure as defined and clarified on January 1, 2000 by the NAREIT. Fortin et al. (2008) and Ong et al. (2010) find evidence suggesting that Regulation G (2002) effectively requires REITs to follow the NAREIT’s (1999) guidance in measuring FFO.
when they regress stock prices on FFO, the book value of equity, and dividends, and then
repeat the same regression with net income substituting for FFO, there is no significant
difference in explanatory power between these regressions. On the other hand, when they
regress stock prices on the FFO and non-FFO components of net income, the book value of
equity, and dividends, the coefficient on depreciation expense is almost as great as the
coefficient on FFO. This particular result suggests that FFO lacks value-relevant information
embedded in depreciation expense.

Vincent (1999) compares the information content of the two alternative performance
measures, FFO and EPS, for the period 1994–1996. She uses four return-performance
regression models. Three out of the four models regress market-adjusted returns on unexpected
performance metrics (FFO or EPS). These models use three alternative proxies for expected
performance: lagged performance (model 1), a multiplication of lagged performance (model 2),
and the consensus analysts’ forecasts of performance (model 3).\footnote{The autoregressive form of lagged earnings is econometrically equivalent to the model of earnings levels and changes in Easton and Harris (1991).} The fourth model regresses
market-adjusted returns on the current year’s level of FFO versus the current year’s level of net
income (model 4). She compares the explanatory power between regressions using FFO versus
net income.

Vincent (1999) finds mixed results across these models for varying return windows.
These results suggest that, contrary to the REIT industry’s claim, EPS is no worse a
performance measure than FFO. When models 1 and 2 are used, the information content of EPS
is greater than that of FFO for the quarterly window of returns. In contrast, for the same models
1 and 2, the information content of FFO is insignificantly different from that of EPS for the
annual window of returns. When model 4 is used, the information content of EPS is also greater

27 The autoregressive form of lagged earnings is econometrically equivalent to the model of earnings levels and changes in Easton and Harris (1991).
than that of FFO for the quarterly return window, but not for the annual return window. However, the test using model 3 does not provide conclusive results regarding the relative information content of EPS and FFO for either quarterly or annual windows of return.

Gore and Stott (1998) look at REIT stock returns and performance during the period 1991–1996. In contrast to Vincent (1999), they find that levels of FFO explain industry-adjusted stock returns better than levels of net income do. Similar to Fields et al. (1998), they decompose net income into FFO and depreciation expense. They find that the level of depreciation expense is not significantly associated with industry-adjusted returns. Whereas Vincent’s (1999) results tend to indicate that net income dominates FFO in explaining quarterly stock returns; Gore and Stott’s (1998) results indicate the opposite; i.e., FFO tends to outperform net income in explaining annual industry adjusted returns.

In summary, the mixed results of studies looking at REITs in the early 1990s do not conclusively indicate which performance measure, FFO or net income, is more useful for investors.

2.5.2 Studies of REITs in the 2000s

Studies that focus on more recent sample periods have consistently shown that FFO outperforms net income in explaining firm value (Baik et al. 2008; Kang and Zhao 2010). Baik et al. (2008) hypothesize that the NAREIT’s (1999) clarification of the definition of FFO improved the uniformity of FFO disclosures and enabled investors to rely more confidently on FFO for equity valuation than before the clarification of FFO definition. They find evidence consistent with their hypothesis. For example, stock prices are more strongly correlated with net income than with FFO for the period 1995–1999, and the opposite is true for the period

Kang and Zhao (2010) examine the period 2000–2005 and find that accounting depreciation overstates economic depreciation during this period. This conclusion is based on a regression of market-adjusted returns on the change in FFO, change in depreciation expense, and change in gains and losses on sales of property. Kang and Zhao find that the change in depreciation expense does not have significant incremental explanatory power for stock returns over and above the explanatory power of FFO. Kang and Zhao also examine the same question using price levels. They also regress levels of stock prices on net income per share, dividend per share, the book value of equity per share, and accumulated depreciation per share. They find that the coefficient on accumulated depreciation per share is significantly positive and as great as the coefficient on the book value of equity per share. This result implies that the market corrects for the understatement of the book value of equity due to the overstatement of accumulated depreciation.

Ben-Shahar et al. (2011) examine the period 2001–2008 and find that common cash dividends paid during a year are more strongly associated with FFO than with net income. They also find that common cash dividends paid during a year are less strongly associated with the reconciling items between contemporaneous FFO and net income when current depreciation expense deviates more from the normal level of depreciation expense.

In summary, the results of REIT studies looking at the early 2000s implies that, after

---

28 This specification extends the Ohlson (1995) price model in a somewhat ad hoc way. Ohlson (1995) expresses equity value as the book value of equity plus capitalized residual income. This model can be expressed as a linear combination of the book value of equity, net income, and dividends. The book value of equity includes the book value of real property that is equal to the capitalized costs of real property minus accumulated depreciation. Thus, the regression that includes accumulated depreciation as a separate variable allows the researchers to see if accumulated depreciation is valued differently than the other components of the book value of equity.

29 Ben-Shahar et al. (2011) follow Marquardt and Wiedman (2004) to estimate the normal growth of depreciation expense as the previous-year depreciation expense times the current-year growth rate of real property.
2000 FFO explains equity value better than net income does. However, all of these results rely on short-period samples and thus do not represent long-term valuation relations.

2.6 Relation between real estate cycles and relative ability of FFO and net income to explain equity value

This section presents an approach to explaining the relative valuation usefulness of FFO and net income in relation to real estate cycles. This approach attempts to explain the mixed results of prior REIT studies. Section 2.6.1 reviews real estate cycle theories. Section 2.6.2 elaborates the idea of relating real estate cycles to the valuation usefulness of FFO and net income.

2.6.1 Real estate cycle theory

While the idea that real estate fundamentals exhibit cyclical behavior is well-accepted, economists have puzzled over the reasons for this cyclicality. To get a sense for what is meant by cyclicality, the plot of total returns for commercial real estate in Figure 3 Panel A is instructive. It shows two distinct peaks, and one valley in a process that appears to move relatively smoothly between these local maxima and minima. One explanation is that this pattern of behavior occurs due to the responses of real estate time series to multiple movements in underlying, macro-fundamentals such as unemployment or credit availability. A second explanation is that real estate cycles are generated by the endogenous reaction to a single shock (such as a major change to the tax code).

Wheaton (1999) provides a useful summary article for this latter viewpoint. He takes as given that the cyclicality in real estate time series can be tied to serial correlation and
cyclicality in more fundamental macro-variables such as unemployment, and the primary focus of his paper is on the second explanation for real estate cycles. He adopts a relatively simple, stock-flow durable goods model, and demonstrates how variations in parameter assumptions can lead to the possibility of endemic cyclic behavior in property markets. The basic model assumes a demand shifting variable which is subject to unexpected shocks and the equilibration of supply and demand which allows for no vacancies. Construction lags are captured by the flow equation which assumes that new space is generated after an investment; space is assumed to depreciate at a constant rate over time. Finally, decisions about how much new space to put under construction are allowed to exhibit both irrational and rational forecasting of the prices of new space at the end of construction: investment can depend on myopic assumptions that current prices will hold when space is delivered periods from now, or, decision makers can make investment decisions based on rational guesses about the price that will hold when the space is delivered.

In the stock-flow model, the construction of new space will equal the sum of long-term growth of demand and real depreciation at equilibrium. If an unexpected demand shock occurs, levels of prices, rents, and construction will deviate from their equilibrium levels and this misalignment will last for a relatively long period because of construction lags.

Wheaton’s paper suggests that endogenous cyclicality is easier to justify theoretically if developers are irrational. This assumption creates the necessary dependence in the construction of new space on current prices that are higher than future market prices that would be established after new space is added to the current stock of space. With this assumption, a positive demand shock will induce developers to build more space than necessary, leading to an oversupply at the end of the construction of new space. In addition to the requirement that
decision makers have a myopic focus on the current price level for space in Wheaton’s framework, oscillating behavior in rents, prices, and construction requires that the price elasticity of new space construction be greater than the elasticity of demand for space. This constraint on elasticities precludes the convergence of real estate time-series into a steady state given myopic expectation of future prices of space.\(^{30}\) Under myopia and this constraint on elasticities, endogenous cyclicality is shown to be more dramatic, when real depreciation rates and (or) construction lags are greater.

Wheaton suggests that, to generate endogenous cyclicality in a world where decision makers are *rational* requires more assumptions, some of which can be justified based on observed institutional arrangements. For example, in a world of rational price forecasters, long-term lease arrangements with varying lengths can build in the dependency between current prices of space and the decision to deliver space at some point in the future. Alternatively, borrowing for new construction projects requires collateral whose liquidation value depends on arms-length prices that exist before the delivery of space. This could result in the investment decision which requires debt financing, to depend on current rather than future prices of space.

In addition to these two institutionally induced explanations for cycles within a rational world, there are other explanations in the literature where irrationality or current price dependence results from other parties whose fortunes are tied to real estate developers, particularly bankers. Rajan (1994) analytically shows that bank managers’ career concerns and herding behaviour lead to fluctuations in credit policies. Herring and Wachter (1999) propose that bank managers tend to forget a history of past losses and overlook future possible negative shocks. This disaster myopia may induce bank managers to extrapolate current prices into the

\(^{30}\) However, this endless oscillation triggered by demand shock is unrealistic. It is more realistic that a demand shock triggers a finite number of oversupply and undersupply of space.

In summary, real estate cycles may occur either as the real estate market’s endogenous reactions to a single economic shock or as the real estate market’s responses to multiple demand shocks. Construction lags as well as the rationality and incentives of bankers and developers jointly affect the likelihood of an endogenous cycle occurring. This study does not attempt to determine whether an observed market change for a specific period is an endogenous cycle. Rather, this study focuses on how the stock market evaluates the impact of an observed real estate cycle on bias in reported accounting depreciation. Thus, in this study, the term “real estate cycle” will refer to booms and busts in the real estate market and will not be restricted to referring to an endogenous cycle.

2.6.2 Relating real estate cycles to the results of prior REIT studies

The prior REIT studies outlined in Section 2.5 offer an incomplete picture of the relative ability of FFO and net income to explain stock prices and returns. This is primarily because these studies have relied on short-period samples (three-to-six years). As suggested by valuation studies on non-financial firms, valuation relations based on short-period samples will not, in general, represent valuation relations under long-term equilibrium. For example, Johnson (1999) finds that earnings are more persistent in a boom than they are in a bust, and that the corresponding earnings response coefficients are greater in a boom than they are in a bust. The results of prior empirical REIT studies that have focused on short sample periods could easily depend on which phase of a real estate cycle the researchers have sampled. In addition, the empirical findings of prior REIT studies are not based on an asset valuation model
that formally incorporates bias due to accounting depreciation. Thus, it is difficult to determine whether it is accounting depreciation bias or other factors that drive their results about the relative ability of FFO and net income to explain equity value. This section proposes that real estate cycles have contributed to the mixed results of prior REIT studies through the impact of these cycles on the bias in depreciation expense.

The connection between a REIT's market value of equity and GAAP earnings versus FFO will depend in part on the market's perception of the appropriate valuation weight to place on depreciation expense, the largest reconciling item between the two earnings measures. This idea can be elaborated in the residual income valuation framework developed by Feltham and Ohlson (1996). Briefly, a residual income model states a firm's market value as the sum of its current book value of equity, plus the discounted sum of expected future residual income where residual income refers to net income minus a charge for the cost of equity. The model is fully consistent with standard valuation theory that equates the market value of equity to the discounted sum of expected future dividends or free cash flows.

Feltham and Ohlson (1996) assume that operating cash receipts (cash revenues minus cash expenses from operations) follow an autoregressive process. They define net income as operating cash receipts minus depreciation expense. In their article, they assume that if there are no positive NPV investment opportunities, and if depreciation expense persists at the same rate as operating cash receipts, then a firm can be valued using book value of equity and current residual income alone. Under the more likely scenario that depreciation expense does not follow the same autoregressive process, the market must place a different weight on depreciation expense than will be placed on operating cash receipts. In a regression model that

---

31 Feltham and Ohlson (1996) assume that the start-of-period book value of capital assets depreciates at a constant rate. Therefore, the persistence of depreciation expense will be one minus the constant depreciation rate.
contains net income, the valuation coefficient on net income will be equal to a weighted average of the valuation coefficients on the two parts of net income—operating cash receipts and depreciation expense. The explanatory power of this regression will decline when the two parts of net income have different persistence rates. To correct for this, a research design that allows for a separate coefficient on depreciation expense would fully correct for the different persistence rates of the two parts of net income. This idea is formalized in Chapter 3.

Now let us consider two scenarios where the persistence of operating cash receipts generated by a developed property shifts during booms and busts. On the one hand, Figure 4 illustrates that a positive (negative) demand shock is expected to increase (decrease) the perceived persistence of operating cash receipts because of construction lags and fixed supply of land. On the other hand, REITs will construct more new property or spend more on capital maintenance or renovation in a boom than in a bust because they will be under less of a financial constraint in a boom than in a bust. Since the structure of a property depreciates at a faster rate as it ages, a company-level property portfolio with more newly constructed or renovated properties will depreciate at a lower rate. In summary, the company-level property portfolio will experience less economic depreciation in a market boom than in a market bust on average.

While the persistence of operating cash flows is expected to be pro-cyclical, the

32 More precisely, the model would contain not only net income but also book value of equity and dividends. In order to avoid biases in coefficients driven by any measurement errors in residual income, researchers convert the residual income model into a model that contains net income, book value of equity, and dividends.
33 The original Feltham and Ohlson (1996) model does not separate the two components of earnings. In their model, the valuation coefficient on the start-of-period book value of capital assets captures the bias in depreciation because the start-of-period book value of capital assets is assumed to depreciate at a constant rate.
34 Figure 4 assumes that operating cash receipts are equal to cash revenues from renting activities, and that contractual rents are equal to market rents. The long-term supply curve of rental space is upward sloping because of the fixed amount of land usable for new construction. In a market boom triggered by a positive demand shock, the market rents for the post-shock periods are expected to be greater than the market rents for the pre-shock periods. In a market bust triggered by a negative demand shock, the market rents for the post-shock periods are expected to be less than the market rents for the pre-shock periods. Sections 3.3.1 and 3.3.2 will further explain this mechanism.
persistence of the book value of existing property which is directly tied to depreciation is expected to not be sensitive to real estate cycle phases. Therefore, prior research that focuses on particular phases of the real estate cycle would observe different valuation weights on net income, depending on the extent to which the persistence of operating cash receipts differs from the persistence of the book value of existing property across the phases of real estate cycles. This is the essential reasoning behind my argument that the explanatory power of a regression that contains net income will vary across the phases of real estate cycles.

The residual income valuation framework can be reconciled to funds from operation (FFO), an alternative measure of net income. Valuation based on FFO assumes an accounting framework which leaves buildings and land at their gross book values without any charge for depreciation. In practice, FFO does not accommodate capital maintenance expenses that are required to keep real property generating operating cash receipts. If operating cash receipts are not expected to decline significantly over the useful life of real property, we would expect FFO to provide a good valuation metric for market participants. However, if operating cash receipts are expected to decrease significantly over the useful life of real property, a company will be required to incur capital maintenance expenses. In this case, we would expect the explanatory power of a regression based on FFO to be reduced.

In short, booms and busts in the real estate market triggered by positive and negative demand shocks are expected to cause short-term variations in the persistence of operating cash receipts, influencing the valuation usefulness of FFO versus net income for a short sample period. However, such business-cycle effects are expected to be cancelled out over a sufficiently long sample period. As a result, the long-term valuation usefulness of FFO versus

---

35 From the viewpoint of urban and land economic researchers (as discussed in Section 2.3.1), it would be an increase in land value that makes property value higher during a boom time than during a bust time.
net income will depend on whether the cash-generating ability of a developed property is expected to diminish at a significantly lower rate, on average, than the rate assumed by accounting depreciation.

I conjecture that the long-term supply and demand for rental space may enable a developed property to generate a stable stream of cash receipts, despite the natural deterioration and obsolescence of its building component. Over the previous two decades (the 1990s and 2000s), long-term growth in the U.S. economy has led to growing demand for rental space on average. Under conditions of continued growth in the demand for rental space, the fixed amount of land usable for new construction will tend to increase land prices. The long-term appreciation of land may sustain the level of market rents on average, despite natural deterioration and obsolescence of buildings, allowing FFO to provide a better valuation metric in the long term than net income does. In Chapter 4, I will show evidence supporting my conjecture.

Relating real estate cycles to the valuation usefulness of FFO and net income can contribute to the literature on the relation between business cycles and the information content of earnings and earnings components. Several multi-industry studies have examined how macroeconomic business cycles influence the information content of earnings and earnings components (Wilson 1986; Bernard and Stobber 1989; Collins and Kothari 1989; Johnson 1999; Jenkins et al. 2009). However, none of these studies examines whether macroeconomic

---

36 Wilson (1986) finds that the response coefficient on unexpected CFO is greater in bad times than in good times, while the opposite is true for the response coefficient on unexpected working capital accruals. He claims that the market prefers firms that liquidate working capital to save cash in bad times. In contrast, Bernard and Stobber (1989) examine an extended sample period that encompasses the sample period used by Wilson (1986), but finds results that differ from Wilson (1986). Collins and Kothari (1989) find that the response coefficient on unexpected earnings varies with growth opportunities and interest rates, which can vary with business cycles. Johnson (1999) finds that earnings are more persistent in a boom than in a bust and that the earnings response coefficients are greater in a boom than in a bust. Jenkins et al. (2009) find that, after controlling for future earnings and stock returns, the relation between current returns and earnings becomes weaker in market booms than in market busts.
or industry business cycles influence the informativeness of earnings and earnings components through the impact of these cycles on accounting depreciation bias.

2.7 Conclusion

Prior research on the relative valuation usefulness of FFO and net income has found mixed results, but there is no consensus as to why. Earlier studies using data from the early 1990s do not find consistent evidence that FFO is superior to net income in explaining stock prices and returns. In contrast, recent studies examining data from the early 2000s have consistently found evidence that FFO performs better than net income in explaining stock prices and returns. Researchers conjecture that this shift in explanatory power of FFO versus net income between the 1990s and the 2000s is due to the NAREIT’s clarification of the definition of FFO in 2000.

In Chapters 3 and 4, I examine an alternative explanation for this variation in the performance of FFO and net income. In particular, I investigate whether real estate business cycles drive these changes in the relative ability of FFO and net income to explain stock prices and returns. Chapter 3 develops a valuation model in which bias in accounting depreciation varies with real estate business cycles. In Chapter 4, I test whether the cyclicality of accounting depreciation bias results in cyclicality in the relative ability of FFO and net income to explain stock prices and returns. This chapter also shows that the results of this examination are robust to the changes in the FFO disclosure regulations mentioned in Section 2.4.
Chapter 3: Valuation Models for REITs

3.1 Introduction

This chapter develops a valuation model that incorporates accounting depreciation bias and relates this bias to real estate cycles. Within my model, accounting depreciation bias occurs mainly because historical cost depreciation does not reflect any appreciation of the market value of real property arising from shifts in market demand. Moreover, this bias may change over real estate cycles because the market value of real property tends to fluctuate over these cycles. Since depreciation is the dominant reconciling item between FFO and net income, formalizing the relation between depreciation bias and the market value of equity helps us understand the relative ability of FFO and net income to explain the market value of equity.

In this chapter, the formal analysis of bias due to depreciation is built on the residual income framework introduced by Ohlson (1995) and extended by Feltham and Ohlson (1996). Briefly, the residual income valuation (RIV) equation states that the market value of equity is equal to its book value plus the discounted sum of expected future residual income such that

\[ V_t = bv_t + \sum_{\tau=1}^{\infty} R^{-\tau} E_t(ni^a_{t+\tau}) \]  

(RIV)

where \( V_t \) is the market value of equity at the end of year \( t \); \( bv_t \) is the book value of equity at the end of year \( t \); \( R \) is one plus the risk-free discount rate (\( r \)); \( ni^a_{t+\tau} \) is residual income for year \( t+\tau \), measured as net income (\( ni_t \)) minus a capital charge on the beginning-of-period book value of equity (\( rbv_{t-1} \)); and \( E_t(\cdot) \) is the conditional expectation operator. The above equation assumes that investors are risk-neutral.\(^{37}\)

The residual income valuation equation is derived from the present value of expected

\(^{37}\) Christensen and Feltham (2003, p.284) interpret risk-neutrality as assuming that all risks for future residual income are idiosyncratic and that investors can diversify their portfolios to remove the idiosyncratic risks.
future net dividends (PVED) by assuming that the clean surplus relation (CSR) holds. The present value of expected future net dividends (PVED) expresses the market value of equity as:

\[ V_t = \sum_{t=1}^{\infty} R^{-t} E_t (d_{t+\tau}) \]  \hspace{1cm} (PVED)

where \( d_t \) is net dividends (dividends paid to shareholders minus net capital contributions from shareholders) for year \( t \). The clean surplus relation (CSR) attributes the change in the book value of equity only to net income minus net dividends:

\[ \text{bv}_t = \text{bv}_{t-1} + \text{ni}_t - d_t \]  \hspace{1cm} (CSR)

To reconcile PVED to RIV, future net dividend \( d_{t+\tau} \) is replaced with \( \text{ni}_{t+\tau} - \Delta \text{bv}_{t+\tau} \) and then future net income is replaced with future residual income.\(^{38}\)

Ohlson (1995) substitutes CSR into the PVED assumes that residual income follows an autoregressive time-series process and expresses the market value of equity as the book value of equity plus a multiple of current residual income:

\[ V_t = \text{bv}_t + \alpha_{ni} \text{ni}_t^a \]  \hspace{1cm} (O95)

The valuation weight on current residual income (i.e., \( \alpha_{ni} = \omega/(R - \omega) \)) reflects the discounted sum of expected future flows of residual income that persists at the rate \( \omega \). Ohlson shows that when residual income is auto-regressive, accounting is unbiased; in other words, the book value of equity may deviate from, but will eventually converge to, the market value of equity. He also identifies conditions under which mark to market accounting holds (i.e., \( V_t = \text{bv}_t \)) and when value is a multiple of earnings (i.e., \( V_t = (R/r) \text{ni}_t - d_t \)). These conditions occur when \( \omega = 0 \) and \( \omega = 1 \), respectively.

Equation O95 can be reformulated into a weighted average of capitalized net income

\(^{38}\) The transformation of PVED to RIV can be formally shown as

\[ V_t = \sum_{t=1}^{\infty} R^{-t} E_t (d_{t+\tau}) = \sum_{t=1}^{\infty} R^{-t} E_t (\text{ni}_{t+\tau} - \Delta \text{bv}_{t+\tau}) = \sum_{t=1}^{\infty} R^{-t} E_t (\text{ni}_{t+\tau} - \text{bv}_{t+\tau} + \Delta \text{bv}_{t+\tau}) = \text{bv}_t + \sum_{t=1}^{\infty} R^{-t} E_t (\text{ni}_{t+\tau}^*) \]
(adjusted for net dividends) and the book value of equity such that

\[ V_t = k [(R/r)ni_t - d_t] + (1 - k)bv_t \]  \hspace{1cm} (O95a)

where \((R/r)ni_t\) is capitalized net income; and \(k = r\alpha_m\) is the relative importance of net income versus book value in valuation.\(^{39}\)

Although the original Ohlson (1995) model uses historical cost-based net income and book value, his model can also be adapted to alternative accounting regimes so long as the clean surplus relation is maintained. In particular, the prior studies on REIT valuation compares regressions similar to that implied by Eq. O95, but using alternative measures of earnings such as funds from operations (FFO). Since FFO excludes depreciation expense, the use of FFO as an earnings measure implies a clean surplus relation in which the costs attached to buildings are capitalized as assets upon acquisition and then are not depreciated over time. To achieve a simple valuation model, using FFO would require that residual FFO \((ffo_t - rbv_{f_{fo,t-1}})\) follows an autoregressive process, where \(bv_{f_{fo,t-1}}\) is the start-of-period gross book value of equity (i.e., the book value of equity before accumulated depreciation for building). Given these assumptions, we could write equity value as:

\[ V_t = k_{f_{fo}} [(R/r)ffo_t - d_t] + (1 - k_{f_{fo}})bv_{f_{fo,t}} \]  \hspace{1cm} (O95b)

Again \(k_{f_{fo}} = r\alpha_{f_{fo}} = r\alpha_m\) is the relative importance of FFO versus the gross book value of equity; and \(\alpha_{f_{fo}}\) is the valuation coefficient attached to current residual FFO.

A shortcoming of the Ohlson (1995) model is that its consistency with unbiased accounting is unrealistic. Feltham and Ohlson (1996) address this criticism by extending the Ohlson (1995) model to allow for permanent deviations of the market value of equity from the

\(^{39}\) The adjustment for dividends reflects Miller and Modigliani’s (1961) dividend irrelevance theorem that a dollar of dividend payout decreases firm value by a dollar.
book value of equity. These deviations (or bias) can arise due to over-depreciation of capital assets (where the start-of-period book value of capital assets depreciates at a constant rate) and to the existence of unrecorded positive NPV investment opportunities. The valuation model in Feltham and Ohlson (1996) corrects for bias due to over-depreciation of capital assets by adding the start-of-period book value of capital assets to the Ohlson (1995) model. To capture unrecorded positive NPV of capital investment, Feltham and Ohlson (1996) augment the Ohlson (1995) model with current capital investment.

This chapter will review the Feltham and Ohlson (1996) model and modify it to allow two major components of net income, i.e., FFO and depreciation expense, to have different valuation coefficients.\footnote{In this model, depreciation expense is measured as a negative number in order to emphasize its income-decreasing nature.} In this base-case model, the valuation coefficient on depreciation expense is shown to deviate from the coefficient on FFO when the depreciation schedule based on current depreciation policy is a biased proxy for expected future economic depreciation of real property. A further modification allows the difference between the coefficients on FFO and depreciation expense to vary across booms and busts in the real estate market. In other words, investors are assumed to anticipate that accounting depreciation will be more or less conservatively biased when they value a REIT’s equity in a boom than when they value it in a bust. The base-case model also will be augmented with terms pertaining to the confounding effect of different depreciation rules for land and building on the valuation weight on depreciation expense.

Finally, this chapter will end by reviewing the assumptions that lead the modified Feltham and Ohlson (1996) model to reduce the Ohlson (1995) model. In particular, when the market value of real property is expected to decline over the useful life of the property and the
accounting depreciation schedule corresponds to the expected future decline in property value, the valuation weight on FFO would not differ from that on depreciation expense. This leads to a valuation model consistent with Eq. O95a. In this case, FFO and depreciation expense can be collapsed to net income, which serves as an unbiased earnings measure for the Ohlson (1995) model. However, other formulations are possible. For example, if the market value of real property is expected to be constant over the useful life of the property, a valuation model consistent with Eq. O95b will equate the market value of equity to capitalized FFO adjusted for net dividends \( k_{\text{ffo}} = 1 \).

### 3.2 Valuation models with constant valuation weights

This section describes a model with inter-temporally constant valuation weights. This model draws heavily on a variant of the Feltham and Ohlson (1996) model presented in Christensen and Feltham (2003, pp. 339-341). Just as value can be expressed using discounted future dividends, it can also be expressed as discounted free cash flows. The cash flow valuation relation (CVR) states that the market value of equity \( V_t \) is equal to the market value of net financial assets \( f_a_t \) plus the present value of expected future free cash flows from operations such that

\[
V_t = f_a_t + \sum_{t=1}^{\infty} R^t E_t (oc_{t+r})
\]

(CVR)

where \( oc_t \) is free cash flows from operations (i.e., operating cash receipts minus capital investments). Hereafter, \( oc_t \) will be referred to as operating free cash flows. The present value of expected future operating free cash flows is referred to as the market value of operating assets \( vo_t \). Net financial assets are any assets that are not operating assets and typically refer to cash and cash equivalents plus short-term investments less short- and long-term debts. The
distinction between financial assets and operating assets is important for the valuation of a REIT because a REIT finances a large portion of its investment using external debt.\textsuperscript{41} Net financial assets are assumed to be marked to market. Therefore, the market value of net financial assets is equal to the book value of net financial assets.

The CVR can be reconciled to a valuation framework that focuses on the present value of expected future net dividends (PVED). This reconciliation requires the following financial asset relation (FAR) to convert net dividends to a function of financial assets and cash flows:

\[ fa_t = fa_{t-1} + oc_t + (R-1)fa_{t-1} - d_t \]  

(FAR)

In the FAR, the book value of net financial assets is increased by operating free cash flows \((oc_t)\) and financial income \(((R-1)fa_{t-1})\) and is decreased by net dividends \((d_t)\) transferred to shareholders. The FAR equation implies that capital investments are made at the end of the period and that financial income on the start-of-period net financial assets can be used for capital investments at the end of the period.

The development of stationary (i.e., non-time varying) valuation models in this section follows the strategy illustrated in Christensen and Feltham (2003). The cash flow dynamics are specified to translate expected future operating free cash flows into a linear function of current cash receipts and capital investment. This allows valuation to be a linear function of current cash flows. Current cash flows are then transformed to accounting numbers via an assumed accrual accounting procedure. This allows the cash flow valuation model to be transformed into an accounting valuation model which will conform roughly to real-world valuation practices that rely on accounting numbers such as earnings, rather than on cash flows or dividends.

Finally, I derive a valuation model that relates equity value to the two major components of net financial assets.

\textsuperscript{41} The ratio of short- and long-term debts to total assets for my total sample has the median of 0.52 and the standard deviation of 0.17, suggesting that external debt is material.
income—FFO and depreciation expense.

### 3.2.1 Cash flow dynamics (CFD)

The following cash flow dynamics illustrate how a REIT creates value from investments in, and from the operation of, real property. Specifically, these cash flow dynamics imply that current operating cash receipts and current capital investment can be used to predict their one-period-ahead values:

\[
\begin{align*}
    c_{r, t+1} &= \omega_{rr} c_r + \omega_{ri} c_i + \varepsilon_{1, t+1} \\
    c_{i, t+1} &= \omega_{ii} c_i + \varepsilon_{2, t+1}
\end{align*}
\]

(CFD1)  
(CFD2)

where:

- \( c_{r, t} \) = Operating cash receipts (cash revenues minus cash expenses) generated by real property for period \( t \);
- \( c_{i, t} \) = Capital investment in real property for period \( t \);
- \( \omega_{rr} \) = The persistence of operating cash receipts \((0 \leq \omega_{rr} < R)\);\(^{42}\)
- \( \omega_{ri} \) = The impact of date \( t \) capital investment on date \( t+1 \) operating cash receipts \((\omega_{ri} > 0)\);
- \( \omega_{ii} \) = The persistence of capital investment \((0 \leq \omega_{ii} < R)\); and
- \( \varepsilon_{k, t+1} \) = Unpredictable shocks to operating cash receipts and capital investment \((k = 1, 2)\).

All epsilon terms have a mean of zero and a constant variance determined by information available at date \( t \). The cross-equation correlations of error terms are assumed to be zero. In this

\(^{42}\) Ultimately, Equations CFD1 and CFD2 will be used to forecast value using the cash flow valuation relation, CVR. Expected future operating free cash flows for year \( t+s \) discounted at \( R \) will be expressed as a linear combination of operating cash receipts and capital investment for year \( t \), depending on \((\omega_{rr}/R)\) and \((\omega_{ri}/R)\). To ensure that the market value of operating assets \((v_o)\) has a finite number, the sequences \((\omega_{rr}/R)\) and/or \((\omega_{ri}/R)\) must converge. This condition requires that \( \omega_{rr} \) and \( \omega_{ri} \) are less than \( R \) and are greater than \( -R \), respectively. It does not make economic sense that \( \omega_{rr} \) and \( \omega_{ri} \) have negative values.
section, all parameters are assumed to be constant over time. Each equation is described in
detail below.

The cash receipt equation, CFD1, models how future operating cash receipts \( (cr_t) \) are
determined over the forecasting horizon at date \( t \). In the context of a REIT, this equation
captures the idea that future rents net of expenses \( (cr_{t+1}) \) reflect net cash receipts from rental
contracts that have been generated by current and past investments in rental space. New capital
investment at time \( t \) \( (ci_t) \) builds new rental space or enhances the quality of existing rental
space, generating additional revenue or return at \( t+1 \) through \( \omega_{ri} \). For example, a REIT may
acquire or develop a new property, improve an existing rental space or make changes to meet
the requirements of a specific tenant.\(^{43}\) Conceptually, selling a property and realizing capital
gains is a negative capital investment.

In addition, these cash receipts are assumed to persist at a rate \( \omega_{rr} \). The persistence of
operating cash receipts \( (\omega_{rr}) \) reflects the net effects of long-term economic growth,
demographic change, deterioration, and obsolescence on current and future rents and
occupancy rates of a real property. Long-term economic growth and demographic change are
expected to drive long-term change in the demand for rental space. Meanwhile, deterioration
and obsolescence are expected to reduce the operating capacity of a real property gradually
over the useful life of the property; thus, a newer property will tend to generate higher rents
than an older property does. If the combination of these economic factors is expected to cause
rents to increase, the persistence of operating cash receipts \( (\omega_{rr}) \) will exceed one. In contrast, if

\(^{43}\) Building improvements offset the decline in the operating capacity of a property due to physical deterioration or
functional obsolescence. In contrast, ordinary repairs and maintenance that do not substantially extend the
economic life of a property are immediately deducted from operating cash receipts.
rents are expected to decrease, the persistence of operating cash receipts will be less than one.\textsuperscript{44}

Equation CFD2 models how capital investment evolves over time due to persistence in current capital investment. Long-term economic growth, demographic change, deterioration, and obsolescence jointly determine the long-term growth of capital investment. Since most construction projects are multi-year projects, current capital investment predicts future capital investment. The persistence of capital investment ($\omega_{ii}$) reflects the net effects of these economic factors.

### 3.2.2 Cash flow valuation model

Relying on the cash flow valuation relation (CVR) and forecasting operating free cash flows into the future using the cash flow dynamics (CFD1 and CFD2) leads to Equation 1 where the market value of equity is a linear function of the market value of net financial assets, current operating cash receipts, and current capital investment:

\[ V_i = f_a + v_0 = f_a + \beta_{cr} c_r + \beta_{ci} c_i \]

with the following results:

\[ \beta_{cr} = \Phi_i \omega_n \]
\[ \beta_{ci} = 1 + R \Phi_i \eta \]
\[ \Phi_i = (R - \omega_n)^{-1} \]
\[ \Phi_i = (R - \omega_n)^{-1} \]
\[ \eta = \Phi_i \omega_n - 1 \]

See Appendix B.1 for proof. The valuation weight on net financial assets is one because net financial assets have, by assumption, zero net present value and are marked to market. The valuation weight on current operating cash receipts ($\beta_{cr}$) reflects the discounted sum of expected future operating cash receipts generated by existing properties that were built or

\textsuperscript{44} For example, the recent 20-year depression in the Japanese real estate market suggests that long-term growth in real estate demand due to macroeconomic growth may be less than the natural rate of depreciation and obsolescence of real property.
acquired by past investments. A higher persistence of operating cash receipts ($\omega_r$) leads to a higher valuation weight on operating cash receipts ($\beta_{cr}$).

Current capital investment has a valuation weight ($\beta_{ci}$) that reflects a dollar of current capital investment plus its net present value. The component $\Phi_{iR}$ of $\beta_{ci}$ is the discounted sum of all current and future capital investments associated with a dollar of current capital investment. The net present value of a dollar of capital investment is referred to as

$$\eta = \Phi_r \omega_r - 1,$$

where $\Phi_r = (R - \omega_r)^{-1}$ is the discounted sum of a perpetuity of one dollar that persists at the rate $\omega_r$ ($0 \leq \omega_r < R$). If the NPV of capital investments is positive ($\eta > 0$), then the coefficient on current capital investment will be greater than one. If capital investment has zero NPV, then one can show that the coefficient on current capital investments is one.

### 3.2.3 Accounting relations for REITs

Prior research on REITs has estimated valuation models using accrual accounting information such as net income and funds from operations, not free cash flows. Accordingly, the cash flow valuation model is of limited use in providing insights on prior studies. In this section, the cash flows are translated into GAAP net income and FFO. Consistent with Feltham and Ohlson (1996), the major accrual which is modeled is depreciation expense.

As in Christensen and Feltham (2003, pp.287–289), this study relies on the following equations which summarize the financial statements of a general company:

$$bv_t = oa_t + fa_t \quad \text{(BS)}$$

$$oa_t = oa_{t-1} + ox_t - oc_t \quad \text{(OAR)}$$

$$ni_t = ox_t + (R-1)fa_{t-1} \quad \text{(IS)}$$

The balance sheet, operating asset relation, and income statement are denoted by BS, OAR, and
In the balance sheet equation, BS, the book value of equity (bv$_t$) is separated into the book value of operating assets (oa$_t$) and the book value of net financial assets (fa$_t$). Recall from the financial asset relation that net financial assets are assumed to be marked to market and earn zero NPV. Operating assets, however, potentially generate rents. Consistent with real-world accounting, the operating asset relation, OAR, reflects that the book value of operating assets is increased by operating income (ox$_t$) and it is decreased by operating free cash flows (oc$_t$) transferred to net financial assets. Since operating free cash flows (oc$_t$) refer to operating cash receipts (cr$_t$) less capital investment (ci$_t$), the OAR implies that operating income (ox$_t$) equals operating cash receipts (cr$_t$) plus operating accruals ($\Delta$oa$_t$ – ci$_t$). The IS conveys that net income (ni$_t$) equals operating income generated by operating assets (ox$_t$) plus net financial income generated by net financial assets ((R–1)fa$_{t-1}$).

REITs capitalize and depreciate their investments in real property using the historical cost of their investments. The following equation, Accounting Relation 1 (AR1) restates the balance sheet for a REIT. Specifically I assume that the book value of real property, pe$_t$, is the only operating asset and all other assets and liabilities are assumed to be financial.\(^{45}\)

\[
\text{bv}_t = \text{pe}_t + \text{fa}_t \quad \text{(AR1)}
\]

The AR1 is based on the observation that REITs use their real property to generate value.

From an accounting perspective, rents generated by a real property are credited to revenues. With respect to the costs of real property, the accounting requires first capitalization of the investments as assets. This cost outlay is deducted from revenues through the periodic recording of depreciation expense. Hence, the book value of operating assets (pe$_t$) is updated according to Accounting Relation 2, AR2:

\(^{45}\) In Appendix B.5, following Christensen and Feltham (2003, pp. 340–343), I show how the model can be extended to include working capital as a further operating asset. Working capital accruals are used to resolve the timing mismatch of revenue-expense recognition and operating cash receipts.
\[ pe_t = pe_{t-1} + ci_t + \text{depr}_t \]  

(AR2)

where \( \text{depr}_t \) is depreciation expense, expressed as a negative number to emphasize its income-decreasing nature.

While AR2 captures the acquisition of properties through \( ci_t \), it does not explicitly handle the sale of property. To non-accountants, it might seem straightforward to let \( ci_t \) include both cash outflows due to investing and cash inflows due to sales. However, these transactions are not mirror images with respect to the accounting entry. When real estate is sold, the book value of real estate is reduced by the current book value of the real estate sold and, to the extent the proceeds from the sale are greater (less) than this book value, accountants will increase (decrease) net income by a gain (loss). In other words, AR2 assumes either that on average there are no gains and losses on the sale of real property or that REITs never sell their properties. However, this section does not formally model gains and losses on the sale of real property for the sake of tractability.

Another accounting nuance that is not captured by AR2 is a decrease in the book value of real property due to impairment losses. Current impairment losses also influence the amount of future depreciation expense. See section 2.3.2 for the description of impairment tests.

As in Feltham and Ohlson (1996), I assume that the book value of real property depreciates over the useful life of real property based on the declining-balance method for an infinite horizon:

\[ \text{depr}_t = \Delta pe_t - ci_t = -(1 - \delta_{pe})pe_{t-1} \]  

(AR3)

where \( 1 - \delta_{pe} \) is the depreciation rate of the book value of real property and \( 0 < \delta_{pe} < 1 \).\(^{46}\)

---

\(^{46}\) In practice, the straight-line method for a finite estimated useful life of real property is used. Under this method, the book value of the non-land component of real property is evenly expensed over its estimated useful life. The declining balance method for an infinite estimated useful life is used for analytical convenience. The Appendix A
AR1, AR2, and OAR imply that depreciation expense for real property is the only operating accrual, i.e., $\Delta oa_t - ci_t = \Delta pe_t - ci_t = depr_t$. As a result, net income for a REIT is defined as

$$ni_t = cr_t + depr_t + (R - 1)fa_{t-1} \quad (AR4)$$

Finally, I introduce funds from operations and cash flows from operating activities:

$$cfo_t = cr_t + (R - 1)fa_{t-1} \quad (AR5)$$

$$ffo_t = ni_t - depr_t = cfo_t \quad (AR6)$$

Cash flows from operating activities ($cfo_t$) are defined as operating cash receipts ($cr_t$) plus net financial income ($R - 1)fa_{t-1}$ and are assumed to be equal to funds from operations ($ffo_t$).\footnote{The accountant’s definition of CFO incorporates operating cash receipts plus (minus) cash interest received (paid) on financial assets. AR5 assumes that all financial income is received in (paid in) cash (i.e., financial income contains no accruals).} This definition differs from the notion of funds from operations that is used in practice. In practice, FFO includes working capital accruals. Without loss of generality, I ignore working capital accruals for analytical convenience for now. Interested readers can find a fuller model with working capital accruals in Appendix B.5. In Chapter 4, the empirical work examines the sensitivities of results based on the inclusion of these accruals.

### 3.2.4 The conditions for accounting bias

future periods. Feltham and Ohlson (1995, 1996) define accounting bias as the expected
difference between the market value of equity and the book value of equity over the forecasting
horizon at a valuation date. Following Feltham and Ohlson (1996), this section lays out the
reason for accounting bias for REITs.

According to Feltham and Ohlson (1996, Proposition 3, p.219), accounting is
conservative if $E_t[V_{t+s} - bv_{t+s}] > 0$ as $s \to \infty$ ($t$ is a valuation date), where $V_{t+s} - bv_{t+s}$ is the
difference between the market value of equity and the book value of equity at year $t+s$. Since
net financial assets are marked to market and real property is the only operating asset, the
condition for conservative accounting can be restated as

$$E_t[V_{t+s} - bv_{t+s}] = E_t[(fa_{t+s} + vo_{t+s}) - (fa_{t+s} + pe_{t+s})] = E_t[vo_{t+s} - pe_{t+s}] > 0$$

as $s \to \infty$

where $E_t[vo_{t+s} - pe_{t+s}]$ is the expected difference between the market value of real property and
the book value of real property at year $t+s$.

The expected market value of real property at year $t+s$ ($vo_{t+s}$) can be expressed as

$$E_t(vo_{t+s}) = E_t\left[\sum_{q=0}^{t+s} ci_{t-\tau+q} + \sum_{q=0}^{t+s} [\Delta vo_{t-\tau+q} - ci_{t-\tau+q}]\right]$$

where $t-\tau$ is the year in which an initial investment was made; $E_t\left[\sum_{q=0}^{t+s} (\cdot)\right]$ is the sum of the
expected value of a variable from year $t-\tau$ to year $t+s$; $ci_{t-\tau+q}$ is the cost of capital investment
for year $t-\tau+q$; and $\Delta vo_{t-\tau+q} - ci_{t-\tau+q}$ is the change in the market value of real property unrelated
to the cost of investment during year $t-\tau+q$.

Analogously, the expected book value of real property at year $t+s$ can be expressed as

$$E_t(pe_{t+s}) = E_t\left[\sum_{q=0}^{t+s} ci_{t-\tau+q} + \sum_{q=0}^{t+s} [\Delta pe_{t-\tau+q} - ci_{t-\tau+q}]\right]$$

where $\Delta pe_{t-\tau+q} - ci_{t-\tau+q}$ is the periodic revaluation of capital assets during year $t-\tau+q$ ($depr_{t-\tau+q}$),
which is the change in the book value of real property unrelated to the cost of new investment.
Therefore, conservative accounting bias \( (E_t[V_{t+\tau} - bw_{t+\tau}] = E_t[vo_{t+\tau} - pe_{t+\tau}] > 0) \) arises if expected cumulated changes in the market value of real property are greater than expected cumulated periodic revaluation of real property over the forecasting horizon at valuation date \( t \):

\[
E_t \left[ \sum_{q=0}^{t+\tau} \left( \Delta vo_{t+q} - ci_{t+q} \right) \right] > E_t \left[ \sum_{q=0}^{t+\tau} \left( \Delta pe_{t+q} - ci_{t+q} \right) \right]
\]

This condition suggests that an accounting-based valuation model should have terms to correct for conservative accounting bias due to the difference between price changes and book value revaluations. In this section, depreciation expense is the only accrual pertaining to asset revaluation and thus \( E_t \left[ \sum_{q=0}^{t+\tau} \Delta pe_{t+q} - ci_{t+q} \right] \) indicates the expected future accumulated depreciation at valuation date \( t \).

The above condition for conservative accounting can be simplified as the relations between the parameters of cash flow dynamics (i.e., \( \omega_{\tau} \)) and accounting depreciation (i.e., \( \delta_{pe} \)). This simplification is possible because the cash flow dynamics and accounting relations allow current cash flows and accounting numbers to predict future cash flows and accounting numbers. In short, these relations represent the unrecorded positive net present value of current and expected future investments and the overstatement of expected future accumulated depreciation for existing property. The accounting-based valuation models in the next section reflect these conditions for conservative accounting.

### 3.2.5 Feltham and Ohlson (1996) model

This section uses the accounting relations (shown in Section 3.2.3) to convert the cash-flow valuation model (Eq. 1) to accounting-based valuation models. To highlight how accounting depreciation bias drives the relative ability of FFO and net income to explain equity
value, I present two valuation models that rely on net income and FFO, respectively. I start by showing a residual income valuation model. I then convert this model into a form that is comparable to empirical works that relate value to concurrent earnings and book values rather than to residual income.

The accounting relations presented in Section 3.2.3 can transform the residual income valuation equation (i.e., RIV in Section 3.1) into book value of equity plus a linear combination of current residual income, lagged book value of equity, and current capital investment:

\[ V_t = bv_t + \alpha_{ni}(ni_t - rbv_{t-1}) + \alpha_{pe} pe_{t-1} + \alpha_{ci} ci_t \]  

(RIV(a))

with valuation weights:

\[ \alpha_{ni} = \Phi_r \omega_{rr} \]
\[ \alpha_{pe} = R\Phi_r (\omega_{rr} - \delta_{pe}) \]
\[ \alpha_{ci} = R\Phi_r \eta \]

where:

\[ \Phi_r = (R - \omega_{rr})^{-1} \]
\[ \Phi_i = (R - \omega_{ir})^{-1} \]
\[ \eta = \Phi_r \omega_{ri} - 1 \]

See Appendix B.2 for proof.

As in the Ohlson (1995) model (Eq. O95 in Section 3.1), the coefficient on residual income \( \alpha_{ni} = \omega_{rr} / (R - \omega_{rr}) \) represents the present value of expected future residual income, where current residual income is expected to persist in the future at the rate of \( \omega_{rr} \). Recall that current residual income is determined by operating cash receipts plus depreciation expense minus a capital charge for lagged gross book value of real property. Net financial income is cancelled out with a capital charge for lagged financial assets. Residual income will follow a first-order autoregressive process only if the persistence of operating cash receipts is equal to that of the book value of real property (i.e., \( \omega_{rr} = \delta_{pe} \)).

While the Ohlson (1995) model assumes unbiased accounting, the Feltham and Ohlson (1996) model (i.e., RIV(a)) includes \( \alpha_{pe} pe_{t-1} + \alpha_{ci} ci_t \) to undo conservative accounting bias.
Conservative accounting bias arises if accounting depreciation is overstated and if there are future investment opportunities with positive NPVs that are not recognized in the current book value of real property. If the persistence of the book value of existing property is less than the persistence of operating cash receipts (\(\delta_{pe} < \omega_{rr}\)), then the coefficient on lagged book value of real property will be positive (\(\alpha_{pe} > 0\)), reflecting that the market corrects for accounting bias due to the over-depreciation of existing property. If \(\delta_{pe} = \omega_{rr}\), then \(\alpha_{pe}\) will be zero. If \(\delta_{pe} > \omega_{rr}\), then \(\alpha_{pe}\) will be negative, reflecting that the market corrects for accounting bias due to the under-depreciation of existing property.

Current capital investment takes on a valuation coefficient (\(\alpha_{ci} = R\Phi_i\eta\)) that reflects the unrecorded NPV of current and expected future investments, where \(\Phi_i = (R - \omega_i)^{-1}\) is the discounted sum of current investment and future investments predicted by a dollar of current investment; and \(\eta = \Phi_i \omega_i - 1\) is the unrecorded NPV of a dollar of investment. Unlike its counterpart in the cash-flow valuation model (\(\beta_{ci} = 1 + R\Phi_i\eta\); See Eq. 1), the coefficient on current investment \(\alpha_{ci} = R\Phi_i\eta\) in RIV(a) excludes the cost of current investment because the cost of current investment is included in the book value of equity. Note that a positive coefficient on current investment in RIV(a) indicates that the positive NPV of investment opportunities is not recorded until the returns on those investments are realized.

Similar to Feltham and Ohlson (1996), RIV(a) can be converted to a model that relates equity value linearly to net income, net dividend, and the book value of equity, after correcting for accounting bias:

\[
V_i = \gamma_{ni} n_i + \gamma_{di} d_i + \gamma_{bv_i} bv_i + \gamma_{pe} pe_{t-1} + \gamma_{ci} ci_i
\]

(2)

with valuation weights:
\[
\gamma_u = R\Phi, \omega_u = R\alpha_u \quad \gamma_d = -\Phi, \omega_d r \quad \gamma_{bv} = 1 - \Phi, \omega_d r
\]

\[
\gamma_{pe} = R\Phi, (\omega_{pe} - \delta_{pe}) = \alpha_{pe} \quad \gamma_{ci} = R\Phi, \eta = \alpha_{ci} \quad \eta = \Phi, \omega_{ci} - 1
\]

See Appendix B.2 for proof. Equation 2 can be easily applied to empirical analysis because a regression based on Eq. 2 does not rely on an empirical proxy for the cost of equity. Instead, this is impounded into the coefficient on \( bv_t \).

The first three components of Eq. 2 \( (\gamma_u, ni_t + \gamma_d, d_t + \gamma_{bv}, bv_t) \) are similar to the Ohlson (1995) model (Eq. O95a in Section 3.1). Recall the Ohlson (1995) model assumes unbiased accounting. When accounting is unbiased, lagged book value of equity \( (pe_{t-1}) \) and current capital investment \( (ci_t) \) will have the valuation weights of zero \( (\gamma_{pe} = \alpha_{pe} = 0 \text{ and } \gamma_{ci} = \alpha_{ci} = 0) \), implying that an accounting depreciation policy is unbiased and that the NPV of investment opportunities associated with current capital investment is zero. The market value of equity can then be expressed as a weighted average of capitalized net income, adjusted for net dividends, and the book value of equity \( (i.e., V_t = (1 - \gamma_{ni})[(R/r)ni_t - d_t] + \gamma_{bv} bv_t) \).\(^{48}\) The valuation weight on book value of equity \( (\gamma_{bv}) \) can be thought of as conveying the relative importance of the book value of equity versus net income in the valuation function \( (Ohlson \text{ and Zhang } 1998, \text{ p.94}) \). As mentioned in Section 3.1, the coefficient on net dividends is consistent with Miller and Modigliani’s (1961) Dividend Irrelevance Theorem. Again, their theorem predicts that a dollar of net dividend reduces the market value of equity by a dollar. Consistent with this theorem, when accounting is unbiased, the cum-dividend market value of equity can be viewed as a weighted average of capitalized net income and cum-dividend book value of equity \( (i.e., V_t + d_t = (1 - \gamma_{ni})(R/r)ni_t + \gamma_{bv} (bv_t + d_t)) \).

\(^{48}\) The proof of Eq. 2 presented in Appendix B.2 suggests that the coefficient on net income in Eq. 2 is the sum of the coefficient on residual income in Eq. RIV(a) and the discounted sum of future capital charges on retained net income for future periods such that \( \gamma_u = \Phi, \omega_u + r\Phi, \omega_u = (1 + r)\alpha_u \).
Note that the relative importance of the book value of equity versus net income for valuation, $\gamma_{bv}$, can be related to the time-series property of net income. An asset revaluation policy, e.g., the depreciation parameter, $\delta_{pe}$, determines the time series of net income. Suppose there are no positive NPV investment opportunities. If accruals pertaining to asset revaluation (i.e., $\Delta pe_t - ci_t$) are closer to the per-period change in property price unrelated to the cost of concurrent capital investment (i.e., $\Delta vo_t - ci_t$), the relative importance of GAAP book value to earnings ($\gamma_{bv}$) will be higher (Feltham and Ohlson 1996, pp.224 - 225). Feltham and Ohlson provide two extreme cases pertaining to $\gamma_{bv}$. If $\Delta pe_t - ci_t$ is equal to $\Delta vo_t - ci_t$, then the book value of equity (which retains all past net incomes adjusted for all past net dividends) will be equal to the market value of equity ($\gamma_{bv} = 1$). In contrast, if an asset revaluation policy perfectly smoothes net income, the cum-dividend market value of equity will be equal to capitalized current net income ($\gamma_{bv} = 0$).\(^{49}\) This section assumes that depreciation expense is the only accrual pertaining to asset revaluation and the beginning-of-period book value of real property depreciates at a constant rate. Thus, the asset revaluation policy in this section is likely to yield neither of these extreme cases ($0 < \gamma_{bv} < 1$). If a depreciation policy equates the persistence of the book value of existing property to the persistence of operating cash receipts ($\delta_{pe} = \omega_{rr}$), the book value of equity will converge to the market value of equity.

When accounting is biased, at least one of the lagged book value of equity ($pe_{t-1}$) and current capital investment ($ci_t$) will have a positive valuation weight ($\gamma_{pe} = \alpha_{pe} > 0$ or $\gamma_{ci} = \alpha_{ci} > 0$). This condition implies that an accounting depreciation policy is unbiased or the NPV of investment opportunities associated with current capital investment is zero.

The residual income valuation model (RIV(a)) can be transformed to rely on residual

\(^{49}\) According to Feltham and Ohlson (1996, p.225), an asset revaluation policy that smoothes net income will reduce net income by a multiple of current cash receipts and increase net income by a fraction of expected decrease (increase) in future cash receipts beyond that predicted by current cash flows.
FFO and gross book values, rather than on GAAP net income and book values. The clean surplus relation compatible to FFO and gross book values is expressed as
\[ b_{t}^{\text{flo}} = b_{t-1}^{\text{flo}} + ffo_{t} - d_{t} \]
where \( b_{t}^{\text{flo}} \) refers to gross book value of equity at the end of year \( t \).

Gross book value of equity refers to the book value of equity before accumulated depreciation (and accumulated depreciation is measured as a negative number). Gross book value of real property does not include any accruals pertaining to the periodic revaluation of the book value of real property (i.e., \( p_{t}^{\text{flo}} = p_{t-1}^{\text{flo}} + c_{t} \)).\(^{50}\) Thus, gross book value of real property is equal to the undiscounted sum of all past capital investments, and it does not depreciate or appreciate at all.

These assumptions lead to the following residual income valuation formula:
\[ V_{t} = b_{t}^{\text{flo}} + \alpha_{t}^{\text{ffo}} (ffo_{t} - rbv_{t}^{\text{flo}}) + \alpha_{p,e,flo}^{\text{pe,flo}} p_{t-1}^{\text{flo}} + \alpha_{c,i}^{\text{ci}} c_{t} \quad \text{(RIV(b))} \]
with valuation weights:
\[ \alpha_{t}^{\text{ffo}} = \Phi_{1}^{\omega_{rr}} = \alpha_{ni} \quad \alpha_{p,e,flo}^{\text{pe,flo}} = R\Phi_{1}^{\omega_{rr} - 1} \quad \alpha_{c,i}^{\text{ci}} = R\Phi_{1}^{\eta} \quad \eta = \Phi_{1}^{\omega_{rr} - 1} \]

See Appendix B.2 for proof.

Similar to the coefficient on residual income in RIV(a), the coefficient on residual FFO in RIV(b) represents the present value of expected future residual FFO, where current residual FFO is expected to persist in the future at the rate of \( \omega_{rr} \). While FFO is defined as operating cash receipts (\( cr_{t} \)) plus financial income (\( rf_{a,t-1} \)), residual FFO is determined solely by operating cash receipt minus a capital charge for lagged gross book value of real property because financial income is cancelled out with a capital charge for lagged financial assets. Residual FFO will follow a first-order autoregressive process if the persistence of operating cash receipts is equal to that of gross book value of real property (i.e., \( \omega_{rr} = 1 \)).

\(^{50}\) This section ignores impairment loss. US REITs had excluded impairment loss and depreciation expense from FFO prior to September 2003. In September 2003, the SEC prohibited REITs from excluding impairment losses from FFO. Thus, FFO reporting has allowed the book value of real property to be revaluated through impairment loss but not through depreciation expense since September 2003.
The components $\alpha_{pe} ffo_{t-1} + \alpha_c ci_t$ of RIV(b) are expected to capture accounting bias. The coefficient on lagged gross book value of real property (i.e., $\gamma_{pe, ffo} = R\Phi, (\omega_r - 1)$) captures the perceived appreciation of existing property relative to its original cost. If existing property is expected to generate a stream of constant operating cash receipts over its useful life ($\omega_{rr} = 1$), $\gamma_{pe, ffo}$ will be zero. If existing property is expected to generate a stream of diminishing operating cash receipts over its useful life ($\omega_{rr} < 1$), then $\gamma_{pe, ffo}$ will be negative ($\gamma_{pe, ffo} < 0$). This can be thought of as a correction for accounting bias due to diminishing operating cash receipts. Similarly, if operating cash receipts generated by existing property are expected to grow over the useful life of property ($\omega_{rr} > 1$), $\gamma_{pe, ffo}$ will be positive. The coefficient on capital investment in RIV(b) is the same as its counterpart in RIV(a).

Equation RIV(b) can be converted to an equation that relates equity value linearly to FFO, net dividend, and gross book value of equity, after correcting for accounting bias:

$$V_t = \gamma_{ffo} ffo_t + \gamma_{d, ffo} d_t + \gamma_{bv, ffo} bv_t + \gamma_{pe, ffo} pe_{t-1} + \gamma_{ci, ffo} ci_t$$

with valuation weights:

$$\gamma_{ffo} = R\Phi, \omega_r = \gamma_n$$  \hspace{1cm}  $$\gamma_{d, ffo} = -\Phi, \omega_r, r = \gamma_d$$  \hspace{1cm}  $$\gamma_{bv, ffo} = 1 - \Phi, \omega_r, r = \gamma_{bv}$$

$$\gamma_{pe, ffo} = R\Phi, (\omega_{rr} - 1)$$  \hspace{1cm}  $$\gamma_{ci, ffo} = R\Phi, \eta = \gamma_{ci}$$  \hspace{1cm}  $$\eta = \Phi, \omega_{rr} - 1$$

See Appendix B.2 for proof.

The first three components in Eq. 3 (i.e., $\gamma_{ffo} ffo_t + \gamma_{d, ffo} d_t + \gamma_{bv, ffo} bv_t$) are just another representation of the Ohlson (1995) model with different definitions of earnings and book value. The remaining components of Eq. 3 (i.e., $\gamma_{pe, ffo} pe_{t-1} + \gamma_{ci, ffo} ci_t$) reflect the market’s correction for accounting bias.
3.2.6 Relation between the Feltham and Ohlson (1996) model and the valuation models of prior REIT studies

This section discusses how the foregoing three valuation models (Equations 1, 2, and 3) are related to each other. In turn, it compares these models with the valuation models envisaged by prior REIT studies (e.g., Fields et al. 1998).

The models in Equations 1, 2, and 3 show that if the simple linear information dynamics and certain accounting rules apply, then equity value can be expressed as a linear function of operating cash receipts, funds from operations, or net income, with other reconciling variables included in each respective model. In the simplest formulation, the cash flow model (Eq. 1) can explain the value of operating assets using just two variables, i.e., current operating cash receipts \( (cr_t) \) that imply future operating cash receipts, and current capital investment \( (ci_t) \) that implies the costs and net present values of current and future capital investments. The market value of equity \( (V_t) \) in this model is equal to the market value of operating assets \( (vo_t) \) plus the market value of net financial assets \( (fa_t) \).

As shown in Feltham and Ohlson (1996), the net income model (Eq. 2) can be derived from GAAP book value \( (bv_t) \) and residual income reformulation of the cash flow dynamics. Net income \( (ni_t) \) captures future operating cash receipts, but in order to decompose current operating cash receipts, the model needs adjusting terms for interest income, a capital charge on beginning book value of equity, and bias in accruals (i.e., depreciation expense). This explains the inclusion of book value of equity \( (bv_t) \), lagged book value of real property \( (pe_{t-1}) \), and net dividends \( (d_t) \) in the net income model. The FFO model (Eq. 3) can be considered a special case of the net income model (where net income is measured before depreciation expense); therefore, operating cash receipts adjusted for interest income are captured by FFO. In the
presence of FFO, the clean surplus relation requires that book value of equity and lagged book value of real property are measured before deducting accumulated depreciation. These two variables are included in the model, along with net dividends, to disentangle operating cash receipts from interest income and to allow a capital charge. Current capital investment is also included in both the net income and FFO models, similar to its inclusion in the cash flow model. But it takes on an adjusted valuation weight because current investment is also part of the book value of equity.

The three models indicate what other variables should be included along with net income or FFO in order to be fully consistent with the cash flow model. If the underlying assumptions of the cash flow model and accounting system are true, then all three models should perform equally as well in explaining the market value of equity. To the extent that the above assumptions do not fully reflect the mapping of current operating cash receipts, net income or FFO onto future operating cash receipts, then one model may perform better in explaining the market value of equity than another.

In Chapter 4, this dissertation seeks to reveal reasons that prior studies that compare valuations based on net income versus FFO find differing conclusions based on sample periods. However, these prior studies (for example, Fields et al. 1998) do not estimate a full model that is consistent with Feltham and Ohlson (1996) and described above. Specifically, the models in these prior studies contain some of the variables in Equations 2 and 3 above, but their models are missing some of the reconciling variables such as capital investment and lagged book value of real property that can capture accounting bias. Relative to the theoretical valuation models (Eq. 1 through Eq. 3), the empirical models in the literature are misspecified, and if the assumptions of the theoretical models hold, then the existing models from the literature should
underperform their theoretical counterparts.

The theory helps us to identify what a more complete valuation specification would include and the adjustment role played by variables that are omitted from the existing empirical models. For example, in Fields et al. (1998), two regressions are estimated, one containing net income, book value of equity, and dividends, and the other containing FFO, book value of equity, and dividends. In comparison to Equations 2 and 3, each of the Fields et al. (1998) regressions is missing capital investments and lagged gross book value of real property.\(^{51}\) The effect of these omissions on the conclusions is difficult to predict. Clearly, lagged book value of real property is important because it allows for an adjustment for bias in depreciation expense (where \(\delta_{pe} \neq \omega_{rr}\)). As Equations 2 and 3 capture equity valuation under two alternative accounting regimes with different amounts of depreciation bias, the Fields et al. (1998) regressions that omit lagged book value of real property will tend to have more explanatory power when the bias in asset book values due to depreciation bias is less severe. For example, if the capital assets of REITs (and their expected future cash flows) experience very little or no economic depreciation (implying negligible decay in future cash flows), then accounting depreciation is unnecessary. This state of nature would make inclusion of lagged book value of real property in the net income model very important to correct for the bias in depreciation expense (where \(\delta_{pe} \neq \omega_{rr}\)). This implies that the net income regression which excludes lagged book value of real property will underperform the empirical version of the full net income model, Eq. 2. If depreciation expense is unnecessary, the FFO regression which measures earnings before deducting depreciation expense does not require the book value of equity and a correction for depreciation bias. In this case, the FFO regression is expected to outperform the

\(^{51}\) In addition, the Fields et al. (1998) regressions include the book value of equity, not the gross book value of equity, even when this regression is based on FFO.
net income regression which omits the control for depreciation bias. I address this issue in Chapter 4 by presenting results using specifications that are closer to Equations 2 and 3.

### 3.2.7 Valuation model using FFO and depreciation expense

This section presents another version of the net income model (Eq. 2) that decomposes net income into its two major components—funds from operations (ffo$_t$) and depreciation expense (depr$_t$). In this model, FFO and depreciation expense will take on different valuation weights. The accounting relations 5 and 6 imply that net income in Eq. 2 can be decomposed into FFO and depreciation expense. I have replaced the lagged book value of real property in Eq. 2 with a multiple of depreciation expense, i.e., pe$_{t-1} = -(1 - \delta_{pe})^{-1} \text{depr}_t$. As a result, the valuation weight on depreciation expense will reflect the combination of the existing valuation weights on net income and lagged book value of real property in Eq. 2.

The aforementioned conversion procedures lead to the following model:

$$V_t = \gamma_{ffo} ffo_t + \gamma_{depr,pe} \text{depr}_t + \gamma_d d_t + \gamma_{bv} \text{bv}_t + \gamma_{ci} ci_t$$

(2a)

where $\gamma_{ffo} = R\Phi_t \omega_n$ is a valuation weight on FFO; $\gamma_{depr,pe} = \gamma_{ffo} - R\Phi_t (\omega_n - \delta_{pe})(1 - \delta_{pe})^{-1}$ is a valuation weight on depreciation expense; and the other valuation weights are the same as their counterparts in Eq. 2. Note that the valuation weight on FFO ($\gamma_{ffo}$) is equal to the valuation weight on net income in Eq. 2 ($\gamma_{ni}$) and to the valuation weight on FFO in Eq. 3 ($\gamma_{ffo}$). The equality of $\gamma_{ffo}$ in Eq. 2(a), $\gamma_{ni}$ in Eq. 2, and $\gamma_{ffo}$ in Eq. 3 is because lagged book value of real property in Eq. 2, lagged gross book value of real property in Eq. 3, and depreciation expense in Eq. 2(a) correct for the gap between economic depreciation and accounting depreciation.

The valuation weight on depreciation expense ($\gamma_{depr,pe}$) equals the valuation weight on FFO less the market’s correction of bias in accounting depreciation. Suppose that depreciation
expense is equal to \( \text{depr}_t^u = -(1 - \omega_t)\text{pe}_{t-1} \).\(^{52}\) In this case, the valuation weight on depreciation expense is equal to the valuation weight on FFO, and \( \gamma_{\text{flo,depr}}^u \) equals the discounted sum of expected future economic depreciation over the useful life of property.\(^{53}\) In other words, a valuation equation in which depreciation expense retains the same coefficient as FFO would indicate a scenario where depreciation is “unbiased”.

In contrast, depreciation expense based on conservative depreciation policy is equal to \( \text{depr}_t^c = -(1 - \delta_{\text{pe}})\text{pe}_{t-1} \), where \( \delta_{\text{pe}} < \omega_t \).\(^{54}\) In this case, the valuation weight on FFO multiplied by conservatively biased depreciation expense (\( \gamma_{\text{flo,depr}}^c \)) will exceed the discounted sum of expected future economic depreciation over the useful life of property.\(^{55}\) Therefore, to correct the conservative bias in depreciation, the market needs to place a lower valuation weight on conservatively biased depreciation expense than on unbiased depreciation expense.

The sign of the valuation weight on depreciation expense can be shown to depend on whether investors expect the market value of real property to appreciate or depreciate over the useful life of real property. To see this, note that the valuation weight on depreciation expense can be rearranged to \( \gamma_{\text{depr,pe}} = R\Phi_t (1 - \omega_t)\delta_{\text{pe}} (1 - \delta_{\text{pe}})^{-1} \).\(^{56}\) If the market value of real property is expected to decline over the useful life of real property \( (\omega_t < 1) \), then \( \gamma_{\text{depr,pe}} > 0 \). If the market value of real property is expected to appreciate over the useful life of real property \( (1 < \omega_t < \)...

\(^{52}\) The superscript \( u \) indicates unbiased depreciation policy.

\(^{53}\) The time-series of depreciation expenses will be \(-\delta_{\text{pe}}\delta_{\text{pe,pe},t-1}, -\omega_t\delta_{\text{pe},t-1}, (1 - \delta_{\text{pe}})\delta_{\text{pe},t-1}, -\omega_t\delta_{\text{pe},t-1}, (1 - \delta_{\text{pe}})\delta_{\text{pe},t-1}, ... \) The discounted sum of expected future depreciation expenses for existing properties is equal to \(-\sum_{t=1}^{\infty} R^{t-1}\delta_{\text{pe}} (1 - \delta_{\text{pe}})\delta_{\text{pe},t-1} = -R\Phi_t (1 - \delta_{\text{pe}})\delta_{\text{pe},t-1} \). If \( \omega_t = \delta_{\text{pe}} \), then the discounted sum of expected future unbiased depreciation expenses for existing properties is equal to \(-R\Phi_t (1 - \omega_t)\delta_{\text{pe},t-1} = R\Phi_t(1 - \delta_{\text{pe}})\delta_{\text{pe},t-1} = \gamma_{\text{flo,depr}}^u \).

\(^{54}\) The superscript \( c \) indicates conservative depreciation policy.

\(^{55}\) If \( \omega_t > \delta_{\text{pe}} \), then \( \gamma_{\text{flo,depr}}^c = -(1 - \delta_{\text{pe}})\Phi_t(1 - \omega_t)\delta_{\text{pe},t-1} < -(1 - \omega_t)\delta_{\text{pe},t-1} \).

\(^{56}\) The proof is \( \gamma_{\text{depr,pe}} = R\Phi_t [\omega_t(1 - \omega_t)(1 - \delta_{\text{pe}})] = R\Phi_t [\omega_t(1 - \omega_t)(1 - \delta_{\text{pe}})] = R\Phi_t(1 - \omega_t)\delta_{\text{pe}} (1 - \delta_{\text{pe}})^{-1} \).
R), then $\gamma_{\text{depr,pe}} < 0$. If the market value of real property is expected to be constant over the useful life of real property ($\omega_{rr} = 1$), then $\gamma_{\text{depr,pe}} = 0$.  

### 3.3 Valuation models with time-varying valuation weights

In the valuation models derived in Section 3.2, the parameters for cash flow dynamics and discount rates are set to be constant across valuation dates. However, a body of empirical evidence suggests that such parameters and discount rates may actually vary across valuation dates (Fama and French 1989; Fama 1990; Johnson 1999; Chervachidze and Wheaton 2011). Time-variability in parameters and discount rates implies time-varying valuation weights.

This section allows the parameters of cash flow dynamics to vary across real estate cycle phases. In Section 3.3.1, I discuss how a shock to the demand for rental space is expected to drive the growth of, or decline in, operating cash receipts and capital investments over the forecasting horizon. Then I augment the stationary cash flow dynamics with other information, i.e., a variable capturing the impact of the demand shock on future operating cash receipts and capital investment over and above that predicted by current operating cash receipts and current capital investment. Section 3.3.2 will augment this model further by allowing for variation in the parameters of cash flow dynamics over the real estate cycle phases.

This study assumes that discount rates are constant across valuation dates as well as over the forecasting horizon at a valuation date for two reasons.  

---

57 The valuation weight on the book value of equity will also depend on the persistence of operating cash receipts. If the persistence of operating cash receipts is less than 1 ($\omega_{rr} < 1$), then $\gamma_{\text{bv}} > 0$. If the persistence of operating cash receipts is greater than 1 and less than R ($1 < \omega_{rr} < R$), then $\gamma_{\text{bv}} < 0$. If the persistence of operating cash receipts is equal to 1 ($\omega_{rr} = 1$), then $\gamma_{\text{bv}} = 0$.

58 Several studies model time-varying risk adjustments for equity valuation. Feltham and Ohlson (1999) show that the risk adjustment should depend on the covariance between residual income and priced macroeconomic risk factors. Their risk-adjustment has an infinite number of covariance terms, making an empirical test for this model intractable. Ang and Liu (2001) extend the Ohlson (1995) model by deriving the time-varying coefficient on
discount rates reduces the absolute value of the valuation weights on FFO and depreciation expense at the same time, while my main thesis is that the valuation weights on FFO and depreciation expense move opposite to one another across booms and busts in the real estate market. In addition, focusing on the time-variations in parameters increases analytical convenience. In empirical tests in Chapter 4, I will test whether the results are robust with and without the confounding effects of variations in discount rates across valuation dates.

3.3.1 The impact of market-level demand shocks on cash flows

This section incorporates other information into a stationary model Eq. 2(a). The following cash flow dynamics includes other information that is relevant to future cash flows over and above what is predicted by date $t$ cash flows:

\[ cr_{t+1} = \omega_{r}cr_t + \omega_{c}ci_t + \omega_{rc}v_{ct} + \epsilon_{1,t+1} \] \hspace{1cm} (CFD1(a))

\[ ci_{t+1} = \omega_{c}ci_t + \omega_{rc}v_{ct} + \epsilon_{2,t+1} \] \hspace{1cm} (CFD2(a))

\[ v_{ct+1} = \epsilon_{3,t+1} \] \hspace{1cm} (CFD3)

where:

$\omega_{rc}$ = The impact of a demand shock observed at the end of year $t$ on date $t+1$ operating cash receipts ($\omega_{rc} > 0$); 

$\omega_{ic}$ = The impact of a demand shock observed at the end of year $t$ on date $t+1$ capital investment ($\omega_{ic} > 0$); and


59 The subscript c indicates that a demand shock reflected in other information may be correlated with real estate cycles.
\[ \epsilon_{t+1} = \text{Unpredictable shocks to other information.} \]

The other variables and parameters are the same as CFD1 and CFD2.

As other information \( v_{ct} \) is orthogonal to current cash flows in definition, a demand shock reflected in \( v_{ct} \) is supposed to influence year \( t+1 \) cash flows, but not year \( t \) cash flows. There are two possible scenarios. One scenario is that other information \( v_{ct} \) reflects the impact of a demand shock occurring at the end of year \( t \). Figure 4 provides intuition on how a cyclical demand shock influences operating cash receipts and capital investments. The analysis is based on the Wheaton’s (1999) stock-flow model (which is discussed in Section 2.6.1). For the sake of simplicity, I assume 1) contractual rents actually received by a REIT are equal to market rents; 2) operating cash receipts are equal to market rents multiplied by the stock of space (where cash expenses are ignored); and 3) there is no vacancy in market equilibrium. The supply of rental space is price-inelastic in the short run because of construction lags. Land is in relatively fixed supply and thus new construction increases the marginal cost of supplying rental space. Thus, the long-run supply of rental space is not completely price-elastic in the long run.

Panel A in Figure 4 shows that a positive demand shock observed at the end of year \( t \) is expected to induce the growth of operating cash receipts and capital investments. A positive demand shock shifts the demand curve upward. Since the supply of rental space is inflexible in the short run, the market rents will increase in the short run, with the stock of space unchanged. The supply of rental space will adjust gradually over time as capital investment increases. The market will eventually return to new long-term equilibrium. The post-demand shock market rents are higher than the pre-demand shock market rents, leading to the average growth of operating cash receipts generated by an existing property built or acquired by past investments.
The demand shock observed at the end of year $t$ does not influence cash flows during year $t$. Panel B in Figure 4 shows the symmetric reaction to a negative demand shock observed at the end of year $t$ which is expected to reduce operating cash receipts and capital investments in future periods.

The other scenario for other information $v_{ct}$ to be orthogonal to current cash flows is that there is a delay in receiving higher or lower rental rates due to fixed term contracts held by tenants. In particular, if all current rental contracts of a REIT are fixed for a finite period (e.g., 5 years), the contractual rents during year $t$ received by a REIT will not adjust immediately to new market rents that are influenced by a demand shock occurring during year $t$. In this case, a demand shock occurring during year $t$ can influence the year $t+1$ contractual rent and occupancy rate, but not the year $t$ contractual rent and occupancy rate. In this case, other information $v_{ct}$ can predict the growth (decline) of operating cash receipts over and above that predicted by current operating cash receipts and its persistence.

Other information at date $t$ ($v_{ct}$) predicts date $t+1$ capital investment beyond that predicted by date $t$ capital investment and its persistence. When a real estate developer observes a positive or negative demand shock at the end of year $t$, she or he may decide to start or delay new real estate projects in future periods.

Equation CFD3 indicates that the market anticipates other information $v_{ct}$ to be purely random over the forecasting horizon. In other words, investors in the real estate market cannot know the timing and content of future demand shocks in advance. Therefore, they anticipate that there is no future demand shock on average. However, they are able to correctly forecast the impact of an observed demand shock on market rents and investments.

The notable difference between the abovementioned cash flow dynamics and the
counterpart in Feltham and Ohlson (1996) and Christensen and Feltham (2003, pp. 339-341) is the terms pertaining to other information. This study assumes that a single non-cash variable that reflects a single demand shock observed at the end of year $t$ predicts both future operating cash receipts and future capital investments. Feltham and Ohlson (1996) and Christensen and Feltham (2003) allow separate non-cash variables to represent other information on future operating cash receipts, and other information on future capital investment, respectively.

The abovementioned revision of the cash-flow dynamics transforms Equation 3 into a more complex valuation equation:

$$V_t = \gamma_{ffo} ffo_t + \gamma_{depr,pe} depr_t + \gamma_d d_t + \gamma_{bv} bv_t + \gamma_{ci} ci_t + \gamma_{vc} vc_t$$

(2b)

with the valuation weights (see Appendix B.3 for proof):

$$\gamma_{ffo} = R\Phi_i \omega_n$$

$$\gamma_{depr,pe} = \gamma_{ffo} - R\Phi_i (1 - \delta) (\omega_n - \delta)$$

$$\gamma_d = -\gamma_{ffo} r/R$$

$$\gamma_{bv} = 1 - \gamma_{ffo} r/R$$

$$\gamma_{ci} = R\Phi_i (\Phi_i \omega_n - 1)$$

$$\gamma_{vc} = \Phi_i \omega_{ic} + \Phi_i \eta \omega_{ic}$$

where:

$$\Phi_i = (R - \omega_n)^{-1}$$

$$\Phi_i = (R - \omega_n)^{-1}$$

The valuation weights in this new valuation equation have the same functional forms as their counterparts in Eq. 2(a), with the exception of the valuation weight on other information that is newly added to the model. The valuation weight on other information ($\gamma_{vc}$) reflects the present value of expected future operating free cash flows ($oc_{t+s} = cr_{t+s} - ci_{t+s}$) predicted by other information $vc_t$. The component $\Phi_i \omega_{ic}$ of $\gamma_{vc}$ represents the persistent impact of a demand

---

60 For example, Christensen and Feltham (2003, pp.339-341) formalize that date $t$ operating transactions on credit (e.g., non-cash rental or purchase) predict date $t+1$ operating cash receipts and therefore act as a different type of other information. Christensen and Feltham relate this type of other formation to working capital accruals. Appendix B.5 expands the cash flow dynamics to deal with this type of other information.
shock on future operating cash receipts generated by existing property, if its impact on future capital investments is ignored. The other component \( \Phi_i \eta_{\omega_c} \) of \( \gamma_{ic} \) represents the NPV of expected future capital investments predicted by other information \( v_{icr} \).

### 3.3.2 Time-varying parameters of the cash flow dynamics for REITs

Equation 2(b) assumes that the parameters of cash flow dynamics are constant across valuation dates, regardless of booms and busts in the real estate market. In this stationary model, depreciation bias which depends on the relative magnitude of these parameters is constant across valuation dates. Therefore, this model fails to explain why prior studies have found differing valuation relevance of FFO and net income across different sample periods. This section develops a simple non-stationary model with valuation weights that vary across valuation dates. In particular, I allow the parameters of cash flow dynamics to vary with real estate cycle phases. These time-varying parameters lead to time-varying valuation weights that are a function of these time-varying parameters.

To forecast future cash flows, investors need to predict the impact of all current and future economic events on future cash flows. However, investors have imperfect information about the timing and content of future economic events. It is plausible to assume that investors have beliefs about probability distributions for the stochastic parameters at a valuation date and update their beliefs about these probability distributions using new information available at future valuation dates. However, this approach is difficult to implement for valuation modeling because the attempt to generate a closed form valuation equation will yield an infinite number of cross-product terms.

To circumvent this sort of problem, Barski and De Long (1993) assume that investors
apply an ex-ante constant rate of dividend growth at a valuation date and re-estimate the dividend growth rate \( (g_t) \) across valuation dates. Their assumptions lead to a valuation formula \( V_t = d_t(1 + g_t)/(r - g_t) \) where \( g_t \) is an ex-ante constant dividend growth rate at a valuation date \( t \); and \( g_t \) follows an ex-post random walk process across valuation dates. They find evidence suggesting that an economic shock influences the market value of equity through its impact on current dividends, as well as on the time-varying dividend growth rate.

My approach is similar to the approach taken by Barski and De Long (1993). I assume that investors estimate some of the parameters of cash flow dynamics based on date \( t \) information and then use these parameter estimates to forecast future cash flows for all future periods. For tractability, I treat these parameters as constant for the forecasting horizon at a given valuation date, and investors are assumed to use new information available at future valuation dates and update their beliefs about these parameters across valuation dates.

I focus on three key parameters, including the persistence of cash receipts, the persistence of capital investment, and the return on investment, and assume these three parameters vary across valuation dates. Recall the valuation mappings of current cash receipts and investment to value are expressed as an increasing function of the time-varying parameters. Specifically, past investments \( (ci_{t-1}) \) were used to generate current cash receipts \( (cr_t) \) which persist at the rate \( \omega_{rr} \). Current investment \( (ci_t) \) contributes to future cash receipts through the return on investment \( (\omega_{ri}) \), and the increment in cash receipts due to current investment is expected to persist at the rate \( \omega_{rr} \). In addition, current investment \( (ci_t) \) predicts future investments that will increase subsequent cash receipts through \( \omega_{ri} \). For tractability, I assume that the parameters pertaining to other information (i.e., \( \omega_{rc} \) and \( \omega_{ic} \)) are constant across
The foregoing idea suggests replacing CFD1(a) and CFD2(a) with more generalized cash flow dynamics:

\[ cr_{t+1} = \omega_{rr,t} cr_t + \omega_{ri,t} ci_t + \omega_{rc} v_{ct} + e_{1,t+1} \]  
(CFD1(b))

\[ ci_{t+1} = \omega_{ri,t} ci_t + \omega_{rc} v_{ct} + e_{2,t+1} \]  
(CFD2(b))

where \( \omega_{rr,t} \) is the persistence of operating cash receipts based on information available to investors at date \( t \); \( \omega_{ri,t} \) is the marginal return on capital investment based on information available to investors at date \( t \); and \( \omega_{ii,t} \) is the persistence of capital investment based on information available to investors at date \( t \).

Next, my strategy is to allow the time-varying parameters in CFD1(b) and CFD2(b) to depend on a state variable that summarizes information about the real estate cycle phase during period \( t \) (hereafter, the state variable \( cycle_t \)). I assume that a series of positive and negative demand shocks occur cyclically across periods such that booms and busts in the real estate market are observed after the fact. As in CFD1(a) and CFD2(a), investors are assumed to be unable to predict the timing and magnitude of these demand shocks in advance. These assumptions can lead to cyclicality without the need for a single demand shock occurring at a particular date that then drives the subsequent oscillation of market rents and investments.\(^62\)

For analytical convenience, I assume that market participants expect the state variable \( cycle_t \) to be constant over the forecasting horizon at a valuation date \( t \), but that it varies, ex post, across valuation dates. The state variable \( cycle_t \) is equal to zero when the real estate market is in long-term equilibrium and fluctuates around zero across valuation dates. Time variation in the cash

---

\(^61\) As a result, the valuation weight on other information varies across valuation dates, depending solely on the time-varying persistence parameters for operating cash flows and capital investment, and marginal return on capital investment.

\(^62\) In a simple stock-flow model developed by Wheaton (1999), myopic expectations about post-shock market rents are needed for a single demand shock to drive the oscillation of a real estate market variable. However, it is difficult, and beyond the scope of this study, to identify whether a boom or a bust in the real estate market observed for a specific period is endogenous or not. See section 2.6.1 for a real estate cycle theory.
flow dynamic parameters is then to be linearly related to \( \text{cycle}_t \):

\[
\omega_{h,t} = \omega_{h,E} + \varphi_h \cdot \text{cycle}_t
\]

where:

\( \omega_{h,t} \) = The time-varying parameters of CFD1(b) and CFD2(b) (where \( h = \text{rr}, \text{ri}, \text{ii} \));

\( \text{cycle}_t \) = A state variable that summarizes information about the real estate cycle phase during year \( t \) (where \( \text{cycle}_t \) is equal to 0 in long-term equilibrium);

\( \omega_{h,E} \) = A parameter in the equation for the long-term equilibrium of the real estate market; and

\( \varphi_h \) = The sensitivity of the time-varying parameter \( \omega_{h,t} \) to the state variable \( \text{cycle}_t \).

If \( \varphi_h \) is positive (negative), then \( \omega_{h,t} \) is pro-cyclical (counter-cyclical). Again, the parameters \( \omega_{rr} \) and \( \omega_{ic} \) are assumed to not change systematically with the real estate cycle because their relation to cycle is not straightforward. The following paragraphs describe hypothetical relations between the three time-varying parameters and the state variable for the real estate cycle phase during year \( t \).

I will assume that the persistence of operating cash receipts (\( \omega_{rr,t} \)) reflects information about booms and busts triggered by demand shocks that occur during current or prior periods. With this assumption, current operating cash receipts and the persistence of operating cash receipts will predict the expected future growth (decline) of operating cash receipts driven by a positive (negative) demand shock when investors value equity at a date. As illustrated in Figure 4, a positive (negative) demand shock observed at date \( t \) or at prior dates is expected to induce the average growth (reduction) of market rents over the forecasting horizon at date \( t \). This is because construction lags deter movement along the supply curve to absorb the demand shock construction. In addition, the dynamics are complicated by fixed rental contracts which prevent
the contractual rents of real property from adjusting immediately to the new market rents implied by the shift in demand.

The persistence of capital investment \((\omega_{ii,t})\) is expected to be greater when \(\text{cycle}_t\) is higher. When developers observe a positive demand shock, a real estate developer is expected to start new construction projects. When observing a negative demand shock, she or he is expected to cancel some existing real estate projects or delay new real estate projects.\(^{63}\) The current period’s capital investment and its persistence can capture the growth or decline of capital investment due to the positive or negative demand shock.

The cyclicality of the marginal return on capital investment \((\omega_{ri,t})\) cannot be predicted unambiguously. As shown in Figure 4, when observing a positive demand shock, developers will build or acquire new property. An increase in supply leads to rent receipts from renting new space. Similarly, when observing a negative demand shock, developers will cancel or delay building projects. A decrease in supply reduces rent receipts. However, it is difficult to predict whether the impact of a positive demand shock on rent receipts per a dollar of new capital investment is greater than that of a negative demand shock. Thus, I assume that the marginal return on capital investment \(\omega_{ri,t}\) is not sensitive to \(\text{cycle}_t\) \((\varphi_{ri} = 0)\).

The revised cash-flow dynamics lead to a simple non-stationary valuation model:

\[
V_t = \lambda_{\text{ffo},t} \text{ffo}_t + \lambda_{\text{depr},t} \text{depr}_t + \lambda_{\text{d},t} \text{d}_t + \lambda_{\text{bv},t} \text{bv}_t + \lambda_{\text{ci},t} \text{ci}_t + \lambda_{\text{vc},t} \text{vc}_t \tag{4}
\]

where each valuation weight has the same functional form of its counterpart of Eq. 2(b). The time-varying parameters in CFD4 depend on the state variable for the real estate cycle phase during period \(t\) \((\text{cycle}_t)\). Therefore, the valuation weights of Eq. 4 are, in fact, the non-linear functions of \(\text{cycle}_t\) such that \(\lambda_{z,t} = \lambda_z(\text{cycle}_t)\), where \(z\_t\) is cfo\(_t\), depr\(_t\), d\(_t\), bv\(_t\), ci\(_t\), and vc\(_t\). For

\(^{63}\) This idea is consistent with evidence that real estate investment varies with changes in gross domestic product and aggregate consumption (Davis and Heathcote 2005).
example, under my assumptions, the valuation weight on FFO ($\lambda_{\text{ffo},t}$) is

$$\lambda_{\text{ffo},t} = R \omega_{n,t} / (R - \omega_{n,t}) = R(\omega_{n,E} + \varphi_{n, \text{cycle}}) / (R - (\omega_{n,E} + \varphi_{n, \text{cycle}}))$$

This suggests that the valuation weights differ across valuation dates as investors re-estimate the time-varying parameters across valuation dates in booms and busts in the real estate market.

To provide a parsimonious valuation model for an empirical analysis, I take a first-order Taylor approximation of each valuation weight in Eq. 4 with regard to cycle$_t$. The purpose of taking this linear approximation is to provide a simple model that interacts variables included in the stationary model (Eq. 2(b)) with a state variable that represents the average real estate cycle phase during year $t$. The Taylor approximation is taken in a neighbourhood of zero because cycle$_t$ is associated with the deviation of a valuation weight from its long-term equilibrium level. This approximation leads to

$$\lambda_{z}(\text{cycle}_t) = \lambda_{z}(0) + [\partial \lambda_{z}(0)/\partial \text{cycle}_t](\text{cycle}_t - 0),$$

where $\partial \lambda_{z}(0)/\partial \text{cycle}_t$ is the first-order derivative of $\lambda_{z}(\text{cycle}_t)$ with regard to cycle$_t$ at zero. As a result, Eq. 4 can be transformed to

$$V_t = (\lambda_{\text{ffo},E} + \lambda_{\text{ffo},C, \text{cycle}})\text{ffo}_t + (\lambda_{\text{depr},E} + \lambda_{\text{depr},C, \text{cycle}})\text{depr}_t + (\lambda_{\text{i},E} + \lambda_{\text{i},C, \text{cycle}})\text{i}_t + (\lambda_{\text{v},E} + \lambda_{\text{v},C, \text{cycle}})\text{v}_t \quad (4a)$$

where:

$$\lambda_{z,t} = \text{The valuation weight on } z_t, \text{ which is equal to } \lambda_{z,t} = \lambda_{z,E} + \lambda_{z,C, \text{cycle}};$$

$$\lambda_{z,E} = \text{The long-term equilibrium component of } \lambda_{z,t} (\text{i.e., } \lambda_{z,E} = \lambda_{z}(0)); \text{ and}$$

$$\lambda_{z,C} = \text{The sensitivity of } \lambda_{z,t} \text{ to } \text{cycle}_t (\text{i.e., } \lambda_{z,C} = \partial \lambda_{z}(0)/\partial \text{cycle}_t).$$

See Appendix B.3 for proof. If the real estate market is at its long-term equilibrium ($\text{cycle}_t = 0$), $\lambda_{z,t}$ collapses to its long-term equilibrium component, $\lambda_{z,E}$. The valuation weight $\lambda_{z,t}$ will change pro-cyclically (counter-cyclically) if its sensitivity to cycle$_t$ ($\lambda_{z,C}$) is positive (negative).

The long-term equilibrium component of each valuation weight ($\lambda_{z,E}$) in Eq. 4(a)
exhibits the same functional form as its counterpart in the stationary models Eq. 2(a) (shown in Section 3.2.7) and Eq. 2(b) (shown in Section 3.3.1):

\[
\begin{align*}
\lambda_{ffo,E} &= R\Phi_{r,E}\omega_{n,E} & \lambda_{depr,pe,E} &= \lambda_{fho,E} - R\Phi_{r,E}(1 - \delta_{pe})^{-1}(\omega_{n,E} - \delta_{pe}) \\
\lambda_{d,E} &= -\lambda_{fho,E}r/R & \lambda_{bv,E} &= 1 - \lambda_{fho,E}r/R \\
\lambda_{ci,E} &= R\Phi_{i,E}\eta_E & \lambda_{vc,E} &= \Phi_{r,E}\omega_c + \Phi_{i,E}\eta_E\omega_i
\end{align*}
\]

where:

\[
\begin{align*}
\Phi_{r,E} &= (R - \omega_{n,E})^{-1} \quad \Phi_{i,E} = (R - \omega_{n,E})^{-1} \quad \eta_E = \Phi_{r,E}\omega_{n,E} - 1
\end{align*}
\]

The valuation weight on other information \(v_{ct}(\lambda_{vc,E})\) reflects the present value of expected future operating free cash flows predicted by \(v_{ct}\). Consistent with the definition of cycle, \(v_{ct}\) is assumed to be zero when the real estate market is in long-term equilibrium because there is expected to be no further impact of a past or current demand shock on future cash flows in long-term equilibrium. This assumption suggests that the long-term equilibrium component \(\lambda_{vc,E}\) is used as a benchmark weight, only when the real estate market is not in the long-term equilibrium. Therefore, the stationary model, Eq. 2(a), expresses a long-term equilibrium relation between equity value and value-relevant information for REITs.

The sensitivity of each valuation weight to cycle \(c(\lambda_{c,E})\) is presented as follows:

\[
\begin{align*}
\lambda_{ffo,C} &= R^2\Phi_{r,E}\phi_{rr} & \lambda_{d,C} &= -\lambda_{fho,C}r/R \\
\lambda_{depr,pe,C} &= -R\Phi_{r,E}\phi_{rr}(R - 1)\delta_{pe}(1 - \delta_{pe})^{-1} = -\lambda_{fho,C}(r/R)\delta_{pe}(1 - \delta_{pe})^{-1} \\
\lambda_{bv,C} &= -\lambda_{fho,C}r/R & \lambda_{ci,C} &= R\Phi_{i,E}\left[\Phi_{r,E}\phi_{rr} + (\Phi_{r,E}\phi_{rr} + \Phi_{i,E}\phi_{ri})\eta_E\right] \\
\lambda_{vc,C} &= \Phi_{r,E}\phi_{rr}\omega_c + \Phi_{i,E}\omega_{i,E}\left[\Phi_{r,E}\phi_{rr} + (\Phi_{r,E}\phi_{rr} + \Phi_{i,E}\phi_{ri})\eta_E\right]
\end{align*}
\]

The valuation weights on FFO and depreciation expense have opposite sensitivities to cycle. Recall that the valuation weight on FFO is an increasing function of the persistence of
operating cash receipts \( \lambda_{\text{oo},t} = R \Phi_{t,t} \omega_{t,t} \), and the valuation weight on depreciation expense can be thought of as a decreasing function of the persistence of operating cash receipts

\[ \lambda_{\text{depr},pe,t} = R \Phi_{t,t} (1 - \omega_{t,t}) \delta_{pe} (1 - \delta_{pe}^{-1}) \]. \(^{64}\)

The persistence of operating cash receipts is assumed to increase with cycle\( t \) in CFD4 \( (\omega_{tr,t} = \omega_{tr,E} + \varphi_{rr} \text{cycle}_t, \varphi_{tr} > 0) \), while the accounting depreciation parameter \( (\delta_{pe}) \) is not expected to vary systematically with cycle\( t \). Therefore, the valuation weight on FFO increases with cycle\( t \) \( (\lambda_{\text{fbo},c} = R^2 \Phi_{t,t} \varphi_{tr} > 0) \), while the valuation weight on depreciation expense decreases with cycle\( t \) \( (\lambda_{\text{depr},pe,C} = -R \Phi_{t,t} \varphi_{tr} (R - 1) \delta_{pe} (1 - \delta_{pe}^{-1}) < 0) \). The intuitive meaning of \( \lambda_{\text{depr},pe,C} < 0 \) is that a higher cycle\( t \) leads to more conservative bias in depreciation expense and thus the market will correct for such bias in depreciation expense by placing a lower valuation weight on depreciation expense when cycle\( t \) is higher.

The sensitivity of the valuation weight on the book value of equity to cycle\( t \) is opposite to that of the valuation weight on FFO \( (\lambda_{\text{v},c} = -\lambda_{\text{fbo},c} t/R < 0) \). Recall that the relative importance of book value versus earnings in the valuation function is lower when earnings are more persistent (see Eq. 2 in Section 3.2.4). When the persistence of operating cash receipts increases with cycle\( t \) \( (\varphi_{rr} > 0) \), the valuation weight on the book value of equity will decrease with cycle\( t \). Equation 4(a) also indicates that the valuation weight on net dividend moves in a counter-cyclical manner \( (\lambda_{\text{v},c} = -\lambda_{\text{fbo},c} t/R < 0) \). \(^{65}\)

The sensitivity of the valuation weight on capital investment to cycle\( t \) will be positive (i.e., \( \lambda_{\text{i},c} = R \Phi_{t,E} \left[ \Phi_{t,E} + (\Phi_{t,E} + \Phi_{t,E} + \varphi_{i,t}) \eta_{t} \right] > 0 \)) if (i) long-term equilibrium NPV of capital investments is not negative \( (\eta_{t} \geq 0) \) and (ii) the persistence of operating cash receipts and capital investment are pro-cyclical \( (\varphi_{rr} > 0 \text{ and } \varphi_{ii} > 0) \). Recall the impact of date \( t \) capital

\(^{64}\) See section 3.2.7 for alternative expressions for the valuation weight on depreciation expense.

\(^{65}\) Recall the valuation weight on book value of equity is equal to one plus the valuation weight on net dividend.
in t+1 operating cash receipts is assumed to be not cyclical \((\varphi_t = 0)\).

The model stipulates that other information \(v_{ct}\) predicts future operating cash receipts and capital investments over and above that predicted by current operating cash receipts and capital investment. Therefore, the sensitivity of the valuation weight on other information to cycle, \(s_t\) can be thought of as the average of the sensitivities of the valuation weights on FFO and capital investment to cycle, \(s_t\) such that \(\lambda_{v,C} = \lambda_{v_0,C} R^{-2} \omega_v + \lambda_{v_1,C} R^{-1} \omega_v\).

### 3.3.3 Relation between the modified Feltham and Ohlson (1996) model and the Ohlson (1995) model

Section 2.5 discusses several prior REIT studies, including Fields et al. (1998) and Kang and Zhao (2010), that use empirical variants of the Ohlson (1995) model to examine which of FFO and net income is superior in explaining stock prices and returns over several distinct periods. The simplest version of the Ohlson (1995) model (hereafter, O95 model) assumes that equity value is a weighted average of capitalized earnings, adjusted for net dividends, and the book value of equity. These studies found mixed results, depending on their sample periods. This section shows that the O95 model is a special case of the modified Feltham and Ohlson (1996) model (hereafter, the modified FO96 model) under certain restrictive assumptions and explains that the regression models used in prior REIT studies are incomplete due to omitted variables.

The modified FO96 model (Eq. 4(a)) can be reduced to the O95 model under the following four restrictions. The first restriction is that all parameters of cash flow dynamics are constant across valuation dates. This restriction reduces the non-stationary model, Eq. 4(a), to the stationary model, Eq. 2(b), which represents a long-term valuation relation. The second
restriction is that current operating cash receipts and capital investment summarize all value-relevant information across all dates \((v_{ct} = 0 \text{ for all date } t)\). The third restriction is that there are no positive NPV investment opportunities \((\Phi_{t,E}\omega_{t,E} = 1)\), eliminating the term pertaining to capital investment. The fourth restriction is that accounting depreciation for real property is unbiased. GAAP depreciation \((0 < \delta_{pe} < 1)\) is unbiased if the cash-generating ability of existing properties is expected to diminish over the useful life of the properties \((0 < \omega_{rr,E} < 1)\) and the GAAP depreciation schedule correctly reflects such expected economic depreciation \((\omega_{rr,E} = \delta_{pe})\). Alternatively, the depreciation policy embedded in FFO reporting \((\delta_{pe} = 1)\) is unbiased if existing properties are expected to maintain their cash-generating ability over their useful life \((\omega_{rr,E} = 1)\). With these alternative restrictions, FFO and depreciation expense can be collapsed to an unbiased earnings measure, either net income or FFO, which has the same valuation weight as FFO \((\lambda_{ffo,E})\).

The foregoing restrictions reduce the modified FO96 model to the O95 model:

\[
V_t = \lambda_{ffo,E}n_i - \phi_{ffo,E}d_t + [1 - \phi_{ffo,E}]bv_t \tag{5}
\]

\[
V_t = (R/r)ffo_t - d_t \tag{5a}
\]

In Eq. 5(a), the valuation weight on FFO (i.e., \(\lambda_{ffo,E}\)) will be equal to \(R/r\) when \(\omega_{rr,E} = 1\). All variables are as defined in Sections 3.2 and 3.3.2.

Equations 5 and 5(a) can be interpreted as a special case of Equations 2 and 3:

\[
V_t = \gamma_{ni,E}n_i + \gamma_{d,E}d_t + \gamma_{bv,E}bv_t + \gamma_{pe,E}pe_{t-1} + \gamma_{ci,E}ci_t \tag{2}
\]

\[
V_t = \gamma_{ffo,E}ffo_t + \gamma_{d,ffo,E}d_t + \gamma_{bv,ffo,E}bv_t + \gamma_{pe,ffo,E}pe_{t-1} + \gamma_{ci,ffo,E}ci_t \tag{3}
\]

where the subscript \(E\) is included to emphasize that these valuation equations hold in the long-term equilibrium. In Equations 2 and 3, all parameters of cash flow dynamics are the same across all valuation dates, depreciation policies are allowed to be biased, and the NPV of future
investment opportunities is not restricted to be zero.

In interpreting the results of prior studies that focus on sub-periods, we need to be cautious in interpreting the coefficients on FFO and net income because the assumptions needed to derive these equations from the modified FO96 model may not hold for a given sample period. In particular, estimating these equations over a long sample period is essential for offsetting the business-cycle effects on valuation weights across valuation dates and uncovering the long-term performance of FFO versus net income in explaining equity value. Long-term economic growth, demographic changes, physical deterioration, and functional obsolescence are expected to determine the long-term persistence of cash receipts. In turn, the difference between the long-term persistence of cash receipts and the long-term persistence of the book value of real property is expected to determine which of FFO and net income outperforms in explaining the market value of equity in the long term.

3.4 Valuation model with different depreciation rules for land and building

This section incorporates different depreciation rules for non-land real estate assets (hereafter, building) and land into the valuation model. The book value of real property \((p_{r})\) consists of the book value of land \((L_{t})\) and the book value of building \((B_{t})\).\(^{66}\) The book value of building is depreciated over the useful life of the asset, while the book value of land does not depreciate over time. As discussed in Section 2.3.1, the market values of building and land components of a developed property are not separately observable. Hence, for accounting-based valuations, rational stock market investors are assumed to estimate the intrinsic values of the building and land components of a developed property.

Accounting Relations 7 and 8 show my assumptions on how capital investments in real

\(^{66}\) ‘Building’ includes the structure, land improvements, building improvements, and tenant improvements.
property are allocated into building and land and how the book values of building and land are adjusted downward by depreciation expense:

\[ B_t = \delta_B B_{t-1} + \theta_B c_i \]  \hspace{1cm} (AR7) 
\[ L_t = L_{t-1} + (1 - \theta_B) c_i \]  \hspace{1cm} (AR8)

The investment-cost allocation weights on building and land are denoted by \( \theta_B \) and \( 1 - \theta_B \). The cost of building depreciates at the rate \( 1 - \delta_B (0 < \delta_B < 1) \), leading to the depreciation expense for building equal to \( \text{depr}_t = -(1 - \delta_B) B_{t-1} \). The cost of land is not depreciated at all. Therefore, the depreciation rate for building \( (1 - \delta_B) \) is greater than the depreciation rate for building plus land \( (1 - \delta_{pc}) \).

In AR7 and AR8, the investment-cost allocation weights are assumed to be stable over time. This assumes that REITs are likely to continue operating in the same property sector, to own a large number of properties in that sector, and to repeat a variety of investment activities in future periods. Each investment activity has its own specific cost-allocation weights for each period. However, the aggregate cost-allocation weights for total property portfolio are not likely to vary significantly over time.\(^\text{67}\)

The following valuation model incorporates the market’s correction for different depreciation biases for building and land. If we regard \( \text{pc}_{t-1} = B_{t-1} + L_{t-1} \) and \( B_{t-1} = -(1 - \delta_B)^{-1} \text{depr}_t \), then Eq. 2a can be rearranged as follows (see Appendix B.4 for proof):

\[ V_t = \gamma_{f_fo} f_{fo_t} + \gamma_{\text{depr,B}} \text{depr}_t + \gamma_d d_t + \gamma_{b_v} b_v_t + \gamma_{L} L_{t-1} + \gamma_{c_i} c_i_t \]  \hspace{1cm} (2c)

where \( \gamma_{\text{depr,B}} = \gamma_{f_fo} - R \Phi_t (\omega_t - \delta_B) (1 - \delta_B)^{-1} ; \lambda_L = R \Phi_t (\omega_t - 1) ; \) and the other coefficients are the

---

\(^{67}\) I perform an analysis of whether the cost-allocation weights are relatively stable over time. I calculate the ratio of gross book value of building to gross book value of real property. This ratio represents the allocation of past periods’ investment costs to land and building. I regress current-year ratio on an intercept and lagged ratio fiscal year-by-fiscal year. Untabulated results indicate that the coefficient on lagged ratio is between 0.82 and 1.13, except for the year 1995 (i.e., the coefficient for year 1995 is 0.53). This result suggests that the cost-allocation weights do not vary significantly over time.
same as their counterparts in Eq. 2a.  

Analogous to its counterpart \( \gamma_{\text{depr}, \text{pc}} \) in Eq. 2(a), the valuation weight on depreciation expense \( \gamma_{\text{depr}, \text{b}} \) in Eq. 2(c) is equal to the valuation weight on FFO \( \gamma_{\text{ffo}} \) plus the market’s correction for bias in depreciation for building. The valuation weight on depreciation expense will be equal to the valuation weight on FFO when the persistence of operating cash receipts is equal to the persistence of the book value of building \( \omega_{r} = \delta_{b} \).

The valuation weight on lagged book value of land \( \gamma_{\text{L}} = \Phi_{r} (\omega_{r} - 1) \) represents the correction for bias in the accounting depreciation for land. If the persistence of operating cash receipts is equal to 1 \( \omega_{r} = 1 \), land value is expected to be constant in the long term. In this case, the economic depreciation for land (which is equal to zero) will be equal to the accounting depreciation for land, leading to the valuation weight on land equal to zero. If the persistence of operating cash receipts is greater than one and less than R \( 1 < \omega_{r} < R \), then land is expected to appreciate in the long term. To correct for the underestimation of the book value of land, the market will place a positive weight on lagged book value of land.  

3.5 Concluding remark

This chapter explains how the Feltham and Ohlson (1996) model can be reinterpreted in the context of the REIT industry. In addition, it introduces some modifications to that framework. The primary modification is to allow the persistence of operating cash receipts to be greater at a valuation date in a market boom than it is at a valuation date in a market bust.

\[ V_t = b_n + \alpha_u (ni - rbv_{i-1}) + \alpha_p B_{i-1} + \alpha_c c_{i-1} \] where \( \alpha_u = \Phi_{r} (\omega_{h} - \delta_{b}) \), \( \Phi_{r} = \gamma_{\text{depr}, \text{b}} \), \( \alpha_{\text{L}} = \gamma_{\text{L}} \), and \( \alpha_{\text{c}} = \gamma_{\text{c}} \).  

Equation 2(c) assumes that the persistence of operating cash receipts is the only factor contributing to the value of land. However, real estate researchers have explained land as development options embedded in land (Titman 1985; Capozza and Sick 1991; Williams 1991). They document that a variety of economic factors, such as net operating income, construction costs, and the age of property, influence the value of this option. The valuation model in this study does not incorporate the value of development option.
This modification reflects a well-known fact that the market value of a real property is expected to appreciate in a market boom and depreciate in a market bust. With this modification, historical cost-based depreciation is expected to be more conservatively biased in a market boom than in a market bust. As a result, the valuation weight on depreciation expense is lower in a market boom than in a market bust, reflecting the market’s correction of accounting depreciation bias. As the persistence of operating cash receipts is assumed to be greater in a market boom than in a market bust, the valuation weight on FFO, an increasing function of the persistence of operating cash receipts, is expected to be higher in a market boom than in a market bust. The cyclicality in accounting depreciation bias provides an implication on which of FFO and net income explains better the market value of equity over different time periods.
Chapter 4: Effects of Real Estate Cycles on the Valuation of REITs

4.1 Introduction

In this chapter, I take the key theoretical valuation models from Chapter 3 and specify their empirical forms. The purpose of developing these models is to support empirical tests of my conjecture that the valuation weights on earnings measures (particularly, net income and FFO) vary with real estate cycles, and that this variation is linked to depreciation bias. Chapter 3 began by showing two stationary FO96 models that rely on two different accounting regimes for determining earnings, book value of equity, and book value of real property.

\[ V_t = (1 - \gamma_{bv}) \left[ \frac{(1 + r)}{r} ni_t - d_t \right] + \gamma_{bv} bv_t + \gamma_{pe} pe_{t-1} + \gamma_{ci} ci_t \]  
(2)

\[ V_t = (1 - \gamma_{bv}) \left[ \frac{(1 + r)}{r} ffo_t - d_t \right] + \gamma_{bv} bv_{t}^{flo} + \gamma_{pe, flo} pe_{t-1}^{flo} + \gamma_{ci} ci_t \]  
(3)

In Eq. 2, the market value of equity \((V_t)\) is the weighted average of capitalized net income reduced by net dividends \(((1+r)/r)ni_t - d_t)\) and the book value of equity \((bv_t)\), with corrections for accounting bias that are based on lagged real property \((pe_{t-1})\) and capital investment \((ci_t)\).\(^{70}\) \(\gamma_{bv}\) reflects the relative importance of book value of equity versus capitalized net income in valuation. In Eq. 3, funds from operations \((ffo_t)\), gross book value of equity \((bv_{t}^{flo})\), and lagged gross book value of real property \((pe_{t-1}^{flo})\) are consistent with the clean surplus relation. Both of these models have fixed valuation weights across valuation dates. If these models are able to fully correct for accounting bias, they will have equal explanatory power.

The stationary models above do not explain why prior REIT studies have found mixed results about the relative explanatory power of net income versus FFO across different sample periods. To resolve the mixed results of these prior studies, I convert Eq. 2 into a simple non-

\(^{70}\) The coefficient on \(pe_{t-1}\) corrects for accounting bias due to depreciation policy, and the coefficient on \(ci_t\) captures the unrecorded NPV of investment opportunities. See Sections 3.2.5 and 3.2.6 for a detailed description of each valuation coefficient.
stationary model (Eq. 4(a) in Section 3.3, referred to as the modified FO96 model). This non-stationary model allows for an interaction between the value-relevant information observed in year $t$ and a state variable for the real estate cycle phase during year $t$. I disaggregate net income into FFO and depreciation expense in order to show the cyclicality of bias in depreciation expense, the largest reconciling item between FFO and net income. Because depreciation expense is a multiple of lagged book value of real property, when I disaggregate net income into FFO and depreciation expense, I am able to drop lagged book value of real property from the model. As a result, the coefficient on depreciation expense will reflect the valuation weight on FFO as well as the market’s correction for depreciation bias. Therefore, the coefficients on FFO and depreciation expense will no longer be equal. Since the size of the correction for depreciation bias is expected to vary over the real estate cycle phases, the difference between the coefficients on FFO and depreciation expense is allowed to vary across the cycle phases.

Chapter 4 carries out empirical tests of the aforementioned theoretical models for a sample of REITs and replicates existing empirical models that can be thought of as special cases of the theoretical models. The main tests proceed in three steps. In the first set of empirical tests, I estimate the two stationery FO96 models (i.e., empirical counterparts to Equations (2) and (3)) and compare their explanatory powers. The second set of tests replicate the models in Fields et al. (1998) and Kang and Zhao (2010) that are related to the stationary FO96 model, and identify business-cycle conditions that influence the mixed results of these studies. Fields et al. estimate two price level regressions for REITs. First they regress stock prices on net income, dividends, and book value of equity, and then they regress stock prices on FFO, dividends, and book value of equity. The Fields et al. models contain some of the variables in the stationary FO96 models, but they omit the capital investments and the lagged
book value of real property, variables used to control for accounting bias. I will test how these omitted variables influence the relative explanatory power of the Fields et al. models versus the empirical versions of the stationary FO96 models. Prior studies have applied their research designs to relatively short sample periods. The longer sample period in my study allows me to run their models across different phases of the real estate cycles.

In carrying out the second set of tests, I am able to test my conjecture about the coefficients on the two earnings measures—net income and FFO—in the Fields et al. models. This conjecture is drawn from the modified FO96 model. The valuation weight on FFO is expected to be greater in boom periods than in bust periods due to higher expected persistence of cash flows in boom periods than in bust periods. However, in a boom, depreciation is likely to be more conservatively biased due to the upward pressure on property values. Therefore, net income, which forces FFO and depreciation expense to have equal weights, will not necessarily have a greater valuation weight in boom periods than in bust periods. This is because accounting depreciation bias is expected to counteract a pro-cyclical change in the valuation weight on FFO.

The empirical model in Kang and Zhao (2010) contains all of the variables in the Fields et al.’s net income model (i.e., net income, book value of equity and dividends) and additional variables. Therefore, the Kang and Zhao model can be viewed as an extension of the net income model in Fields et al. (1998). While Kang and Zhao model does not include a capital investment variable to control for the NPV of investment opportunities, they do include accumulated depreciation to control for depreciation bias. Therefore, the Kang and Zhao model is loosely related to the stationary FO96 model (i.e., Equation 2). I explore whether accumulated depreciation is more conservatively biased in a boom than in a bust.
In the third set of empirical tests, I compare the results of replicating the two prior studies with the results of estimating the modified FO96 model. The modified FO96 model leads naturally to hypotheses regarding the coefficients on two major components of net income—FFO and depreciation expense—in the empirical model. Specifically, these hypotheses are that the coefficients on FFO and depreciation expense in the empirical version of the modified FO96 model will not be equal, and will vary across real estate cycles due to time-varying bias in depreciation. These hypotheses are what lead to my conjecture about the coefficients on net income and FFO in the Fields et al. models. Evidence in support of time-varying valuation weights on FFO and depreciation expense in the modified FO96 model will help to support my claim that real estate cycles can explain the conflicting results of prior studies that have examined the valuation of net income and FFO during different time periods.

A key to interpreting the estimated valuation weights on net income, income components and FFO is the underlying cash flow dynamics that are presented in Chapter 3, and, in particular, the persistence of net free cash flows from operations. However, most of Chapter 4 is silent on whether the assumed cash flow dynamics have empirical validity. I address this, towards the end of this Chapter 4, when I directly estimate an empirical version of the cash flow dynamics using analyst forecasts of future FFO as the dependent variable and lagged measures of CFO and capital investment as independent variables. This exercise provides an estimate of the persistence of operating cash receipts which can then be used to gauge the magnitude of valuation coefficients.

Some might argue that the cash flow dynamics are fundamental to this thesis and should take priority over the estimation of valuation models. Alternatively or in addition, some would argue that I should estimate the valuation equation in a system of equations that takes into
account the estimated persistence parameters using simultaneous estimation techniques. I decided to estimate valuation regressions first and to view cash flow dynamic estimations as a secondary test of my hypotheses because the original motivation for the dissertation is to reconcile results from prior valuation studies which did not motivate their studies based on cash flow equations. As will be shown in Table 4, the valuation regressions on their own provide ample evidence that the empirical model does not hold in all its aspects. While I provide evidence on the cash flow dynamics towards the end of this Chapter, the results in Table 4 indicate that simultaneous estimation techniques are highly likely to reject my model in its strictest form, and are unlikely to provide new insights.

Other tests presented in Chapter 4 attempt to disentangle alternative explanations for the existing results. For example, the regulatory measures taken to improve the uniformity of FFO disclosures in 1999 are expected to induce investors to rely more on FFO in equity valuation following their introduction (Baik et al. 2008). In contrast, these regulations are not likely to have had a direct bearing on the reliability of depreciation expense. I will test whether the business-cycle effect on the valuation coefficients on FFO and depreciation expense remain after controlling for this regulatory change.

Chapter 4 proceeds as follows. Section 4.2 specifies empirical models and discusses the measurement of variables in these models. The theoretical valuation models in Chapter 3 lead naturally to hypotheses regarding the relative explanatory power of these models and the valuation weights on FFO and depreciation expense. The discussion of these hypotheses is followed by a description of the sample in Section 4.3. The empirical tests are presented in Sections 4.4 through 4.5, followed by a conclusion in Section 4.7.
4.2 Empirical models and hypothesis development

This section will derive empirical models from the theoretical models and provide hypotheses on valuation coefficients suggested by the theoretical models.

4.2.1 Empirical versions of the theoretical models

This section presents the empirical models, and discusses issues related to measuring variables in these models. These models include the empirical versions of the stationary FO96 models and the modified FO96 model. I also describe the empirical models used in Fields et al. (1998) and consider the potential implications arising from their omitting variables that are included in the empirical versions of the FO96 models.

The theoretical models assume away much of the richness of the real world. To mitigate this problem, the following modifications are made to all empirical models in this study. In the empirical models, variables that are not included in the theoretical model can potentially explain equity values. To capture uncorrelated omitted variables, I add an error term to each model. Since the regression uses variables in levels, the error term may not have a mean of zero. To ensure that the error term has a mean of zero, I add an intercept to the model. In the cross-sectional regression using variables in levels, firm size may be correlated with independent variables and the error term, leading to potential coefficient bias and heteroscedasticity (Barth and Kallapur 1996). To mitigate this problem, I deflate all independent variables, except for the intercept, by a proxy for the scale of a firm.\textsuperscript{71} Similar to prior REIT studies such as Fields et al. (1998) and Kang and Zhao (2010), all tabulated results in this study use the end-of-period number of shares outstanding as a proxy for the scale of a firm.

\textsuperscript{71} To ensure the mean of scaled error term is zero, this study does not deflate the intercept by a proxy for the scale of a firm.
Recall that the two stationary FO96 models rely on two different accounting regimes for determining earnings, book value of equity, and book value of real property. The empirical models based on the theoretical FO96 models are presented as follows:

\[ P_t = \alpha_0 + \alpha_1NI_t + \alpha_2DIV_t + \alpha_3BV_t + \alpha_4PE_{t-1} + \alpha_5CFI_t + \varepsilon_t \]  

(7)

\[ P_t = \alpha_0 + \alpha_1FFO_t + \alpha_2DIV_t + \alpha_3BV_t^{FFO} + \alpha_4PE^{FFO}_{t-1} + \alpha_5CFI_t + \varepsilon_t \]  

(8)

Estimating these models requires a measure of equity value, the dependent variable, and five independent variables. The dependent variable \( P_t \) is stock price per share. Stock price per share is observed on the 90th day after the end of fiscal year \( t \) because companies are required to file their financial statements to the SEC within 90 days of the fiscal year’s end. This study assumes that stock prices are an unbiased reflection of the market value of common equity.

The two models above use net income per share (\( NI_t \)) and funds from operations per share (\( FFO_t \)) for fiscal year \( t \) as alternative earnings measures. Reported net income is measured as net income before extraordinary items from COMPUSTAT, and reported FFO is obtained from the I/B/E/S summary file. Net income and FFO are deflated by the end-of-period number of shares outstanding. Reported FFO per share largely equals net income before extraordinary items, depreciation expense, and gains and losses on the sale of property, deflated

---

72 Since the number of shares outstanding may be a noisy proxy for the scale of a firm (Brown et al. 1999), I perform robustness tests using total revenue as an alternative proxy for the scale of a firm.

73 Appendix C provides the detailed definition and measurement of all variables used in this study.

74 Prior studies for non-financial firms find that non-GAAP numbers disclosed by management can differ from the corresponding numbers provided by I/B/E/S because I/B/E/S tends to adjust the numbers to analysts’ framework of street earnings (Bhattacharya et al. 2003). However, Baik et al. (2008) find that, in a random sample of 62 REITs, actual FFO per share in I/B/E/S does not significantly differ from actual FFO per share in press releases. I also find that, in a random sample of 21 REITs (173 observations), the difference in the mean of I/B/E/S FFO per share and FFO per share reported in press releases or 10-Ks is insignificantly different from zero (the difference in mean = 0.00, the difference in variance = 0.01, two-tailed \( p \)-value = 0.727).

75 All per-share values are based upon the end-of-period number of shares outstanding. Therefore, I take the COMPUSTAT Basic EPS (excluding extraordinary items) and the I/B/E/S FFO per share and convert them to be based on the end-of-period number of shares outstanding.
by the end-of-period number of shares outstanding. Depreciation is typically larger than gains and losses on the sale of property. Reported FFO can also be thought of as consisting largely of cash flows from operating activities (CFO) and working capital accruals.

As Eq. 7 uses a net income measure of earnings, it also uses the GAAP book value of common equity per share at the end of year $t$ ($BV_t$), consistent with the clean surplus relation. The variable $PE_{t-1}$ is measured as the GAAP book value of real property at the end of year $t-1$. In Chapter 3, depreciation expense is assumed to be a multiple of $PE_{t-1}$; hence, the coefficient on $PE_{t-1}$ captures the correction for accounting bias due to over- or under-depreciation due to a difference between accounting depreciation rates for real property and economic depreciation rates.

Eq. 8 uses FFO, rather than net income, as an earnings measure. Therefore, to be consistent with the clean surplus relation, Eq. 8 sets accumulated depreciation to be zero by adding back accumulated depreciation to $PE_{t-1}$ and $BV_t$. As a result, $PE^{FFO}_{t-1}$ and $BV^{FFO}_t$ in Eq. 8 are the gross book value of real property per share and the gross book value of equity per share (i.e., reported book value plus accumulated depreciation at the end of year $t-1$ and year $t$, respectively). As illustrated in Eq. 2 in Chapter 4, the coefficient on $PE^{FFO}_{t-1}$ captures the appreciation (depreciation) of real property value relative to its original cost, which will depend on the expected growth (decline) in cash receipts associated with the real property. If the

---

76 The gain or loss on the sale of a property will depend on the amount of depreciation expense deducted from the asset’s original cost while holding and operating the asset. As FFO does not include depreciation expense, consistency requires that gains and losses on the sale of property also be excluded from FFO.
77 In the sample period 1995-2008, the mean and median of the ratio of gains and losses on the sale of property to depreciation expense (measured as a negative number) are -0.16 and -0.02. The negative mean and median ratios indicate that on average REITs reported gains on the sale of property.
78 Reported FFO may include items that are neither CFO nor working capital accruals. In 1995 NAREIT guided REITs to exclude all non-recurring items from FFO. Then in 1999 NAREIT changed their recommendation and guided REITs to include these non-recurring items (other than gains and losses on the sale of property) in FFO. Prior to this date there is more variation in what firms include in FFO and what they exclude (Baik et al. 2008). Finally, in 2003 the SEC required that asset impairment losses and write-downs be included in FFO. See section 2.4 for the definition of FFO.
persistence of cash receipts ($\omega_{tr}$) is greater than one (less than one), then the coefficient on $\text{PE}_{t-1}^{\text{FFO}}$ will be positive (negative).

Cash dividends declared on common stock for fiscal year $t$ ($\text{DIV}_t$) is used as a proxy for net dividend per share. While net dividend ($d_t$) in the theoretical model is defined as common cash dividends less net capital contributions (the proceeds from new stock issues less share purchases), missing data for net capital contributions would reduce the sample size. In addition, replicating Fields et al. (1998) and Kang and Zhao (2010) requires the use of common cash dividends. Therefore, throughout this study, $\text{DIV}_t$ is simply common cash dividends per share.

The proxy for capital investment for fiscal year $t$ ($\text{CFI}_t$) is measured as cash flows from investing activities per share multiplied by $-1$. In the theoretical model, capital investment ($\text{ci}_t$) is restricted to net investments in real property. $\text{CFI}_t$ includes net investments in real property and other long-term assets.\textsuperscript{79} Fortunately, the fraction of non-real property investments in $\text{CFI}_t$ is likely to be low because the U.S. tax code requires that the majority of a REIT’s assets be invested in real estate (see Section 2.2).\textsuperscript{80} In the model, the coefficient on $\text{CFI}_t$ captures the unrecorded net present values of current capital investment and of expected future capital investments predicted by current capital investment.\textsuperscript{81}

Equations 7 and 8 are expected to have the same explanatory power if the assumptions of the static Feltham and Ohlson (1996) model are true. This is expected to occur under the following conditions: (1) the sample period is long enough to offset any short-term cyclical variations in valuation weights; and (2) the underlying cash flow dynamics and accounting

\textsuperscript{79} Net investments in real property refer to the cost of acquiring new properties, constructing new properties, acquiring the shares of other real estate investment companies, and the cost of maintaining and improving existing properties, less cash proceeds from the sale of property.

\textsuperscript{80} Supporting this idea, I find the median ratio of real estate assets to total assets, 0.911, while the top and bottom 5\% are above 0.975 and below 0.727, respectively. See Table 4.

\textsuperscript{81} Recall that the cost of capital investment is capitalized and thus it is also included in the book value of equity.
relations (presented in Sections 3.2.1 and 3.2.3) are valid on average.

The empirical models estimated by Fields et al. (1998, Table 4) rely on two accounting regimes for determining earnings, i.e., net income and FFO. These models omit lagged book value of real property and capital investment which are included in the FO96 models (Equations 7 and 8) to correct for accounting bias. The Fields et al. models are presented as

\[ P_t = \alpha_0 + \alpha_1 \text{NI}_t + \alpha_2 \text{DIV}_t + \alpha_3 \text{BV}_t + \epsilon_t \]  
\[ (7a) \]

\[ P_t = \alpha_0 + \alpha_1 \text{FFO}_t + \alpha_2 \text{DIV}_t + \alpha_3 \text{BV}_t + \epsilon_t \]  
\[ (8a) \]

All variables are as defined above in the description of Eq. 7 and Eq. 8.

To test the impact of real estate cycles on the valuation weights of the FO96 model, I will estimate the following empirical version of the modified FO96 model (i.e., Eq. 4(a) in Section 3.3.2):

\[ P_t = \delta_0 + (\delta_1 + \delta_7 \text{CYCLE}_t)\text{CFO}_t + (\delta_2 + \delta_8 \text{CYCLE}_t)\text{DEPR}_t + (\delta_3 + \delta_9 \text{CYCLE}_t)\text{BV}_t \\
+ (\delta_4 + \delta_{10} \text{CYCLE}_t)\text{DIV}_t + (\delta_5 + \delta_{11} \text{CYCLE}_t)\text{CFI}_t + (\delta_6 + \delta_{12} \text{CYCLE}_t)\text{CYCLE}_t + \epsilon_t \]  
\[ (9) \]

The variables \( P_t, \text{BV}_t, \text{DIV}_t, \) and \( \text{CFI}_t \) are as described above. \( \text{CFO}_t \) is measured as cash flows from operating activities per share (CFO). In the theoretical model Eq. 4(a), FFO and CFO are assumed to be equal. However, empirically they are not equal as FFO contains working capital accruals, while CFO does not. Therefore, empirical tests of Eq. 9 will run separate regressions that include CFO with and without an extra variable capturing working capital accruals to check the robustness of results and to make them comparable to the results of regressions based on reported FFO. \( \text{DEPR}_t \) is depreciation expense per share, expressed as a negative number to emphasize its income-decreasing nature.

The variable \( \text{CYCLE}_t \) refers to a composite index for the real estate cycle phase during fiscal year \( t \). The composite index is designed to reflect common business-cycle information.
conveyed by three real estate market variables, which are assumed to capture the impacts of industry-wide supply and demand shocks. These variables include the total return for commercial real property, the gap between demand and supply indices for commercial real property, and the housing starts index. The total return indicates the total rate of return on a pool of commercial real estate properties acquired in the private market for investment purposes (National Council of Real Estate Investment Fiduciaries 2005). Total return for a period is the sum of each property’s net operating income plus the change in the property’s market value over the period. The MIT Center for Real Estate provides the demand and supply indices for commercial real estate market. Housing starts (provided by the Federal Reserve Bank at St. Louis) are the number of privately owned new houses for which construction started during the period, and this number is converted to an index with a value of 100 in 1972. Using a filtering technique developed by Hodrick and Prescott (1997), I take the cyclical component of the time series of each of these real estate market variables. I then use principal component analysis to construct a composite index of these cyclical components. The composite index is constructed to have a mean of zero across the valuation dates. See Appendix D for a more detailed description of the measurement of the composite index.

The composite index for the real estate cycle phase for fiscal year $t$ ($\text{CYCLE}_t$) is also included separately in the model to proxy for other information $\nu_{ct}$. A positive (negative) demand shock reflected in the cycle proxy is expected to influence the persistence of current cash flows generated by real property, because the positive (negative) demand shock is expected to boost (reduce) current and future market rents due to construction lags and fixed-term rental contracts. In contrast, other information $\nu_{ct}$ in the theoretical model (Eq. 4(a))

---

82 To check the robustness of results to the filtering technique, I also form a composite index of the three real estate market variables (not their cyclical components).
should predict future cash flows beyond that predicted by current cash flows and its persistence. This notion implies that a demand shock that occurs in a period can affect future rents without immediately affecting current rents.\textsuperscript{83}

I perform my regressions using two different measures of real estate cycle in alternative regression tests. First, I use the continuous proxy for real estate cycle described above. Alternatively, I collapse the proxy down to five real estate cycle phases during the period 1995–2008 (based on the direction of the change in the composite index over the fiscal year). These cycle phases are used to test which model, the net income model (Eq. 7 and Eq. 7(a)) or the FFO model (Eq. 8 and Eq. 8(a)), better explains stock prices during specific sub-periods. A boom denotes a period starting at a trough and ending at a peak. A bust denotes a period starting at a peak and ending at a trough. I require each boom and bust to last at least two years to avoid counting short and volatile fluctuations in the market. The five periods identified for this study include the 1995–1997 boom, the 1998–1999 bust, an undetermined period (2000–2002), the 2003–2006 boom, and the 2007–2008 bust.\textsuperscript{84} See Figure 3, Panel D for the composite index.\textsuperscript{85}

In this dissertation, I estimate all regression coefficients, except for the replication of Kang and Zhao (2010), using Ordinary Least Squares (OLS) and I adjust standard errors to the correlations of error terms within firm clusters and year clusters. This procedure ensures that the statistical inference based on the $t$-value is neutral to bias that might occur due to such correlations (Peterson 2008).

\textsuperscript{83} This condition may hold when all rentals are governed by long-term contracts and none of the rental contracts are renewed at post-shock market rates during the year when the demand shock occurred.

\textsuperscript{84} In Figure 3, the period 2000–2002 can alternatively be viewed as part of a bust that started in 1998.

\textsuperscript{85} In Figure 3, the fluctuating line is the monthly composite index. The smoothed line is the sixth-order polynomial approximation of the fluctuating line.
4.2.2 Empirical hypotheses

This section presents four testable hypotheses. The first two hypotheses concern the relative explanatory power of the empirical models based on the stationary FO96 models and the empirical models used in Fields et al. (1998). The remaining two hypotheses concern the cyclicality of the valuation weights on FFO and depreciation expense in the empirical version of the modified FO96 model (i.e., Eq. 9). Investigating these hypotheses provides insight about how the relative explanatory power of the Fields et al. models changes over time.

The first hypothesis (H1) concerns the relative explanatory power of Eq. 7 and Eq. 8. As discussed above, these empirical models are based on the theoretical Feltham and Ohlson (1996) models given by Eq. 2 and Eq. 3 of Chapter 3, under two alternative accounting regimes for determining earnings, the book value of equity, and the book value of real property. If the underlying assumptions about cash flow dynamics and accounting relations hold and do not vary across time, then both of models should correct for accounting bias and thus are predicted to have equal explanatory power. Therefore, I present H1 in an alternative form:

**H1: Eq. 7 and Eq. 8 have the same explanatory power.**

The second hypothesis (H2) compares the explanatory power of the Feltham and Ohlson (1996) models (i.e., Eq. 7 and Eq. 8) to that of the Fields et al. (1998) models (i.e., Eq. 7(a) and Eq. 8(a)). Equation 7 includes all of the variables in Eq. 7(a) plus two additional variables, i.e., lagged book value of real property and capital investment. These variables are included in order to correct for accounting bias. If such accounting bias exists, then the explanatory power of the less restrictive model, Eq. 7 is expected to be greater than that of the more restrictive model, Eq. 7(a) which lacks a correction for bias.
Eq. 8 includes FFO and net dividends which are also in Eq. 8(a) and it replaces the book value of equity from Eq. 8(a) with the gross book value of equity. Similar to Eq. 7, Eq. 8 also includes two additional variables, lagged gross book value of real property and capital investment, to correct for accounting bias. If these modifications are warranted due to accounting bias, then Eq. 8 will have greater explanatory power than Eq. 8(a). In summary, I present H2(a) and H2(b) in alternative forms:

**H2(a):** *Eq. 7 has greater explanatory power than Eq. 7(a).*

**H2(b):** *Eq. 8 has greater explanatory power than Eq. 8(a).*

The third hypothesis (H3) concerns the coefficient on CFO and its relation to the real estate cycle proxy variable (CYCLE) in Eq. 9. Recall the theoretical model treats CFO and FFO as equal. The theoretical valuation coefficient on CFO increases with the persistence of operating cash receipts. A positive demand shock during a year is expected to increase the persistence of both current and future market rents due to construction lags and fixed-term rental contracts. As the supply of rental space and new rental contracts adjust gradually over time, the real estate market will gradually move to a new equilibrium. Since constructing new space is expected to increase land prices due to the relatively fixed supply of land, land price appreciation is expected to increase the marginal cost of new rental space. As a result, post-shock market equilibrium rents will be greater than pre-shock market equilibrium rents. For a similar reason, a negative demand shock during a year is expected to decrease both current and future market rents, reducing the persistence of rental receipts. If booms and busts, triggered by

---

86 This section does not provide hypotheses on the coefficient on working capital accruals. Intuitively, when there are no manipulations and estimation errors in working capital accruals, the coefficient on working capital accruals should be equal to the coefficient on CFO. A proxy for working capital accruals will be included in alternative versions of empirical models in Equation 9.

87 See Figure 4 for a description of how an industry-wide demand shock is expected to affect rental rates over multiple years when the short-run supply of rental space is not flexible due to construction lags.
positive and negative demand shocks, reflect the impacts of these demand shocks on current and future market rents, investors will anticipate greater persistence in operating cash receipts in a boom than in a bust. This discussion leads to H3 in an alternative form:

**H3:** The valuation coefficient on CFO is positively correlated with CYCLE.

The fourth hypothesis (H4) concerns the coefficient on depreciation expense and its relation to the real estate cycle proxy in Eq. 9. In the theoretical model, the coefficient on depreciation expense equals a coefficient on CFO minus a correction for any conservative bias in accounting depreciation. As discussed in H3, investors anticipate that real property will generate more future cash receipts over its remaining useful life when they value equity in a boom than in a bust. This creates upward pressure on property prices in a boom, which means that the market’s perception of the anticipated depreciation in real property value is expected to be less during a boom than during a bust. While accounting rules allow for some modification to depreciation rates when the expected future cash flows of a capital asset decline, in general accounting depreciation rates are unrelated to the real estate cycle. Thus, accounting depreciation is expected to be more conservatively biased in a boom than in a bust. To correct for the cyclicality in accounting depreciation bias, investors will place a lower weight on depreciation expense in a boom than in a bust. The foregoing discussion leads to H4 in an alternative form:

**H4:** The valuation coefficient on depreciation expense is negatively correlated with CYCLE.

---

88 The theoretical valuation model Eq. 4(a) does not formally accommodate the fact that accounting recognition of impairment losses can alter the post-impairment depreciation schedule and that impairment losses are observed more frequently in market busts than in market booms.
It is difficult to make firm hypotheses about how the relative explanatory power of the net income and FFO models in Fields et al. (1998) are expected to vary over the real estate cycle phases. As discussed in Section 3.3.2, when investors value equity in a boom period, they are likely to anticipate higher persistence in cash receipts and have less concern regarding depreciation in property values in the presence of FFO (i.e., net income before depreciation). In contrast, investors are likely to anticipate a decline in cash receipts and an associated decline in real property values when they value equity in a bust period; however, it is difficult to know the extent to which this anticipated decline in cash receipts will differ from that implied by GAAP depreciation. If, as predicted in hypothesis H4, there is less role for depreciation in a boom than in a bust, then I conjecture that the FFO model (Eq. 8(a)) should outperform the net income model (Eq. 7(a)) during booms, but not necessarily during busts. However, both models omit capital investment and lagged book value of real property, and the importance of these omitted variables will depend on the extent of accounting bias and their correlations with the variables included in the models. In addition, the book value of equity included in the FFO model (Eq. 8(a)) is inconsistent with the clean surplus relation. The omission of variables, in combination with the mismeasurement of book value of equity for the FFO model, makes it difficult to make definite predictions.

4.3 Sample selection and descriptive statistics

This section describes sample selection and descriptive statistics. Table 1 describes the sample formation. Four different samples, spanning the period from 1995 to 2008, are formed. A separate sample is used for each valuation model as different outliers are excluded for each model. For example, Panel A describes the sample selection procedure for the replication of the
price regressions in Fields et al. (1998). Accounting data from COMPSTAT is merged with stock price from CRSP, and FFO data from the I/B/E/S summary file (SIC code = 6798–6799, REITs). Mortgage REITs and hybrid REITs are excluded because depreciation expense is not a material component of earnings for these REITs (Vincent 1999). Observations with missing values of the variables used in the regressions and 3 observations with zero depreciation expense are also deleted resulting in a sample of 1,274 firm-year observations. For each valuation regression, to mitigate the effects of extreme outliers, I exclude observations with variables outside the mean ± 3 standard deviations. The final sample consists of 1,179 observations for 172 REITs.

Table 2 presents the summary statistics of the sample used to estimate the valuation models. Stock price per share is typically greater than the book value of equity per share, reflecting future growth opportunities or conservative accounting. The mean and median of FFO per share are greater than those of common cash dividend per share and net income per share. The mean and median of the book value of buildings per share are considerably larger than those of the book value of land per share. The age of a property portfolio, which is measured as the ratio of accumulated depreciation to gross book value of buildings, ranges from 0.01 to 0.57. As argued by Chapter 2, depreciation bias is likely to vary with firm age. This suggests that, if depreciation expense is conservatively biased on average, there is likely to be considerable variation in cumulative depreciation bias within the sample. The mean and median of the analysts’ forecasts of FFO indicate that analysts typically anticipate FFO to grow over the forecasting horizon.

89 My sample period begins the year 1995 because the number of observations for the period before 1995 is too small to perform a reliable analysis for this period.

90 The samples used in other tables differ from the sample used in Table 5 because of the availability of the data for working capital, building, land, accumulated depreciation, and the I/B/E/S analysts’ forecasts of future FFO. I hand collect the data pertaining to working capital, building, land, and accumulated depreciation from 10-Ks.
Panel A of Table 3 shows the correlation coefficients between market and accounting data. Stock price per share is more strongly correlated with earnings and book values before depreciation (i.e., FFO and gross book value of equity) than with earnings and book values after depreciation (i.e., net income and book value of equity). Common cash dividends per share is more strongly correlated with FFO than with net income, consistent with the finding of Ben-shahar et al. (2011). The negative correlation between stock prices and depreciation expense suggests that depreciation expense predicts future benefits from past investments.

Panel B of Table 3 reports the correlation coefficients between the real estate cycle proxy, macroeconomic variables, and discount rates. The real estate cycle proxy is positively correlated with GDP growth and negatively correlated with term premium and default spread. This result is consistent with the theory that real estate cycles are aligned with general business cycles (Wheaton 1999). In contrast, the real estate cycle proxy is not significantly correlated with real estate industry cost of equity, estimated by the Fama and French three-factor model. As the cost of equity is based on beta estimated from the past five years of returns, this is unlikely to be sensitive to fluctuations in real estate business cycles unless such cycles are correlated with the risk free rate or the market risk premium.

4.4 Empirical Results

This section presents the results of estimating the empirical models and testing the hypotheses. I begin by estimating the stationary FO96 models (Eq. 7 and Eq. 8) and testing the hypothesis that these models have equal explanatory power. I then replicate the price regressions from Fields et al. (1998) and test the hypothesis that the stationary FO96 models outperform the models in Fields et al. (1998). I also replicate the price level regressions in

91 See Appendix C for a detailed explanation of how the real estate industry cost of equity is estimated.
Kang and Zhao (2010). Recall Fields et al. (1998) and Kang and Zhao (2010) looked at the relative importance of FFO versus net income in determining stock prices over relatively short sample periods and found conflicting results. This section replicates the tests in these studies across different stages of the real estate cycles to explore whether business-cycle conditions can be used to explain the differing results of these studies. Finally, I estimate the modified FO96 model and test the hypothesis that the valuation weights on FFO and depreciation expense have opposite sensitivities to real estate cycle phases.

4.4.1 Estimating the stationary Feltham and Ohlson (1996) models

This section presents the results of estimating the stationary Feltham and Ohlson (1996) models (Eq. 7 and Eq. 8). It then tests H1 that these models have equal explanatory power. The relative explanatory power of Eq. 7 versus Eq. 8 is estimated using a Young (1989) test first for the entire sample period and then separately for the phases of the real estate cycles. If a Z-value for the Young (1989) test is negative, this indicates that the FFO model (Eq. 8) outperforms the net income model (Eq. 7) in explaining stock prices for a specific period. If these models do not have equal explanatory power, this suggests that the underlying cash flow dynamics and accounting relations are incomplete.

A test of H1, that a fully-specified net income model (i.e. Eq. 7) should perform as well as a fully-specified FFO model (i.e., Eq. 8) is presented in Table 4. The first three columns report the results if all firm years are combined together (column a), if boom periods are combined together (column b) and if bust periods are combined together (column c). Columns (d) through (h) report the results by individual sub-periods comprising sample lengths that are similar to prior studies. There are notable conclusions that can be drawn from this Table.
First, the evidence in Table 4 allows me to reject H1 (that the explanatory power of the net income versus FFO models are the same), if all firm-years are assumed to have the same parameters (column a), or during boom periods (columns b, d, and g) as indicated by the Vuong tests at the bottom of Table 4. Note that the negative and significant \( z \)-value observed in column (a) indicates that, generally the full FFO model has greater explanatory power than the full net income model. However, for bust periods (columns c, e, and h), we are unable to reject H1. Hence, H1 can be accepted only during busts, and not during booms. This result suggests that, relative to my static theoretical framework, there is greater model misspecification during periods labelled as booms, than for those labelled as busts.

Second, further inspection of the magnitudes of coefficients on FFO in Eq. 8 and on lagged book value of real property in Eq. 7 reveals that these move up and down, depending on whether a sub-period is classified as a boom or bust. If the persistence of cash receipts is greater in booms than in busts, the coefficient on FFO and net income will be higher in column (b) than in column (c), and, the coefficient on lagged book value of real property will be higher in column (b) than in column (c). Though no formal tests are presented, point estimates reported in Table 4 are consistent with this prediction for FFO, \( PE_{t-1} \), and \( PE_{t-1,F FO} \). In particular, the variation in the coefficients on FFO, \( PE_{t-1} \), and \( PE_{t-1,F FO} \) are consistent with the main argument in this dissertation that the valuation coefficient on FFO and proxies for depreciation bias should vary with cycles.

Third, Table 4 shows that investing behaviour by REITs provides information that equity investors can use to update market values. The estimated valuation coefficients on investing cash flows are positive and statistically different from zero in every column of Table 4, in both of the net income and FFO models. This result suggests that stockholders perceive
investment in real property to be a positive net present value undertaking whether REITs engage in this activity during booms or busts.

Fourth, the results in Table 4 also suggest that the theoretical framework engendered in Equations 7 and 8 are not fully supported by the data as implemented. For example, there are obvious violations of the cross-coefficient restrictions that are implied by Equation 7 and 8. Some noticeable violations include: 1) the coefficient on common cash dividend should be negative and should be smaller in absolute value than the coefficient on FFO or net income by a factor of $1 + r$; and 2) the coefficient on net income should be the same as the coefficient on FFO and it should co-vary with booms and busts in a manner similar to that illustrated by the coefficient on FFO.

Though no formal tests are presented, it appears that these conditions do not hold. Similar violations are evident in the coefficient on book value of equity. Thus, although aspects of the static model in Equations 7 and 8 are consistent with theory, other aspects are not.

One potential reason for the appearance of some anomalous results is that Table 4 constrains coefficients within sub-periods to be constant. If however, as theorized in Section 3.3, the persistence of operating cash receipts varies as REITs move through cycles, the coefficients in Table 4 should vary in a continuous fashion over time. In a subsequent analysis, contained in Table 7, I allow the coefficients on income components to vary continuously with a measure of the real estate cycle. This relaxes the implicit restriction in Table 4 that coefficients are constant within sub-periods. Table 7 provides additional support for my

---

92 The significantly positive coefficient on common cash dividend suggests that the Dividend Irrelevance Theorem does not hold for my sample. Other studies have found a positive coefficient on dividends in the regression of stock prices on net income, book value of equity, and dividends. Hand and Landsman (2005) summarize three possible reasons for a positive coefficient on dividends. The other information hypothesis predicts that dividends are a proxy for information that helps predict future abnormal earnings beyond current abnormal earnings and its persistence. The profitability signaling hypothesis predicts that managers use dividends as a signal of their private information about future profitability. The agency cost hypothesis predicts that managers pay dividends to signal that they will not extract personal benefits from retaining cash at the expense of shareholders.
contention that real estate cycles can explain variation in the ability of net income versus FFO to map into REIT valuations.

4.4.2 Replicating a test of Fields et al. (1998)

Fields et al. (1998) assess the usefulness of FFO versus net income by comparing the ability of these measures to explain current stock prices. They find that, during the period 1991–1995, FFO is not able to explain stock prices and returns any better than net income. The analysis presented in Chapter 3 suggests that given the stationary parameters, such results should not be surprising, provided both models contain variables that capture accounting biases (i.e., lagged book value of real property and capital investments). This section applies the tests performed in Fields et al. to the period 1995–2008 to explore whether their results are sensitive to the real estate cycle phases across sub-periods. If a Z-value for the Vuong (1989) test for Eq. 7(a) versus Eq. 8(a) is negative, this indicates that the Fields et al. FFO model (Eq. 8(a)) outperforms their net income model (Eq. 7(a)) in explaining stock prices for a specific period. In addition, I test H2 that the FO96 models that include additional variables to correct for accounting bias outperform the Fields et al. models.

Table 5 presents the results of estimating the Fields et al. models, Eq. 7(a) and Eq. 8(a). Recall these models are the incomplete and reduced versions of the stationary FO96 models because the Fields et al. models exclude variables that capture accounting bias. All results of estimating the Fields et al. models are largely consistent with the results of estimating the stationary FO96 models in Table 4. As in Table 4, column (a) reports the regression estimation for the full sample period 1998–2008, while columns (b) to (h) report results of boom and bust sub-periods. In brief, the results of the Young (1989) test for the full period 1995–2008, as
shown in column (a), indicates that the FFO model outperforms the net income model on average. The results of the Vuong tests for the sub-periods, as shown in columns (b) through (h), indicate that the FFO model outperforms the net income model in boom periods (1995–1997 and 2003–2006) but not in bust periods (1998–1999 and 2007–2008) and not in an indefinite period (2000–2002). These results suggest that FFO has been a better indicator of stock prices than net income when the sample period consists mostly of market booms but that this is not the case when a sample period consists mostly of market busts. Note that the original data included in Fields et al. combines two sub-periods, a market downturn in 1991–1992 and a short market upturn 1994–1995.

On a side note, column (f) of Table 5 shows that the FFO model outperforms the net income model for the period 2000–2002, although this period is not a market boom. A potential reason for this is that transitory gains and losses on the sale of property and asset write-downs, which are excluded from FFO, occurred frequently during this period. These items are non-recurring in nature and thus may have limited relevance in explaining stock prices. Another potential reason is that, as argued by Baik et al. (2008), the clarification of the definition of FFO by the NAREIT in 1999 may have enhanced the uniformity and reliability of FFO in the 2000–2002 period, inducing investors to rely more on FFO in valuing equity. However, during the same period, the Z-value is not significantly different from zero in Table 4, suggesting that undoing accounting bias due to unrecorded NPV of investment opportunities and accounting depreciation reduces the discrepancy between the explanatory powers of the FFO model and the net income model during this period.

Changes in the estimated coefficients in Table 5 across the phases of real estate cycles

---

93 Untabulated results indicate that the mean and variance of the incidence of asset write-downs and gains and losses on the sale of property are greater for the period 2000–2002 than for the period 1995–1999 at the significance level of 0.01.
are consistent with the results of the Vuong tests and the theoretical predictions. In general, the estimated coefficient on FFO is larger in a boom than in a bust, while the estimated coefficient on net income is larger in a bust than in a boom. As in Table 4, the significantly positive coefficient on common cash dividend per share (DIV$_t$) suggests that the Dividend Irrelevance Theorem does not hold for my sample.

To check the incremental explanatory power of the two omitted variables (H2), I perform the Vuoug tests for Eq. 7 versus Eq. 7(a) and for Eq. 8 versus Eq. 8(a), respectively. A positive Z-value for the Vuong (1989) test indicates that the FO96 model outperforms the Fields et al. model in explaining stock prices for a specific period. The Z-values of the Vuong tests for the FO96 models versus the Fields et al. models are significantly positive (where p-values for two tailed tests are below the critical cutoff of 0.10). This result supports H2 that the FO96 models have greater explanatory power than the Fields et al. models. A similar result is observed for most of the sub-periods. Relatively large increases in the R-squared from the Fields et al. model Eq. 8(a) to the FO96 model Eq. 8 suggest that lagged book value of real property and capital investment have significant incremental explanatory power. In contrast, small positive increases in the R-Squared from the Fields et al. model Eq. 7(a) to the FO96 model Eq. 7 suggest that using FFO and gross book value of equity appears to largely eliminate most of accounting bias due to GAAP depreciation, so lagged book value of real property does not add much explanatory power to the model on average.

In untabulated findings, I check the robustness of the regression results based on stock price by relating net income and FFO to stock returns. To do this, I regress annual stock returns on the level of, and change in, FFO per share, and lagged dividend per share, and then running
the same regression with net income substituted for FFO.\textsuperscript{94} All independent variables are deflated by lagged stock prices. Stock returns are measured by compounding monthly returns over the twelve month period ending at the end of the third month after the fiscal year end. In results not reported in the tables, the FFO regressions have higher explanatory power than the net income regressions in boom periods, and the net income regressions have higher explanatory power in bust periods. However, these return regressions are similar to those estimated in Vincent (1999) and do not contain variables that captures a change in accounting bias during a period (e.g., depreciation and capital investments). Therefore, it is an interesting research avenue to investigate how the relation between stock returns and alternative earnings measures change over the real estate cycle phases.

4.4.3 Replicating a test of Kang and Zhao (2010)

As mentioned above, Kang and Zhao (2010) also estimate a price level regression for REITs. Using a recent sample (2000-2005), they estimate a net income model similar to the one in Fields et al. (1998), but augmenting the model to include accumulated depreciation and control variables for sales growth, leverage, and fiscal year. The Kang and Zhao model is loosely related to the static FO96 model through its inclusion of net income, book value of equity and dividends and its addition of accumulated depreciation to correct for depreciation bias. They find that accumulated depreciation (measured as a positive value) has a positive and significant coefficient of 0.98, suggesting that the market corrects for an understatement of equity value, due to the over-depreciation of real property. In this section I re-estimate Table 5 of Kang and Zhao (2010) and I extend their test to explore whether accumulated depreciation is

\textsuperscript{94} Taking first differences in the Fields et al. models Eq. 7(a) and Eq. 8(a), invoking the clean surplus assumption, rearranging terms and dividing through by lagged price leads to these return models. In contrast, Fields et al. (1998) regress realized returns on the level of FFO versus the level of net income deflated by lagged stock prices.
perceived to be more conservatively biased in a market boom than in a market bust.

The Kang and Zhao (2010) model takes the following form:

\[ P_{k,z,t} = \gamma_0 + \gamma_1 \text{NI}_{k,z,t} + \gamma_2 \text{BVE}_{k,z,t} + \gamma_3 \text{ACCUDEP}_{k,z,t} + \gamma_4 \text{DIV}_{k,z,t} + \gamma_5 \text{Sgr}_t + \gamma_6 \text{LEV}_t + \sum_{y=2000}^{2004} \gamma_y Y_y + \varepsilon_t \]  

(10)

where \( P_{k,z,t} \), \( \text{NI}_{k,z,t} \), \( \text{BVE}_{k,z,t} \) and \( \text{DIV}_{k,z,t} \) are as defined above. \( \text{ACCUDEP}_{k,z,t} \) is accumulated depreciation per share at the end of year \( t \); \( \text{Sgr}_t \) is sales growth rate for year \( t \); \( \text{LEV}_t \) is leverage ratio at the end of year \( t \); and \( Y_y \) is a dummy variable for fiscal year \( y \). All variables, except for \( \text{Sgr}, \text{LEV}, \) and \( Y_y \), are adjusted for stock splits. Kang and Zhao (2010) include year dummy variables to control for variations in macroeconomic conditions across years. The dummy variables are likely to capture some of the impact of real estate cycles on REIT market values.

Table 6 reports the results of re-estimating the Kang and Zhao (2010) model during my sample period and for various boom and bust sub-periods. Column (a) reports Kang and Zhao (2010)'s original regression estimated over their 2000-2005 sample period. In column (b) I re-estimate their model for my entire 1995 - 2008 sample period, implicitly restricting all coefficients, other than the year dummies to be fixed across time. The significance of coefficients in the re-estimated full sample regression is very similar to Kang and Zhao's original results, except that the dividend variable, which was not significant in their analysis, is significantly positive for my sample. The magnitude of coefficients on NI, BVE and ACCUDEP is smaller in the re-estimated regression than in their original regression, but they remain positive and significant. The coefficient on accumulated depreciation, which was close to one in Kang and Zhao is 0.66 in the re-estimated model and is significantly less than

---

95 To mitigate bias due to scale differences, I estimate Eq. 10 using Weighted Least Squares (WLS) with the inverse of the square of lagged total assets used as a weight variable. I also control for the correlation of error terms within firm clusters.

96 In untabulated analysis, when I re-estimate their model restricting the sample to only include their 2000-2005 sample period the direction and significance of coefficients are the same as those reported for my full sample, and the magnitude of the coefficients on NI, BVE and DIV is between those estimated by Kang and Zhao (2010) and my estimates for the full sample.
This suggests that on average the market does not add back all of accumulated depreciation when valuing REITs. In columns (c) to (i) I estimate the model during various sub-periods. Boom periods are combined in column (c) while busts are combined in column (d). The direction and significance of coefficients during booms is consistent with results for the full sample, but the magnitude of the add back of accumulated depreciation is larger. The estimated coefficient on accumulated depreciation during booms is 1.16 which is not significantly different from one. This suggests that during boom periods REIT market values add back all past charges for the depreciation of real estate assets. The same is not true during the bust periods, as the coefficient on accumulated depreciation in column (d) is not significantly different from zero.

The individual sub-period analysis is reported in columns (e) through (i). In general, the coefficients on the sub-period year dummy variables are consistent with what we expect should be happening to market values during booms versus busts. During the two bust periods the dummy variable is positive in the first year of the bust, reflecting the fact that market values are higher at the beginning of the bust than in the second year of the bust. During the 2003-2006 boom period the reverse is true as prices increase over the period. The 1995 – 1997 boom period is a little more mixed as prices go from a low in 1995 to a high in 1996 and drop back down in 1997.

In the sub-period analysis, we see more variation in the significance of accumulated depreciation than for the pooled sample. During the first three sub-periods accumulated depreciation is not significant. But in the 2003 - 2006 boom period it is significantly positive and greater than one, suggesting a run up in property values to above their original cost, consistent with negative depreciation during this sub-period. While in the final 2007 - 2008
bust period the coefficient on accumulated depreciation is significantly positive, but
significantly less than one, suggesting that some, but not all, of the past depreciation of real
property is being added back into market values during this bust period. This variability in the
valuation coefficient on accumulated depreciation further supports the view that regression
coefficients should be allowed to vary with the real estate cycle.

In summary, the pooled sample results in Table 6 are consistent with the maintained
hypothesis in this thesis, that historical depreciation is less relevant for the pricing of REITs
during boom periods than during bust periods. However, the results over shorter boom and bust
periods are more mixed.

4.4.4 Estimating the modified Feltham and Ohlson (1996) model

This section tests my hypotheses about the cyclicality of the coefficients on CFO and
depreciation expense in the empirical versions of the modified FO96 model (Eq. 9). The
hypotheses predict that the coefficient on CFO is positively correlated with the real estate cycle
proxy (H3) and that the coefficient on depreciation expense is negatively correlated with the
real estate cycle proxy (H4). If these hypotheses are supported in the data, this will help to
explain why in Table 5 the FFO model of Fields et al. (1998) explains stock prices better than
the net income model in boom periods, but not in bust periods.

In Table 7, I estimate the modified FO96 model, Eq. 9, together with more restrictive
and less restrictive variations of this base case model. One variation, reported in column (a)
estimates a simplified version of the modified FO96 model that sets all of the interactive cycle
variables to zero and simply includes CYCLE as an other information variable. This model is
based on Eq. 2(b) in chapter 3 and is simply a variation of the stationary FO96 net income
model, dividing net income into CFO and depreciation expense, and including CYCLE as other information. The theoretical model in Eq. 2(b) is sufficient to explain price if the cash flow dynamics are fixed, i.e. it does change with CYCLE. Other variations of Eq. 9, reported in columns (c) to (h) of Table 7, augment Eq. 9 with additional variables to control for items omitted by the empirical model. These variables include working capital accruals, separating real property into land and buildings, and the age of a property portfolio. The rational for including these variables is discussed below. All regressions in Table 7 are estimated for the entire sample period.

The regression results and explanatory power of the simplified model in column (a) can be compared to the stationary FO96 net income model in column (a) of Table 4. The coefficient on CFO in Table 7 is similar to the coefficient on net income in Table 4, but the coefficient on depreciation is less. This occurs because depreciation loads both due to its impact as part of net income and because it acts as a proxy for lagged book value of real property. If depreciation is conservatively biased on average, then this tends to reduce the coefficient on depreciation from the weight it would receive as part of net income. As we move from Eq. 7 in column (a) of Table 4 to the model that includes a single CYCLE variable in column (a) of Table 7, the adjusted R² goes from 45% to 49.5% (Z-value of a Vuong (1989) test is 3.14, p-value = 0.002), suggesting that the level of CYCLE alone helps to explain variation in market values. This is consistent with what we observed for the year dummy variables in the re-estimated Kang and Zhao (2010) model.

The full modified FO96 model (Eq. 9) is reported in column (b). These results support hypotheses H3 and H4 on how the coefficients on CFO and DEPR vary with the real estate cycle proxy (CYCLE_t). Consistent with H3, the coefficient on CFO_t*CYCLE_t is significantly
positive in column (b). This result suggests that the valuation weight on CFO is greater when CYCLE is high, consistent with a higher expected persistence in CFO during boom times. Consistent with hypothesis H4, the coefficient on DEPR*CYLE is significantly negative in column (b). This result suggests that the market perceives accounting depreciation as more conservatively biased when CYCLE is high than when CYCLE is low.

The results in column (b) supporting H3 and H4 provide a partial explanation for the results in Table 5 that show the explanatory power of a net income-based model falls during booms. In a boom, the coefficient on CFO, (i.e., a proxy for FFO) increases as the state variable for the real estate cycle phase increases. At the same time, the valuation weight on depreciation expense moves in the opposite direction, suggesting the charge for depreciation expense is becoming less relevant as CYCLE moves up. Net income adds together CFO and depreciation, so a model like the one in Table 5, that constrains the valuation weights on CFO and depreciation to be the same, will become less able to explain value as the cycle variable increases. Hence, these results help to explain why the net income model loses explanatory power during booms.

Results in (b) indicate that investors have different viewpoints about the long-term and short-term profitability of capital investments. The positive coefficient on CFI in these columns suggests that investors perceive the NPV of expected capital investments as positive in the long term. The negative coefficient on CFI*CYLE suggests that investors perceive the NPV of expected future capital investments as lower when CYCLE is higher.

The modified FO96 model in Eq. 9 is derived by assuming that net income can be decomposed into FFO plus depreciation expense and that FFO and CFO are equal. Empirically these assumptions are not entirely true. In particular, there are non-depreciation accruals,
referred to in this dissertation as working capital accruals, which are included in net income and also in FFO. However, these accruals are not part of CFO. Therefore, FFO is not entirely a cash flow performance measure, as it includes accruals such as rents receivable, rents received in advance and non-current operating accruals other than depreciation. In order to come closer to reflecting more of the components of net income and FFO in the estimation of the modified FO96 model, I extend the base case models reported in columns (a) and (b) to include these omitted working capital accruals, defined as the difference between FFO and CFO (i.e., FFO–CFO). These results are reported in columns (c) and (d) of Table 7.

Working capital accruals are an, as yet, unmodelled component of FFO. They can be thought of as providing information to the market about expected future cash flows associated with current non-cash operating transactions. For example, current rentals not yet collected, or purchases on credit are regarded as working capital accruals because these items do not incur current operating cash receipts but they predict future operating cash receipts. Although CFO is significantly larger than working capital accruals for REITs, omitting these items could bias the coefficients in Eq. 9.

The logic behind incorporating working capital accruals is discussed in Christensen and Feltham (2003). Similar to the valuation weight on depreciation expense, the valuation weight on working capital accruals is equal to the valuation weight on CFO less the market’s

---

97 As the regulatory definition of FFO changed during my sample period (see Appendix A for the rules regarding items that are required to be included in FFO) items such as impairment losses and other non-recurring items are not part of FFO during the first part of my sample period, but are included in FFO during the later part of the period. In the model extensions in section 4.5.2 I examine the Baik et al. (2008) hypothesis that market's reliance on FFO as a valuation metric was enhanced after 2000 when the NAREIT began to require that FFO include non-recurring items.

98 Appendix B.5 provides the augmented static model (Eq. 2(d)) that accommodates working capital (wc) and working capital accruals (Δwc). Modeling these items draws on Christensen and Feltham (2003, pp.339-341) who regard the managers’ information on current non-cash operating transactions (e.g., growth in receivables) as other information on future operating cash receipts.
correction of bias in working capital accruals. If working capital accruals predict future operating cash receipts in an unbiased manner, the valuation coefficient on this item will equal the coefficient on CFO. Lagged working capital (WC_{t-1}), defined as the beginning-of-period net book value of all operating assets excluding real estate property, is included in the model to capture the market’s correction for the cumulative bias in past working capital accruals. If periodic working capital accruals are unbiased, lagged working capital is expected to have the valuation weight of zero.

The second extension to Eq. 9 included in Table 7, is to include land separately in the regression to allow for a difference in accounting depreciation bias between land and buildings. Such a difference is expected to stem from different depreciation rules for land and buildings. When the lagged book value of land is included in the regression as an additional variable, the valuation weight on depreciation expense captures depreciation bias for buildings, rather than depreciation bias for total property (i.e., land and buildings) and the coefficient on land will capture any depreciation bias for land. As land is not required to be depreciated under GAAP, lagged book value of land will have a positive weight if the historical cost of land understates land’s current value.

The third extension to Eq. 9 is to interact depreciation expense with the average age of a REIT’s property portfolio. An older property portfolio will have had more time to accumulate a larger depreciation bias than a younger property portfolio. Recall depreciation loads due to its impact on net income and as a proxy for lagged book value of real property. Thus, the age of a

---

99 For example, if working capital accruals are aggressively biased, the model will place a lower weight on working capital accruals than on CFO to correct for such bias in working capital accruals.

100 See Appendix C for the detailed measurement for working capital.

101 As discussed in Section 2.3.1, the market values of building and land components of a developed property are not separately observable. In contrast, this study assumes that rational stock market investors can evaluate the intrinsic values of the building and land components of a developed property.

102 Equation 2(c) in Section 3.4 is a static model that includes lagged book value of land as an additional variable.
property portfolio is expected to have a negative confounding effect on the valuation weight on
depreciation expense in a similar manner to the role of accumulated depreciation in the Kang
and Zhao (2010) model. I calculate the age of a property portfolio as the ratio of accumulated
depreciation to gross book value of buildings and then convert this ratio into a quartile variable
(QAGE_{t-1}). The quartile variable QAGE_{t-1} is assigned a value of zero for firms in the youngest
property portfolio and a value of three for firms in the oldest property portfolio.

Columns (c) and (d) of Table 7 show the results of estimating the modified FO96 model
including working capital accruals (FFO_{t}-CFO_{t}) and lagged working capital (WC_{t-1}). When I
add these omitted variables to the regression, the coefficient on FFO-CFO is positive and
significant and the adjusted R^2 of the model increases.\textsuperscript{103} These results imply that non-
depreciation accruals included in FFO are relevant in the valuation of REITs. The coefficient
on lagged working capital is not significant, implying no correction for past bias in the book
value of working capital. Interestingly, as we add working capital accruals to the model the
coefficients on CFO increase from 3.456 and 3.625 in columns (a) and (b) to 8.911 and 8.129 in
columns (c) and (d)\textsuperscript{104} and the coefficients on book value of equity decline from 0.275 and
0.358 to become insignificantly different from zero in column (c) and 0.177 (which is
significantly positive) in column (d). Also the weight on working capital accruals included in
FFO is very similar to the new higher weight on CFO.\textsuperscript{105} In general these results provide
strong support for a model that includes the working capital accruals component of FFO and

\textsuperscript{103} The Z-value of a Vuong (1989) test comparing the explanatory power of the model in column (c) to the model
in column (a) is 4.59 (p-value = <.0001). The Z-value of a Vuong (1989) test comparing the explanatory power of
the model in column (d) to the model in column (b) is 4.69 (p-value = <.0001).

\textsuperscript{104} A two standard deviation confidence interval around the coefficient on CFO in column (b) ranges from 2.68 to
4.57, while in column (d) the same confidence interval around CFO ranges from 6.75 to 9.51. These confidence
intervals do not intersect, suggesting the coefficient on CFO is significantly higher when working capital accruals
and lagged working capital are included.

\textsuperscript{105} The Chi-squared test reported at the bottom of Table 7 shows that the two coefficients are equal in column (c),
however, the coefficient on CFO is significantly larger than the coefficient on FFO-CFO in column (d).
suggest that the market perceives working capital accruals as typically unbiased in the long run.

In column (f), the coefficient on LAND\textsubscript{t-1} is significantly positive, but the coefficient on LAND\textsubscript{t-1}*CYCLE\textsubscript{t} is not significantly different from zero. While the book value of land tends to understate the market’s perception of its value on average, it is surprising that the understatement of land value is not sensitive to the real estate cycle on average. The cyclicality of bias in the book value of real property appears to be captured by cyclicality in the bias of book value of buildings.

In columns (g) and (h), the negative coefficient on QAGE\textsubscript{t-1}*DEPR\textsubscript{t} suggests that conservative bias in depreciation increases in proportion to the length of period during which depreciation bias is accumulated. The coefficient on DEPR\textsubscript{t} (where QAGE\textsubscript{t-1} = 0) in columns (g) and (h) is greater than that in the other columns, suggesting that a younger property portfolio has less conservative bias in depreciation than an older property portfolio does. Notice also that the coefficient on the book value of equity increases when this control for accumulated depreciation is included in the model.

Consistent with the results for the base case model in column (b), the coefficient on CFO\textsubscript{t}*CYCLE\textsubscript{t} is positive and significant for the two extended models in columns (d) and (f), indicating that the regression weight on CFO\textsubscript{t} is higher when CYCLE\textsubscript{t} is high.\textsuperscript{106} The opposite is true for the coefficient on DEPR\textsubscript{t}*CYCLE\textsubscript{t} for all three extended models, which indicates a larger add back of depreciation expense when CYCLE\textsubscript{t} is high. These results continue to support H3 and H4.

Results also indicate that the market perceives depreciation expense to be conservatively biased in the long run (where CYCLE\textsubscript{t} = 0). In all of the regressions except for

\textsuperscript{106} In column (h), the coefficient on CFO\textsubscript{t}*CYCLE\textsubscript{t} is insignificantly different from zero (p-value = 0.11). When LAND and LAND*CYCLE are excluded, the coefficient on CFO\textsubscript{t}*CYCLE\textsubscript{t} becomes significantly positive.
the base case model in column (b), the coefficient on DEPR, is significantly lower than that on CFO, suggesting that the accounting depreciation of real property exceeds the expected long-run economic depreciation of real property. Despite such depreciation bias, the significantly positive coefficient on depreciation expense in all columns suggests that depreciation expense is relevant to the expected long-run economic depreciation of real property to some extent.

4.5 Extensions to the modified Feltham and Ohlson (1996) model

In this section, I discuss results for various alternative specifications of the base-case FO96 model. Lagged real property is substituted for depreciation expense enabling me to test how bias in the book value of real property varies over real estate cycles (Section 4.5.1). Section 4.5.2 examines the confounding effects of NAREIT (1999) regulations and discount rates on valuation coefficients. Section 4.5.3 presents the results of estimating the cash flow dynamics for the modified FO96 model. Section 4.5.4 reports the results of a robustness test pertaining to an alternative real estate cycle proxy variable.

4.5.1 The cyclicality of bias in the book value of real property

Section 4.4.4 examined the ability of depreciation expense, an income statement number, to predict expected future economic depreciation. If periodic accounting depreciation deviates from periodic economic depreciation, the book value of real property is also expected to deviate from the market value of real property. This section performs a complementary test that examines how bias in the book value of real property varies over real estate cycles. This test also complements the test for the bias in accumulated depreciation in Section 4.4.3.

In column (b), there is no significant difference between the coefficients on CFO, and DEPR. This result appears to be attributable to the omitted variables such as FFO-CFO, and WC.
In the derivation of the modified FO96 model, depreciation expense of real property is assumed to follow a declining balance schedule where \( \text{depr}_t = -(1-\delta_{pe})\text{pe}_{t-1} \). Therefore depreciation expense can be replaced with the lagged book value of real property (\( \text{pe}_{t-1} \)). If the functional form of depreciation expense is valid, the coefficients on \( \text{PE}_{t-1} \) and \( \text{PE}_{t-1} \times \text{CYCLE}_t \) will have the opposite signs to those on \( \text{DEPR}_t \) and \( \text{DEPR}_t \times \text{CYCLE}_t \) reported in Table 7, that is, the coefficient on \( \text{PE}_{t-1} \) is expected to be negative and the coefficient on \( \text{PE}_{t-1} \times \text{CYCLE}_t \) is expected to be positive.

To examine the effect of differing depreciation rules for land and building, I replace lagged book value of real property per share (\( \text{PE}_{t-1} \)) with lagged book value of buildings per share (\( \text{BUILD}_{t-1} \)) and lagged book value of land per share (\( \text{LAND}_{t-1} \)). Depreciation of buildings is expressed as \( \text{depr}_t = -(1-\delta_B)\text{B}_{t-1} \). The sign of the coefficients on \( \text{BUILD}_{t-1} \) and \( \text{BUILD}_{t-1} \times \text{CYCLE}_t \) will be similar to the signs of the coefficients on \( \text{PE}_{t-1} \) and \( \text{PE}_{t-1} \times \text{CYCLE}_t \).

Table 8 presents the results of the foregoing extension of Eq. 9. All columns in Table 8 are symmetric to their counterparts in Table 7, except for the replacement of \( \text{DEPR}_t \) and \( \text{DEPR}_t \times \text{CYCLE}_t \) with \( \text{PE}_{t-1} \) and \( \text{PE}_{t-1} \times \text{CYCLE}_t \) (\( \text{BUILD}_{t-1} \) and \( \text{BUILD}_{t-1} \times \text{CYCLE}_t \)). The overall results in Table 8 are consistent with those in Table 7 and with H4 on the effect of real estate cycles on accounting depreciation bias. Consistent with H3, the coefficients on \( \text{CFO}_t \times \text{CYCLE}_t \) are significantly positive in all regressions that include the interactive cycle variable. In addition the coefficients on \( \text{PE}_{t-1} \times \text{CYCLE}_t \) in columns (b) and (d) and \( \text{BUILD}_{t-1} \times \text{CYCLE}_t \) in columns (f) and (h) are significantly positive, consistent with H4. While the coefficient on \( \text{PE}_{t-1} \) is not significant in columns (a) to (d), when real property is divided into land and its depreciable component, buildings, the coefficient on buildings is significantly negative when

---

108 \( 1-\delta_{pe} \) is the depreciation rate of the book value of real property (see AR3 in Section 3.2.3).
109 \( 1-\delta_B \) is the depreciation rate of the book value of building (see AR7 in Section 3.4).
variation in CYCLE is controlled for in columns (f) and (h).

4.5.2 Confounding effects of the NAREIT (1999) regulation and discount rates

The new definition of FFO provided by NAREIT in 1999 and time-variations in discount rates are likely to confound the apparent business-cycle effect. Baik et al. (2008) find evidence suggesting that the regulatory measures taken to improve the uniformity of FFO disclosure enhanced the reliability of FFO and the explanatory power of FFO for stock prices and returns. Their findings suggest that the regulatory effect on valuation weights may confound the business-cycle effect reported in Table 7. In addition, empirical financial research has found evidence suggesting that discount rates vary over time (e.g., Fama and French 1989). Since a valuation weight is a decreasing function of discount rates, variations in discount rates may induce variations in valuation weights.

This section investigates the incremental effects of the real estate cycle, the NAREIT (1999) regulation, and discount rates. I estimate the following regression:

\[ P_t = \delta_0 + \sum_{i=1}^9 (\delta_{li} + \delta_{2i} \text{CYCLE}_t + \delta_{3i} \text{REG}_t + \delta_{4i} \text{COEC}_t)z_{it} + \epsilon_t \]  \hspace{1cm} (13)

In Eq. 13, \( z_{it} \) refers to CFO\(_t\), FFO–CFO\(_t\), DEPR\(_t\), BV\(_t\), DIV\(_t\), WC\(_{t-1}\), LAND\(_{t-1}\), CFI\(_t\), and CYCLE\(_t\). REG\(_t\) is an indicator variable that is equal to zero for the pre-NAREIT period (1995–1999) and one for the post-NAREIT period (2000–2008). COEC\(_t\) is the cyclical component of the industry cost of equity at the end of the third month after the end of fiscal year \( t \). As in measuring the CYCLE variable, the Hodrick and Prescott (1997) filter is used to decompose the long-term trend and cyclical component of the industry cost of equity.

\(^{110}\) In 1999, the NAREIT recommended to its member companies that all non-recurring items, except for gains and losses on the sale of property and extraordinary items, should be included in FFO. This guidance is intended to clarify the definition of FFO and reduce managers’ discretion in calculating FFO.
Table 9 presents the results of estimating the reduced forms of Eq. 13. Column (a) reports the results of a model that only includes the regulatory effect. This is the model in column (e) of Table 7, with an interactive dummy variable for the 1999 NAREIT regulation. Column (b) shows the results of a model that includes both the regulatory effect and a business-cycle effect. Column (c) reports the results of a model that adds an interactive discount-rate variable to the model in column (e) of Table 7. The results of a model that includes both a business-cycle effect and a discount-rate effect are presented in column (d). Column (e) presents the results of the full model, Eq. 13, which includes all three effects.

Results in columns (b), (d), and (e) of Table 9 indicate that the business-cycle effect reported in Table 7 is robust to the confounding effects of NAREIT (1999) regulation and discount rates. In these columns, the positive coefficient on CFOt*CYLEt supports the procyclicality of the valuation weight on CFO (H3). The negative coefficient on DEPRt*CYLEt confirms the counter-cyclicality of the valuation weight on depreciation expense (H4). Similar to what was observed in Table 7, the coefficients on CFO and DEPR move further apart as CYCLE increases, suggesting that when CYCLE is high, FFO is likely to outperform net income in explaining stock prices.

Results in columns (a), (b), and (e) of Table 9 indicate that after the NAREIT’s (1999) clarification of the definition of FFO investors were willing to place a larger valuation weight on FFO in valuing the equity of REITs. Specifically, the significantly positive coefficients on CFOt*REGt and (FFO–CFOt)*REGt suggest that the NAREIT (1999) regulation has had a significantly positive impact on the valuation weights on CFO and FFO–CFO. In contrast, the insignificant coefficient on DEPRt*REGt is consistent with the NAREIT (1999) guidance being unrelated to depreciation expense. These results suggest that the NAREIT (1999) regulation has
a greater impact on the explanatory power of FFO more than on that of net income.

Results in columns (c), (d), and (e) of Table 9 suggest that the variation in discount rate
does not influence accounting depreciation bias. Specifically, the difference between the
coefficients on CFO, and DEPR, is not significantly correlated with the cyclical component of
industry cost of equity (COEC,t). The coefficients on CFO, FFO−CFO, and DEPR, are
negatively correlated with the cyclical component of industry cost of equity.

To summarize, the results of Table 9 suggest that the shift in the relative explanatory
power of FFO and net income across different periods can be regarded as the combined
outcome of the effect of real estate cycles on accounting depreciation bias and the effect of the
NAREIT (1999) guidance on the reliability of FFO.

4.5.3 Estimation of the dynamics of operating cash receipts

The foregoing empirical tests depended on the assumption that the average persistence
of operating cash receipts over the forecasting horizon at a valuation date is pro-cyclical. To
verify this assumption, I estimate the underlying dynamics of operating cash receipts (see
CFD1(b) and CFD4 in Section 3.3.2).

The empirical dynamics of operating cash receipts is presented as follows:

\[
AF_{t+s} = \omega_0 + (\omega_1 + \omega_2 \text{CYCLE}_t)\text{FFO}_{t-1} + (\omega_3 + \omega_4 \text{CYCLE}_t)\text{CFI}_{t-1} + (\omega_5 + \omega_6 \text{CYCLE}_t)\text{CYCLE}_t + \epsilon_{t+s}
\]  

(14)

where AF_{t+s} is the consensus (median) of analysts’ forecasts of FFO per share for year t+s (s = 0
to 3), which is released after the end of year t and before the announcement date of FFO for
year t. Using year t to t+3 data is to capture the average persistence of operating cash receipts
over the forecasting horizon. As in Eq. 9, CFI and CYCLE are used as a proxy for capital
investment and a proxy for other information, respectively. The coefficient on FFO_{t-1} (\omega_1)
represents the persistence of operating cash receipts in the long-term equilibrium. The coefficient on $\text{FFO}_{t-1}\times \text{CYCLE}_t(\omega_4)$ indicates the correlation between the persistence of operating cash receipts and the real estate cycle proxy.

I use the consensus analysts’ forecasts of FFO as a proxy for future operating cash receipts for several reasons. Analysts are sophisticated information intermediaries and are expected to incorporate the impact of real estate cycles on future operating cash receipts into their forecasts of future FFO.\footnote{The analysts’ forecasts have two shortcomings. Analysts do not forecast operating cash receipts. Operating cash receipts are the most important component of FFO but not equivalent to FFO. In addition, analysts’ forecasts might be subject to biases due to the forecasting efficiency and incentives of analysts. See Ramnath et al. (2008) for a review of prior studies on bias in analysts’ earnings forecasts.} Therefore, the consensus analysts’ forecasts of FFO are compatible to expected future cash flows over the forecasting horizon embedded in market prices. I do not use realized future operating cash receipts because these will be affected by future economic shocks that are unknown at the valuation date. Thus, if current valuation date is around the peak of the real estate cycle phase, these future economic shocks might be negatively correlated with current real estate cycle phase.

Table 10 presents the results obtained by estimating variants of Eq. 14. Panels A and B show the results of Eq. 14 with and without controlling for the confounding effects of the NAREIT (1999) regulatory effect. For each panel, columns (a) and (b) show the results of a pair of regressions without and with the business-cycle effect when the dependent variable is the consensus analysts’ forecast of FFO for year $t$. Similarly, columns (c) through (h) present the results of a pair of regressions using the consensus analysts’ forecast of FFO for year $t+s$ (where $s = 1, 2, 3$).

The overall results of Table 10 coincide with my assumption that the persistence of operating cash receipts is pro-cyclical. In both Panels A and B of Table 10, the significantly
positive coefficient on $\text{FFO}_{t-1} \times \text{CYCLE}_t$ in columns (d), (f), and (h) suggests that equity analysts perceive the persistence of operating cash receipts ($\omega_{\tau t}$) as largely pro-cyclical. The magnitude of the estimated coefficient on FFO in Table 10 is compatible to the estimated coefficients on CFO and FFO in Table 7. In Table 10, the coefficient on FFO ranges between 0.90 to 1.01 where CYCLE$_t$ is zero. When we measure discount rate as 10-year U.S. Treasury bond yield plus default spread (i.e., yield to maturity on an Aaa corporate bond minus yield to maturity on a Baa corporate bond), the average discount rate is 6.0% for the period 1995–2008. When we input these estimates into the theoretical valuation coefficient on FFO, the coefficient on FFO will be 9.1.\textsuperscript{112} Considering the impact of equity risk premium over and above default spread, the imputed coefficient on FFO (i.e., 9.1) is similar to the estimated coefficient on CFO and FFO – CFO in columns (d) and (f) of Table 7 (i.e., 7.8 to 8.1).

Both Panels A and B of Table 10 present mixed results about whether the marginal return on capital investment ($\omega_{\tau t}$) is cyclical. The coefficient on $\text{CFI}_{t-1} \times \text{CYCLE}_t$ is significantly negative if the dependent variable is the consensus analysts’ forecast of FFO for year $t$ (as shown in column (b)), but not if the dependent variable is the consensus analysts’ forecast of FFO for year $t+1$, $t+2$, and $t+3$, respectively (as shown in columns (d), (f), and (h)). This suggests that equity analysts largely perceive the return on capital investment as not being sensitive to real estate cycles. This is inconsistent with the significantly negative coefficient on $\text{CFI}_t \times \text{CYCLE}_t$ obtained by estimating Eq. 9 (as shown in Table 7).

I perform two robustness tests. To mitigate any bias due to cross-sectional difference in firm size, I re-estimate Eq. 14 after deflating all per-share variables by the book value of total assets per share at the end of year $t-1$. The untabulated results are not substantively different from those reported in Table 10. In addition, I also regress one-year-ahead and two-year-ahead

\textsuperscript{112} The theoretical coefficient on CFO is $\lambda_{\text{cfo}} = \frac{R \omega_{\tau}}{R - \omega_{\tau}}$. If we solve $(1+0.06) \times 0.95 / (1+0.06 - 0.95) = 9.2$.  

123
realized operating cash receipts per share on current operating cash receipts per share and capital investment per share.\textsuperscript{113} Untabulated results indicate that the coefficient on operating cash receipts per share is positively correlated with the real estate cycle proxy.

To summarize, analysts typically perceive FFO as more persistent in boom periods than in bust periods. This result is consistent with the results of price regressions in Table 7.

\textbf{4.5.4 A robustness test pertaining to the real estate cycle proxy}

The foregoing empirical tests incorporate the square of the real estate cycle proxy to capture the cyclicality in the valuation weight on other information. Although using the square of the cycle proxy is based on the theoretical model, an empirical issue pertaining to this term emerges. In particular, the correlation between the cycle proxy and the square of the cycle proxy may influence the coefficients on the interaction terms of accounting numbers and the cycle proxy.\textsuperscript{114}

Untabulated results indicate that, when I exclude the square of the cycle proxy from the regressions in Tables 7 through 10, all coefficients pertaining to my hypotheses, except for the coefficient on $\text{CFO}_t \times \text{CYCLE}_t$ in Tables 7 through 9, have the same signs and remain significant. In contrast, when I deflate all variables, except the cycle proxy and the square of the cycle proxy, by total revenue, eliminating the square of the cycle proxy does not influence the signs and significance of any coefficients pertaining to my hypotheses in Tables 7 through 9. In addition, replacing the square of the cycle proxy with year-fixed effects does not change the

\textsuperscript{113} I measure realized future operating cash receipts per share as realized future cash flows from operating activities per share plus realized future interest expense per share. Using three-year-ahead and four-year-ahead realized operating cash receipts reduces sample size significantly.

\textsuperscript{114} The Pearson correlation coefficient between the cycle proxy and the square of the cycle proxy for the period 1995–2008 is 0.74. The fluctuation of the cycle proxy around zero partially mitigates the correlation between the cycle proxy and the square of the cycle proxy.
signs and significance of any coefficients pertaining to my hypotheses in Tables 7 through 10.

In summary, the results with respect to the variability of the coefficient on CFO (H3) are sensitive to the inclusion or exclusion of the cycle squared variable if the scalar is shares outstanding. Recall that this choice of scalar is driven by its use in prior studies. The result is insensitive to other scalers. The results are generally robust to the use of time dummies rather than a cycle proxy variable.

4.6 Concluding remark

Researchers have examined the relative ability of FFO and net income to explain the market value of equity for relatively short-period samples and have found mixed results across different sample periods. In this chapter I explore whether those mixed results are due to their inadequate control for accounting bias that is related to real estate cycles.

I begin by comparing the relative explanatory power of two stationary FO96 models that use FFO versus net income as alternative earnings measures in Table 4. These models can be thought of as more general models than the models in Fields et al. (1998) because these FO96 models include variables from the Fields et al. models together with additional variables that are included to control for accounting bias. The two stationary FO96 models are hypothesized to have equal explanatory power if these additional variables fully capture accounting bias. When I estimate these models, holding the coefficients fixed across the entire sample period, this hypothesis is not supported by the data. However, when I allow the coefficients to differ across different sub-periods that are formed to reflect when the real estate cycle is in a boom or a bust I find that during the bust periods the two models have equal explanatory power as predicted. It is during the boom times that the FFO model outperforms
the net income model, indicating that the stationary FO96 net income model is unable to fully control of accounting depreciation bias. When I estimate the Fields et al. models for the same combined period and sub-periods, the results (as shown in Table 5) show similar cyclicality in the relative explanatory power of the FFO model versus the net income model to that of the stationary FO96 model. The two models perform equally as well during bust periods, but the Fields et al. (1998) FFO model outperforms the net income model during booms. When taken together the results in Table 4 and in Table 5 suggest that the explanatory power of net income and FFO regressions are influenced by cycles, but that the accounting bias variables I have modeled in the stationary FO96 model are an incomplete explanation for the influence of cycles.

To further investigate the impact of real estate cycles on accounting bias across different periods, I estimate the modified (non-stationary) FO96 model that decomposes net income into CFO (i.e., the largest component of FFO) and depreciation expense and allows the valuation weights on these net income components to vary over the real estate cycle phases. The results of estimating this model (as shown in Table 7) support my hypotheses that when an index representing the real estate cycle phase during a year is higher, the coefficient on CFO is higher (presumably due to greater persistence in cash flows) and that the coefficient on depreciation expense is lower (presumably due to less economic depreciation in asset values). This implies that the market is places greater weight on CFO and less weight on depreciation expense when the real estate cycle phase is high, which helps to partially explain why the Fields et al. (1998) FFO model outperforms their net income model during boom periods, since the net income model restricts CFO and depreciation expense to have equal weights.

Consistent with the results in Baik et al. (2008), I also confirm that the valuation
coefficients on my two components for FFO (CFO and FFO-CFO) are higher in the period after the NAREIT (1999) clarified the definition of FFO in order to reduce the managerial discretion on the calculation of FFO. After controlling for the effect of this regulatory change, I continue to find that the market's valuation weight on CFO is higher when the real estate cycle phase is high, while at the same time, the weight on depreciation expense is reduced.

Overall, the results in this chapter suggest that both the business-cycle effect and the NAREIT (1999) effect contribute to the shift in the relative explanatory power of FFO and net income across different time periods.
Chapter 5: Conclusion

This dissertation examines, both theoretically and empirically, the mapping of REIT accounting data to market values. In particular, it is concerned with two key performance measures that can be used by market participants to estimate intrinsic value, GAAP net income and a measure promoted by the REIT industry, funds from operation (FFO). The main difference between these two performance measures is depreciation expense: net income is calculated after deducting this charge for depreciable assets while FFO is computed before the deduction of this expense. Prior research in accounting has empirically examined which of the two measures provide a better mapping to market values. Prior research from the early 1990’s finds that the two measures provide equal explanatory power, while, research that uses data from the 2000’s finds that FFO tends to dominate net income. My dissertation attempts to reconcile the results of these apparently mixed results by theoretically examining the conditions under which valuation models based on net income versus FFO should provide the same explanatory power, and by examining the effects of real estate business cycles on accounting bias that is implied by the reliance of net income on depreciation charges.

Chapter 2 provides a review of the institutional setting for the REIT industry and draws a hypothetical relation between accounting depreciation bias and real estate cycles. Real estate cycles occur because a demand shock has persistent impacts on market rents and construction for real estate due to construction lags, fixed-length rental contracts, and other institutional features. In relation to valuation, real estate cycles change the persistence of cash receipts from rental property across valuation dates, but accounting depreciation does not change with these cycles. I hypothesize that this discrepancy creates cyclicality in the bias of accounting depreciation relative to expected future economic depreciation embedded in the current market.
value of equity.

Chapter 3 tackles the task of formalizing this idea by modelling the valuation process for a REIT under two different accounting regimes. The valuation model draws on insights provided by Chapter 2 and valuation models proposed by Feltham and Ohlson (1996). I show two stationary Feltham and Ohlson (1996) models in which the market value of equity after reflecting the reduction of value due to dividends is expressed as a weighted average of an earnings measure (either FFO or GAAP net income) and a book value measure (either gross book value of equity or GAAP book value of equity) with variables controlling for accounting bias. These models can be thought of as more general models than those used in prior empirical studies, such as Fields et al. (1998), because these FO96 models include explicit controls for accounting biases, whereas these variables are missing in prior empirical work. I extend these stationary FO96 models by relaxing the assumption that the information dynamics of cash flows and valuation weights are constant across real estate cycle phases. This results in a modified version of the FO96 model that allows two components of net income (FFO and depreciation expense) to have valuation weights that have opposite sensitivities to a state variable that summarizes information pertaining to the real estate cycle phase during a year.

Chapter 4 goes on to examine, using a sample of US REITs over the period 1995–2008, the theoretical implications of Chapter 3. In particular, I explore whether the mixed results of prior studies are due to their inadequate control for accounting bias that is related to real estate cycles. I begin by comparing the relative explanatory power of two stationary FO96 models that use FFO versus net income as alternative earnings measures. The stationary FO96 models are hypothesized to have equal explanatory power if the additional variables in these models fully capture accounting bias. However, the results of estimating these FO96 models indicate
that the FFO model has greater explanatory power than the net income model in boom periods and they do not have significantly different explanatory power in bust periods. This result is somewhat puzzling in the context of Feltham and Ohlson’s valuation theory. When I estimate the Fields et al. (1998) model over the real estate cycle phases, the results show similar cyclicality in the relative explanatory power of the FFO model versus the net income model.

To more fully investigate the impact of real estate cycles on accounting bias across different periods, I estimate the non-stationary FO96 model that decomposes net income into CFO (i.e., the largest component of FFO) and depreciation expense. This non-stationary model allows the valuation weights on these net income components to vary over the real estate cycle phases. The results of estimating this model support my hypotheses that when an index representing the real estate cycle phase during a year is higher, the coefficient on CFO is higher and that the coefficient on depreciation expense is lower. This implies that the market is placing greater weight on CFO and less weight on depreciation expense when the real estate cycle phase is high. Consistent with the results in Baik et al. (2008), I also confirm that the valuation coefficient on CFO and FFO-CFO has increased for the period after the NAREIT (1999) clarified the definition of FFO in order to reduce the managerial discretion on the calculation of FFO. Overall, the results in Chapter 4 suggest that both the business-cycle effect and the NAREIT (1999) effect contribute to the shift in the relative explanatory power of FFO and net income across different time periods.

In total, the dissertation contributes to the literature in accounting in four ways. First, the theoretical model in Chapter 3 makes clear that given appropriate assumptions it should not be surprising that a net income model and a FFO model drawn from Feltham and Ohlson (1996) can provide the same explanatory power for equity value. This theory clarifies that
prior research drawing on both the early 1990’s and in the 2000’s should take care to include appropriate control variables for accounting biases.

This thesis also contributes to the valuation literature by incorporating real estate business cycles into the Feltham and Ohlson (1996) model. Feltham and Ohlson (1996) formalize a constant relation between value and bias in accounting depreciation. This study extends the Feltham and Ohlson (1996) model by allowing accounting depreciation to deviate from economic depreciation over the booms and busts in the real estate market. While Ang and Liu (2001) allow valuation weights to vary with time-varying interest rates and risk aversion, my model allows valuation weights to vary with time-varying parameters in the dynamics of operating and investing cash flows.

Third, the results in Chapter 4 provide a partial reconciliation of the mixed results of prior studies on the valuation usefulness of FFO and net income. Using relatively short-term data sets, researchers have found mixed results on the relative performance of FFO and net income in explaining REIT stock prices and returns. However, no one has attempted to explain this variation in the relative efficacy of FFO and net income across sub-periods, except for Baik et al. (2008). Baik et al. (2008) propose that the NAREIT (1999) regulation reduced managerial discretion in the calculation of FFO and enhanced the reliability of FFO disclosure. My study finds evidence suggesting that the real estate business cycles and the NAREIT (1999) regulations both contribute to shifts in the relative explanatory power of FFO and net income across the sample periods used in prior studies.

This study also contributes to a better understanding of the relation between business cycles and the valuation usefulness of accounting information by providing an example of that relation in a unique setting. Several prior studies, including Wilson (1986), Bernard and
Stobber (1989), Johnson (1999), and Jenkins et al. (2009), investigate the impact of business cycles on the information content of earnings (or earnings components) for non-financial firms. Their results are not based on a valuation model that formally shows a link between business cycles and the information content of earnings components. Unlike these studies, my study identifies a unique setting, namely REITs, where accounting depreciation bias plays a crucial role in differentiating a pro forma earnings measure (i.e., FFO, which excludes accounting depreciation) from net income (which includes depreciation expense). In this setting, my study finds that accounting depreciation bias changes with business cycles, influencing the association between stock prices and the two performance measures. I show that these results can be interpreted in the context of the Feltham and Ohlson (1996) model adapted to REITs.

I acknowledge six limitations of this study. First, according to urban economists, land value reflects the value of real options which vary with the real estate cycles; however, Chapter 3 does not formally incorporate real options into the valuation models. Accordingly, the empirical models in Chapter 4 omit the real options. While real options might be captured by the interaction term of CYCLE with land in Table 7, it is not clear that this would be a complete control for real options. The interpretation of the empirical results could change substantially if real options were properly modelled.

Second, the empirical tests do not allow economic depreciation to vary across the types of real property held by the various REITs in my sample. Yet, as pointed out in Chapter 2 the type of real property held by a REIT will determine the composition of buildings and land and the average length of rental contracts. The empirical implementation of my thesis fails to capture this cross-sectional variation among REIT types, limiting the generalization of findings. In particular, any cyclicality in the persistence of cash flows may vary across types of real
properties held by REITs, but my empirical model constrains the coefficients to be constant across firms.

Third, the non-stationary Feltham and Ohlson (1996) model tested in Tables 7 to 9 simply assumes that a series of exogenous demand shocks for real estate occurs in a cyclical manner, leading to cyclical changes in expected future cash flows. The model does not formally incorporate fundamental economic drivers (e.g., general business cycles) for these demand shocks. In addition, neither does the model encompass an endogenous cycle driven by a single demand shock.

Fourth, the results of this study rely on institutional features inherent to the real estate industry—that is, the fair values of commercial real properties held by REITs can be estimated with reasonable precision (Kang and Zhao 2010). Thus, my results may not be generalized to firms in manufacturing industries where the market of capital assets has limited liquidity.

Fifth, even though I use a longer-horizon sample than prior REIT studies, my sample period may not be long enough to obtain a reliable long-term valuation equation. Finally, my results are potentially subject to omitted correlated variables or to possible measurement errors in the real estate cycle proxy.

This thesis suggests three potential avenues for new research. This study does not explain the reason for the evidence that the FFO model has higher explanatory power than the net income model in booms, but not in busts even after these models are augmented with a set of control variables for accounting bias based on valuation theory. Therefore, further research should be made to fully resolve this puzzle. It also would be interesting to examine whether managers use classificatory manipulation of FFO to achieve their objectives, including facilitating external financing or influencing their compensation, and if so, how the related
regulations regarding FFO disclosure influence this classificatory manipulation. Finally, it would also be interesting to examine the impact of business cycles on valuation in other industries, such as the banking industry, in which firm performance and the value of major assets are highly cyclical.
Figure 1  Economic depreciation of a real property

Figure 1 analyzes how economic depreciation of a real property is determined by various economic factors. The economic depreciation of a real property captures decreases (or increases) in the market value of the real property for a period, holding investments constant. The market price of a real property fluctuates along the long-term growth path. The market price of a real property can be decomposed into four components. The first component is (a) the fair valued initial investment in the property. The second component is (b) the decline in the market price of a real property due to physical deterioration or functional obsolescence as the property ages. This figure assumes that the economic life of the building component of the property is 60 years and that the market value of the building component at the end of its economic life is zero. Physical deterioration and functional obsolescence are assumed to reduce the value of real property at a greater rate as the property gets older. The third component is (c) the long-term growth or decline in the market price of a real property driven by the long-term growth in market demand for that property. The fourth component is (d) the short-term fluctuation in the market price of a real property driven by short-term fluctuation in market demand.
Figure 2 summarizes how accounting depreciation departs from economic depreciation. For this figure, I assume (i) that the book value of a real property is not revalued at the market value of the property for every period, (ii) there is no investment in the property made after the property is acquired, and (iii) the residual value at the end of the estimated useful life (e.g., 39 years) is zero. On the date of acquisition of a real property, its market value equals its book value, but the market value deviates from the book value afterwards. As depicted in Figure 1, the market price of a real property fluctuates in the short run along the long-run growth path. In contrast, the book value of a real property, i.e., the sum of the book values of the land and non-land components, adjusts downward over time by depreciation expense associated with the non-land component. The estimated useful life of the building component is expected to be shorter than the economic life of the building (e.g., 60 years in figure 1). In addition, the write-down of real property can reduce the book value of the property. The reversal of prior write-down is not allowed when the market value of the property increases in subsequent periods. As a result, the book value of a real property tends to understate its market prices to a greater (lesser) extent for a boom (a bust). Similarly, a decrease in the book value of a real property tends to overstate a decrease in the market value of the property in a boom, and this bias diminishes in a bust.
Figure 3  The cyclical pattern in the real estate market variables

Panel A. The NCREIF total market return for commercial real estate

Panel B. The excess demand for commercial real estate

Panel C. The natural logarithm of housing starts

Panel D. The real estate cycle proxy ($c_{\text{cycle}}$)

$R^2 = 0.8631$
Panel E. A composite index of the (raw) real estate market variables

Figure 3 (Continued)

Figure 3 shows the cyclical pattern in the real estate market variables. Panel A shows the time series of the NCREIF total return for commercial real estate. The data is denominated in percentage points. The data is available at the NCREIF. The original data for a quarter is constant for three months within the quarter. Panel B shows the time series of the excess demand for commercial real estate. This variable is measured as the difference between the demand index and supply index for commercial real estate. The demand and supply indices are initially set at 100 as of January 1984. The original data for a quarter is constant for three months within the quarter. The data are available at the MIT center of real estate. Panel C shows the time series of the natural logarithm of housing starts. The data is available at the Federal Reserve Bank at Saint Louis. Panel D shows the time series of the composite index for real estate cycle (CYCLE$_t$). The red line indicates the first principal component of the cyclical components of the NCREIF total return, the excess demand for commercial real property, and housing starts. The cyclical component of each real estate market variable is extracted using the Hodrick and Prescott (1997) filter. The black thick line indicates smoothed line of CYCLE$_t$ that fits CYCLE$_t$ to a 6th order polynomial with regard to time $t$. The fitted regression has R-squared of 0.863. Panel E shows the time series of an alternative composite index for real estate cycle (CYCLE$_a,t$). The red line indicates the first principal component of the NCREIF total return, the excess demand for commercial real property, and housing starts (not their cyclical components). The black thick line indicates smoothed line of CYCLE$_a,t$ that fits CYCLE$_a,t$ to a 6th order polynomial with regard to time $t$. The fitted regression has R-squared of 0.948.
Figure 4 shows how real estate cycles affect operating cash receipts generated by a real property and investments in real properties. This assumes rental contract rates are able to adjust immediately to the change in demand and thus contractual rents are equal to market rents. It also assumes that operating cash receipts are simply the market rents multiplied by the stock of space (where cash expenses are ignored). In addition, there is assumed to be no vacancy in equilibrium. These assumptions are similar to those implied by the stock-flow model in Wheaton (1999). The real estate market is assumed to be in long-term equilibrium during year $t$, and a demand shock is assumed to occur at the end of year $t$. Panel A shows the growth of operating cash receipts and capital investment in a boom. A positive demand shock at the end of year $t$ shifts upward demand for rental space. Because the supply of rental space is price-inelastic in the short run, the market rents will increase in year $t+1$. As the supply of rental space adjusts gradually over time through increases in investments, the new equilibrium for market rents will decrease and the stock of space will increase. The supply of rental space is not completely price-elastic even in the long run because the limited quantity of land available for construction increases the marginal cost of constructing new rental space. Consequently, the market rents will be greater than the pre-shock market rents. As a result, the operating cash receipts for the post-shock periods will be greater than the operating cash receipts for the pre-shock periods. Panel B shows the decrease in operating cash receipts and capital investment in a bust. A negative demand shock at date $t$ shifts downward the demand for rental space. Since the supply of rental space is price-inelastic in the short run, the market rents will decrease in year $t+1$. As the supply of rental space adjusts gradually over time through decreases in investments, the market rents will increase and the stock of space will decrease. Because the supply of rental space is not completely price-elastic in the long run, the new equilibrium for market rents will be greater than the pre-shock market rents. As a result, the operating cash receipts for the post-shock periods will be less than the operating cash receipts for the pre-shock periods.
### Table 1 Sample selection process

<table>
<thead>
<tr>
<th>Panel</th>
<th>Description</th>
<th>Number of Firm-years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A. Sample for Table 5 (Replication of Table 3 in Fields et al. (1998))</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>All equity REITs on COMPUSTAT 2009 (SIC = 6798, 6799) for the period 1995–2008</td>
<td>2,663</td>
</tr>
<tr>
<td>b)</td>
<td>Merge with firm-years having non-missing actual FFO from I/B/E/S summary file.</td>
<td>(1,114)</td>
</tr>
<tr>
<td>c)</td>
<td>Merge with firm-years having non-missing stock prices from CRSP monthly file (2009).</td>
<td>(115)</td>
</tr>
<tr>
<td>d)</td>
<td>Delete observations that have missing values for net income, depreciation expense, gains and losses on the sale of property, capital investment, book value of common equity, common cash dividend (per-share data).</td>
<td>(157)</td>
</tr>
<tr>
<td>e)</td>
<td>Delete observations that have depreciation expense of zero.</td>
<td>(3)</td>
</tr>
<tr>
<td>f)</td>
<td>Delete observations that have values exceeding ±3 standard deviations from the mean of each variable of stock prices, FFO, net income, depreciation expense, gains and losses on the sale of property, investment, book value of common equity, common cash dividend.</td>
<td>(95)</td>
</tr>
<tr>
<td></td>
<td>(Number of equity REITs of the final sample = 172)</td>
<td>1,179</td>
</tr>
<tr>
<td><strong>Panel B. Sample for Table 6 (Replication of Table 5 in Kang and Zhao (2010))</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) ~ e)</td>
<td>Perform the procedures a) and e) in Panel A</td>
<td>1,274</td>
</tr>
<tr>
<td>g)</td>
<td>Merge the hand-collected dataset taken in step f) with CRSP/COMPUSTAT/IBES data taken in step a) ~ e). Delete observations that have missing values for stock prices, funds from operations, net income, book value of equity, accumulated depreciation, common cash dividend, sales growth, leverage, and lagged total assets (split-adjusted, per-share data).</td>
<td>(93)</td>
</tr>
<tr>
<td></td>
<td>(Number of equity REITs of the final sample = 161)</td>
<td>1,181</td>
</tr>
<tr>
<td>h)</td>
<td>Delete observations that are in the bottom and top 1% of each variable mentioned in procedure g).</td>
<td>(95)</td>
</tr>
<tr>
<td></td>
<td>(Number of equity REITs of the final sample = 161)</td>
<td>1,086</td>
</tr>
<tr>
<td><strong>Panel C. Sample for Table 4 (Stationary Feltham and Ohlson (1996) models) and Tables 7, 8, 9 (Modified Feltham and Ohlson (1996) models)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) ~ f)</td>
<td>Perform the procedures a) and f) in Panel B.</td>
<td>1,274</td>
</tr>
<tr>
<td>g)</td>
<td>Merge the hand-collected dataset with CRSP/COMPUSTAT/IBES data taken in step a) ~ e). Delete observations that have missing values for stock prices, FFO, net income, depreciation expense, gains and losses on the sale of property, investment, the book value of common equity, the lagged book value of land, the lagged book value of working capital, and common cash dividend (per-share data).</td>
<td>(104)</td>
</tr>
<tr>
<td></td>
<td>(Number of equity REITs of the final sample = 172)</td>
<td>1,170</td>
</tr>
</tbody>
</table>
Panel C (Continued)

h) Delete observations with values exceeding ± 3 standard deviations from the mean of each variable of stock prices, CFO, FFO–CFO, depreciation expense, gains and losses on the sale of property, other non-FFO item, capital investment, the book value of common equity, the lagged book value of land, the lagged book value of building, the lagged book value of working capital, common cash dividend, and the age of a property portfolio (per-share data).

(Number of equity REITs of the final sample = 159) 1,041

Panel D. Sample for Table 10 (The dynamics of operating cash receipts for modified Feltham and Ohlson (1996) model)

a) Keep observations that do not have missing values for one-year-ahead actual FFO, and the median of analyst’s forecasts of one-year-ahead FFO, two-year-ahead FFO, and three-year-ahead FFO of Equity REITs (IBES 2010). 1,444

b) Keep observations that do not have missing values for current-period FFO and capital investment. 1,257

c) Keep firm years for the period 1995–2008. 1,068

d) Delete the extreme outliers of one-year-ahead FFO deflated by lagged total assets and forecast error of one-year-ahead FFO deflated by lagged total assets. 1,063

e) Keep observations for which the IBES statistical period date and the announcement date of FFO fall within 90 calendar days after the end of the issuer's fiscal year, and the IBES statistical period date is earlier than the announcement date of FFO. 982

(Number of equity REITs of the final sample = 157)

Notes:
1) List of mortgage and hybrid REITs for the period 1999–2008 obtained at the NAREIT’s website. FTSE provides U.S. Real Estate Index series that cover Equity, Mortgage, and Hybrid REITs. I delete all firm-years of all REITs that are included in the list.
Table 2 Summary statistics of a trimmed sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>P25</th>
<th>Median</th>
<th>P75</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variables used in Table 5 (N = 1,179)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_t$</td>
<td>24.67</td>
<td>13.07</td>
<td>0.71</td>
<td>14.92</td>
<td>23.11</td>
<td>31.90</td>
<td>75.40</td>
</tr>
<tr>
<td>$NI_t$</td>
<td>0.91</td>
<td>0.85</td>
<td>-2.20</td>
<td>0.37</td>
<td>0.90</td>
<td>1.47</td>
<td>3.84</td>
</tr>
<tr>
<td>$FFO_t$</td>
<td>2.06</td>
<td>0.93</td>
<td>-0.64</td>
<td>1.35</td>
<td>2.02</td>
<td>2.67</td>
<td>4.94</td>
</tr>
<tr>
<td>$DIV_t$</td>
<td>1.52</td>
<td>0.67</td>
<td>0.00</td>
<td>1.02</td>
<td>1.55</td>
<td>1.95</td>
<td>3.70</td>
</tr>
<tr>
<td>$BV_t$</td>
<td>14.26</td>
<td>6.39</td>
<td>-3.76</td>
<td>9.21</td>
<td>14.26</td>
<td>18.73</td>
<td>33.45</td>
</tr>
<tr>
<td>$BV_{t+i}^{FFO}$</td>
<td>20.37</td>
<td>7.40</td>
<td>3.07</td>
<td>14.36</td>
<td>19.57</td>
<td>25.74</td>
<td>45.73</td>
</tr>
<tr>
<td>$PE_{t+i}^{FFO}$</td>
<td>41.59</td>
<td>18.34</td>
<td>3.78</td>
<td>27.88</td>
<td>38.95</td>
<td>51.88</td>
<td>112.88</td>
</tr>
<tr>
<td><strong>Variables used in Table 6 (N = 1,086)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{\text{kt},t}$</td>
<td>25.74</td>
<td>15.15</td>
<td>2.33</td>
<td>14.95</td>
<td>23.20</td>
<td>32.36</td>
<td>96.80</td>
</tr>
<tr>
<td>$NI_{\text{kt},t}$</td>
<td>1.12</td>
<td>1.03</td>
<td>-5.02</td>
<td>0.61</td>
<td>1.10</td>
<td>1.65</td>
<td>5.79</td>
</tr>
<tr>
<td>$DIV_{\text{kt},t}$</td>
<td>1.56</td>
<td>0.71</td>
<td>0.00</td>
<td>1.07</td>
<td>1.56</td>
<td>1.97</td>
<td>4.42</td>
</tr>
<tr>
<td>$BV_{\text{kt},t}$</td>
<td>14.80</td>
<td>7.12</td>
<td>-0.55</td>
<td>9.03</td>
<td>14.43</td>
<td>19.36</td>
<td>44.82</td>
</tr>
<tr>
<td>$ACCUDEP_t$</td>
<td>5.90</td>
<td>3.74</td>
<td>0.59</td>
<td>3.11</td>
<td>5.07</td>
<td>7.90</td>
<td>19.68</td>
</tr>
<tr>
<td>$Sgr_t$</td>
<td>0.21</td>
<td>0.31</td>
<td>-0.25</td>
<td>0.03</td>
<td>0.12</td>
<td>0.28</td>
<td>2.25</td>
</tr>
<tr>
<td>$LEV_t$</td>
<td>0.64</td>
<td>0.14</td>
<td>0.20</td>
<td>0.56</td>
<td>0.64</td>
<td>0.74</td>
<td>1.02</td>
</tr>
<tr>
<td><strong>Variables used in Table 4, Table 7, Table 8, and Table 9 (N = 1,041)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_t$</td>
<td>25.18</td>
<td>13.62</td>
<td>0.39</td>
<td>14.96</td>
<td>23.67</td>
<td>32.70</td>
<td>78.56</td>
</tr>
<tr>
<td>$CFO_t$</td>
<td>2.54</td>
<td>1.21</td>
<td>-0.49</td>
<td>1.69</td>
<td>2.38</td>
<td>3.29</td>
<td>6.64</td>
</tr>
<tr>
<td>$FFO-CFO_t$</td>
<td>-0.41</td>
<td>0.66</td>
<td>-2.93</td>
<td>-0.71</td>
<td>-0.29</td>
<td>0.01</td>
<td>1.49</td>
</tr>
<tr>
<td>$DEPR_t$</td>
<td>-1.36</td>
<td>0.70</td>
<td>-3.82</td>
<td>-1.76</td>
<td>-1.26</td>
<td>-0.82</td>
<td>0.00</td>
</tr>
<tr>
<td>$DIV_t$</td>
<td>1.56</td>
<td>0.66</td>
<td>0.00</td>
<td>1.09</td>
<td>1.61</td>
<td>1.97</td>
<td>3.70</td>
</tr>
<tr>
<td>$BV_t$</td>
<td>14.64</td>
<td>6.41</td>
<td>-3.23</td>
<td>9.40</td>
<td>14.82</td>
<td>19.09</td>
<td>36.62</td>
</tr>
<tr>
<td>$CFI_t$</td>
<td>4.13</td>
<td>4.66</td>
<td>-13.06</td>
<td>1.13</td>
<td>3.01</td>
<td>6.29</td>
<td>21.80</td>
</tr>
<tr>
<td>$WC_{t-1}$</td>
<td>0.49</td>
<td>3.59</td>
<td>-12.70</td>
<td>-0.84</td>
<td>0.33</td>
<td>2.08</td>
<td>14.81</td>
</tr>
<tr>
<td>$LAND_{t-1}$</td>
<td>6.81</td>
<td>3.53</td>
<td>0.30</td>
<td>4.04</td>
<td>6.48</td>
<td>9.09</td>
<td>19.64</td>
</tr>
<tr>
<td>$BUILD_{t-1}$</td>
<td>29.59</td>
<td>14.13</td>
<td>3.29</td>
<td>19.50</td>
<td>27.62</td>
<td>36.55</td>
<td>80.62</td>
</tr>
<tr>
<td>$PE_{t-1}$</td>
<td>36.40</td>
<td>16.24</td>
<td>3.59</td>
<td>24.42</td>
<td>33.96</td>
<td>44.94</td>
<td>98.72</td>
</tr>
<tr>
<td>$AGE_{t-1}$</td>
<td>0.15</td>
<td>0.08</td>
<td>0.01</td>
<td>0.09</td>
<td>0.14</td>
<td>0.19</td>
<td>0.57</td>
</tr>
<tr>
<td>$CYCLE_t$</td>
<td>0.19</td>
<td>0.85</td>
<td>-0.95</td>
<td>-0.68</td>
<td>0.02</td>
<td>0.58</td>
<td>1.73</td>
</tr>
<tr>
<td>$COEC_t$</td>
<td>0.00</td>
<td>0.02</td>
<td>-0.04</td>
<td>-0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Variables used in Table 10 (N = 982)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$AF_t$</td>
<td>2.41</td>
<td>1.11</td>
<td>-1.20</td>
<td>1.57</td>
<td>2.35</td>
<td>3.10</td>
<td>7.01</td>
</tr>
<tr>
<td>$AF_{t+1}$</td>
<td>2.55</td>
<td>1.13</td>
<td>0.31</td>
<td>1.65</td>
<td>2.49</td>
<td>3.26</td>
<td>6.57</td>
</tr>
<tr>
<td>$AF_{t+2}$</td>
<td>2.72</td>
<td>1.20</td>
<td>0.24</td>
<td>1.77</td>
<td>2.67</td>
<td>3.47</td>
<td>7.02</td>
</tr>
<tr>
<td>$AF_{t+3}$</td>
<td>2.93</td>
<td>1.31</td>
<td>0.23</td>
<td>1.88</td>
<td>2.84</td>
<td>3.75</td>
<td>7.69</td>
</tr>
<tr>
<td>$FFO_{t+1}$</td>
<td>2.31</td>
<td>1.08</td>
<td>-2.04</td>
<td>1.49</td>
<td>2.20</td>
<td>3.01</td>
<td>6.10</td>
</tr>
<tr>
<td>$CFL_{t-1}$</td>
<td>5.40</td>
<td>6.03</td>
<td>-13.92</td>
<td>1.54</td>
<td>4.10</td>
<td>7.77</td>
<td>39.73</td>
</tr>
</tbody>
</table>

Note:
P1, P25, P75, and P99 indicate the 1st, the 25th, the 75th, and the 99th percentiles of each variable.  
***, **, and * respectively indicate two-tailed significance at the 1%, 5%, and 10% level.
Table 2 (continued)

Variable definition (See Appendix C for detailed definitions of the variables):

\[ P_t \] = Stock price per share at the end of the third month after the end of year \( t \).
\[ BV_t \] = The book value of common equity per share at the end of year \( t \).
\[ NI_t \] = Net income per share for year \( t \).
\[ FFO_t \] = Funds from operations per share for year \( t \).
\[ DIV_t \] = Common cash dividend per share for year \( t \).
\[ BV_{FPO}^t \] = Gross book value of equity per share (i.e., book value of equity per share plus accumulated depreciation per share) at the end of year \( t \).
\[ PE_{FPO}^{t-1} \] = Gross book value of real property per share (i.e., book value of real property per share plus accumulated depreciation per share) at the end of year \( t-1 \).
\[ P_{kz,t} \] = Stock price per share adjusted for stock splits.
\[ NI_{kz,t} \] = Net income per share adjusted for stock splits.
\[ BVE_{kz,t} \] = Book value of equity adjusted for stock splits.
\[ ACCUDEP_t \] = Accumulated depreciation per share adjusted for stock splits.
\[ DIV_{kz,t} \] = Common cash dividend per share adjusted for stock splits.
\[ Sgr_t \] = Sales growth rate for year \( t \) relative to year \( t-1 \).
\[ LEV_t \] = Leverage ratio at the end of year \( t \), measured as \((\text{total assets} – \text{common equity}) / \text{total assets}\).
\[ CFO_t \] = Cash flows from operating activities (CFO) per share for year \( t \).
\[ FFO-CFO_t \] = FFO less CFO per share for year \( t \).
\[ DEPR_t \] = Depreciation expense (measured as negative values) per share for year \( t \).
\[ CFI_t \] = Capital investment per share for year \( t \).
\[ WC_{t-1} \] = Book value of working capital per share at the end of year \( t-1 \).
\[ LAND_{t-1} \] = Book value of land per share at the end of year \( t-1 \).
\[ BUILD_{t-1} \] = Book value of building per share at the end of year \( t-1 \).
\[ PE_{t-1} \] = Book value of real property per share at the end of year \( t-1 \).
\[ AGE_{t-1} \] = The age of a property portfolio at the end of year \( t-1 \).
\[ CYCLE_t \] = The composite index for the real estate cycle phase for year \( t \) (See Appendix D for measurement of this variable).
\[ COEC_t \] = The cyclical component of industry cost of equity at the end of third month after the end of year \( t \).
\[ AF_{t+s} \] = Consensus analysts’ forecasts of FFO for year \( t + s \) (s = 0, 1, 2, 3)
Table 3 Spearman rank correlations


<table>
<thead>
<tr>
<th></th>
<th>$P_t$</th>
<th>$CFI_t$</th>
<th>$DIV_t$</th>
<th>$NI_t$</th>
<th>$FFO_t$</th>
<th>$CFO_t$</th>
<th>$DEPR_t$</th>
<th>$QAGE_{t-1}$</th>
<th>$AF_{t+1}$</th>
<th>$BV_t$</th>
<th>$BV_{FPO}$</th>
<th>$ACCUDEP_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$CFI_t$</td>
<td>0.23***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$DIV_t$</td>
<td>0.65***</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$NI_t$</td>
<td>0.54***</td>
<td>0.17***</td>
<td>0.59***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$FFO_t$</td>
<td>0.70***</td>
<td>0.08***</td>
<td>0.83***</td>
<td>0.71***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$CFO_t$</td>
<td>0.61***</td>
<td>0.11***</td>
<td>0.76***</td>
<td>0.58***</td>
<td>0.86***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$DEPR_t$</td>
<td>-0.34***</td>
<td>0.10***</td>
<td>-0.51***</td>
<td>0.00</td>
<td>-0.57***</td>
<td>-0.65***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$QAGE_{t-1}$</td>
<td>0.10***</td>
<td>-0.18***</td>
<td>0.02**</td>
<td>-0.13***</td>
<td>-0.01</td>
<td>0.02</td>
<td>-0.11***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$AF_{t+1}$</td>
<td>0.73***</td>
<td>0.12***</td>
<td>0.85***</td>
<td>0.70***</td>
<td>0.96***</td>
<td>0.86***</td>
<td>-0.57***</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$BV_t$</td>
<td>0.55***</td>
<td>0.22***</td>
<td>0.62***</td>
<td>0.54***</td>
<td>0.67***</td>
<td>0.59***</td>
<td>-0.32***</td>
<td>-0.34***</td>
<td>0.69***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$BV_{FPO}$</td>
<td>0.63**</td>
<td>0.13***</td>
<td>0.74***</td>
<td>0.45***</td>
<td>0.78***</td>
<td>0.74***</td>
<td>-0.62***</td>
<td>-0.03</td>
<td>0.80***</td>
<td>0.89***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ACCUDEP_t$</td>
<td>0.38***</td>
<td>-0.21***</td>
<td>0.50***</td>
<td>0.04</td>
<td>0.51***</td>
<td>0.57***</td>
<td>-0.78***</td>
<td>0.62***</td>
<td>0.49***</td>
<td>0.07***</td>
<td>0.49***</td>
<td>-0.13***</td>
</tr>
<tr>
<td>$CYCLE_t$</td>
<td>0.08***</td>
<td>0.27***</td>
<td>-0.14***</td>
<td>-0.17**</td>
<td>-0.21***</td>
<td>-0.21***</td>
<td>0.11***</td>
<td>-0.01</td>
<td>-0.16**</td>
<td>-0.10***</td>
<td>-0.12***</td>
<td>-0.13***</td>
</tr>
</tbody>
</table>

Note: ****, ***, and * respectively denote two-tailed significance at the 1%, 5%, and 10% levels.

Variable definition:

- $P_t$: Stock price per share at the end of the third month after the end of year $t$
- $CFI_t$: Capital investment per share for year $t$
- $DIV_t$: Common cash dividend per share for year $t$
- $NI_t$: Net income per share for year $t$
- $FFO_t$: FFO per share for year $t$
- $CFO_t$: CFO per share for year $t$
- $DEPR_t$: Depreciation expense per share for year $t$, measured as a negative number
- $QAGE_{t-1}$: The quartile of age of a property portfolio at the end of year $t-1$
- $AF_{t+1}$: Consensus analysts’ forecasts of FFO per share for year $t+1$
- $CYCLE_t$: The composite index for the real estate cycle phase for year $t$ (See Appendix D for measurement of this variable)
- $BV_t$: Book value of equity per share at the end of year $t$
- $BV_{FPO}$: Gross book value of equity per share (i.e., book value of equity per share plus accumulated depreciation per share) at the end of year $t$
- $ACCUDEP_t$: Accumulated depreciation per share at the end of year $t$, measured as a positive number
Table 3 (continued)

Panel B: Macroeconomic variables, industry costs of equity, and a real estate cycle proxy (1995–2008)

<table>
<thead>
<tr>
<th></th>
<th>CYCLE</th>
<th>gdp</th>
<th>term</th>
<th>default</th>
<th>rf</th>
</tr>
</thead>
<tbody>
<tr>
<td>gdp</td>
<td>0.41***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>term</td>
<td>-0.58***</td>
<td>-0.72***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>default</td>
<td>-0.25***</td>
<td>-0.17***</td>
<td>0.29***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rf</td>
<td>0.29***</td>
<td>0.55***</td>
<td>-0.75***</td>
<td>-0.56***</td>
<td>0.73***</td>
</tr>
<tr>
<td>COE</td>
<td>0.07</td>
<td>0.48***</td>
<td>-0.58***</td>
<td>-0.43***</td>
<td></td>
</tr>
</tbody>
</table>

Note: ***, **, and * respectively denote two-tailed significance at the 1%, 5%, and 10% levels.

Variable definition:
- CYCLE\_t = The composite index for the real estate cycle phase for year t (See Appendix D for measurement of this variable)
- gdp\_t = The cyclical component of the natural logarithm of GDP during year t
- rf\_t = Real risk-free interest rate at the end of the third month after the end of year t
- term\_t = Term premium at the end of the third month after the end of year t. The difference is yield to maturity on a government bond with 10 years to maturity and yield to maturity with 1 year to maturity
- default\_t = Default-risk spread at the end of the third month after the end of year t. The difference is yield to maturity on an Aaa corporate bond and yield to maturity on a Baa corporate bond.
- COE\_t = Industry cost of equity at the end of the third month after the end of year t, denominated in real terms.

See Appendix C for detailed definitions of the variables.
Table 4 Estimation of the Feltham and Ohlson (1996) model

<table>
<thead>
<tr>
<th></th>
<th>(a) Full period</th>
<th>(b) Booms</th>
<th>(c) Busts</th>
<th>(d) Boom</th>
<th>(e) Bust</th>
<th>(f) Undetermined</th>
<th>(g) Boom</th>
<th>(h) Bust</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model:</strong></td>
<td>( P_t = \alpha_0 + \alpha_1 N_{t-1} + \alpha_2 D_{t-1} + \alpha_3 B_{t-1} + \alpha_4 F_{t-1} + \alpha_5 C_{t-1} + \epsilon_t )</td>
<td>( (7) )</td>
<td>( (8) )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>2.15**</td>
<td>1.79</td>
<td>-2.13</td>
<td>1.76</td>
<td>-1.91</td>
<td>1.88*</td>
<td>3.32**</td>
<td>-1.55</td>
</tr>
<tr>
<td>( N_{t-1} )</td>
<td>3.23***</td>
<td>4.32***</td>
<td>5.23***</td>
<td>2.29**</td>
<td>5.12***</td>
<td>2.95***</td>
<td>5.62***</td>
<td>8.22***</td>
</tr>
<tr>
<td>( D_{t-1} )</td>
<td>7.28***</td>
<td>6.83***</td>
<td>7.91***</td>
<td>6.07***</td>
<td>4.22***</td>
<td>6.06***</td>
<td>7.26***</td>
<td>10.02***</td>
</tr>
<tr>
<td>( B_{t-1} )</td>
<td>0.10</td>
<td>0.22**</td>
<td>-0.15</td>
<td>0.68***</td>
<td>0.24***</td>
<td>0.26***</td>
<td>0.01*</td>
<td>-0.42**</td>
</tr>
<tr>
<td>( F_{t-1} )</td>
<td>0.15***</td>
<td>0.31***</td>
<td>0.13***</td>
<td>0.02</td>
<td>0.06</td>
<td>0.05^*</td>
<td>0.34***</td>
<td>0.10</td>
</tr>
<tr>
<td>( C_{t-1} )</td>
<td>0.45***</td>
<td>0.16*</td>
<td>0.41***</td>
<td>0.29***</td>
<td>0.31***</td>
<td>0.72***</td>
<td>0.43***</td>
<td>1.07***</td>
</tr>
<tr>
<td><strong>Adj-R^2</strong></td>
<td>0.45</td>
<td>0.61</td>
<td>0.48</td>
<td>0.65</td>
<td>0.69</td>
<td>0.72</td>
<td>0.66</td>
<td>0.56</td>
</tr>
</tbody>
</table>

The Young (1989) tests for

**H1:** Eq. 7 and Eq. 8 have equal explanatory power.

Z-value: \( -4.10^{***} \) \( -4.57^{***} \) \( -1.39 \) \( -1.81^* \) \( 0.99 \) \( -1.14 \) \( -2.88^{***} \) \( 0.52 \)

**Definitions of variables:**

- \( P_t \): Stock price per share at the 90th day after the end of year \( t \).
- \( N_{t-1} \): Net income per share for year \( t-1 \).
- \( B_{t-1} \): Book value of common equity per share at the end of year \( t-1 \).
- \( F_{t-1} \): Funds from operations per share for year \( t \).
- \( C_{t-1} \): Book value of real property per share at the end of year \( t-1 \).
- \( D_{t-1} \): Common cash dividend per share for year \( t \).
- \( P_{t-1} \): Book value of real property per share plus accumulated depreciation per share at the end of year \( t \).
- \( F_{t-1} \): Funds from operations per share plus accumulated depreciation per share at the end of year \( t \).
Table 4 (continued)

Note:
The coefficients of all regressions in this table estimated using Ordinary Least Squares (OLS). The standard error of the coefficient of each variable is adjusted for the correlations of error terms within firm clusters and year clusters (Peterson 2008). ***, **, and * respectively denote two-tailed significance at the 1%, 5%, and 10% levels. The statistical significance for each variable is based on a two-tailed $p$-value based on $t$-statistics for the coefficient of each explanatory variable. If a $Z$-value of the Vuong (1989) test is significantly different from zero, the results reject H1. If a $Z$-value of the Vuong (1989) test is significantly positive, the net income model (Eq. 7) outperforms the FFO model (Eq. 8).
Table 5. Replicating a test of Fields et al. (1998)

<table>
<thead>
<tr>
<th></th>
<th>(a) Full period</th>
<th>(b) Booms 95–97/03–06</th>
<th>(c) Busts 98–99/07–08</th>
<th>(d) Boom 95–97</th>
<th>(e) Bust 98–99</th>
<th>(f) Undetermined 00–02</th>
<th>(g) Boom 03–06</th>
<th>(h) Bust 07–08</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( P_i = \alpha_0 + \alpha_1 \text{NI}_i + \alpha_2 \text{DIV}_i + \alpha_3 \text{BV}_i + \epsilon_i )</td>
<td>(7a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>5.94***</td>
<td>6.85***</td>
<td>2.5</td>
<td>3.20**</td>
<td>0.47</td>
<td>2.60***</td>
<td>9.76***</td>
<td>4.70</td>
</tr>
<tr>
<td>( \text{NI}_i )</td>
<td>2.99***</td>
<td>3.29***</td>
<td>4.45***</td>
<td>2.82**</td>
<td>5.33***</td>
<td>3.03***</td>
<td>4.98***</td>
<td>7.86***</td>
</tr>
<tr>
<td>( \text{DIV}_i )</td>
<td>7.71***</td>
<td>8.94***</td>
<td>8.51***</td>
<td>6.57***</td>
<td>4.39***</td>
<td>6.63***</td>
<td>9.30***</td>
<td>10.47***</td>
</tr>
<tr>
<td>( \text{BV}_i )</td>
<td>0.30***</td>
<td>0.47***</td>
<td>-0.04</td>
<td>0.71***</td>
<td>0.29***</td>
<td>0.39***</td>
<td>0.30**</td>
<td>-0.35*</td>
</tr>
<tr>
<td><strong>Adj-R²</strong></td>
<td>0.39</td>
<td>0.52</td>
<td>0.39</td>
<td>0.55</td>
<td>0.65</td>
<td>0.63</td>
<td>0.57</td>
<td>0.40</td>
</tr>
</tbody>
</table>

|                |                |                        |                        |               |               |                        |                |              |
| **Model:**     |                |                        |                        |               |               |                        |                |              |
| \( P_i = \alpha_0 + \alpha_1 \text{FFO}_i + \alpha_2 \text{DIV}_i + \alpha_3 \text{BV}_i + \epsilon_i \) | (8a)            |                        |                        |               |               |                        |                |              |
| Intercept      | 3.61***        | 3.61***                | 0.17                   | 0.13          | -0.83         | -0.53                  | 5.87***        | 1.75         |
| \( \text{FFO}_i \) | 7.28***        | 11.24***               | 7.70***                | 8.02***        | 4.78***        | 7.20***                | 11.56***       | 9.94***      |
| \( \text{DIV}_i \) | 2.79***        | 1.21                   | 2.64**                 | 1.65          | 3.09***        | 2.67**                 | 2.37*          | 1.32         |
| \( \text{BV}_i \) | 0.13**         | 0.17**                 | -0.09                  | 0.59***        | 0.25***        | 0.1                   | -0.06          | -0.27        |
| **Adj-R²**     | 0.46           | 0.68                   | 0.45                   | 0.6           | 0.61          | 0.69                   | 0.73           | 0.43         |

|                |                |                        |                        |               |               |                        |                |              |
| **The Vuong (1989) tests for** |                |                        |                        |               |               |                        |                |              |
| **P1:** Eq. 7(a) and Eq. 8(a) have equal explanatory power. |                |                        |                        |               |               |                        |                |              |
| **Z-value**    | -3.72***       | -5.36***               | -1.45                  | -1.96*        | 1.46          | -2.25**                | -4.66***       | -0.38        |
| **H2(a):** Eq. 7 has greater explanatory power than Eq. 7(a). |                |                        |                        |               |               |                        |                |              |
| **Z-value**    | 3.89***        | 4.07***                | 1.86*                  | 1.23          | 2.15**        | 3.55***                | 4.16***        | 2.16**       |
| **H2(b):** Eq. 8 has greater explanatory power than Eq. 8(a). |                |                        |                        |               |               |                        |                |              |
| **Z-value**    | 3.37***        | 1.25                   | 1.65*                  | 1.54          | 1.91*         | 3.06***                | 1.49           | 1.80*        |

**Note:** The coefficients of all regressions in this table estimated using Ordinary Least Squares (OLS). The standard error of the coefficient of each variable is adjusted for the correlations of error terms within firm clusters and year clusters (Peterson 2008). ***, **, and * respectively denote two-tailed significance at the 1%, 5%, and 10% levels. The statistical significance for each variable is based on a two-tailed \( p \)-value based on \( t \)-statistics for the coefficient of each explanatory variable. If a Z-value of the Vuong (1989) test for my prediction (P1) is significantly positive, Eq. 7(a) outperforms Eq. 8(a). If a Z-value of the Vuong (1989) test for H2(a) is significantly positive, Eq. 7 outperforms Eq. 7(a). If a Z-value of the Vuong (1989) test for H2(b) is significantly positive, Eq. 8 outperforms Eq. 8(a).
### Table 6: Replicating a test of Kang and Zhao (2010)

Model: $P_{k,t} = \gamma_0 + \gamma_1 N_k + \gamma_2 \text{BVE}_{k,t} + \gamma_3 \text{ACCUDEP}_{k,t} + \gamma_4 \text{DIV}_{k,t} + \gamma_5 \text{Sgr} + \gamma_6 \text{LEV} + \sum_{y=1995}^{2007} \gamma_y Y_y + \epsilon_t$

<table>
<thead>
<tr>
<th></th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
<th>(e)</th>
<th>(f)</th>
<th>(g)</th>
<th>(h)</th>
<th>(i)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KZ</td>
<td>Full period</td>
<td>Booms</td>
<td>Busts</td>
<td>Boom</td>
<td>Bust</td>
<td>Undetermined</td>
<td>Boom</td>
<td>Bust</td>
</tr>
<tr>
<td>00–05</td>
<td>5.24</td>
<td>11.67***</td>
<td>0.96</td>
<td>-4.83</td>
<td>-1.21</td>
<td>-6.00**</td>
<td>-1.81</td>
<td>-0.81</td>
<td>-4.77</td>
</tr>
<tr>
<td>95–08</td>
<td></td>
<td></td>
<td>4.83***</td>
<td>4.71***</td>
<td>5.89***</td>
<td>1.73</td>
<td>5.21***</td>
<td>3.69***</td>
<td>5.31***</td>
</tr>
<tr>
<td>03–06</td>
<td>0.73***</td>
<td>0.44***</td>
<td>0.57***</td>
<td>0.16</td>
<td>0.88***</td>
<td>0.27**</td>
<td>0.36**</td>
<td>0.39</td>
<td>0.10</td>
</tr>
<tr>
<td>07–08</td>
<td>0.98***</td>
<td>0.66***</td>
<td>1.16***</td>
<td>0.40</td>
<td>-0.03</td>
<td>0.02</td>
<td>-0.22</td>
<td>1.37***</td>
<td>0.59**</td>
</tr>
<tr>
<td>1995–07</td>
<td></td>
<td></td>
<td>-1.01</td>
<td>5.01***</td>
<td>5.03***</td>
<td>4.38***</td>
<td>5.52***</td>
<td>4.70***</td>
<td>5.48***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.75*</td>
<td>1.54</td>
<td>2.65**</td>
<td>1.47</td>
<td>3.69**</td>
<td>0.16</td>
<td>1.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13.30**</td>
<td>6.54**</td>
<td>6.05</td>
<td>3.77</td>
<td>4.62</td>
<td>6.55**</td>
<td>10.99**</td>
</tr>
<tr>
<td>1995–97</td>
<td></td>
<td></td>
<td>Y1995</td>
<td>9.76***</td>
<td>-5.67***</td>
<td>-0.67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y1996</td>
<td>12.15***</td>
<td>-3.59**</td>
<td>1.88***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y1997</td>
<td>12.27***</td>
<td>-3.68**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y1998</td>
<td>3.00*</td>
<td>1.53</td>
<td>1.94***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y1999</td>
<td>0.99</td>
<td>-0.39</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y2000</td>
<td>-19.78***</td>
<td>2.60*</td>
<td></td>
<td>-4.24***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y2001</td>
<td>-19.40***</td>
<td>6.78***</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y2002</td>
<td>-18.11***</td>
<td>6.20***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y2003</td>
<td>-8.59***</td>
<td>13.86***</td>
<td>-2.78**</td>
<td></td>
<td>-3.07***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y2004</td>
<td>-7.22***</td>
<td>11.93***</td>
<td>-4.59***</td>
<td></td>
<td>-4.68***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y2005</td>
<td>14.52***</td>
<td>-1.72**</td>
<td></td>
<td>-1.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y2006</td>
<td>16.38***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y2007</td>
<td>9.35***</td>
<td>9.31***</td>
<td></td>
<td></td>
<td></td>
<td>9.44***</td>
</tr>
<tr>
<td>N</td>
<td>468</td>
<td>1,086</td>
<td>498</td>
<td>290</td>
<td>133</td>
<td>159</td>
<td>298</td>
<td>365</td>
<td>131</td>
</tr>
<tr>
<td>Adjusted R2</td>
<td>0.67</td>
<td>0.68</td>
<td>0.70</td>
<td>0.59</td>
<td>0.83</td>
<td>0.67</td>
<td>0.66</td>
<td>0.71</td>
<td>0.52</td>
</tr>
</tbody>
</table>

Tests for bias

$H_0: \gamma_i - 1 = 0$

<table>
<thead>
<tr>
<th></th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
<th>(e)</th>
<th>(f)</th>
<th>(g)</th>
<th>(h)</th>
<th>(i)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma_i - 1$</td>
<td>-0.02***</td>
<td>-0.34***</td>
<td>0.16</td>
<td>-0.60***</td>
<td>-1.03***</td>
<td>-0.98***</td>
<td>-1.22***</td>
<td>0.37*</td>
<td>-0.41</td>
</tr>
</tbody>
</table>
Table 6 (continued)

Definitions of variables:

- $P_{kz,t}$ = Stock price per share at the end of the third month after the end of year $t$, adjusted for stock splits
- $NI_{kz,t}$ = GAAP net income per share adjusted for stock splits
- $BVE_{kz,t}$ = Book value of common equity per share adjusted for stock splits
- $ACCUDEP_{kz,t}$ = Accumulated depreciation and amortization per share adjusted for stock splits
- $DIV_{kz,t}$ = Dividend per share adjusted for stock splits
- $Sgr_t$ = Sales growth rate
- $LEV_t$ = Leverage ratio, measured as (total assets – common equity)/total assets
- $CYCLE_t$ = The composite index for the real estate cycle phase for year $t$ (See Appendix D for measurement of this variable)
- $Y_y$ = An indicator variable for fiscal year $y$ ($y = 1995$ to 2007)

Note: The coefficients of all regressions in this table are estimated using Weighted Least Squares (WLS) with the inverse of the square of lagged total assets used as a weight variable. In all columns, $$*, **, and *$$ respectively denote two-tailed significance at the 1%, 5%, and 10% levels. Standard errors are adjusted for the correlations of error terms within firm clusters, as in Kang and Zhao (2010). The tests for $H_0: \gamma_i - 1 = 0$ are based on the Huber-White heteroscedasticity-consistent covariance matrix. In all columns, $$*, **, and *$$ respectively denote significance at the 1%, 5%, and 10% levels.

**Model (column b):**  
\[ P_t = \delta_0 + (\delta_1 + \delta_1 \text{CYCLE}_t) \text{CFO}_t + (\delta_2 + \delta_2 \text{CYCLE}_t) \text{DEPR}_t + (\delta_3 + \delta_3 \text{CYCLE}_t) \text{BV}_t + (\delta_4 + \delta_4 \text{CYCLE}_t) \text{DIV}_t \]
\[ + (\delta_5 + \delta_5 \text{CYCLE}_t) \text{CFI}_t + (\delta_6 + \delta_6 \text{CYCLE}_t) \text{CYCLE}_t + \varepsilon_t \]

<table>
<thead>
<tr>
<th></th>
<th>Base case model</th>
<th>Adding working capital</th>
<th>Adding land</th>
<th>Adding property age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(d)</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.482</td>
<td>-2.022***</td>
<td>-0.078</td>
<td>-2.086***</td>
</tr>
<tr>
<td>CFO_t</td>
<td>3.456***</td>
<td>3.625***</td>
<td>8.911***</td>
<td>8.129***</td>
</tr>
<tr>
<td>FFO-CFO_t</td>
<td></td>
<td>8.606***</td>
<td>7.217***</td>
<td>8.339***</td>
</tr>
<tr>
<td>DEPR_t</td>
<td>1.234*</td>
<td>2.879***</td>
<td>1.456***</td>
<td>2.928***</td>
</tr>
<tr>
<td>BV_t</td>
<td>0.275***</td>
<td>0.358***</td>
<td>0.063</td>
<td>0.177***</td>
</tr>
<tr>
<td>DIV_t</td>
<td>7.607***</td>
<td>6.941***</td>
<td>3.431***</td>
<td>3.453***</td>
</tr>
<tr>
<td>WC_{t-1}</td>
<td>0.070</td>
<td>0.017</td>
<td>0.071</td>
<td>0.016</td>
</tr>
<tr>
<td>LAND_{t-1}</td>
<td></td>
<td></td>
<td>0.487***</td>
<td>0.450***</td>
</tr>
<tr>
<td>CFI_t</td>
<td>0.220***</td>
<td>0.503***</td>
<td>0.239***</td>
<td>0.513***</td>
</tr>
<tr>
<td>CYCLE_t</td>
<td>4.161***</td>
<td>-6.687***</td>
<td>4.408***</td>
<td>-5.445***</td>
</tr>
</tbody>
</table>

**CFO_t*CYCLE_t**  
1.609***  2.215***  2.186***  1.303

**DEPR_t*CYCLE_t**  
-1.992*** -1.897*** -1.841*** -2.348***

**BV_t*CYCLE_t**  
-0.013  -0.061  -0.055  -0.111

**DIV_t*CYCLE_t**  
0.062  -0.33  -0.108  0.418

**WC_{t-1}*CYCLE_t**  
-0.195*  -0.184*  -0.101  -0.504

**LAND_{t-1}*CYCLE_t**  
-0.117  -0.303***  -0.204***

**CFI_t*CYCLE_t**  
-0.299***  -0.311***  -0.054  0.522

**CYCLE_t*CYCLE_t**  
6.024***  5.468***  5.451***  5.022

<table>
<thead>
<tr>
<th>N</th>
<th>1041</th>
<th>1041</th>
<th>1041</th>
<th>1041</th>
<th>1041</th>
<th>1041</th>
<th>1041</th>
<th>1041</th>
</tr>
</thead>
<tbody>
<tr>
<td>adjusted R2</td>
<td>0.495</td>
<td>0.591</td>
<td>0.56</td>
<td>0.643</td>
<td>0.570</td>
<td>0.651</td>
<td>0.608</td>
<td>0.675</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
</tr>
</thead>
<tbody>
<tr>
<td>H0: CFO = DEPR</td>
<td>14.99***</td>
<td>2.29</td>
<td>84.11***</td>
<td>53.37***</td>
<td>67.70***</td>
<td>43.79***</td>
<td>8.30***</td>
<td>3.21*</td>
</tr>
<tr>
<td>H0: CFO<em>CYCLE = DEPR</em>CYCLE</td>
<td>37.56***</td>
<td>-</td>
<td>26.18***</td>
<td>-</td>
<td>23.6***</td>
<td>-</td>
<td>19.51***</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
<th>Chi-sq</th>
</tr>
</thead>
<tbody>
<tr>
<td>H0: CFO = FFO-CFO</td>
<td>-</td>
<td>0.27</td>
<td>3.17*</td>
<td>0.04</td>
<td>1.39</td>
<td>0.25</td>
<td>1.86</td>
<td></td>
</tr>
<tr>
<td>H0: CFO*CYCLE = (FFO-CFO)*CYCLE</td>
<td>-</td>
<td>-</td>
<td>1.57</td>
<td>-</td>
<td>3.23*</td>
<td>-</td>
<td>1.01</td>
<td></td>
</tr>
</tbody>
</table>
Table 7 (continued)

Definitions of variables:
P_t = Stock price at the end of the third month after the end of year t
CFO_t = Cash flows from operating activities per share for year t
DEPR_t = Depreciation expense per share for year t
FFO-CFO_t = Non-CFO components of FFO per share for year t
BV_t = The book value of common equity per share at the end of year t
DIV_t = Common cash dividend per share for year t
WC_{t-1} = The book value of working capital per share at the end of year t – 1
LAND_{t-1} = The book value of land per share at the end of year t – 1
CFI_t = Capital investment per share at the end of year t – 1
CYCLE_t = The composite index for the real estate cycle phase for year t (See Appendix D for measurement of this variable)
QAGE_{t-1} = The quartile of the age of a property portfolio at the end of year t – 1. QAGE_{t-1} has values of 0 (youngest property) to 3 (oldest property).

Note: The coefficients of all regressions in this table are estimated using Ordinary Least Squares (OLS). In all columns, ***, **, and * respectively denote two-tailed significance at the 1%, 5%, and 10% levels. The standard error of the estimated coefficient of each variable is based on the correction of the correlations of error terms within firm clusters as well as within year clusters (Peterson 2008).

1) The chi-square statistics for tests for accounting bias are based on the Huber-White heteroscedasticity-consistent covariance matrix. ***, **, and * respectively denote significance at the 1%, 5%, and 10% levels.

Model (column b):
\[ P_t = \delta_0 + (\delta_1 + \delta_{CYCLE_t})CFO_t + (\delta_2 + \delta_{CYCLE_t})PE_{t-1} + (\delta_3 + \delta_{CYCLE_t})BV_t + (\delta_4 + \delta_{CYCLE_t})DIV_t + (\delta_5 + \delta_{CYCLE_t})CFI_t + (\delta_6 + \delta_{CYCLE_t})CYCLE_t + \varepsilon_t \]

<table>
<thead>
<tr>
<th></th>
<th>Base case model</th>
<th>Adding working capital</th>
<th>Building and land</th>
<th>Adding property age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(d)</td>
</tr>
<tr>
<td>Intercept</td>
<td>-0.340</td>
<td>-3.046**</td>
<td>-0.984</td>
<td>-3.178***</td>
</tr>
<tr>
<td>CFO_t</td>
<td>2.776***</td>
<td>2.692***</td>
<td>8.057***</td>
<td>6.949***</td>
</tr>
<tr>
<td>FFO-CFO_t</td>
<td>8.459***</td>
<td>6.948***</td>
<td>8.231***</td>
<td>7.047***</td>
</tr>
<tr>
<td>BV_t</td>
<td>0.269***</td>
<td>0.376***</td>
<td>0.061</td>
<td>0.191***</td>
</tr>
<tr>
<td>DIV_t</td>
<td>7.645***</td>
<td>7.181***</td>
<td>3.549***</td>
<td>3.888***</td>
</tr>
<tr>
<td>PE_{t-1}</td>
<td>0.021</td>
<td>-0.033</td>
<td>0.019</td>
<td>-0.027</td>
</tr>
<tr>
<td>BUILD_{t-1}</td>
<td>-0.050</td>
<td>-0.098**</td>
<td>-0.136***</td>
<td>-0.166***</td>
</tr>
<tr>
<td>LAND_{t-1}</td>
<td>0.487***</td>
<td>0.476**</td>
<td>0.399***</td>
<td>0.410***</td>
</tr>
<tr>
<td>WC_t</td>
<td>0.121</td>
<td>0.090</td>
<td>0.089</td>
<td>0.045</td>
</tr>
<tr>
<td>CFI_t</td>
<td>0.256***</td>
<td>0.551***</td>
<td>0.278***</td>
<td>0.563***</td>
</tr>
<tr>
<td>CYCLE_t</td>
<td>4.056***</td>
<td>4.638***</td>
<td>4.279***</td>
<td>4.490***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Adding property age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(e)</td>
</tr>
<tr>
<td>CFO_t,CYCLE_t</td>
<td>1.772***</td>
</tr>
<tr>
<td>FFO-CFO_t,CYCLE_t</td>
<td>1.461</td>
</tr>
<tr>
<td>BV_t,CYCLE_t</td>
<td>-0.037</td>
</tr>
<tr>
<td>DIV_t,CYCLE_t</td>
<td>-0.344</td>
</tr>
<tr>
<td>PE_{t-1},CYCLE_t</td>
<td>0.083**</td>
</tr>
<tr>
<td>BUILD_{t-1},CYCLE_t</td>
<td>0.084***</td>
</tr>
</tbody>
</table>

Definitions of variables:
PE_{t-1} = The book value of real property per share at the end of year t – 1
BUILD_{t-1} = The book value of building per share at the end of year t – 1
CYCLE_t = The composite index for the real estate cycle phase for year t (See Appendix D for measurement of this variable)

All other variables are as defined in Table 7.

Note: In all columns, 1,041 observations are used. The coefficients of all regressions in this table are estimated using Ordinary Least Squares. The standard error of the estimated coefficient of each variable is based on the correction of the correlations of error terms within firm clusters as well as within year clusters (Peterson 2008). ***, **, and * respectively denote two-tailed significance at the 1%, 5%, and 10% levels.
Table 9 Effects of NAREIT (1999) regulations and discount rates on valuation weights

Model (column e): \[ P_i = \delta_0 + \sum_{j=1}^{m} (\delta_1 \cdot \text{CYCLE}_t + \delta_2 \cdot \text{REG}_t + \delta_3 \cdot \text{COEC}_t)z_i + \varepsilon_i \]

<table>
<thead>
<tr>
<th></th>
<th>( \text{a} )</th>
<th>( \text{b} )</th>
<th>( \text{c} )</th>
<th>( \text{d} )</th>
<th>( \text{e} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.466</td>
<td>-1.075</td>
<td>-1.913**</td>
<td>-2.762**</td>
<td>-0.768</td>
</tr>
<tr>
<td>( \text{CFO}_t )</td>
<td>3.942***</td>
<td>3.843***</td>
<td>8.703***</td>
<td>7.986***</td>
<td>4.295***</td>
</tr>
<tr>
<td>( \text{FFO-CFO}_t )</td>
<td>2.909***</td>
<td>3.459***</td>
<td>8.567***</td>
<td>7.569***</td>
<td>3.886***</td>
</tr>
<tr>
<td>( \text{DEPR}_t )</td>
<td>4.550***</td>
<td>4.521***</td>
<td>1.877***</td>
<td>2.919***</td>
<td>4.703***</td>
</tr>
<tr>
<td>( \text{BV}_t )</td>
<td>0.415***</td>
<td>0.436***</td>
<td>0.036</td>
<td>0.150***</td>
<td>0.465***</td>
</tr>
<tr>
<td>( \text{DIV}_t )</td>
<td>5.224***</td>
<td>5.443***</td>
<td>3.083***</td>
<td>2.907***</td>
<td>4.631***</td>
</tr>
<tr>
<td>( \text{WC}_{t-1} )</td>
<td>0.120</td>
<td>0.216</td>
<td>0.461***</td>
<td>0.435***</td>
<td>0.154</td>
</tr>
<tr>
<td>( \text{LAND}_{t-1} )</td>
<td>0.279**</td>
<td>0.339**</td>
<td>0.033</td>
<td>0.002</td>
<td>0.292**</td>
</tr>
<tr>
<td>( \text{CFI}_t )</td>
<td>0.527***</td>
<td>0.605***</td>
<td>0.314***</td>
<td>0.549***</td>
<td>0.661***</td>
</tr>
<tr>
<td>( \text{CYCLE}_t )</td>
<td>-3.262*</td>
<td>-7.792***</td>
<td>4.176***</td>
<td>-4.288***</td>
<td>-5.750***</td>
</tr>
<tr>
<td>( \text{CFO}, \text{CYCLE}_t )</td>
<td>2.142***</td>
<td>2.554***</td>
<td>2.502***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{(FFO-CFO)}_t \cdot \text{CYCLE}_t )</td>
<td>0.779</td>
<td>1.074</td>
<td>0.813</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{DEPR}, \text{CYCLE}_t )</td>
<td>-1.710***</td>
<td>-1.496***</td>
<td>-1.217**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{BV}, \text{CYCLE}_t )</td>
<td>-0.055</td>
<td>-0.063</td>
<td>-0.068</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{DIV}, \text{CYCLE}_t )</td>
<td>0.032</td>
<td>-0.204</td>
<td>0.040</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{WC}_{t-1} \cdot \text{CYCLE}_t )</td>
<td>-0.111</td>
<td>-0.132</td>
<td>-0.126</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{LAND}_{t-1} \cdot \text{CYCLE}_t )</td>
<td>-0.207*</td>
<td>-0.170</td>
<td>-0.182</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{CFI}, \text{CYCLE}_t )</td>
<td>-0.271***</td>
<td>-0.334***</td>
<td>-0.289**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{CYCLE}, \text{CYCLE}_t )</td>
<td>3.840***</td>
<td>4.501***</td>
<td>2.370***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{CFO}, \text{REG}_t )</td>
<td>5.405***</td>
<td>5.021***</td>
<td>4.526***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{(FFO-CFO)}_t \cdot \text{REG}_t )</td>
<td>5.386***</td>
<td>4.147***</td>
<td>3.951**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{DEPR}, \text{REG}_t )</td>
<td>-1.665</td>
<td>-0.915</td>
<td>-1.575</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{BV}, \text{REG}_t )</td>
<td>-0.461***</td>
<td>-0.384***</td>
<td>-0.420***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{DIV}, \text{REG}_t )</td>
<td>-1.762</td>
<td>-2.525*</td>
<td>-1.621</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{WC}_{t-1} \cdot \text{REG}_t )</td>
<td>0.280</td>
<td>0.175</td>
<td>0.255</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{LAND}_{t-1} \cdot \text{REG}_t )</td>
<td>-0.286</td>
<td>-0.381**</td>
<td>-0.331*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{CFI}, \text{REG}_t )</td>
<td>-0.118</td>
<td>-0.056</td>
<td>-0.109</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{CYCLE}, \text{REG}_t )</td>
<td>7.872***</td>
<td>4.180**</td>
<td>3.319</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{CFO}, \text{COEC}_t )</td>
<td>-102.30</td>
<td>-112.23***</td>
<td>-96.20***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{(FFO-CFO)}_t \cdot \text{COEC}_t )</td>
<td>-43.40</td>
<td>-53.85*</td>
<td>-37.38*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{DEPR}, \text{COEC}_t )</td>
<td>-103.11</td>
<td>-75.49***</td>
<td>-86.23***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{BV}, \text{COEC}_t )</td>
<td>-2.453</td>
<td>0.185</td>
<td>0.070</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{DIV}, \text{COEC}_t )</td>
<td>39.68</td>
<td>38.52</td>
<td>22.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{WC}_{t-1} \cdot \text{COEC}_t )</td>
<td>9.42</td>
<td>9.65**</td>
<td>12.13***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{LAND}_{t-1} \cdot \text{COEC}_t )</td>
<td>2.00</td>
<td>1.959</td>
<td>1.097</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{CFI}, \text{COEC}_t )</td>
<td>3.28</td>
<td>8.558**</td>
<td>8.254**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{CYCLE}, \text{COEC}_t )</td>
<td>204.56</td>
<td>58.78*</td>
<td>113.09***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>\text{Adjusted } R^2</td>
<td>0.607</td>
<td>0.660</td>
<td>0.619</td>
<td>0.665</td>
<td>0.677</td>
</tr>
</tbody>
</table>
Table 9 (continued)

<table>
<thead>
<tr>
<th>Tests for depreciation bias</th>
<th>(a) Chi-sq.</th>
<th>(b) Chi-sq.</th>
<th>(c) Chi-sq.</th>
<th>(d) Chi-sq.</th>
<th>(e) Chi-sq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>H0: CFO$_t$ = DEPR$_t$</td>
<td>0.320</td>
<td>0.380</td>
<td>81.95$^{***}$</td>
<td>57.84$^{***}$</td>
<td>0.120</td>
</tr>
<tr>
<td>H0: CFO$_t$*CYCLE$_t$ = DEPR$_t$*CYCLE$_t$</td>
<td>21.02$^{***}$</td>
<td>24.28$^{***}$</td>
<td>19.41$^{***}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H0: CFO$_t$*REG$_t$ = DEPR$_t$*REG$_t$</td>
<td>25.90$^{***}$</td>
<td>19.26$^{***}$</td>
<td>20.56$^{***}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H0: CFO$_t$*COEC$_t$ = DEPR$_t$*COEC$_t$</td>
<td>0.000</td>
<td>1.74</td>
<td>0.120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

where:
- $z_{it}$ = Value-relevant information including CFO$_t$, FFO-CFO$_t$, DEPR$_t$, BV$_t$, DIV$_t$, WC$_{t-1}$, LAND$_{t-1}$, CF$_t$, and CYCLE$_t$
- CYCLE$_t$ = The composite index for the real estate cycle phase for year $t$ (See Appendix D for measurement of this variable)
- REG$_t$ = An indicator variable for the period 2000–2008 during which the NAREIT (1999) regulation has been in effect
- COEC$_t$ = The cyclical component of the industry cost of equity at the end of the third month after the end of fiscal year $t$

Other variables are as defined in Tables 7 and 8.

Note:
All columns use 1,041 observations during the period 1995 - 2008. The coefficients of all regressions in this table are estimated using Ordinary Least Squares (OLS). The standard error of the estimated coefficient of each variable is estimated by controlling for the correlations of observations within firm clusters and within year clusters (Peterson 2008). $^{***}$, $^{**}$, and $^*$ respectively denote two-tailed significance at the 1%, 5%, and 10% levels.

1) The chi-square statistics for tests for accounting bias are based on the Huber-White heteroscedasticity correction. $^{***}$, $^{**}$, and $^*$ respectively denote significance at the 1%, 5%, and 10% levels.
Table 10 Estimating cash flow dynamics using consensus analysts’ forecasts of FFO

Model (base case):  
\[ AF_{t+s} = \delta_0 + \delta_1 FFO_{t+1} + \delta_2 CFI_{t+1} + \delta_3 CYCLE_t + \delta_4 FFO_{t-1} CYCLE_t + \delta_5 CFI_{t-1} CYCLE_t + \delta_6 CYCLE_t CYCLE_t + \varepsilon_{t+s} \]

Panel A. Base case model (N = 982)

<table>
<thead>
<tr>
<th></th>
<th>( AF_t )</th>
<th>( AF_{t+1} )</th>
<th>( AF_{t+2} )</th>
<th>( AF_{t+3} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(d)</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.206***</td>
<td>0.248***</td>
<td>0.322***</td>
<td>0.400***</td>
</tr>
<tr>
<td>FFO_{t-1}</td>
<td>0.906***</td>
<td>0.898***</td>
<td>0.907***</td>
<td>0.901***</td>
</tr>
<tr>
<td>CFI_{t-1}</td>
<td>0.020***</td>
<td>0.021***</td>
<td>0.024***</td>
<td>0.025***</td>
</tr>
<tr>
<td>CYCLE_t</td>
<td>0.039***</td>
<td>0.002</td>
<td>0.113***</td>
<td>0.026</td>
</tr>
<tr>
<td>FFO_{t+1} CYCLE_t</td>
<td>0.030</td>
<td>0.043**</td>
<td>0.055**</td>
<td>0.057**</td>
</tr>
<tr>
<td>CFI_{t+1} CYCLE_t</td>
<td>-0.008**</td>
<td>-0.006</td>
<td>-0.006</td>
<td>-0.007</td>
</tr>
<tr>
<td>CYCLE_t CYCLE_t</td>
<td>-0.017</td>
<td>-0.043***</td>
<td>-0.058***</td>
<td>-0.077**</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.800</td>
<td>0.805</td>
<td>0.774</td>
<td>0.781</td>
</tr>
</tbody>
</table>

Panel B. Effects of NAREIT (1999) regulations (N = 982)

<table>
<thead>
<tr>
<th></th>
<th>( AF_t )</th>
<th>( AF_{t+1} )</th>
<th>( AF_{t+2} )</th>
<th>( AF_{t+3} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(d)</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.195***</td>
<td>0.232***</td>
<td>0.303***</td>
<td>0.381***</td>
</tr>
<tr>
<td>FFO_{t-1}</td>
<td>0.907***</td>
<td>0.882***</td>
<td>0.940***</td>
<td>0.902***</td>
</tr>
<tr>
<td>CFI_{t-1}</td>
<td>0.027***</td>
<td>0.028***</td>
<td>0.030***</td>
<td>0.031***</td>
</tr>
<tr>
<td>CYCLE_t</td>
<td>0.024</td>
<td>0.036</td>
<td>0.059</td>
<td>0.027</td>
</tr>
<tr>
<td>FFO_{t+1} CYCLE_t</td>
<td>0.028</td>
<td>0.041*</td>
<td>0.053**</td>
<td>0.054**</td>
</tr>
<tr>
<td>CFI_{t+1} CYCLE_t</td>
<td>-0.008**</td>
<td>-0.006</td>
<td>-0.005</td>
<td>-0.007</td>
</tr>
<tr>
<td>CYCLE_t CYCLE_t</td>
<td>-0.011</td>
<td>-0.037***</td>
<td>-0.048***</td>
<td>-0.063**</td>
</tr>
<tr>
<td>FFO_{t-1} REG_t</td>
<td>0.006</td>
<td>0.019</td>
<td>-0.024</td>
<td>0.005</td>
</tr>
<tr>
<td>CFI_{t-1} REG_t</td>
<td>-0.011</td>
<td>-0.010</td>
<td>-0.012</td>
<td>-0.009</td>
</tr>
<tr>
<td>CYCLE_t REG_t</td>
<td>0.014</td>
<td>-0.029</td>
<td>0.052</td>
<td>0.005</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.802</td>
<td>0.805</td>
<td>0.776</td>
<td>0.781</td>
</tr>
</tbody>
</table>

Definitions of variables:
AF_{t+s} = The consensus analysts’ forecasts of FFO for year \( t+s \) immediately before the end of the third month after the end of year \( t \)  
FFO_{t-1} = Funds from operations per share for year \( t-1 \)  
CFI_{t-1} = Capital investment per share for year \( t-1 \)  
CYCLE_t = The continuous-variable proxy for real estate cycle phase for year \( t \)  
REG_t = An indicator variable for the period 2000–2008 during which NAREIT (1999) regulations are in effect

Note: The coefficients of all regressions in this table are estimated using Ordinary Least Squares (OLS). ***, **, and * respectively denote two-tailed significance at the 1%, 5%, and 10% levels. The standard error of the estimated coefficient of each variable is estimated by controlling for the correlations of observations within firm and year clusters (Peterson 2008)
References


159


Roychowdhury, S. and R. Watts. 2007. Asymmetric timeliness of earnings, market-to-book and


Appendices

Appendix A  Regulatory definition of FFO and an example of FFO measurement
Appendix A summarizes changes in the regulatory definition of FFO and provides an example of FFO disclosure.

A.1  Regulatory definition of FFO

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation expense on real property</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Depreciation expense on company office buildings and improvements</td>
<td>O</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Gains and losses on sales of property</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Extraordinary items</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Impairment losses</td>
<td>Not specified</td>
<td>O</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Other non-recurring items</td>
<td>Not specified</td>
<td>O</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Note: The symbol O indicates that an item in the column is excluded from FFO in the definition of FFO for the period at the head of each column. The symbol X indicates that the opposite is true.

A.2  Example of reconciliation of net income to FFO (Boston Properties, 10-K)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Income before minority interests and unconsolidated joint venture income</td>
<td>296,921</td>
<td>272,349</td>
<td>225,014</td>
<td>178,555</td>
<td>137,740</td>
</tr>
<tr>
<td>Add:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real estate depreciation and amortization</td>
<td>192,574</td>
<td>153,550</td>
<td>134,386</td>
<td>119,583</td>
<td>74,649</td>
</tr>
<tr>
<td>Income from unconsolidated joint ventures</td>
<td>7,954</td>
<td>4,186</td>
<td>1,758</td>
<td>468</td>
<td>—</td>
</tr>
<tr>
<td>Income from discontinued operations</td>
<td>1,384</td>
<td>3,483</td>
<td>3,765</td>
<td>3,817</td>
<td>2,835</td>
</tr>
<tr>
<td>Less:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minority property partnership's share of funds from operations</td>
<td>(3,223)</td>
<td>(2,322)</td>
<td>(1,061)</td>
<td>(3,681)</td>
<td>(4,185)</td>
</tr>
<tr>
<td>Preferred dividends and distributions</td>
<td>(28,711)</td>
<td>(33,312)</td>
<td>(32,994)</td>
<td>(32,111)</td>
<td>(5,830)</td>
</tr>
<tr>
<td>Funds from operations</td>
<td>466,899</td>
<td>397,934</td>
<td>330,868</td>
<td>266,631</td>
<td>205,209</td>
</tr>
</tbody>
</table>
Appendix B Mathematical derivation of equations

B.1 Proof of Equation 1
From CVR, the value of operating assets can also be expressed as
\[ V_t - fa_t = R^{-1}E_t(oc_{t+1}) + R^{-1}E_t(vo_{t+1}) \]  
(a)
See Section 3.2.1 for the definition of variables and parameters.

With CFD1 through CFD2, expected future operating free cash flows can be expressed as
\[ E_t(oc_{t+1}) = E_t(cr_{t+1}) - E_t(ci_{t+1}) = \omega_n cr_t + \omega_n ci_t - \omega_n ci_t = \omega_n cr_t + (\omega_n - \omega_n)ci_t \]

We can conjecture that
\[ vo_t = V_t - fa_t = \beta_cr_t + \beta_ci_t \]  
(1)
Equation a can be rearranged into
\[
V_t - fa_t = R^{-1}(\omega_n cr_t + (\omega_n - \omega_n)ci_t) + R^{-1}E_t(\beta_cr_{t+1} + \beta_ci_{t+1}) \\
= R^{-1}(\omega_n cr_t + (\omega_n - \omega_n)ci_t) + R^{-1}\beta_cr_t(\omega_n cr_t + \omega_n ci_t) + R^{-1}\beta_ci(\omega_n cr_t + \omega_n ci_t) + R^{-1}\beta_ci(\omega_n v_{c_t}) \\
= R^{-1}\omega_n(1+\beta_cr_t)cr_t + R^{-1}((\omega_n - \omega_n) + \beta_ci(\omega_n + \beta_ci)ci_t)  \\
\]
(b)
The coefficients of Eq. 1 are compared with their counterparts of Eq. b as follows:
\[ \beta_cr = R^{-1}\omega_n(1+\beta_cr) \]
\[ \beta_ci = R^{-1}((\omega_n - \omega_n) + \beta_ci(\omega_n + \beta_ci)\omega_n) \]
Solving the above system of equations leads to the following valuation weights:
\[ \beta_cr = \Phi_c \omega_n \]
\[ \beta_ci = R\Phi_c/\eta + 1 \]
where \( \Phi_c = (R - \omega_n)^{-1} \), \( \Phi_i = (R - \omega_n)^{-1} \), and \( \eta = \Phi_c \omega_n - 1 \)

B.2 Proofs of Equation 2, Equation 3, and Equation 2(a)

Proof of Eq. 2
The following accounting relations are defined as
\[ bvt = pe_t + fa_t \]  
(AR1)
\[ pe_t = pe_{t-1} + ci_t + depr_t \]  
(AR2)
\[ depr_t = -(1 - \delta_p)pe_{t-1} \]  
(AR3)
\[ ni_t = cr_t + depr_t + (R - 1)fa_{t-1} \]  
(AR4)
\[ bv_t = bv_{t-1} + (ni_t - d_t) = pe_{t-1} + fa_{t-1} + (ni_t - d_t) \]  
(CSR)
where \( bv_t \) is book value of equity at the end of year \( t \); \( pe_t \) is book value of real property at the end of year \( t \); \( depr_t \) is depreciation expense during year \( t \); \( 1 - \delta_p \) is a depreciation rate for real property; \( ni_t \) is net income during year \( t \); and \( d_t \) is net dividends during year \( t \).

The residual income valuation equation is expressed as
\[ V_t - bv_t = \sum_{r=t}^{\infty}(1+r)^{-1}E_t(ni_{tr}^{\mu}) = (1+r)^{-1}\left[ (E_t(ni_{t_{t+1}}) - rbv_t) + E_t(V_{t+1} - bv_{t+1}) \right] \]  
(RIV)
where \( ni_t = ni_t - rbv_t \). Following Christensen and Feltham (2003, Appendix 10A), we can conjecture
\[ V_t = bv_t + \alpha_m n_i^t + \alpha_{pe} pe_{t+1} + \alpha_{ci} ci_t \]  \hspace{1cm} \text{(RIV(a))}

We then substitute

\[ E_t(n_i^t) = \omega_n n_i^t + (R - \delta_{pe})(\omega_n - \delta_{pe}) pe_{t+1} + [\omega_n - (R - \delta_{pe})] ci_t \]

\[ E_t(p_e_{t+1}) = \omega_{pe} p_e_{t+1} \]

\[ E_t(p_e_{t+1}) = E_t(\delta_{pe} p_e_{t+1} + ci_{t+1}) = \delta_{pe} E_t(\delta_{pe} p_e_{t+1} + ci_{t+1}) + E_t(ci_{t+1}) = \delta_{pe}^2 p_e_{t+1} + (\delta_{pe} + \omega_n) ci_t \]

These leads to an equation expressed in terms of variables \( n_i^t, p_e_{t+1}, \) and \( c_i_t \). Collecting the terms associated with each of the three variables yields three equations in three unknowns:

\[ \alpha_m = (1+r)^{-1}\omega_n (1+\alpha_m) \]

\[ -(R - \delta_{pe})\alpha_m + \alpha_{pe} = (1+r)^{-1} \left[ -(R - \delta_{pe})\delta_{pe} (1+\alpha_m) + \delta_{pe} \alpha_{pe} \right] \]

\[ \alpha_{ci} = (1+r)^{-1} \left[ (\omega_n - (R - \delta_{pe}) (1+\alpha_m) + \alpha_{pe} + \omega_{ci} \alpha_{ci} \right] \]

Solving this system of equation yields the following solutions for valuation weights for RIV(a)

\[ \alpha_m = \Phi_i \omega_n = \beta_{ci} \]

\[ \alpha_{pe} = R \Phi_i (\omega_n - \delta_{pe}) \]

\[ \alpha_{ci} = R \Phi_i \eta = \beta_{ci} - 1 \]

Substituting AR1 and AR4 into RIV(a) leads to

\[ V_t = [1 - \beta_{ci} r] bv_i + \beta_{ci} r b v_i + \beta_{ci} n_i - \beta_{ci} r (p_e_{t+1} + f a_{t+1}) + R \Phi_i (\omega_n - \delta_{pe}) p e_{t+1} + (\beta_{ci} - 1) c_i_t \]  \hspace{1cm} \text{(c)}

If we substitute the clean surplus relation \( bv_i = p e_{t+1} + f a_{t+1} + n_i - d_i \) into Eq. (c), then Eq. c will be

\[ V_t = [1 - \beta_{ci} r] bv_i + (\beta_{ci} + \beta_{ci} r) n_i - \beta_{ci} r d_i + R \Phi_i (\omega_n - \delta_{pe}) p e_{t+1} + (\beta_{ci} - 1) c_i_t \]

\[ \text{(d)}\]

If we define \( k = \beta_{ci} r \), then Eq. d will be

\[ V_t = (1-k) bv_i - k d_i + R \beta_{ci} n_i + R \Phi_i (\omega_n - \delta_{pe}) p e_{t+1} + (\beta_{ci} - 1) c_i_t \]

\[ \text{(2)} \]

**Proof of Eq. 3**

The following accounting relations are defined as

\[ b v_i^{ffo} = p e_i^{ffo} + f a_i \]  \hspace{1cm} \text{(AR1(a))}

\[ p e_{t+1}^{ffo} = p e_{t+1}^{ffo} + c_i_t \]  \hspace{1cm} \text{(no accumulated depreciation)} \hspace{1cm} \text{(AR2(a))}

\[ c f o_i = c r_i + (R - 1) f a_{t+1} \]  \hspace{1cm} \text{(AR5)}

\[ f f o_i = n_i - d e p_t = c f o_i \]  \hspace{1cm} \text{(AR6)}

\[ b v_i^{ffo} = b v_i^{ffo} + (f f o_i - d_i) \]  \hspace{1cm} \text{(CSR(a))}

where \( b v_i^{ffo} \) is gross book value of equity based on FFO reporting; \( p e_{t+1}^{ffo} \) is gross book value of real property based on FFO reporting; \( c f o_i \) is cash flows from operating activities; and \( f f o_i \) is funds from operations.

The residual income valuation equation is expressed as

\[ V_t - b v_i^{ffo} = \sum_{t=3}^{\infty} (1+r)^{-t} E_t( f f o_{t+1}^{ffo}) = (1+r)^{-1} \left[ (E_t( f f o_{t+1}^{ffo}) - r b v_i^{ffo}) + E_t( V_{t+1} - b v_i^{ffo}) \right] \]  \hspace{1cm} \text{(RIV_{ffo})}

where \( f f o_{t+1}^{ffo} = f f o_{t+1} - r b v_i^{ffo} \). Following Christensen and Feltham (2003, Appendix 10A), we can conjecture
We then substitute
\[ E_t(ffo_{t+1}) = \omega_{t}ffo_t^r + (R-1)(\omega_{t} - (1 + \alpha_{fio})fto_t) + [\omega_{t} - (R-1)]ci_t, \]
\[ E_t(ci_{t+1}) = \omega_{t}ci_t, \]
\[ E_t(pe_{t+1}) = E_t(pe_{t+1} + ci_{t+1}) = E_t(pe_{t+1} + ci_t) + E_t(ci_{t+1}) = \omega_{t}pe_{t+1} + (1 + \omega_{t})ci_t, \]
These leads to an equation expressed in terms of variables \( ffo_t^r \), \( pe_{t-1}^r \), and \( ci_t \). Collecting the terms associated with each of the three variables yields three equations in three unknowns:
\[ \alpha_{fio} = (1+r)^{-1}(\omega_{t} - (1 + \alpha_{fio})fto_t), \]
\[ -(R-1)\alpha_{fio} + \alpha_{pe} = (1+r)^{-1}[-(R-1)(1 + \alpha_{fio}) + \alpha_{pe}], \]
\[ \alpha_{ci} = (1+r)^{-1}[\omega_{t} - (R-1)(1 + \alpha_{fio}) + \omega_{t} + \alpha_{pe} + \alpha_{ci}], \]
Solving this system of equation yields the following solutions for valuation weights for RIV(b)
\[ \alpha_{fio} = \Phi_{t} \omega_{t} = \beta_{cr}, \quad \alpha_{pe} = R\Phi_{t} (\omega_{t} - 1), \quad \alpha_{ci} = R\Phi_{t} \eta = \beta_{ci} - 1. \]
Substituting AR1 and AR4 into RIV(b) leads to
\[ V_t = [1-\beta_{cr}r]bv_t + \beta_{cr}rbv_t + \beta_{cr}ni - \beta_{cr}r(p_e - fa_{t-1}) + R\Phi_{t} (\omega_{t} - \delta_{pe})pe_{t-1} + (\beta_{ci} - 1)ci_t \]
If we substitute the clean surplus relation \( bv_{t}^{fio} = pe_{t-1} + fa_{t-1} + ffo_t - d_t \) into Eq. e, then Eq. e will be
\[ V_t = [1-\beta_{cr}r]bv_{t}^{fio} + (\beta_{cr} + \beta_{cr}r)ffo_t - \beta_{cr}rd_t + R\Phi_{t} (\omega_{t} - 1)pe_{t-1}^{fio} + (\beta_{ci} - 1)ci_t \]
If we define \( k = \beta_{cr}r \), then Eq. f will be
\[ V_t = (1-k)bv_{t}^{fio} - kd_t + R\beta_{cr}ffo_t + R\Phi_{t} (\omega_{t} - 1)pe_{t-1}^{fio} + (\beta_{ci} - 1)ci_t \]
**Proof of Eq.2(a)**
We transform Eq. 2 into a valuation model that incorporates two major components of net income. When we substitute \( depr_t = -(1-\delta_{pe})p_{e_{t-1}} \) (AR3) and \( ffo_t = ni_t - depr_t = cfo_t \) (AR5 and AR6) into Eq. 2, Eq. 2 can be rearranged into
\[ V_t = R\beta_{cr}ffo_t - R\Phi_{t} (\omega_{t} - \delta_{pe})p_{e_{t-1}} - (1-k)bv_t - kd_t + (\beta_{ci} - 1)ci_t \]
We conjecture that
\[ V_t = \gamma_{fio}ffo_t + \gamma_{depr}depr_t + \gamma_d d_t + \gamma_{bv}bv_t + \gamma_{ci}ci_t \] (2(a))
The coefficients in Eq. 2(a) are compared with those in Eq. g. The results are as follows:
\[ \gamma_{fio} = R\beta_{cr}, \quad \gamma_{depr} = \gamma_{fio} - R\Phi_{t} (\omega_{t} - \delta_{pe}) - (1-\delta_{pe})^{-1}, \]
\[ \gamma_d = -\beta_{cr}(R-1), \quad \gamma_{bv} = 1-\beta_{cr}(R-1), \]
\[ \gamma_{ci} = \beta_{cr} - 1 - R\Phi_{t} \eta \] (where \( \eta = \Phi_{t} \omega_{t} - 1 \))
B.3 Proofs of Equation 2(b) and Equation 4(a)

Proof of Eq. 2(b)

The revised cash flow dynamics are presented as follows:

\[ \text{cr}_{t+1} = \omega_b \text{cr}_t + \omega_c \text{ci}_t + \omega_r \text{v}_\alpha + \epsilon_{t+1} \]  
(CFD1(a))

\[ \text{ci}_{t+1} = \omega_r \text{ci}_t + \omega_k \text{v}_\alpha + \epsilon_{2,t+1} \]  
(CFD2(a))

\[ \text{v}_{\alpha,t+1} = \epsilon_{3,t+1} \]  
(CFD4)

See section 3.3.1 for the definitions of the variables and parameters.

With CFD1(a) and CFD2(a), expected future operating free cash flows can be presented as

\[ \text{E}_{(o\alpha_{t+1})} = \text{E}_{(cr_{t+1})} - \text{E}_{(ci_{t+1})} 
= (\omega_b \text{cr}_t + \omega_c \text{ci}_t + \omega_r \text{v}_\alpha) - (\omega_r \text{ci}_t + \omega_k \text{v}_\alpha) 
= \omega_b \text{cr}_t + (\omega_b - \omega_r) \text{ci}_t + (\omega_r - \omega_k) \text{v}_\alpha \]

We conjecture that

\[ \text{V}_t - \text{fa}_t = \beta_{\alpha} \text{cr}_t + \beta_{\alpha} \text{ci}_t + \beta_{\alpha} \text{v}_\alpha \]  
(h)

From CVR, the value of operating assets can also be expressed as

\[ \text{V}_t - \text{fa}_t = R^{-1} \text{E}_{(o\alpha_{t+1})} + R^{-1} \text{E}_{(vo_{t+1})} \]  
(i)

If we substitute Eq. h into Eq. i, then Eq. i can be rearranged into

\[ \text{V}_t - \text{fa}_t = R^{-1} (\omega_b \text{cr}_t + (\omega_b - \omega_r) \text{ci}_t + (\omega_r - \omega_k) \text{v}_\alpha) + R^{-1} \text{E}_{(\alpha_{cr_{t+1}} + \beta_{\alpha} \text{ci}_t + \beta_{\alpha} \text{v}_{\alpha_{t+1}})} 
+ R^{-1} \beta_{\alpha} ((\omega_b - \omega_r) \text{ci}_t + (\omega_r - \omega_k) \text{v}_\alpha) 
+ R^{-1} ((\omega_b - \omega_k) + \beta_{\alpha} \omega_r + \beta_{\alpha}) \text{ci}_t 
+ R^{-1} ((\omega_k - \omega_r) \text{v}_\alpha) + \beta_{\alpha} \omega_r + \beta_{\alpha} \omega_k) \text{v}_\alpha \]  
(j)

The comparison of the coefficients of Eq. j with those of Eq. h results in the following system of equations:

\[ \beta_{\alpha} = R^{-1} \omega_b (1 + \beta_{\alpha}) \]
\[ \beta_{\alpha} = R^{-1} ((\omega_b - \omega_r) + \beta_{\alpha} \omega_r + \beta_{\alpha} \omega_k) \]
\[ \beta_{\alpha} = R^{-1} ((\omega_r - \omega_k) + \beta_{\alpha} \omega_r + \beta_{\alpha} \omega_k) \]

Solving the above system of equations leads to the following valuation weights:

\[ \beta_{\alpha} = \Phi \omega_r \]
\[ \beta_{\alpha} = R \Phi \eta + 1 \]
\[ \beta_{\alpha} = \omega_r \Phi_j + \omega_r \Phi \eta \]

where:

\[ \Phi_j = (R - \omega_r)^{-1} \]
\[ \Phi_j = (R - \omega_r)^{-1} \quad \eta = \Phi_j \omega_r - 1 \]

Suppose there is no impairment in period t. If we substitute AR1 and AR2 into Eq. h, we can get

\[ \text{V}_t = \text{fa}_t + \beta_{\alpha} \text{cr}_t + \beta_{\alpha} \text{ci}_t + \beta_{\alpha} \text{v}_\alpha \]
\[ = \text{fa}_t + \text{pe}_t - \text{pe}_t + \beta_{\alpha} \text{cr}_t + \beta_{\alpha} \text{ci}_t + \beta_{\alpha} \text{v}_\alpha \]
\[ = \text{bv}_t - \left[ \delta_{\alpha} \text{pe}_{t-1} + \text{ci}_t \right] + \beta_{\alpha} \text{cr}_t + \beta_{\alpha} \text{ci}_t + \beta_{\alpha} \text{v}_\alpha \]
\[ V_t = [1 - \beta_{cr} (R - 1)]bv_t + \beta_{cr} (R - 1)bv_{t-1} + \beta_{cr} ni_t - \delta_{pe} pe_{t+1} + \beta_{cr} (1 - \delta_{pe}) pe_{t-1} - \beta_{cr} (R - 1) fa_{t-1} + (\beta_{ci} - 1) ci_t + \beta_{vc} v_{ci} \]

Substituting AR3 and AR4 into (k) leads to
\[ V_t = (1 - k) bv_t - kd_t + R \beta_{cr} ni_t + R \Phi_t (\omega_t - \delta_{pe}) pe_{t+1} + (\beta_{ci} - 1) ci_t + \beta_{vc} v_{ci} \]

If we substitute the clean surplus relation (CSR) into Eq. 1 and define \( k_t = \beta_{cr} (R - 1) \), then Eq. 1 will be
\[ V_t = (1 - k) bv_t - kd_t + R \beta_{cr} ni_t + R \Phi_t (\omega_t - \delta_{pe}) pe_{t+1} + (\beta_{ci} - 1) ci_t + \beta_{vc} v_{ci} \]

Since \( \text{depr}_t = -(1 - \delta_{pe}) pe_{t+1} \) (AR3) and \( \text{ffo}_t = ni_t - \text{depr}_t = \text{cfo}_t \) (AR6), Eq. m can be rearranged into
\[ V_t = R \beta_{ffo} ffo_t + (R \beta_{ffo} - R \Phi_t (\omega_t - \delta_{pe})(1 - \delta_{pe})^{-1}) \text{depr}_t + (1 - k) bv_t - kd_t + (\beta_{ci} - 1) ci_t + \beta_{vc} v_{ci} \]

We conjecture
\[ V_t = \gamma_{ffo} ffo_t + \gamma_{\text{depr}} \text{depr}_t + \gamma_d d_t + \gamma_{bv} bv_t + \gamma_{ci} ci_t + \gamma_{vc} v_{ci} \]

The coefficients in Eq. 2(b) are compared with those in Eq. n. The results are as follows:
\[
\begin{align*}
\gamma_{ffo} &= R \Phi_t \omega_t \\
\gamma_{\text{depr}} &= -R \Phi_t (\omega_t - \delta_{pe})(1 - \delta_{pe})^{-1} \\
\gamma_d &= \Phi_t \omega_t (R - 1) \\
\gamma_{ci} &= -\Phi_t \omega_t (R - 1) \\
\gamma_{vc} &= \Phi_t \omega_t + \Phi_t \omega_t
\end{align*}
\]

Proof of Eq. 4(a)
Suppose investors perceive the parameters of cash flow dynamics to be constant over the forecasting horizon at a valuation date and they update the parameters \( \omega_{nt} \) and \( \omega_{ni} \) across valuation dates when new information about the real estate cycle phase is available at future valuation dates. The revised cash flow dynamics are presented as follows:
\[
\begin{align*}
\omega_{nt, t+1} &= \omega_{nt, t} e_{nt, t+1} + \omega_{nt, t} \omega_{vt, t} + \omega_{nt, t} e_{vt, t+1} \\
\omega_{ni, t+1} &= \omega_{ni, t} e_{ni, t+1} + \omega_{ni, t} \omega_{vt, t} \\
\end{align*}
\]

With CFD1(b), CFD2(b), and CFD4, Equation 2(b) turns out to be
\[ V_t = \lambda_{ffo, t} ffo_t + \lambda_{\text{depr,pe}, t} \text{depr}_t + \lambda_{d, t} d_t + \lambda_{bv, t} bv_t + \lambda_{ci, t} ci_t + \lambda_{vc, t} v_{ci, t} \]

with valuation weights:
\[
\begin{align*}
\lambda_{ffo, t} &= R \Phi_t \omega_{nt, t} \\
\lambda_{\text{depr,pe}, t} &= -R \Phi_t (\omega_{nt, t} - \delta_{pe})(1 - \delta_{pe})^{-1} \\
\lambda_{d, t} &= \Phi_t \omega_{nt, t} (R - 1) \\
\lambda_{ci, t} &= -\Phi_t \omega_{nt, t} (R - 1) \\
\lambda_{vc, t} &= \Phi_t \omega_{nt, t} + \Phi_t \omega_{nt, t}
\end{align*}
\]

where
\[
\begin{align*}
\Phi_t &= (R - \omega_{nt, t})^{-1} = (R - \omega_{nt, t} - \varphi_n \text{cycle}_t)^{-1} \\
\Phi_t &= (R - \omega_{ni, t})^{-1} = (R - \omega_{ni, t} - \varphi_n \text{cycle}_t)^{-1}
\end{align*}
\]

The valuation weights in Eq. 4 are a non-linear function of the state variable cycle.}

Let \( \lambda(cycle) \) be the non-linear valuation weight in Eq. 4 with regard to cycle. We assume that cycle is equal to zero when the real estate market is in long-term equilibrium and that cycle fluctuates around its
long-term equilibrium level across valuation dates.

Now, we take a first-order Taylor expansion of \( \lambda(\text{cycle}_t) \) with regard to \( \text{cycle}_t \), at the point of zero (i.e., \( \text{cycle}_t = 0 \)). Then, \( \lambda(\text{cycle}_t) \) will be approximated to a linear function of \( \text{cycle}_t \); at the point of zero such that \( \lambda(\text{cycle}_t) = \lambda(0) + (\partial \lambda(0)/\partial \text{cycle}_t)(\text{cycle}_t - 0) \) where \( \lambda(0) \) is the long-term equilibrium valuation weight when \( \text{cycle}_t = 0 \), and \( \partial \lambda(0)/\partial \text{cycle}_t \) is the first-order derivative of \( \lambda(\text{cycle}_t) \) with regard to \( \text{cycle}_t \), at the point of zero. As a result, a valuation weight in Eq. 4 will be transformed into

\[
\lambda_z(\text{cycle}_t) = \lambda_{z,E} + \lambda_{z,C}\text{cycle}_t
\]

where:

\( z_t \) = A value-relevant information, where \( z_t \) is \( \text{ffo}_t, \text{depr}_t, \text{depr}_E, \text{bv}_t, \text{ci}_t, \text{ve}_t \);

\( \lambda_z(\text{cycle}_t) \) = The valuation weight on \( z_t \);

\( \lambda_{z,E} \) = The long-term equilibrium component of \( \lambda_z(\text{cycle}_t) \) at the point of zero; and

\( \lambda_{z,C} \) = The sensitivity of \( \lambda_z(\text{cycle}_t) \) to \( \text{cycle}_t \).

The following is a linear approximation of each valuation weight with regard to \( \text{cycle}_t \):

(i) \( \lambda_{\text{ffo}}(\text{cycle}_t) \approx \lambda_{\text{ffo},E} + \lambda_{\text{ffo},C}\text{cycle}_t \)

\[
\lambda_{\text{ffo}}(\text{cycle}_t) = R\Phi_{r,t,E} \omega_{r,t,E} = R(\text{R} - \omega_{r,E}) - \phi_{r,E}\text{cycle}_t - (\omega_{r,E} + \phi_{r,E}\text{cycle}_t)
\]

We take a first-order Taylor expansion of \( \lambda_{\text{ffo}}(\text{cycle}_t) \) with regard to \( \text{cycle}_t \) at the point of zero:

\[
\lambda_{\text{ffo},E}(0) = R(\text{R} - \omega_{r,E}) - \phi_{r,E}\text{cycle}_t - (\omega_{r,E} + \phi_{r,E}\text{cycle}_t)
\]

where \( \text{cycle}_t = 0 \) and \( \Phi_{r,E}(0) = (\text{R} - \omega_{r,E})^{-1} \)

\[
\lambda_{\text{ffo},C} = (\partial \lambda_{\text{ffo}}/\partial \text{cycle}_t)\big|_{\text{cycle}_t = 0} = \left[ (\partial R\Phi_{r,t}/\partial \text{cycle}_t) \omega_{r,t,E} + R\Phi_{r,t}(\partial \omega_{r,t}/\partial \text{cycle}_t) \right]_{\text{cycle}_t = 0}
\]

\[
= (-1)R\Phi_{r,E}^2 \omega_{r,E}(-\phi_{r,E})
\]

\[
\therefore \lambda_{\text{ffo},C} = (-1)R\Phi_{r,E}^2 \omega_{r,E}(-\phi_{r,E}) + R\Phi_{r,E}\phi_{r,E} = R^2\Phi_{r,E}\phi_{r,E}
\]

(ii) \( \lambda_{\text{depr,pe}}(\text{cycle}_t) \approx \lambda_{\text{depr,pe},E} + \lambda_{\text{depr,pe},C}\text{cycle}_t \)

\[
\lambda_{\text{depr,pe}}(\text{cycle}_t) = R\Phi_{r,t}(1 - \omega_{r,E}) \delta_{pe}(1 - \delta_{pe})^{-1}
\]

(See sections 3.2.7 for the formula)

\[
= R(\text{R} - \omega_{r,E} - \phi_{r,E}\text{cycle}_t) - (\omega_{r,E} - \phi_{r,E}\text{cycle}_t)\delta_{pe}(1 - \delta_{pe})^{-1}
\]

We take a first-order Taylor expansion of \( \lambda_{\text{depr,pe}}(\text{cycle}_t) \) with regard to \( \text{cycle}_t \) at the point of zero:

\[
\lambda_{\text{depr,pe},E}(0) = R(\text{R} - \omega_{r,E})^{-1}(1 - \omega_{r,E})\delta_{pe}(1 - \delta_{pe})^{-1}, \quad \text{where cycle}_t = 0
\]

\( \lambda_{\text{depr,pe,E}} \) can be expressed as the unbiased component plus the market’s correction for bias in depreciation such that
\[ \lambda_{\text{depr,pe,0}} = R\Phi_{r,E}(1 - \omega_{r,E})\delta_{\text{pe}}(1 - \delta_{\text{pe}})^{-1} \]
\[ = \left[ R\Phi_{r,E}\omega_{r,E}(1 - \delta_{\text{pe}}) - R\Phi_{r,E}\omega_{r,E}(1 - \delta_{\text{pe}}) + R\Phi_{r,E}(1 - \omega_{r,E})\delta_{\text{pe}} \right](1 - \delta_{\text{pe}})^{-1} \]
\[ = R\Phi_{r,E}\omega_{r,E} - R\Phi_{r,E}(\omega_{r,E} - \delta_{\text{pe}})(1 - \delta_{\text{pe}})^{-1} \]
\[ \lambda_{\text{depr,pe,c}} = \left( \frac{\partial \lambda_{\text{depr,pe,0}}}{\partial \text{cycle}_1} \right)_{\text{cycle}_1 = 0} \]
\[ = \left( \frac{\partial R\Phi_{r,E}}{\partial \text{cycle}_1} \right)_{\text{cycle}_1 = 0} \]
\[ = \left( \frac{\partial R\Phi_{r,E}\omega_{r,E}}{\partial \text{cycle}_1} \right)_{\text{cycle}_1 = 0} - \left( \frac{\partial R\Phi_{r,E}\omega_{r,E}}{\partial \text{cycle}_1} \right)_{\text{cycle}_1 = 0} \]
\[ = R\Phi_{r,E}\omega_{r,E} + R\Phi_{r,E}\omega_{r,E}(1 - \delta_{\text{pe}})^{-1} \]
\[ = R\Phi_{r,E}\omega_{r,E}\delta_{\text{pe}}(1 - \delta_{\text{pe}})^{-1} \]
\[ \therefore \lambda_{\text{depr,pe,c}} = \left( \frac{\partial \lambda_{\text{depr,pe,0}}}{\partial \text{cycle}_1} \right)_{\text{cycle}_1 = 0} = (R - 1)(1 - \delta_{\text{pe}})^{-1} \]

(iii) \[ \lambda_{d,t} = \lambda_{d,E} + \lambda_{d,c,\text{cycle}_t} \]
\[ \lambda_{d,t} = -\Phi_{r,t}\omega_{r,t}(R - 1) = -[R - (\omega_{r,E} + \varphi_{r,c,\text{cycle}_t})](\omega_{r,E} + \varphi_{r,c,\text{cycle}_t})(R - 1) \]

We take a first-order Taylor expansion of \( \lambda_t(\text{cycle}_t) \) with regard to \( \text{cycle}_t \) at the point of zero:
\[ \lambda_{d,E} = \lambda_{d,t}(0) = -\Phi_{r,E}\omega_{r,E}(R - 1), \text{ where } \text{cycle}_t = 0 \text{ and } \Phi_{r,E} = (R - \omega_{r,E})^{-1} \]
\[ \lambda_{d,c} = \left( \frac{\partial \lambda_{d,E}}{\partial \text{cycle}_t} \right)_{\text{cycle}_t = 0} = -(R - 1) \left[ (\varphi_{r,t} / \text{cycle}_t) \omega_{r,E} + \Phi_{r,E} (\varphi_{r,t} / \text{cycle}_t) \right] \]
\[ \left[ \omega_{r,E} (\varphi_{r,t} / \text{cycle}_t) \right]_{\text{cycle}_t = 0} = -(R - 1) \Phi_{r,E} \omega_{r,E} (\varphi_{r,t}) \]
\[ \therefore \lambda_{d,c} = -(R - 1)(-\varphi_{r,t}) \]

Similarly,
\[ \left[ \Phi_{r,t} (\varphi_{r,t} / \text{cycle}_t) \right]_{\text{cycle}_t = 0} = \Phi_{r,E} \varphi_{r,t} \]
\[ \therefore \lambda_{d,c} = -(R - 1)(-1)\Phi_{r,E} \omega_{r,E} (-\varphi_{r,t}) + \Phi_{r,E} \varphi_{r,t} = -(R - 1)R\Phi_{r,E} \varphi_{r,t} \]

(iv) \[ \lambda_{b,v,t} = \lambda_{b,v,E} + \lambda_{b,v,c,\text{cycle}_t} \]
\[ \lambda_{b,v,t} = 1 - \Phi_{r,t}\omega_{r,t}(R - 1) = 1 - [R - (\omega_{r,E} + \varphi_{r,c,\text{cycle}_t})]^2(\omega_{r,E} + \varphi_{r,c,\text{cycle}_t})(R - 1) \]

We take a first-order Taylor expansion of \( \lambda_{b,v}(\text{cycle}_t) \) with regard to \( \text{cycle}_t \) at the point of zero:
\[ \lambda_{b,v,E} = 1 - \Phi_{r,E}\omega_{r,E}(R - 1) \]
\[ \lambda_{b,v,C} = -(R - 1)R\Phi_{r,E} \varphi_{r,t} \]
For the same of brevity, I will skip detailed calculations in the proofs in (v) through (vi).

(v) \( \lambda_{c,t} \approx \lambda_{c,E} + \lambda_{c,C} \text{cycle}_t \)

\[
\lambda_{c,t} = R \Phi_{c,t} \eta_t = [R \Phi_{c,t} \eta_t]^{-1} [(R \Phi_{c,t} \eta_t)^{-1} \omega_{h,E} - 1], \text{ where } \eta_t = \Phi_{c,t} \omega_{h,t} - 1.
\]

We take a first-order Taylor expansion of \( \lambda_{c,t} \) with regard to \( \text{cycle}_t \) at the point of zero:

\[
\lambda_{c,t} = \Phi_{c,t} \omega_{c,E} + \Phi_{c,t} \eta_t \omega_{c,C} + \Phi_{c,t} \Phi_{c,E} \eta_t \omega_{c,E} + \Phi_{c,t} \Phi_{c,C} \eta_t \omega_{c,C}, \text{ where } \eta_t = 0.
\]

(vi) \( \lambda_{vc,t} \approx \lambda_{vc,E} + \lambda_{vc,C} \text{cycle}_t \)

\[
\lambda_{vc,t} = \Phi_{vc,t} \omega_{vc,E} + \Phi_{vc,t} \eta_t \omega_{vc,C} + \Phi_{vc,t} \Phi_{vc,E} \eta_t \omega_{vc,E} + \Phi_{vc,t} \Phi_{vc,C} \eta_t \omega_{vc,C}, \text{ where } \eta_t = 0.
\]

B.4 Proof of Equation 2(c)

We incorporate land and building into Eq. 2 by decomposing the book value of real property into its land and building components such that

\[
B_t = \delta_B B_{t-1} + \theta_d c_i_t \quad \text{(AR7)}
\]

\[
L_t = L_{t-1} + (1 - \delta_B) c_i_t \quad \text{(AR8)}
\]

where \( B_t \) is the book value of building; \( 1 - \delta_B \) is a depreciation rate for building; \( \theta_d \) is the cost allocation weight on building; \( L_t \) is the book value of land;

Substituting AR7 and AR8 into Eq. 2 leads to

\[
V_t = (1-k)B_{v,t} - k d_i + R \beta_d c_i + \Phi_{v,t} (\omega_{v,d} - \delta_B) B_{v,t-1} + R \Phi_{v,t} (\omega_{v,d} - 1)L_{v,t-1} + (\beta_d - 1)c_i_t \quad \text{(o)}
\]

Substituting AR6 and depr; = -(1 - \delta_B)B_{v,t-1} into Eq. o leads to

\[
V_t = R \beta_d f_v f_i + \left[ R \beta_d - \Phi_{v,t} (\omega_{v,d} - \delta_B) (1 - \delta_B)^{-1} \right] \text{depr}_t - k d_i + (1-k)b_v + R \Phi_{v,t} (\omega_{v,d} - 1)L_{v,t-1} + (\beta_d - 1)c_i_t \quad \text{(p)}
\]

We can conjecture that

\[
V_t = \gamma_f f_v f_i + \gamma_{depr} \text{depr}_t + \gamma_d d_i + \gamma_b b_v + \gamma_l L_{v,t-1} + \gamma_c c_i_t \quad \text{(2c)}
\]

The coefficients in Eq. 2c are compared with those in Eq. p. I solve the system of equations with regard
to each valuation weight $\gamma_k$ (where $k = \text{ffo, depr, d, bv, L, ci, vc}$). The results are as follows:

$$\gamma_{\text{depr,B}} = \gamma_{\text{ffo}} - R\Phi_r (\omega_r - \delta_r) (1 - \delta_r)^{-1} \quad \gamma_1 = R\Phi_r (\omega_r - 1)$$

The other valuation weights in Eq. 2c are the same as their counterparts in Eq. 2(a).

**B.5 Modeling working capital**

Appendix B.5 shows a more comprehensive static model that includes working capital. This model is shown in Christensen and Feltham (2003, Chapter 10). In this model, working capital is treated as a part of managers’ information about future operating cash flows. In addition, I treat the sale of a property as a negative investment. Accordingly, the cash flow dynamics and the accounting relations can be revised as follows:

$$c_t = \omega_{c_t} c_t + \omega_{v_t} v_t + \omega_{w_t} w_t + \epsilon_{t+1}$$  \hspace{1cm} (CFD1-vr)

$$v_{t+1} = \omega_{v_t} v_t + \epsilon_{t+1}$$  \hspace{1cm} (CFD-vr)

$$b_{t+1} = f_{a_t} + o_{a_t} = f_{a_t} + p_{c_t} + w_{c_t}$$  \hspace{1cm} (AR1(b))

$$p_{c_t} = p_{c_{t-1}} + c_t + \text{depr}$$  \hspace{1cm} (AR2(c))

$$n_t = c_t + \Delta w_t - (1 - \delta_{v_t}) p_{c_{t-1}} + (R - 1) f_{a_{t-1}}$$  \hspace{1cm} (AR4(b))

$$f_{a_t} = n_t - \text{depr} = c_{f_{a_t}} + \Delta w_t$$  \hspace{1cm} (AR6(b))

$$w_{c_t} = \delta_{w_t} w_{c_{t-1}} + \xi_{w_t} v_t$$  \hspace{1cm} (AR9)

$$\Delta w_t = -(1 - \delta_{w_t}) w_{c_{t-1}} + \xi_{w_t} v_t$$  \hspace{1cm} (WCA)

where:

- $o_{a_t} = \text{The book value of operating assets at the end of year } t.$
- $w_{c_t} = \text{The book value of working capital at the end of year } t.$
- $\Delta w_t = \text{Working capital accruals for year } t.$
- $v_{t+1} = \text{Other information on one-year-ahead operating cash receipts associated with current operating transactions on credit (e.g., non-cash rental or purchase).}$
- $\omega_{v_t} = \text{The persistence of } v_t.$
- $\xi_{w_t} = \text{The fraction of } v_{t+1} \text{ recognized as a change in working capital in year } t.$
- $\delta_{w_t} = \text{The persistence of the book value of working capital.}$
- $\epsilon_{t+1} = \text{Unexpected shock to other information } v_t$

See Appendix B.2 for the definition of the other variables.

With the revised cash-flow dynamics, Eq. 1 is converted into

$$V_t = f_{a_t} + \beta_{c_t} c_t + \beta_{c_t} c_t + \beta_{w_t} v_t$$  \hspace{1cm} (q)

where $\beta_{v_t} = R\Phi_{v_t} \Phi_r$ and $\Phi_{v_t} = (R - \omega_{v_t})^{-1}$

Substituting the revised accounting relations into Eq. q leads to

$$V_t = f_{a_t} + (p_{c_t} + w_{c_t}) - (p_{c_t} + w_{c_t}) + \beta_{c_t} c_t + \beta_{c_t} c_t + \beta_{v_t} v_t$$

$$= b_{v_t} - \left[ \delta_{v_t} p_{c_{t-1}} + c_t + \delta_{w_t} w_{c_{t-1}} + \xi_{w_t} v_t \right] + \beta_{c_t} c_t + \beta_{c_t} c_t + \beta_{v_t} v_t$$

$$= b_{v_t} + \beta_{c_t} c_t - \delta_{v_t} p_{c_{t-1}} - \delta_{w_t} w_{c_{t-1}} + (\beta_{c_t} - 1) c_t + (\beta_{v_t} - \xi_{w_t}) v_t$$  \hspace{1cm} (r)
If we define $cfo_i = cr_i + (R - 1)fa_{ct-1}$ (AR5) and $k = \pi_{ct}(R - 1)$, Eq. r can be rearranged into

$$V_i = (1 - k)bv_i + kbv_i - kfa_{ct-1} + \beta_i \cdot cf_{oi} - \delta_{pe}pe_{ct-1} - \delta_{we}wc_{ct-1} + (\beta_{ci} - 1)ci_i + (\beta_{ri} - \xi_{we})v_{ri}$$  \hspace{1cm} (s)

If we substitute $bv_i = bv_{ct-1} + ni_i - d_i$ (CSR) and $ni_i = cf_{oi} - (1 - \delta_{we})wc_{ct-1} + \xi_{we}v_{ri} - (1 - \delta_{pe})pe_{ct-1}$ (AR4(b)) into Eq. s, then Eq. s can be rearranged into

$$V_i = (1 - k)bv_i - kd_i + R \Phi_i \omega_{ct-1} + \Phi_i \omega_{ct-1} + \delta_{pe}pe_{ct-1} - \delta_{we}wc_{ct-1} + (\beta_{ci} - 1)ci_i + (k - 1)\xi_{we} + \beta_{ri}v_{ri}$$  \hspace{1cm} (t)

Substituting Equation WCA into Eq. t leads to

$$V_i = (1 - k)bv_i - kd_i + R \Phi_i \omega_{ct-1} + \Phi_i \omega_{ct-1} + \delta_{we}wc_{ct-1} + \delta_{we}(k - 1)\xi_{we} + \beta_{ri}v_{ri}$$  \hspace{1cm} (u)

If we substitute $pe_{ct-1} = -(1 - \delta_{pe})^{-(1-c)} depr_i$ (AR3) into Eq. u, then Eq. u can be rearranged into

$$V_i = R \Phi_i \omega_{ct-1} + \Phi_i \omega_{ct-1} + \delta_{we}wc_{ct-1} + \delta_{we}(1 - \delta_{pe})^{-(1-c)} depr_i$$  \hspace{1cm} (u)

We can conjecture that

$$V_i = \gamma_{ct}cf_{oi} + \gamma_{we}wc_{ct-1} + \gamma_{we}pe_{ct-1} depr_i + \gamma_{bv}bv_i + \gamma_{ci}ci_i$$  \hspace{1cm} (2d)

The coefficients in Eq. 2d are compared with those in Eq. u. I solve the system of equations with regard to each valuation weight. The results are as follows:

$$\gamma_{we} = R \Phi_i \omega_{ct-1} + \Phi_i \omega_{ct-1}$$

$$\gamma_{we} = R \Phi_i \omega_{ct-1} + \Phi_i \omega_{ct-1}$$

The valuation weights on the other variables of Eq. 2d are the same as their counterparts of Eq. 2(a).

Christensen and Feltham (2003) discuss unbiased working capital policy. Working capital will be unbiased if the present value of all future operating cash receipts predicted by $v_{ri}$ is fully recognized as a change in working capital in year $t$ (i.e., $\xi_{we} = (R - \omega_{ct-1})^{-1}$) and if the beginning-of-period working capital ($wc_{ct-1}$) diminishes at the same rate at which future cash flows associated with working capital diminishes (i.e., $1 - \delta_{we} = 1 - \omega_{ct-1}$). If $\xi_{we} = (R - \omega_{ct-1})^{-1}$ and $\delta_{we} = \omega_{ct-1}$, then $\gamma_{we}$ will be equal to $\gamma_{cf}$, and $\gamma_{we}$ will be equal to zero.
Appendix C Definitions of variables

\( P_t \) = Closing stock prices (PRC, CRSP monthly file) at the final trading date of the third month after the end of fiscal year \( t \). PRC is adjusted to stock splits and dividends between the end date of year \( t \) and the valuation date.

\( N_{It} \) = Net income per share, which is measured as Basic EPS (COMPUSTAT epspx) times the number of shares outstanding used to compute Basic EPS (COMPUSTAT cshpri) deflated by the number of shares outstanding at the end of year \( t \) (COMPUSTAT csho).

\( B_{Vt} \) = Book value of common equity per share at the end of year \( t \) (COMPUSTAT ceq/csho).

\( P_{E_{t-1}} \) = The book value of real property per share at the end of year \( t-1 \) (COMPUSTAT ret/COMPUSTAT csho). If ret is missing, I hand collect the data from the 10–Ks.

\( D_{IVt} \) = Common cash dividend per share for year \( t \) (COMPUSTAT dvc/csho).

\( C_{FI_t} \) = Capital investment per share for year \( t \), measured as -1*COMPUSTAT ivncf/csho where ivncf is cash flows from investing activities.

\( F_{FOt} \) = Funds from operations per share, which is measured as stock-split adjusted FFO per share (I/B/E/S summary file) times the I/B/E/S cumulative adjustment factor times the number of shares outstanding used to compute diluted EPS (cshfd) deflated by the number of shares outstanding at the end of year \( t \) (csho). Cumulative adjustment factors are based on adjustment factors (adjspf of I/B/E/S summary file). If cshfd is missing, cshfd is replaced with (epspx*cshpri)/epsfx, where epsfx is diluted EPS.

\( B_{Vt,fio} \) = Gross book value of common equity per share at the end of year \( t \) (\( B_{Vt} + \) accumulated depreciation per share at the end of year \( t \)).

\( P_{E_{t-1,fio}} \) = Gross book value of real property per share at the end of year \( t-1 \) (\( P_{E_{t-1}} + \) accumulated depreciation per share at the end of year \( t-1 \))

\( R_{ETt} \) = One-year buy-and-hold return (including dividend) for the period starting from the fourth month after the end of year \( t-1 \) and ending at the end of the third month after the end of year \( t \).

\( P_{kz,t} \) = Stock price at the end of third month after the end of year \( t \), adjusted for all past stock splits retrospectively

\( N_{I_{kz,t}} \) = Net income per share for year \( t \) adjusted for all past stock splits retrospectively

\( B_{VE_{kz,t}} \) = Book value of equity per share for year \( t \) adjusted for all past stock splits retrospectively

\( A_{CCUDEP_{kz,t}} \) = Accumulated depreciation and amortization per share adjusted for all past stock splits retrospectively

\( D_{IV_{kz,t}} \) = Common cash dividend per share for year \( t \) adjusted for all past stock splits retrospectively

\( S_{gr_{t}} \) = Sales growth rate for year \( t \) relative to year \( t-1 \)

\( L_{EV_{t}} \) = Leverage ratio at the end of year \( t \) ((total assets – common equity)/total assets)

\( C_{FO_{t}} \) = Cash flows from operating activities per share for year \( t \), which are measured as CFO (COMPUSTAT oancf) deflated by the number of shares outstanding at the end of year \( t \) (csho).

\( F_{FO-CFO_{t}} \) = Non-CFO component of FFO measured as FFO minus CFO.

\( D_{EPR_{t}} \) = Depreciation expense per share, which is measured as -1*COMPUSTAT dpc/csho where dpc is depreciation expense in the statement of cash flows. If dpc is missing, depreciation expense for real estate (COMPUSTAT dpret) is used.

\( W_{C_{t-1}} \) = The book value of working capital per share at the end of year \( t-1 \). In this paper,
working capital is defined as net operating assets other than real property. The book value of working capital is measured as total assets (COMPUSTAT at) – total liabilities (COMPUSTAT tl) – real property (COMPUSTAT ret) – cash and cash equivalents (COMPUSTAT che) + debts (COMPUSTAT dltt). If these values are missing in COMPUSTAT, I hand collect the data from the companies’ 10-Ks.

LAND_{t-1} = The book value of land per share at the end of year t-1

BUILD_{t-1} = The book value of building per share at the end of year t-1 (pet-l – landt-1)

AGE_{t-1} = The age of a property portfolio is measured as accumulated depreciation for buildings deflated by (book value of buildings + accumulated depreciation for buildings).

QAGE_{t-1} = The quartile of the age of a property portfolio at the end of year t-1.

AF_{t+s} = Consensus analysts’ forecasts of FFO for period t+s (s = 0 to 3), which is measured as the median of analysts’ forecasts of FFO in I/B/E/S summary file. If the median of analysts’ forecasts of FFO for t+3 is missing, then AF_{t+3} is measured as the AF_{t+3} = AF_{t+2}*(1 + the median of analysts’ forecasts of long-term growth rate of FFO). If long-term growth rate is also missing, then AF_{t+3} = AF_{t+2}*[1+(AF_{t+2}− AF_{t+1})/AF_{t+1}].

CYCLE_{t} = A composite index for real estate cycle phase for year t (See Appendix D for estimation)

COE_{t} = Annualized industry cost of equity is based on the Fama and French three-factor model. The first step is to estimate the time-series regression for a rolling 60-month period prior to time t such that

\[ r_t - r_{ft} = \alpha + \beta_1 (SMB_{t} - r_{ft}) + \beta_2 SMB_{t} + \beta_3 HML_{t} + \epsilon_t \]  

(FF)

where \( r_t \) is a rolling 60-month sequence of historical industry value-weighted returns; SMB (Small minus Big) is the monthly average return on the three small-cap portfolios minus the average return on the three large-cap portfolios;\(^{115} \) \( r_{ft} \) is the value-weighted return on all NYSE, AMEX and NASDAQ stocks; \( r_{ft} \) is the three-month Treasury Bill rate; and HML (High minus Low) is the monthly average return on the two value portfolios minus the average return on the two growth portfolios.\(^{116} \) The autocorrelation of error terms is corrected using the Prais-Winsten procedure. The conditional heteroscedasticity of the variance of error terms is corrected using the GARCH (1, 1) procedure. Next, the annualized industry cost of equity in year t (COE_{t}) is computed as:

\[ COE_{t} = r_t + \beta_1 \times \overline{SMB}_t - r_{ft} + \beta_2 \times \overline{SMB}_t + \beta_3 \times \overline{HML}_t \]  

(COE)

Where \( \overline{SMB}_t \) and \( \overline{HML}_t \) refer to the geometric average of excess returns on market risk, firm size, and the book-to-market ratio for 30 years prior to time t; and \( \beta_k \)

(k = 1, 2, 3) is the estimated beta for kth risk factor in the estimation of FF.

COEC_{t} = A cyclical component of annualized industry cost of equity using the Hodrick and Prescott (1997) filter. The estimation does not take a log of COE_{t} because COE_{t} does not include a growth trend.

REG_{t} = An indicator variable for the post-NAREIT (1999) period, which is equal to one for the period 2000–2008 during which the NAREIT (1999) regulation is in effects, and is equal to zero for the period 1995–1999.

\(^{115} \) Professor French formulates nine portfolios in terms of size: small-cap portfolios (3), medium-cap portfolios (3), and large-cap portfolios (3).

\(^{116} \) All needed data are available at [http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html](http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html)
Appendix D Measurement of the real estate cycle proxy

Appendix D describes the measurement of a proxy for the real estate cycle phase during a fiscal year. Since there are no definitive or uncontroversial proxies, this study forms a composite index that reflects common variation in three real estate market variables that capture the market demand for and supply of real estate. These variables include (1) the quarterly National Council of Real Estate Investment Fiduciaries (NCREIF) total return (hereafter, the NCREIF total return), (2) the difference between the quarterly demand and supply indices for the U.S. private commercial real estate market (hereafter, the excess demand), and (3) the monthly housing starts index (hereafter, housing starts). The following paragraphs will introduce each of these real estate market variables and discuss how they are formed into a composite index.

The NCREIF total return represents the market-level economic income on investment in commercial real property (NCREIF 2005). The NCREIF total return is computed by aggregating the net operating income and change in the market value of all commercial real property for a quarter. The value of a property is regarded as having changed during a quarter if an independent third party appraiser externally appraises the property, or if property managers observe changes in market conditions such as occupancy rates, rental rates, or interest rates. The quarterly index data are available from 1978 to 2009.

Excess demand is measured as the difference between the demand and supply indices for commercial real estate provided by the Commercial Real Estate Data Laboratory at the MIT Center for Real Estate (MIT/CRE). The MIT/CRE measures the demand and supply indices by estimating the reservation prices of suppliers and demanders (unobservable latent variables) using observed trading prices and volumes, and the attributes of traded property. Excess demand represents market liquidity that is presumably positively correlated with real estate cycles (Fisher et al. 2003). These indices are available from 1984 to 2009.

Housing starts are expected to be correlated with the performance of REITs that specialize in the residential property sector. According to Mayer and Somerville (2000), housing starts are a function of changes in housing prices and construction costs, and changes in housing prices convey information on the unanticipated growth in demand for houses. The data are available from 1978 to 2009.

Each real estate market variable is likely to contain a common business-cycle component and an idiosyncratic component. To capture the common business-cycle information embedded in these variables, this study forms a composite index of these real estate market variables. The first step is to isolate the cyclical components of the three real estate market variables by using a filtering technique developed by Hodrick and Prescott (1997). The Hodrick and Prescott (1997) filter (hereafter, the HP filter) is used to decompose a real estate market variable into the equilibrium component and the

---

117 As a result, some variables seem to reflect a given shift in market demand or supply earlier than others. For example, the NCREIF total return (as shown in Figure 3 Panel A) declines in 1998 and does not change significantly in 1999 and 2000. The excess demand (as shown in Figure 3 Panel B) declines and rebounds in 1998; it declines significantly in 1999; and it increases and declines in 2000.
cyclical component. Specifically, the HP filter is used to find a solution to the following optimization problem:

$$\begin{align*}
\min \left\{ \sum_{t=1}^{T} c_t^2 + \lambda \sum_{t=1}^{T} \{(g_t - g_{t-1}) - (g_{t+1} - g_{t-1})\}\right\} \\
\text{Subject to } y_t = g_t + c_t \text{ for } t = 1, 2, 3, \ldots, T
\end{align*}$$

(HP)

where $y_t$ is the natural logarithm of one of the three variables, representing the total growth of the variable; $g_t$ is the equilibrium level of $y_t$; and $c_t$ is the cyclical component of $y_t$, oscillating around a mean of zero. The HP filter relies on the notion that the long-term equilibrium growth rate of an aggregate economic variable (i.e., $g_t - g_{t-1}$) must be smooth. A sufficiently large number for $\lambda$ is used to penalize the variability of the long-term equilibrium growth rate of the variable. Following Ravn and Uhlig (2002), $\lambda = 129,600$ is used for monthly data. Quarterly real estate market variables are assumed to have the same value for all three months within a quarter.

Next, this study computes the 12-month moving average of the cyclical components so that these variables may reflect cumulative changes in market demand during the last 12 months. The moving average data not only are compatible with contemporaneous annual financial data in the regressions but also reduce the effect of idiosyncratic variation in the individual real estate market variables.

Finally, this study forms a composite index of these cyclical components and matches it to annual financial data. Principal components analysis leads to the following composite index

$$\text{CYCLE}_t = 0.381c_{1t} + 0.351c_{2t} + 0.363c_{3t}$$

where $c_{1t}$, $c_{2t}$, and $c_{3t}$ are the 12-month moving average of the cyclical components of the NCREIF total return, the excess demand index, and the housing starts index, respectively.

To check the robustness of results to the HP filtering, this study uses principal component analysis to measure a composite index of the three real estate market variables (not their cyclical components)

$$\text{CYCLE}_{a,t} = 0.385\text{NCREIF}_t + 0.344\text{EXC}_t + 0.366\text{HSTARTS}_t$$

where NCREIF$_t$, EXC$_t$, and HSTARTS$_t$ are the 12-month moving averages of the NCREIF total return, the excess demand index, and the housing starts index, respectively. This alternative proxy, CYCLE$_{a,t}$, reflects the common variations of these three real estate market variables. Note that firms have different fiscal-year-end months, so the composite index during a fiscal year can vary across firms, depending on fiscal-year-end months. For example, a firm may have fiscal year that ends in May. The April 2008 to May 2009 data are used to compute CYCLE$_{2008}$ for this firm.

---

118 This study takes a log of housing starts to eliminate the growth trend of the variable. In contrast, this study does not take a log of the NCREIF total return on the excess market demand, because these variables do not include a growth trend.