MELISSA PORRAS PRADO

The Long and Short Side of Real Estate, Real Estate Stocks, and Equity

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Melissa Porras Prado

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”Long” en ”Short” posities binnen vastgoed, vastgoed-aandelen en effecten

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Melissa Porras Prado
Rotterdam, The Netherlands
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Chapter 1

Introduction

This thesis consists of three studies in the investments field that look at the interaction between ”long” and ”short” positions and their impact on market participants, prices and portfolio allocations. In Chapter 2, we examine the optimal portfolio composition for institutional investors when considering liabilities. Institutional investors, by taking into account their short positions, which in effect are their liabilities, make different asset allocation decisions (long position). Important in the optimization is the role of the asset classes in hedging the market value of liabilities. In Chapter 3, we turn to the impact of short positions of market participants on prices by showing that limits to shorting lead to biased prices. In particular, we find that the presence of short sale constraints can explain the existence of a premium to Net Asset Value (NAV) for REITs. In Chapter 4, I show that the anticipation of shorting in turn also leads to higher prices. I show that revenue associated with security lending is capitalization in prices, as investors are willing to pay a premium associated with lending fees. The results of this study suggest that overpricing caused by the presence of short sale constraints is not solely due to restriction on negative information but also partly a result of capitalized lending profits. In the remainder of this chapter, I will outline the thesis and describe how the studies relate to the literature.

1.1 The Long Side

Traditional mean variance asset-only analysis predicts an optimal real estate allocation of 20%-30%. Nonetheless, Bajtelsmit and Worzala (1995) and Dhar and Goetzmann (2006) surveyed institutional investors from the U.S. and found the reported allocation among funds who invest in real estate to be relatively small between 3% and 5%. The inclusion of real estate assets in mean-variance optimal portfolios resulted in a widespread belief that actual real estate allocations in investment portfolios fall short.

In Chapter 2, we perform an Asset liability Management (ALM) study on real estate allocations. Asset liability management (ALM) pertains to coordinating the management of assets and liabilities in order to maintain a surplus of assets beyond liabilities. Pension liabilities are the starting point in determining the appropriate investment strategies. The ALM approach focuses on considering risk on a relative basis versus liabilities when making asset allocation decisions and seeks to maximize the risk adjusted surplus of assets minus liabilities.

We study US data for the period 1984-2008 to quantify the assets' impact on the pensions fund's future funding surplus and quantify the utility that investors with liabilities can derive from real estate in view of other asset classes. This enables us to determine whether to classify real estate and other assets as reserve asset, an asset which moves in tandem with liabilities, or return-generating asset, an asset that merits an inclusion in the portfolio because of its attractive risk-reward characteristics (see Black and Jones (1988)). We widen the investment opportunity set by distinguishing between direct and indirect real estate investments.

This chapter differentiates itself from previous studies as Chun et al. (2000) and Craft (2001, 2005A, 2005B) by the way in which we define the return on liabilities. To compare the effect of changing accounting practices of the pension liabilities on portfolio allocations we use different liability return definitions. First, we proxy the traditional book value of liabilities, which only include actuarial changes, using the changes related to the value of projected pension obligations (PBOs) in accordance with Chun et al. (2000) and Craft (2001, 2005A, 2005B). Next to this traditional definition of liability returns, we also estimate the market value of liabilities, in line with fair value accounting. This chapter adds to the existing literature by examining the liability hedge qualities of real estate in light of liabilities being denominated at fair value.

1.2 The Short Side

In Neo-classical asset-pricing models it is assumed that market participants can buy, sell and short sell securities at no cost. In practice, restrictions on short selling a security can make shorting a stock not as straightforward as simple selling or buying. Miller (1977), Seneca

(1967), Figlewski (1981), Chen et al. (2002), Harrison and Kreps (1978), and Morris (1996) all argue that security prices are upward biased when short-sales constraints exist. In the presence of short sale constraints, negative information will be kept out of the market.

The influence of short sale constraints on prices is examined in chapter 3. Several prior papers test the overvaluation hypothesis by focusing on the relation between short sales and subsequent returns; a negative ex post calendar time abnormal return is consistent with overvaluation. Figlewski (1981), Brent et al. (1990), Senchank and Starks (1993), Figlewski and Webb (1993), Aitken et al. (1998), Dechow et al. (2001), Angel et al. (1998), Asquith et al. (2005), Desai et al. (2002), Boehmer et al. (2008), Diether, Lee and Werner (2009), and Boehmer et al. (2010) observe a negative relation between stock returns and short interest levels.

However, negative abnormal returns do not automatically imply overvaluation, since a stock can decline in price without being overvalued. Pessimistic information regarding the future cash flow outlook of a stock is consistent with a reduction in valuation to a new value estimate, not necessarily brought about by short sellers or short sale constraints. Similarly, a stock can be overvalued for sustained periods of time without experiencing negative abnormal returns. The limits of arbitrage theory of Shleifer and Vishny (1997) focuses on the case where mispricing may deepen in the short run, even though there is no long run fundamental risk in the trade. By using the NAV value of REITs, we extend previous findings to statements about the level of prices and address the importance of relative valuation in the short sale decision. REITs offer the advantage of being more straightforward to price, as corroborated by Mühlhofer and Ukhov (2009). We contribute to the literature on short sale and price discovery by directly linking short sales and short sale constraints to valuation using a unique data set and by taking advantage of the parallel market valuation of REITs. In addition to providing further evidence on Millers theory we contribute to the literature on the NAV pricing divergence in REITs by exploring whether the presence of short sale constraints can explain the existence of a premium to NAV of REITs. More specifically, we address the question of how much of the cross-sectional variation in REIT premium can be attributed to short sale constraints?

In Chapter 4, I show that the anticipation of shorting in turn also leads to higher prices. In the presence of short sale constraints negative information will be withheld from the market and the marginal investor will be an optimist. Additionally, the price inflation can go beyond the most optimistic valuation in that it can be attributed to the prospect of the future lending fees. Duffie et al. (2002) present a dynamic model of asset valuation in which short-selling requires searching for security lenders and bargaining over the lending fee. They argue that an investor is willing to pay more than his valuation, if he expects to profit from lending it in the future when the opportunity arises. The prospect of lending fees elevates prices above even the most optimistic buyer's valuation of the security's future dividends. The price is the expected valuation of the marginal investor, plus the expected future revenue associated with the potential to lend the asset.

Securities lending is defined as a market process whereby securities are temporarily transferred by one party to another for a fee. The size of the securities lending market has increased significantly in recent years. At its peak in 2007, the equity securities lending market represented nearly \$850 billion with over \$400 billion in U.S. equities alone, according to estimates of Data Explorers Ltd. As 2007 turned into 2008 and the stock market steadily declined, securities lending revenues and loan volumes reached new highs. Average loan spreads widened from 20-30 basis points in 2005-2006, to over 60 basis points in 2008. In 2009, the SECs ban on short sales of financial stocks reduced the security lending market in size, however the securities lending market regained some of that volume from March to September.

The business of securities lending is a lucrative business for funds with large portfolios of stocks. Securities lending is therefore increasingly recognized and managed. Dimensional Advisors for example earned \$182 million in net lending revenue for the fiscal year 2008. The resulting performance enhancement ranged from 0.04% for their US Large Company Portfolio to 0.66% for their Japanese Small Company Portfolio. Mutual funds reported \$1 billion in lending revenue and pension funds added \$500 million to their overall portfolio returns in 2008.

Given that security lending revenue is an additional source of income, I test whether investors are willing to pay a premium associated with lending fees, in Chapter 4. The purpose is to examine whether security prices incorporate lending profits. This chapter contributes to the literature on short sale constraints and valuation and to the literature on the informativeness of short sales. The results of this study suggest that overpricing is not solely due to restriction on negative information but also partly a result of capitalized lending profits.

Chapter 2

Real Estate in an ALM Framework: The Case of Fair Value Accounting*

2.1 Introduction

Real estate assets have traditionally been regarded as safe investments with inflation hedging capabilities that offer diversification potential and high absolute returns. Nevertheless there is no consensus as to its role within an investment context. In the selection of portfolios based on means and covariances of returns the role for real estate, as a diversifier in a portfolio, appears to be substantial. For real estate allocations the mean-variance literature predicts allocations of at least 20% to be optimal.[1] Conversely, institutional investors like pension funds are not solely aspiring for maximum returns at a selected level of risk in their portfolio choice. Their focus in making asset allocation decisions is on considering risk on a relative basis versus liabilities to optimize their risk adjusted surplus. When taking pension liabilities as the starting point and coordinating the management of assets and liabilities in order to maintain a surplus of assets beyond liabilities the role for real estate seems much more limited.

Chun et al. (2000) offered the first empirical analysis of real estate allocations within an Asset Liability Management (ALM) framework. In their research they recognize real estate assets' correlation and diversification potential with other assets, while simultaneously adjusting

*This chapter is an extended version of Brounen et al. (2010) and has benefited from the comments of the anonymous referee, the editor and participants at the 2007 Netspar Workshop and the 2007 European Real Estate Society Annual Conference.

[1]For empirical evidence on real estate allocation within mean variance optimizations we like to refer to: Friedman (1971), Fogler (1984), Brinson and Schlarbaum (1986), Firstenberg (1998), Irwin and Landa (1987), Ennis and Burik (1991), Hoesli et al. (2003) and Lee and Stevenson (2005).

for the covariance with the liability stream. The diversification potential on the liability side as a hedge against inflation turns out to be more limited and accounts for the reduced exposure to this asset class as witnessed in institutional portfolios. Even so, this earliest achievement in the asset-liability literature circumvents the imperfections associated with real estate by focusing on real estate securities (REITs) and as such limits the opportunity set of assets to include solely indirect real estate. Furthermore, Chun et al. (2000) focus on the reported value of projected benefit obligations and in the advent of market-based accounting obligations for pension funds it becomes of interest how real estate performs in hedging the fair value of liabilities.

This chapter differentiates itself from previous studies as Chun et al. (2000) and Craft (2001, 2005A, 2005B) by the way in which we define the return on liabilities. With the introduction of the Pension Protection Act the dynamics of liabilities are likely to change. To compare the effect of changing accounting practices of the pension liabilities on portfolio allocations we use different liability return definitions. First, we proxy the traditional book value of liabilities, which only include actuarial changes, using the changes related to the value of projected pension obligations (PBOs) in accordance with Chun et al. (2000) and Craft (2001, 2005A, 2005B). Next to this traditional definition of liability returns, we also estimate the market value of liabilities, in line with fair value accounting. This chapter adds to the existing literature by examining the liability hedge qualities of real estate in light of liabilities being denominated at fair value.[2]

We study US data for the period 1984-2008 to quantify the assets' impact on the pensions fund's future funding surplus and quantify the utility that investors with liabilities can derive from real estate in view of other asset classes. This will enable us to determine whether to classify real estate and other assets as reserve asset, an asset which moves in tandem with liabilities, or return-generating asset, an asset that merits an inclusion in the portfolio because of its attractive risk-reward characteristics (see Black and Jones (1988)). We widen the investment opportunity set by distinguishing between direct and indirect real estate investments. This chapter is the first to include the MIT transaction index in a portfolio optimization problem following an ALM specification. The Transaction Based Index (TBI) estimates quarterly market price changes based on the verifiable sales prices of properties sold from the NPI database each quarter, avoiding the smoothing and lagging problems of the NCREIF appraisal based index used in previous studies. Moreover, we compute inflation hedge ratios to determine

[2]Fair value is an estimated market value of pension liabilities in the absence of a market price, fair value is thus the best estimate of the market value.

which asset class provides the appropriate payout structure for indexation policies.

Our results indicate that the portfolio composition differs depending on the definition of the liability return. When liability returns solely follow actuarial changes the mean variance efficient portfolio allocations toward direct real estate and fixed income decreases compared to the asset-only optimization. Once accounting for interest rate risk the hedging benefits of direct real estate materialize for short term holding periods. However, over longer holding periods real estate proves to be a poor interest rate and particularly poor inflation hedge. Direct real estate is a return generating asset class that merits an inclusion in an ALM portfolio because of its attractive risk reward characteristics and its low correlation with stocks and bonds, though its role in an ALM portfolio is considerably limited when accounting for inflation risk. Whereas indirect real estate obtains an allocation in an asset-only portfolio, in an ALM inflation hedge portfolio it has no position. Commercial real estate is a perverse inflation and interest rate hedge and offers pension funds no additional advantage beyond its attractive risk reward characteristics and diversification potential.

The remainder of this chapter is organized as follows: we present a synthesis of the most relevant theoretical and empirical analysis on real estate allocations and asset-liability management. In the section 2.3 the methodology and in section 2.4 the data set of the empirical tests are presented. We initially proceed by quantifying real estate allocations assuming an asset-only mean variance optimization. In section 2.6, we analyze the liability hedging potential of various assets classes, compared both to the fair value and to the actuarial denomination of liabilities. This will allow us to answer the question whether the change in accounting practices to fair value accounting of pension liabilities will cause a significant change in pension plan allocations. In section 2.7 we compute optimal ALM portfolios and asses the interplay between the different weights attached to liabilities, levels of risk tolerance and funding levels of pension schemes. Subsequently in section 2.8, we calculate inflation hedging capabilities of the asset classes over various holding periods to asses the desirability of the asset class with respect to indexation policies. The last empirical test is regarding the influence of return predictability on ALM portfolios. Finally, section 2.10 summarizes our most important findings.

2.2 Literature Review

In the context of real estate allocations Friedman (1971) was one of the first to use the mean-variance methodology to select optimal direct real estate and mixed-asset portfolios. The inclusion of real estate assets in mean-variance optimal portfolios resulted in a widespread belief that actual real estate allocations in investment portfolios fall short. Bajtelsmit and Worzala (1995) put forward that on average American pension funds allocate less than 4% of their assets to equity real estate. In their survey among 96 pension funds the dominant asset classes were domestic stock (42.6%) and bonds (32%) followed by international stocks (7.2%). More recently, Dhar and Goetzmann (2006) surveyed leading investment managers from the U.S. and found the reported allocation among funds who invest in real estate to be relatively small 3%-5%, although a large number of funds announced plans to increase their respective allocations. Hoesli et al. (2003) explicitly compare the actual and suggested weights of real estate in the institutional portfolio and find that against the classic mean-variance framework, the predicted allocations are inconsistent with reported allocations.

The discrepancy between actual allocations and theoretical predications in this asset-only view lead Chun et al. (2000) to examine pension plan investments in an asset-liability framework using U.S. REITs. The relation between assets and liabilities seems to be at the heart of explaining the limited exposure to real estate. Within the mean-variance framework real estate plays an important role as a diversifying asset class, but when accounting for liability obligations real estate seems to offer reduced diversification benefits as a hedge against actuarial changes and inflation on the liability side of the balance sheet. The latter diversification potential accounts for the reduced exposure to this asset class as apparent among institutional portfolios. Chun et al. (2000) also found cross-sectional differences in REIT allocations. For overfunded plans the optimal allocation is higher than for underfunded funds.

Following this first empirical ALM study on real estate allocations Craft (2001) further examined real estate investments by distinguishing between private and public real estate allocations, while correcting for appraisal smoothing. The asset-liability framework predicts an allocation of 12.5% to private real estate and 4.7% to public real estate. And as the returns increase the private real estate allocation decreases sharply while the allocation to public real estate decreases at a lower progressive pace. Moreover, in accordance with Chun et al. (2000) overfunded pension plans are much more likely to hold both private and public real estate than underfunded counterparts (Craft, 2005A, 2005B). The particular nature and conditions of a pension fund apparently influence the optimal allocation decision. Similarly, Booth (2002) finds considerably different optimal portfolios depending on the liability structure of the pension funds. For mature U.K. schemes (whose members have already retired) direct real estate allocations prevail around 10%. For immature pension plans (active members) index-linked U.K. government bonds and U.S. equities replace real estate allocations.

Finally, another strand of literature by Fugazza and Nicodano (2007) and Hoevenaars et al. (2008) incorporates predictability of asset returns in the optimal portfolio choice. Fugazza, Guidolin and Nicodano (2007) explicitly distinguish the time-varying properties of indirect real estate in light of bonds and stocks. When allowing for linear predictability patterns in indirect real estate returns the optimal allocation should obtain a weight between 12% and 44%, depending on the risk tolerance, parameter uncertainty and investment horizon. On the other hand when optimizing returns in excess of liabilities, Hoevenaars et al. (2008) find that the role for indirect real estate in a liability driven investment portfolio is negligible.

This chapter extends the work of Chun et al. (2000), Craft (2001) and Booth (2002) by examining the fair value liability hedge qualities of real estate in light of other asset classes. We explicitly model liabilities as being subject to interest rate risk and summarize the assets' impact on the pensions fund's future funding surplus. Furthermore, we contrast optimal ALM portfolio allocations using various liability denominations to distinguish the impact accounting practices of liability valuation have on the portfolio composition. To do so, this study applies a liability framework as developed by Sharpe and Tint (1990), which arises from a traditional mean-variance optimization problem. More specifically, the objective function follows a standard asset-only optimization problem, while considering the change in pension liabilities and their covariance with assets. The latter, also referred to as the liability hedge credit, quantifies the utility due to assets correlation with a pension fund liabilities. This methodology further allows for a differential in emphasis attached to liabilities, the level of risk tolerance and the funding level of pension schemes. This enables us to determine how sensitive the results are to these factors, but more importantly it permits pension funds to tailor their portfolios to their particular nature and objectives.[3] And most notably, it allows institutional investors to quan-

[3]The analysis in principal departs from a DB pension scheme but would be also applicable to a DC scheme. The difference between a DB and DC scheme is who holds the investment risk, in a DB scheme it is the pension fund and a DC scheme the participant. The portfolio optimization involves a single-period surplus optimization that links investment opportunities and pension plan obligations, in the sense that we account for the funding level of funds in the calculation of the liability hedge credit (LHC). The LHC follows directly from the correlations of the asset return with the liability returns, current asset to liability ratio and the risk tolerance. These parameters can be adjusted to tailor the portfolio to the nature and objectives of the scheme. Important differences would be in a DC scheme the valuation is simply the market value of the assets held in the retirement account. The

tify the liability hedging utility of each asset class both in terms of the estimated fair value and in terms of actuarial changes. Finally, we model the portfolio trade-offs of long-term institutional investors who face inflation risk. Institutional investors like pension funds face inflation risk not solely for real income purposes but also to provide indexation to participants. We quantify the hedge ratio with respect to inflation and interest rate risk for various holding periods.

2.3 Methodology

To determine real estates' role as a reserve asset, asset which moves in tandem with liabilities, or a return-generating asset we apply a single-period surplus optimization investment framework of Sharpe and Tint (1990) that explicitly links investment opportunities and pension-plan obligations. The objective of the pension fund is to maximize surplus, defined as:

$$S_{t+1} = A_{t+1} - kL_{t+1}, \tag{2.1}$$

where A_{t+1} represents the value of the fund's assets at t+1, L_{t+1} the value of the relevant liability concept and k the attached importance to it. Choosing k=1 means that full importance is attached to the liabilities, k=0 corresponds to an asset-only optimization. Denoting the return on the asset portfolio by $R_{A,t+1}$ and the growth rate of the liabilities by $R_{L,t+1}$, the surplus can be written as:

$$S_{t+1} = A_t \left[(1 + R_{A,t+1}) - k\frac{L_t}{A_t}(1 + R_{L,t+1}) \right], \tag{2.2}$$

where $\frac{L_t}{A_t}$ denotes the fund's current inverse funding ratio. Maximizing the expected utility of S_{t+1} is equivalent to maximizing that of:

$$Z_{t+1} = R_{A,t+1} - k\left(\frac{L_t}{A_t}\right)(R_{L,t+1}) \tag{2.3}$$

Accordingly, Sharpe and Tint (1990) formulate the optimization problem of the pension fund as:

$$max \left[E_t(Z_{t+1}) - \frac{1}{\lambda} var_t(Z_{t+1}) \right], \tag{2.4}$$

actual size of the DC scheme will depend upon the realized investment performance of the retirement fund, the interest rate, inflation, and the ultimate wage path of the employee. In this case a DC scheme optimization will put weight on hedging the active (wage) liability, interest and inflation rate and adjust the optimization according to its funding level relative to its desired fund size and risk tolerance.

where λ denotes a fund's risk tolerance. If the portfolio weights to be chosen are denoted by *w*, we have $R_{A,t+1} = \sum_i w_i R_{i,t+1}$, where $R_{i,t+1}$ denotes the return on asset *i*.

Following Sharpe and Tint (1990) let us focus on the second term in (2.4), which can be written as:

$$var_t \left(R_{A,t+1} - k \frac{L_t}{A_t} R_{L,t+1} \right)$$

$$= var_t(R_{A,t+1}) + k^2 \frac{L_t^2}{A_t^2} var_t(R_{L,t+1}) - 2k \frac{L_t}{A_t} cov_t(R_{A,t+1} R_{L,t+1}) \tag{2.5}$$

The second term is irrelevant to the outcome of the maximization problem. The difference with the standard asset-only optimization problem is concentrated in the last term. It stresses that the assets' covariances with the growth rate of the liabilities are key for the optimal allocation. Sharpe and Tint (1990) define the liability hedge credit for any asset *i* as

$$LHC_i = \frac{2}{\lambda} k \frac{L_t}{A_t} cov_t(R_{i,t+1}, R_{L,t+1}), \tag{2.6}$$

while the LHC of the entire portfolio is simply

$$LHC_a = \sum_i w_i LHC_i \tag{2.7}$$

The total objective function follows a standard asset-only optimization problem, the expected surplus return minus a risk penalty, while considering the change in pension liabilities and their covariance with assets (LHC_a).

$$max\,[\mathrm{E}xpected\ Return - Risk\ Penalty + Liability\ Hedge\ Credit]$$

$$max \left[R_{A,t+1} - \frac{var_t(R_{A,t+1})}{\lambda} + LHC_a \right] \tag{2.8}$$

Other things being equal, an asset whose returns are highly correlated with liabilities provide better liability hedging and receive a greater liability hedging credit. This ultimately results in a higher weight in the ALM portfolio than under the traditional mean variance optimization. The optimal portfolio weights in an asset-liability context will be a combination of the global minimum variance portfolio in an asset-only case, with an asset-liability hedged portfolio.

Finally, we zoom into the risk associated with inflation and measure the extent to which the various asset classes provide appropriate payout structures for indexation policies. We also test whether the degree of inflation protection varies with the investment horizon. We regress the asset returns on expected and unexpected inflation and vary the horizons from 1 quarter to 10 years, resulting in the following equation:

$$\sum_{h=1}^{H} R_{t+H} = c_H + \beta_H E_t\left[\sum_{h=1}^{H}\pi_{t+H}\right] + \varphi_H\left(\sum_{h=1}^{H}\pi_{t+H} - E_t\left[\sum_{h=1}^{H}\pi_{t+H}\right]\right) + \sum_{h=1}^{H}\xi_{t+h} \quad (2.9)$$

This equation decomposes the H-period return into a constant, two parts related to expected and unexpected inflation and an unexpected return. The β measures the relation between expected inflation and the asset return. If $\beta = 1$ the Fisher hypothesis holds in that there is a one-to-one relation between expected nominal returns and expected inflation and expected real returns are constant.[4] The coefficient φ is the inflation sensitivity of the asset class with respect to inflation shocks.

Following, Schotman and Schweitzer (2000) and Brounen et al. (2007) we assume inflation follows an autoregressive process.

$$\pi_{t+1} = c + \alpha\pi_t + \eta_{t+1} \quad (2.10)$$

We use this to construct an empirical measure of the expected and unexpected inflation components in equation (2.9), estimating the unknown coefficients using a rolling window of 40 quarterly observations. In equation (2.10) α represents the inflation persistence and measures how fast inflation returns to its long term average in the advent of an inflation shock η_{t+1}. Subsequently, we use the AR(1) time series model to calculate the hedge ratio of Schotman and Schweitzer (2000), which quantifies the composition adjustment of the portfolio to reduce inflation risk in order to have the optimal inflation protection for various holding periods.

The hedge ratio for horizon H is a function of the estimated inflation persistence parameter α from (2.10), expected inflation hedge parameter β and unexpected inflation parameter ϕ from (2.9), and the variance of the error terms of both equations. The covariance matrix of asset returns and inflation changes with the investment horizon. As the hedge ratio quantifies the composition adjustment of the portfolio to reduce inflation risk, we can determine which asset class is capable of providing the appropriate payout structure to hedge interest rate risk and aid in providing indexation also for longer holding periods.

[4]Note we do not assume the Fisher effect applies to all assets similarly in describing the link between real and nominal returns.

2.4 Data Description

Our study employs data from the United States, as for this country broad data coverage on both transaction based property indices and property share indices are available. The analysis of the asset returns is based on the 1984 to 2008 (Q2) period, taking quarterly observations. We choose an investment feasibility set in accordance with previous papers of Chun et al. (2000) and Craft (2001), Craft (2005*a*). The inclusion of additional asset classes will trouble the results making inferences concerning the contribution of real estate in an ALM portfolio difficult to ascertain. Furthermore the objective is not to establish the optimal allocation but to asses the interplay between the various definitions of liabilities, the weights attached to liabilities, levels of risk tolerance and funding levels of pension schemes on portfolio allocations.

Data on stock returns were taken from Datastream Advance. Stock returns are approximated by the returns on the MSCI US index. Indirect real estate returns are based on Global Property Research (GPR) General National index. Direct real estate returns are from the MIT TBI series. MIT TBI is based on actual transaction prices of properties in the NCREIF database using advanced econometrics techniques to correct for sample selection bias and noise filtering. In comparison to the appraisal-based NCREIF Property Index, the MIT TBI index does not suffer from appraisal biases and has slightly higher volatility, less autocorrelation, and 1 to 3 years lead in major peaks and troughs (Fisher and Pollakowski (2007)). This chapter is the first to include the MIT transaction index in an optimization problem in an ALM setting. The 20-year treasury bond and the Moody's Seasoned Aaa corporate bond are in the asset mix (duration matched portfolio) while the 10 year constant maturity bond is used in the calculation of nominal pension liabilities. Both the 10-year constant maturity and Moody's Seasoned Aaa Corporate bond yields, are from the US Federal Reserve Bank website.[5] Moody's Seasoned Aaa Corporate Bond Yield are averages of daily data within a given quarter. The 20-year Treasury bond is based on an index from Lehman Brothers.

Table 2.1 presents a summary of the performance of the asset categories that are considered in our study. The mean returns and standard deviations are computed for the 1984-2008 sample period. We document the highest return for indirect real estate, while direct real estate appears to have outperformed stocks and indirect real estate in terms of the risk adjusted performance of the asset class. The Sharpe ratio of direct real estate, calculated as annualized excess return divided by the annualized standard deviation of returns, is 0.52 versus 0.42 for

[5] http://research.stlouisfed.org/

stocks and 0.40 for indirect real estate.

We further combine the two fixed income securities, the 20-year treasury bond and the Moody's Seasoned Aaa corporate bond, to establish a duration matched portfolio similar to those of the pension liabilities for the ALM portfolio. This is done to control for the influence of duration mismatches on the portfolio composition. The duration of the fixed income assets is calculated as:

$$D_{n,t} = \frac{1-(1+Y_{n,t})^{n}}{1-(1+Y_{n,t})^{-1}} \tag{2.11}$$

where, $Y_{n,t}$ is the log annualized yield of a n-year maturity bond at time t. The average duration is 12.09 years for the 20 year Treasury bond and 5.67 years for the Moody's Seasoned Aaa Corporate bond. To obtain the fraction weight *(w)* of each fixed income security in the duration hedged portfolio we solve the following equation:

$$D_{L,t} = w * D_{20,t} + (1-w) * D_{7,t}, \tag{2.12}$$

$$w = \frac{D_{20,t} - D_{7,t}}{D_{L,t} - D_{7,t}} \tag{2.13}$$

where D_L equals the duration of the pension liability, set equal to the average duration of pension liabilities, 17 years. $D_{20,t}$ is the duration of the first fixed income security per quarter, the 20-year treasury bond and similarly $D_{7,t}$ is the duration of the Corporate bond.

A crucial step in determining optimal portfolios for pension funds is the definition of the liability. Each definition of the liability conceivably can result in different portfolio allocations. Subsequently this chapter differentiates itself from previous studies as Chun et al. (2000) and Craft (2001), Craft (2005*a*) by the way in which we define the return on liabilities. These previous studies measure the returns on liabilities using the value of projected pension benefit obligations (PBOs) of corporate-sponsored defined benefit pension plans. Projected benefit obligations represent actuarial present value of all benefits earned by employees to the annual reporting date, plus projected benefits attributable to future salary increases as determined by each company's benefit formula. To compare the effect of changing accounting practices of the pension liabilities on allocations we model the market value of liabilities and proxy the actuarial changes using the changes related to the value of projected pension obligations (PBOs), the latter in accordance with Chun et al. (2000) and Craft (2001), Craft (2005*a*). We obtain the annual PBOs from Compustat. We construct a panel of pension liabilities using firms reporting over the entire available study period (1988-2007).[6] Our study includes 471 firm plans.

[6]By 1988 firms were required by the Financial Accounting Standards Board (FASB) to report PBO annually.

Table 2.1
Sample Statistics

Mean returns and standard deviations are annualized continuously compounded quarterly total returns related to the sample period of 1984-2008. The mean returns are also displayed in excess of the 3-month T-bill. Stock returns are based on the U.S. MSCI index, direct real estate returns are from the NAREIT series and indirect real estate returns are based on the MIT TBI index. Moody's Seasoned Aaa Corporate Bond (Duration 7 years) and the 3-month T-bill were obtained from the US Federal Reserve Bank website. The 20-year Treasury bond is based on an index from Lehman Brothers. The duration matched portfolio is constructed using the two fixed income classes to match the duration of the Fair value of real pension liabilities. Panel D exhibits the correlation matrix of the asset classes. MSCI=Morgan Stanley Capital International; GPR=Global Property Research; MIT TBI=Massachusetts Institute of Technology Transaction-Based Index.

Panel A: Annualized Return	Return	Excess Return	σ	Sharpe ratio
Stock (MSCI)	11.27%	6.53%	15.43%	0.42
Real Estate Stock (GPR)	11.56%	6.82%	16.94%	0.4
Direct Real Estate (MIT TBI)	8.59%	3.86%	7.38%	0.52
20-Year Treasury Bond	9.37%	4.63%	12.66%	0.37
Moody's Aaa Corporate Bond Yield	8.70%	3.96%	4.65%	0.85

	Subperiod (1984-1994)		*Subperiod (1995-2007)*	
Panel B: Annualized Return Sub periods	Return	σ	Return	σ
Stock (MSCI)	12.99%	15.37%	9.90%	15.60%
Real Estate Stock (GPR)	11.48%	20.20%	11.62%	14.03%
Direct Real Estate (MIT TBI)	4.16%	7.44%	12.12%	6.90%
20-Year Treasury Bond	10.40%	13.62%	8.55%	11.95%
Moody's Aaa Corporate Bond Yield	10.43%	5.39%	7.32%	3.87%

Panel C: Descriptive Statistics Bonds	YTM	Return	Excess return
20-Year Treasury Bond	6.35%	9.37%	4.63%
Moody's Aaa Corporate Bond Yield	7.73%	8.70%	3.96%
Duration matched portfolio		8.56%	3.87%

Panel D: Correlation Asset Returns	Direct Real Estate (MIT TBI)	Stock (MSCI)	Real Estate Stock (GPR)	20-Year Treasury Bond
Direct Real Estate (MIT TBI)	1			
Stock (MSCI)	-0.13	1		
Real Estate Stock (GPR)	0.01	0.55	1	
20-Year Treasury Bond	0.01	-0.13	0.08	1
Moody's Aaa Corporate Bond Yield	-0.03	-0.16	-0.11	0.12

The actuarial change is approximated by the equally weighted annual rate of change of this sample. The mean annual rate of change in pension liabilities was 9.88% and the standard deviation 6.22%, close to those reported by Craft (2001).

For the analysis of the fair value of liability changes we assume that the returns on liabilities follow the returns of the long-term constant maturity bond, estimated over the 1984 to 2008 period. A general assumption in pension studies as Nijman and Swinkels (2003), Hoevenaars et al. (2008) and Binsbergen and Brandt (2005).

Before the introduction of the Pension Protection Act, liabilities were valued using actuarial principles and the present value of liabilities was determined by discounting future these future contributions at a fixed or smoothed historical discount rate (r).

$$V_t^{actuarial} = \sum_n CF_{t+n} * (1+r)^{-n} \tag{2.14}$$

The Pension Protection Act requires a market-based valuation of liabilities. Valuation of the fair value of liabilities comes down to discounting nominal fixed payments using the market rates R_t^m, typically market yields of fixed income securities.[7]

$$V_t^{market} = \sum_n CF_{t+n} * (1+R_t^m)^{-n}$$

If longevity risk is ignored, the cash flows of the portfolio of nominal pension liabilities equal those of a portfolio of bonds. Further assuming a pension fund is in stationary state the distribution of the age cohorts and pension rights are constant over time, we can describe its liabilities as a constant maturity bond. The fair value of liabilities is solely influenced by changes in interest rates. The liability return is derived as a function of the log yield of the constant maturity bond, assuming duration of 17 years, the average duration of pension liabilities.

$$(1+r_{n,t+1}) = D_{n,t}(1+Y_{n,t}) - (D_{n,t} - \frac{1}{4})(1+Y_{n-1,t+1} = \frac{1}{4}Y_{n-1,t+1} - (D_{n,t}(Y_{n-1,t+1} - Y_{n,t})) \tag{2.15}$$

where, $Y_{n,t}$ is the log annualized yield of a n-year maturity bond at time t. We further approximate $Y_{n-1,t+1}$ by $Y_{n,t+1}$, a common assumption also made by Hoevenaars et al. (2008).

[7]The new funding rules under the 2006 Pension protection Act, requires that discount rates are based on the high quality corporate bond yield curve. Transition measures have been introduced for 2006 and 2007, but since January 1st 2008, pension benefits are discounting liabilities using a corporate bond yield curve.

The mean annual rate of change in the fair value of pension liabilities was 14.67% and the standard deviation is significantly higher namely 15.27%. Fair valuation thus imposes larger variability and with this higher risk.

The main difference relates to the choice of discount rates used to calculate the present value of accrued benefits. If pension funds apply a higher discount rate, their liabilities will be underestimated, especially in a low interest rate environment. Furthermore, a fixed rate smoothes pension obligations while mark-to-market valuation induces considerable interest rate risk, which could conceivably lead to different ALM portfolios.

Subsequently, we also define pension liabilities to include active liabilities. Active liabilities are salary linked liabilities, the relationship between salary linked liabilities and asset returns will determine the attractiveness of the various asset classes in a young versus mature pension fund portfolio. For the calculation of active liabilities we include wage increases in addition to the nominal liability returns. The data on wage growth was obtained using the U.S. national average wage index.[8]

Finally, pension funds are long term investors who face inflation risk. Pension funds face inflation risk not solely for real income purposes but also to provide indexation to participants. Several papers indicate an important horizon effect in hedging inflation risk. In the short run, many empirical studies observe a negative relation between inflation and stocks returns[9], while in the long run Schotman and Schweitzer (2000) show that stocks can be a hedge against inflation depending on the investment horizon.[10] We therefore study the hedging potential against nominal liability returns and inflation for different investment horizons. This way, we determine which asset class is capable of providing the appropriate payout structure to hedge interest rate risk and aid in providing indexation also for longer holding periods.

The difference between an actuarial ALM and an ALM at fair value lies mostly in differences between actuarial changes (mortality, longevity, projected salary increases), interest and inflation. Active liabilities further stress the importance of hedging wage developments. Other things being equal, an asset whose returns are highly correlated with developments in mortality, longevity (or wages) provide better liability hedging in an actuarial ALM (active ALM) than an asset class that hedges interest rate and inflation shocks. By allowing for vari-

[8] http//www.ssa.gov

[9] See for example, Fisher (1930), Bodie (1976), Fama (1975), Fama (1981), Fama (1990), Fama and Schwert (1977), Geske (1983), James (1985) and Lee (1992) who find stocks to be a poor inflation hedge.

[10] Similarly, Brounen et al. (2007) find that the hedging capability of housing increases with extending investment horizons.

ous definitions of liabilities we can establish the role of each asset class within various ALM portfolios.

2.5 Asset-only Optimization

Mean-variance methodology ensures a portfolio selection that embodies diversification between assets and identifies the efficient set of portfolios that maximize expected return while minimizing the variance of the expected returns. Risk reduction is a function of low or negative correlation coefficients between asset classes. Table 2.1, panel D, presents a correlation matrix between the returns on stocks, long-term Treasury bonds, corporate bonds and direct and indirect real estate. Direct real estate returns appear to be negatively correlated to stocks and corporate bonds and positively correlated with treasury bonds. Real estate stocks in contrast do not appear to be highly correlated with direct real estate investments, but more with common stocks. In the context of portfolio diversification direct real estate offers greater risk diversification benefits. The low covariance of direct real estate with stocks and bonds should greatly reduce portfolio risk.

Table 2.2
Asset-Only Allocation

Portfolios were derived using historical return and risk characteristics (1984-2008). The fixed income assets consist of a 20-year Treasury maturity bond (effective duration 10 years) and Moody's Seasoned Aaa Corporate bond (effective duration 7 years). The tangency portfolio represents the optimal Sharpe portfolio that optimizes the mean excess return divided by the standard deviation of returns. Panel B reports portfolio compositions for five portfolios along the efficient frontier.

Mean-Variance Efficient Portfolios (Asset-Only)							
	Minimum Variance	Sharpe Optimal	1	2	3	4	5
μ	8.98%	9.07%	9.28%	9.41%	9.51%	9.61%	9.70%
σ	3.43%	3.47%	3.81%	4.16%	4.51%	4.85%	5.20%
Portfolio Weights							
Direct Real Estate	24.99%	23.38%	19.71%	17.56%	15.60%	14.13%	12.62%
Stock	9.51%	11.10%	14.73%	16.87%	18.62%	20.24%	21.71%
Real Estate Stock	0.68%	2.26%	5.83%	7.97%	9.74%	11.30%	12.78%
Fixed Income	64.82%	63.26%	59.73%	57.60%	56.04%	54.33%	52.88%
Total Real Estate	25.67%	25.63%	25.54%	25.52%	25.34%	25.43%	25.41%

The efficient set of portfolios that maximize expected return for a given level of risk are constructed under the standard mean-variance analysis. We impose short-selling constraints on all assets and portfolios must be fully invested. Table 2.2 reports portfolio compositions for seven portfolios on the efficient frontier, beginning with the minimum variance portfolio (MVP), the tangency portfolio and ending up at the high risk range of the efficient frontier.

In the selection of portfolios based on means and variances of returns the role for direct real estate, as a risk diversifier in a portfolio, is substantial. The low correlation of direct real estate with bonds and stocks in combination with the low standard deviation of returns results in high allocations to this asset class in the low-risk range of the efficient frontier. The mean-variance model, on the basis of transaction based real estate returns, estimates allocations to direct real estate of 24.99%. At the higher risk tolerance levels indirect property investments substitute the direct counterpart. The absence of indirect real estate in the low risk portfolios can be explained by the high standard deviation of the asset class and the high correlation with stocks, while direct real estate offers superior risk-adjusted returns next to risk diversification properties. The efficient real estate allocation is relatively stable around 25%. The results are in line with those of Ziering and McIntosh (1997), Ziobrowski and Ziobrowski (1997), Kallberg et al. (1996), and Mueller and Mueller (2003), who use the NCREIF index while accounting for the added smoothing risk and still find an optimal real estate allocation of 20%-30%. On the basis of a mean-variance asset-only optimization direct real estate warrants inclusion in a mixed-asset portfolio because of its attractive risk-reward properties and its low correlation with stocks and bonds.

2.6 The Liability Hedge Potential

An asset-liability model (ALM) is a model of the assets and liabilities that facilitates decision-making with respect to asset allocation and the properties of the liabilities. An important distinguishing feature is the interdependence between assets and liabilities. Table 2.3 presents the contemporaneous correlations between the different liability specifications and asset returns for the asset classes considered in this analysis.

Table 2.3

Correlation of asset returns with pension liabilities

Table 2.3 displays the correlation coefficients of the asset returns with liabilities, both actuarial and the fair value of liabilities. We proxy the actuarial changes using the changes related to the value of projected pension obligations (PBOs). For the analysis of the fair value of liability changes we assume that the return on liabilities follows the return of the long-term constant maturity bond, estimated over the 1984 to 2008 period. The fair value of liabilities is solely influenced by changes in interest rates. The liability return is derived as a function of the log yield of the constant maturity bond, assuming duration of 17 years, the average duration of pension liabilities. For the definition of active liabilities we partition from wage, the data on wage growth was obtained using the national average wage index: http//www.ssa.gov. MSCI=Morgan Stanley Capital International; GPR=Global Property Research; MIT TBI=Massachusetts Institute of Technology Transaction-Based Index.

	Direct RE (MIT TBI)	Stock (MSCI)	Real Estate Stock (GPR)	20-Year Treasury Bond	Moody's Aaa Corporate Bond	Duration Matched Portfolio	Liability Actuarial	Nominal Liability (MV)
Direct Real Estate (MIT TBI)	1							
Stock (MSCI)	-0.13	1						
Real Estate Stock (GPR)	0.01	0.55	1					
20-Year Treasury Bond	0.01	-0.13	0.08	1				
Moody's Aaa Corporate Bond	-0.03	-0.16	-0.11	0.12	1			
Duration matched portfolio	-0.04	-0.21	0.02	0.92	0.37	1		
Liability Actuarial	0.16	0.16	0.18	0.57	0.68	0.03	1	
Nominal Liability (MV)	0.07	-0.03	0.12	0.33	0.85	0.78	0.7	1
Active Liability (MV)	0.14	0.43	-0.09	-0.13	-0.07	-0.16	0.15	-0.06

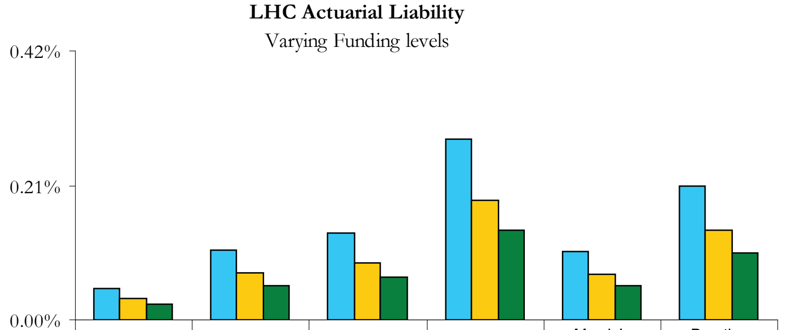
For all the asset classes we document positive correlations compared to the actuarial definition of liabilities. This is most pronounced for the fixed income securities. Interestingly, direct real estate appears to have the lowest correlation with actuarial changes, while indirect real estate proves a better hedge in that respect. For indirect real estate we document positive correlations compared to the actuarial definition of liabilities in line with Chun et al. (2004). Once we define liabilities as active or salary linked liabilities hedging potential of indirect real estate is lost. In effect direct real estate, bonds and stocks appear to be positively correlated with wage increases. With equities correlating the most with wage changes. Once we account for interest rate risk the correlation coefficients is positive for direct real estate, indirect real estate and the fixed income securities. Though the magnitude of the correlation is quite small indirect real estate in particular appears to offer hedging benefits against contemporaneous interest rate risk, especially in comparison to stocks.

In terms of the liability utility to be derived, the liability hedge credit (LHC) follows directly from the correlations of the asset return with the liability returns, current assets to liability ratio and the risk tolerance.

$$LHC_i = \frac{2}{\lambda} k \frac{L_t}{A_t} cov_t(R_{i,t+1}, R_{L,t+1})$$

The liability hedge credit is positively related to the covariance between an asset and liabilities and to the inverse of the current funding ratio (L_t/A_t), while inversely related to the risk tolerance (λ). The LHC as specified under actuarial change is positive for direct real estate, ranging from 0.03% in the full surplus optimization scenario for fully funded funds with a typical risk tolerance (λ=5) to 0.05% for underfunded funds (L/A=1.5) under similar constraints (Figure 2.1). Once we define liabilities as active liabilities, indirect real estate obtains a lower hedge credit, as the correlation with respect to wage developments is negative (Figure 2.2). For direct real estate the liability hedging credit is slightly more pronounced due to positive correlation with interest between salary linked liabilities and direct real estate.

Once we account for interest rate risk as under the fair value of liability, the hedging utility becomes slightly stronger for indirect real estate, 0.16% for a fully funded fund, see Figure 2.3. Direct real estate provides significantly less hedging benefits for interest rate shock as its liability hedge credit is close to zero. For nominal liabilities we are also able to establish long horizon correlations and liability hedging potential, as we have a long data span. Over longer holding periods direct and indirect real estate turn out to be perverse hedges for interest rate changes. The liability hedge credit decreases from 0.04% (1 Quarter) to -0.38% for direct real estate for a holding period of 10 years. Similarly for real estate stocks, while at first the liability hedge credit increases over a 1 year holding period to 0.36%, this decreases for longer holding periods. In sharp contrast stocks and bonds prove to be a better interest rate hedge over longer horizons.



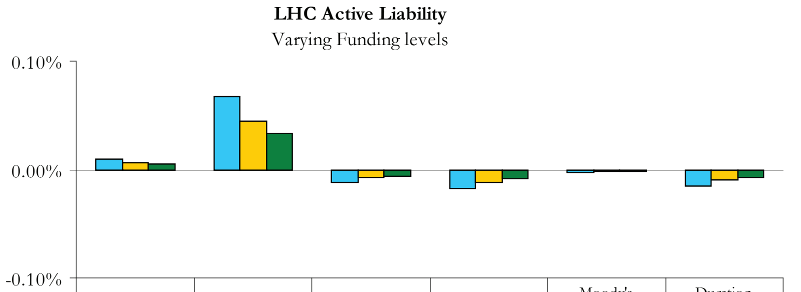
	Direct Real Estate (MIT TBI)	Stock (MSCI)	Real Estate Stock (GPR)	20-Year Treasury Bond	Moody's Seasoned Aaa Corporate Bond	Duration matched fixed income
L/A=1.5 k=1 λ=5	0.0487%	0.1085%	0.1346%	0.2812%	0.1062%	0.2094%
L/A=1 k=1 λ=5	0.0325%	0.0723%	0.0897%	0.1875%	0.0708%	0.1396%
L/A=0.75 k=1 λ=5	0.0244%	0.0542%	0.0673%	0.1406%	0.0531%	0.1047%

L/A=1.5 k=1 λ=5 L/A=1 k=1 λ=5 L/A=0.75 k=1 λ=5

Figure 2.1
Actuarial liability hedge credit (LHC) per asset class

The liability hedge credit (LHC) quantifies the annualized utility that investors with liabilities can derive from different asset classes. LHC is positively related to the covariance of an asset and the liability and to the current assets to current liabilities (L_0/A_0), while inversely related to the risk tolerance (λ). LHC further depends on the weight of importance attached to it (k), full consideration of liabilities (k=1) yields similar results as surplus optimization, while no consideration (k=0) provides the same results as an asset-only methodology. The following graphs depict LHC's for the actuarial value of liabilities. We proxy the actuarial changes using the changes related to the value of projected pension obligations (PBOs).MSCI=Morgan Stanley Capital International; GPR=Global Property Research; MIT TBI=Massachusetts Institute of Technology Transaction-Based Index.

Overall, we have seen that the definition of liabilities mildly influences the liability hedging return to be derived of the various asset classes. Direct and indirect real estate provide poor hedging utility with respect to nominal liabilities, especially for longer holding periods. In the next section we will advance from the hedging characteristics to the implications for an ALM portfolio and determine how the definition of liabilities influences portfolio allocations.



	Direct Real Estate (MIT TBI)	Stock (MSCI)	Real Estate Stock (GPR)	20-Year Treasury Bond	Moody's Seasoned Aaa Corporate Bond	Duration matched fixed income
L/A=1.5 k=1 λ=5	0.0101%	0.0670%	-0.0114%	-0.0176%	-0.0029%	-0.0150%
L/A=1 k=1 λ=5	0.0067%	0.0446%	-0.0076%	-0.0118%	-0.0019%	-0.0100%
L/A=0.75 k=1 λ=5	0.0051%	0.0335%	-0.0057%	-0.0088%	-0.0014%	-0.0075%

L/A=1.5 k=1 λ=5 L/A=1 k=1 λ=5 L/A=0.75 k=1 λ=5

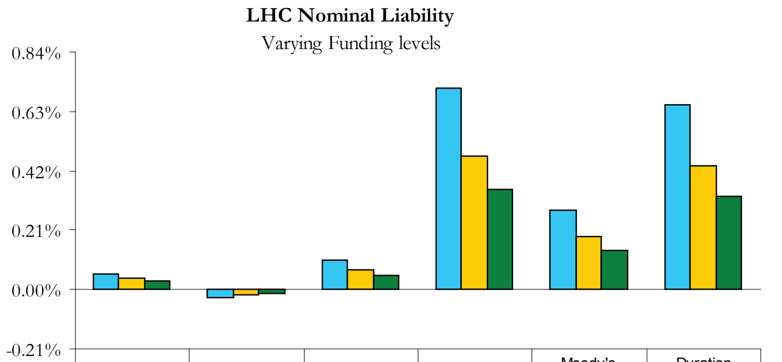
Figure 2.2
Active Liability Hedge Credit (LHC) per asset class
The liability hedge credit (LHC) quantifies the annualized utility that investors with liabilities can derive from different asset classes. LHC is positively related to the covariance of an asset and the liability and to the current assets to current liabilities (L_0/A_0), while inversely related to the risk tolerance (λ). LHC further depends on the weight of importance attached to it (k), full consideration of liabilities (k=1) yields similar results as surplus optimization, while no consideration (k=0) provides the same results as an asset-only methodology. The following graphs depict LHC's for active liabilities. We compute the return of active liabilities by adding wage increases to the real liability returns, the data on wage growth was obtained using the national average wage index: http//www.ssa.gov. MSCI=Morgan Stanley Capital International; GPR=Global Property Research; MIT TBI=Massachusetts Institute of Technology Transaction-Based Index.

Subsequently, we look at the inflation hedging characteristics of the asset classes and calculate hedge ratios.

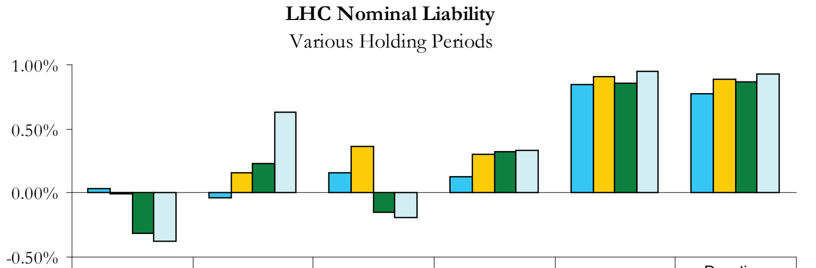
2.7 ALM Portfolio Optimization

Within the mean-variance asset-only framework real estate plays an important role as a diversifying asset class. Mean-variance efficient portfolios tend to contain a high level of direct real estate and a higher portion of indirect real estate at higher risk levels. Within an ALM portfolio, the portfolio composition differs depending on the definition of the liability return. Table

2.4 shows that when liability returns solely follow actuarial changes the mean variance efficient portfolio allocations shift towards fixed income securities, as compared to the asset-only optimization. The actuarial liability hedge credit of the fixed income securities overshadows real estate and stocks and as such the allocation towards the asset classes decreases in an actuarial ALM setting. When following the active definition of liabilities the allocation towards stocks and real estate stocks increases with respect to the asset-only portfolio. Once accounting for wage developments return generating asset classes like stocks and indirect real estate benefit. For short holding periods the allocations for direct real estate increases when accounting for interest rate changes. As compared to the actuarial ALM optimization the allocations are higher for direct real estate. The change in accounting practice influences the optimal portfolio allocation and makes direct real estate more attractive when comparing to an asset-only scenario. Nonetheless, when allowing for longer holding periods direct real estate allocation decreases considerably as can be seen in Table 2.5. For long holding periods indirect real estate prevails, especially in the riskier portfolios.



	Direct Real Estate (MIT TBI)	Stock (MSCI)	Real Estate Stock (GPR)	20-Year Treasury Bond	Moody's Seasoned Aaa Corporate Bond	Duration matched fixed income
L/A=1.5 k=1 λ=5	0.06%	-0.03%	0.10%	0.71%	0.28%	0.66%
L/A=1 k=1 λ=5	0.04%	-0.02%	0.07%	0.47%	0.19%	0.44%
L/A=0.75 k=1 λ=5	0.03%	-0.01%	0.05%	0.36%	0.14%	0.33%



	Direct Real Estate (MIT)	Stocks (MSCI)	Indirect Real Estate (GPR)	Corporate Aaa bond	Treasury bond	Duration Matched Portfolio
1 Quarter	0.04%	-0.04%	0.16%	0.13%	0.84%	0.78%
1 Year	0.00%	0.16%	0.36%	0.30%	0.90%	0.89%
5 Year	-0.31%	0.23%	-0.15%	0.32%	0.86%	0.87%
10 Year	-0.38%	0.63%	-0.20%	0.33%	0.95%	0.93%

Figure 2.3
Nominal Liability Hedge Credit (LHC) per asset class

The liability hedge credit (LHC) quantifies the annualized utility that investors with liabilities can derive from different asset classes. The following graphs depict LHC's for nominal liabilities for various pension characteristics and holding periods. For the analysis of the fair value of liability changes we assume that the return on liabilities follows the return of the long-term constant maturity bond, estimated over the 1984 to 2008 period. The fair value of liabilities is influenced by interest rate changes.

Table 2.4
Actuarial versus fair value asset liability management (ALM) allocations

Table 2.4 displays the optimal portfolio allocations for both the asset-only as the ALM model. Portfolios were derived using historical return and risk characteristics (1984-2008). Furthermore, we use different classifications of the liability return, both actuarial and the fair value of liabilities. We proxy the actuarial changes using the changes related to the value of projected pension obligations. For the analysis of the fair value of liability changes, we assume that the return on liabilities follows the return of the long-term constant maturity bond, estimated over the 1984 to 2008 period. The fair value of liabilities is solely influenced by changes in interest rates. The liability return is derived as a function of the log yield of the constant maturity bond, assuming duration of 17 years, the average duration of pension liabilities. For the definition of active liabilities, we partition from wage increases, the data on wage growth were obtained using the national average wage index (http//www.ssa.gov). The fixed income portfolio includes a Moody's Seasoned Aaa Corporate Bond, a 20-year Treasury bond and a duration-matched portfolio. The duration-matched portfolio was constructed using two fixed income asset classes to match the duration of the fair value of pension liabilities. MSCI=Morgan Stanley Capital International; GPR=Global Property Research; MIT TBI=Massachusetts Institute of Technology Transaction-Based Index.

	Portfolios						
	MV	Sharpe Ratio	1	2	3	4	5
Er	8.98%	9.07%	9.28%	9.41%	9.51%	9.61%	9.70%
Stdev	3.43%	3.47%	3.81%	4.16%	4.51%	4.85%	5.20%
Asset-Only							
Direct RE (MIT TBI)	24.99%	23.38%	19.71%	17.56%	15.60%	14.13%	12.62%
Stock (MSCI)	9.51%	11.10%	14.73%	16.87%	18.62%	20.24%	21.71%
RE Stock (GPR)	0.68%	2.26%	5.83%	7.97%	9.74%	11.30%	12.78%
Fixed Income	64.82%	63.26%	59.73%	57.60%	56.04%	54.33%	52.88%
ALM ($L/A = 1 k = 1 \lambda = 5$)							

Continued on next page

Table 2.4 – continued from previous page

	Portfolios							Changes in Allocations			
	MV	Sharpe Ratio	1	2	3	4	5	Δ wrt Asset Only	Δ wrt Actuarial Liability	Δ wrt Nominal Liability	Δ wrt Real Liability
Actuarial Liability											
Direct RE (MIT TBI)	25.22%	23.54%	19.22%	16.89%	14.88%	13.15%	11.46%	-			
Stock (MSCI)	10.01%	11.27%	14.68%	16.82%	18.52%	20.07%	21.54%	-			
RE Stock (GPR)	0.40%	2.18%	5.69%	7.74%	9.53%	11.10%	12.51%	-			
Fixed Income	64.38%	63.00%	60.40%	58.56%	57.07%	55.68%	54.48%	+			
MV Nominal Liability											
Direct RE (MIT TBI)	23.69%	21.94%	20.51%	19.45%	18.47%	17.73%	16.92%	+	+		
Stock (MSCI)	9.68%	12.37%	14.57%	16.21%	17.59%	18.87%	20.05%	-	-		
RE Stock (GPR)	0.95%	0.92%	0.90%	0.88%	0.90%	0.87%	0.85%	-	-		
Fixed Income	65.68%	64.77%	64.01%	63.46%	63.04%	62.53%	62.18%	+	+		
MV Active Liability											
Direct RE (MIT TBI)	25.23%	23.04%	21.65%	20.18%	19.12%	18.21%	17.09%	+	-	+	+
Stock (MSCI)	10.01%	12.70%	14.42%	16.04%	17.53%	18.84%	20.01%	-	+	-	+
RE Stock (GPR)	0.40%	0.52%	0.52%	0.65%	0.59%	0.63%	0.69%	-	+	-	+
Fixed Income	64.37%	63.75%	63.41%	63.13%	62.77%	62.32%	62.21%	+	-	-	-

Table 2.5

Long horizon Portfolio Allocations (Nominal Liabilities)

Table 2.5 displays the optimal portfolio allocations for both the minimum variance and tangency portfolio for a nominal ALM model. The tangency portfolio represents the optimal Sharpe portfolio that optimizes the mean excess return divided by the standard deviation of returns. Portfolios were derived using rolling window regressions. MSCI=Morgan Stanley Capital International; GPR=Global Property Research; MIT TBI=Massachusetts Institute of Technology Transaction-Based Index.

Long horizon Portfolio Allocation			
Holding Period	1 Quarter	5 Year	10 Year
Portfolio Composition Minimum Variance (Nominal Liabilities)			
Direct Real Estate (MIT TBI)	23.69%	23.86%	12.14%
Stock (MSCI)	9.68%	0.59%	0.00%
Real Estate Stock (GPR)	0.95%	0.00%	0.00%
Fixed Income	65.68%	75.55%	87.86%

Portfolio Composition Tangency (Nominal Liabilities)			
Holding Period	1 Quarter	5 Year	10 Year
Direct Real Estate (MIT TBI)	21.94%	21.53%	0.00%
Stock (MSCI)	12.37%	0.04%	0.00%
Real Estate Stock (GPR)	0.92%	0.00%	14.24%
Fixed Income	64.77%	78.43%	85.76%

The attractiveness of real estate as an asset class is also dependent on the particular disposition of the pension fund (See table 2.6). As funding ratios improve or the importance attached to liabilities deteriorate, direct real estate obtains a higher portfolio allocation. Direct real estate materializes in an asset-liability portfolio as a relatively safe asset class of particular utility to fully or over funded pension funds. In line with Chun et al. (2000) and Craft (2005*a*),Craft (2005*b*) overfunded funds are much more likely to hold public real estate than underfunded counterparts. The optimal portfolio allocations for real estate, both direct and indirect, lingers around 20% to 25%, which result in an expected return utility of around 9%, depending on the level of risk tolerance and funding ratio of the pension fund. Though the hedging utility of real estate relatively to fixed income securities is limited the return enhancement and diversification properties of direct and indirect real estate investments ensure an allocation in an ALM portfolio, real estate can increase returns more sharply than it increases surplus risk. Direct and indirect real estate warrants inclusion in a mixed-asset portfolio because of its attractive risk-reward properties, its diversification potential with stocks and bonds, and to a lesser extent to its interest hedging abilities.

Table 2.6
Sensitivity analysis asset liability management (ALM) allocations

Portfolios were derived using historical return and risk characteristics (1984-2008). The tangency portfolio represents the optimal Sharpe portfolio that optimizes the mean excess return divided by the standard deviation of returns. Portfolio compositions for five portfolios along the efficient frontier are also given. Portfolio weights are determined by maximizing the objective function given the standard deviation of the asset-only portfolios. The ALM portfolio parameters are the inverse funding level, the current liability to current asset level (L_0/A_0), risk tolerance (λ) and the weight of importance attached to liabilities (k), full consideration of liabilities (k=1) yields similar results as surplus optimization, while no consideration (k=0) provides the same results as an asset-only methodology. For the analysis of the fair value of liability changes we use nominal liabilities as adjusted for interest rate risk. MSCI=Morgan Stanley Capital International; GPR=Global Property Research; MIT TBI=Massachusetts Institute of Technology Transaction-Based Index.

			Portfolio Weights				
Portfolios	Er	Std. Dev.	Direct Real Estate (MIT TBI)	Stock (MSCI)	Real Estate Stock (GPR)	Fixed Income	Total Real Estate
ALM Allocations (Nominal Liabilities)							
$L/A = 1.5\ k = 1\ \lambda = 5$							
1	9.20%	3.43%	22.09%	11.62%	2.84%	63.45%	24.93%
2	9.20%	3.43%	22.09%	11.62%	2.84%	63.45%	24.93%
3	9.47%	3.81%	18.52%	13.64%	5.46%	62.38%	23.98%
4	9.62%	4.16%	15.84%	15.30%	7.36%	61.50%	23.20%
5	9.73%	4.51%	13.54%	16.66%	8.88%	60.92%	22.42%
$L/A = 1\ k = 1\ \lambda = 5$							
1	9.72%	3.43%	23.43%	11.68%	0.61%	64.29%	24.03%
2	9.10%	3.47%	23.02%	12.11%	0.61%	64.26%	23.64%
3	10.27%	3.81%	20.97%	14.38%	0.54%	64.10%	21.51%
4	10.57%	4.16%	19.53%	15.89%	0.55%	64.02%	20.09%
5	10.82%	4.51%	18.38%	17.15%	0.58%	63.90%	18.95%
$L/A = 0.5\ k = 0.5\ \lambda = 5$							
1	9.06%	3.43%	22.80%	11.92%	2.76%	62.52%	25.56%
2	9.09%	3.47%	22.41%	12.33%	3.27%	61.98%	25.69%
3	9.30%	3.81%	19.46%	14.66%	6.01%	59.87%	25.47%
4	9.42%	4.16%	17.08%	16.72%	8.17%	58.03%	25.25%
5	9.52%	4.51%	15.17%	18.39%	9.98%	56.46%	25.15%
$L/A = 0.5\ k = 0.5\ \lambda = 10$							
1	9.10%	3.47%	22.42%	12.32%	3.27%	61.99%	25.69%
2	9.10%	3.47%	22.42%	12.32%	3.27%	61.99%	25.69%
3	9.31%	3.81%	19.46%	14.66%	6.01%	59.87%	25.47%
4	9.44%	4.16%	17.08%	16.72%	8.17%	58.03%	25.25%
5	9.54%	4.51%	15.18%	18.38%	9.99%	56.45%	25.17%

2.8 Inflation Hedge

Institutional investors like pension funds also face inflation risk not solely for real income purposes but also to provide indexation to participants. As many studies have already documented the existence of a horizon effect for inflation hedging characteristics of asset classes, we use long horizon regression and calculate hedge ratios.[11] Inflation is separated in an expected and unexpected component. We assume that inflation expectation follows an AR(1) process. The coefficients are estimated using rolling regressions using 10 years of history (40 quarters). For various holding periods we calculate hedge ratios against inflation, which follow from the degree of inflation persistence. The hedge ratio quantifies the composition adjustment of the portfolio to reduce inflation risk. This way, we determine which asset class is capable of providing the appropriate payout structure to hedge interest rate risk and aid in providing indexation also for longer holding periods.

Table 2.7 presents the long run inflation hedge potential of the various asset classes. Firstly, the results indicate that the fisher effect of a one-to-one relationship between expected inflation and asset returns does not hold in the data. Secondly, direct real estate appears to be a poor inflation hedge over the short and long run, both for expected and unexpected inflation. Real estate stocks prove to provide a partial hedge against unexpected inflation for holding periods beyond 10 years. In line with the results of Schotman and Schweitzer (2000) we observe stocks to be a good inflation hedge over long investment periods, but this pertains in great deal to expected inflation. Similarly, bonds are a good hedge for expected inflation but not for inflation shocks.

[11] See for example Schotman and Schweitzer (2000), Brounen et al. (2007)

Table 2.7
Inflation Protection

Estimates for protection against expected and unexpected inflation (1984-2008). Expected inflation is assumed to follow a first order autoregressive process. The coefficients are estimated using rolling regressions using 10 years of history (40 quarters). Newey-West HAC Standard Errors & Covariance were used (lag truncation=3), T-Statistics in parenthesis, * indicates significance at a 5% significance level. MSCI=Morgan Stanley Capital International; GPR=Global Property Research; MIT TBI=Massachusetts Institute of Technology Transaction-Based Index.

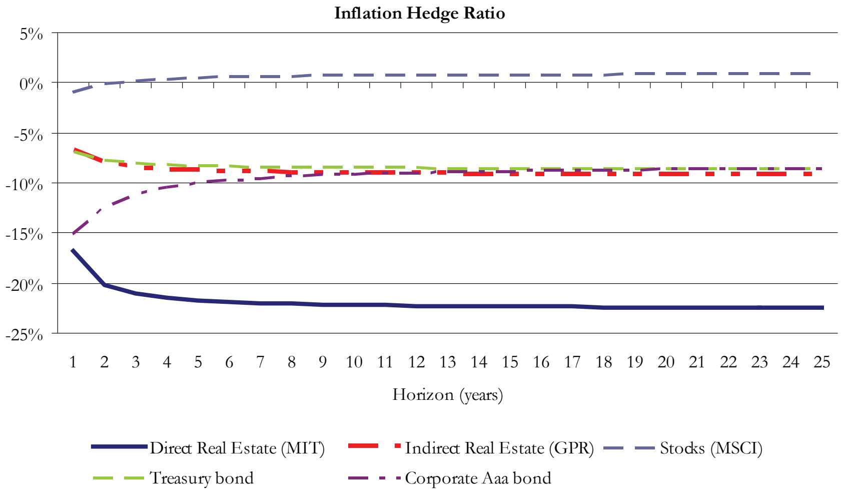
Investment Horizon	c	Expected β	Unexpected φ	R^2
Direct Real Estate (MIT)				
1 Quarter	0.037	-1.758	0.142	0.61%
	*(2.850)**	*(-1.323)*	*(0.253)*	
1 Year	0.246	-4.537	-0.745	26.78%
	*(5.450)**	*(-3.816)**	*(-0.599)*	
5 Year	1.405	-5.986	-2.571	75.75%
	*(12.030)**	*(-10.315)**	*(-2.173)**	
10 Year	2.915	-5.734	-0.501	94.76%
	*(27.145)**	*(-15.613)**	*(-0.561)*	
Real Estate Stocks(GPR)				
1 Quarter	0.031	-0.191	0.557	-1.91%
	(1.506)	*(-0.078)*	*(0.462)*	
1 Year	0.287	-5.515	-6.185	10.96%
	*(2.545)**	*(-1.593)*	*(-1.775)*	
5 Year	1.230	-4.116	-1.341	20.58%
	*(4.283)**	*(-2.384)**	*(-0.519)*	
10 Year	1.768	-1.691	1.063	26.87%
	*(7.177)**	*(-2.098)**	*(0.610)*	
Stocks (MSCI)				
1 Quarter	0.015	1.661	1.099	-1.15%
	(0.571)	*(0.630)*	*(0.796)*	
1 Year	0.022	2.502	-2.513	5.77%
	(0.185)	*(0.803)*	*(-1.124)*	
5 Year	-0.099	2.647	-8.269	42.60%
	(-0.323)	*(1.864)*	*(-2.552)**	
10 Year	-0.050	2.951	-4.730	61.09%
	(-0.181)	*(2.856)**	*(-2.146)**	

Continued on next page

Table 2.7 – continued from previous page

Treasury Bond				
1 Quarter	0.018	0.552	-0.666	-1.42%
	(0.921)	*(0.252)*	*(-0.569)*	
1 Year	0.028	1.056	-4.912	17.20%
	(0.413)	*(0.553)*	*(-3.529)*	
5 Year	0.045	2.086	-0.554	24.72%
	(0.301)	*(2.453)**	*(-0.368)*	
10 Year	0.246	1.285	-2.333	55.84%
	(1.470)	*(2.084)**	*(-2.202)**	
Corporate Aaa Bond				
1 Quarter	0.019	0.243	-1.090	8.55%
	*(3.935)**	*(0.446)*	*(-3.977)**	
1 Year	0.033	1.326	-1.964	31.87%
	(1.425)	*(1.972)**	*(-3.704)**	
5 Year	0.133	1.723	0.185	61.90%
	*(2.520)**	*(5.116)**	*(0.409)*	
10 Year	0.235	1.739	-0.113	81.28%
	*(2.779)**	*(5.456)**	*(-0.245)*	

For all the asset classes with the exception of stocks we find negative hedge ratios in figure 2.4. To obtain inflation protection an institutional investor needs to short real estate. For direct real estate the effective short position to hedge inflation ranges from 16% for a one year holding period to 22% for holding periods beyond 7 years. In effect, given an optimal allocation of 25%, the optimal portfolio weight for a pension fund seeking inflation protection, would decrease to 8% for a one year holding period and to 3% for long term portfolios. For real estate stocks the allocation hedge ratio is slightly lower (-9%, holding period>9 years), as real estate stocks provide a partial hedge against unexpected inflation for holding periods beyond 10 years. Nonetheless, the inflation risk impact on the portfolio composition renders zero or even short allocations. When accounting for inflation risk, the optimal portfolios come close to reported allocations (Bajtelsmit and Worzala (1995), Dhar and Goetzmann (2006)). Accordingly, the hedge ratios indicate a significant downgrade for real estate in an ALM portfolio once accounting for inflation.



$$\Delta^{(H)} = \frac{\frac{\alpha\beta}{(1-\alpha)^2}\left[H-1-\frac{\alpha-\alpha^H}{1-\alpha}(1+\alpha)+\alpha\frac{\alpha^2-\alpha^{2H}}{1-\alpha^2}\right]\sigma_\eta^2+\left[\frac{H}{1-\alpha}-\frac{\alpha-\alpha^{H+1}}{(1-\alpha)^2}\right]\varphi\sigma_\eta^2}{\frac{\alpha^2\beta^2}{(1-\alpha)^2}\left[H-1-2\frac{\alpha-\alpha^H}{1-\alpha}+\frac{\alpha^2-\alpha^{2H}}{1-\alpha^2}\right]\sigma_\eta^2+H\sigma_e^2+2\frac{\alpha\beta}{1-\alpha}\left[H-1-\frac{\alpha-\alpha^H}{1-\alpha}\right]\varphi\sigma_\eta^2+\varphi^2 H\sigma_\eta^2}$$

Figure 2.4
Hedge Ratios
The hedge ratio quantifies the composition adjustment of the portfolio to reduce inflation risk in order to have the optimal inflation protection for various holding periods. The hedge ratio for horizon H is a function of the estimated inflation persistence parameter α, expected inflation hedge parameter β and unexpected inflation parameter φ, and the variance of the error terms of both equations σ_η, σ_ε. The covariance matrix of asset returns and inflation changes with the investment horizon.

2.9 Return Predictability

Following pension liabilities as the starting point in determining the appropriate investment strategies, in this final section we depart from IID assumptions that returns are independently, identically distributed and allow for return predictability. With return predictability we mean the use of certain conditioning information for investors to form expectations on asset returns and risk. As such information changes over time, investment opportunities, drawn from the expected return-risk dynamics, also change over time. Investment decisions are typically made ex-ante and are characterized with future uncertainties. For example, discounted (uncertain) future cash flows determine asset prices, based on which expected returns are calculated. A random shock like unexpected interest rate cut may immediately alter investors' expectations. Thus systematic or common factors may cause certainties, or uncertainties, in terms of expected return or risk characteristics, which ultimately might lead to improved investment decision-making ex-ante.

Recently, a growing number of studies shed light on the REIT's predictability.[12]. Generally speaking, real estate return predictors seem not to be so different from the other asset classes examined. We therefore examine the influence of return predictability on the return risk dynamics of the asset classes and consequently the portfolio allocations. Fugazza and Nicodano (2007) and Hoevenaars et al. (2008) document time-horizon changes in the risk return dynamics of property stocks due to the predictability of real estate stock returns. MacKinnon and AlZaman (2009) find that also direct real estate is predictable and that consequently return and risk of direct real estate differs depending on the investment horizon. In this section we examine the time-varying risk return dynamics of both direct and indirect real estate, and verify real estates role in a long term asset-liability portfolio.

We use a VAR model to model asset return dynamics and to capture the horizon effects on real estate risk, inflation risk and interest rate risk. The VAR model is not only able to capture the time-varying return dynamics over time, but is highly regarded as a credible approach in data description and data forecasting (Stock and Watson (2001)). The risk return dynamics as captured by the VAR(1) model are obtained by regressing the return onto a constant, it's lagged value, lagged values of the other asset classes and the return predictors. The predictions are calculated by plugging the last available quarter values of the state variables and asset classes into the VAR(1) specification. We use state variables that have been identified as return predictors by previous empirical research , such as the short-term interest rate, the dividend price ratio and the yield spread between long and short term bonds. Furthermore, these variables have proven to be good proxies of consumption growth (Kandel and Stambaugh (1990)). In accordance with Fugazza and Nicodano (2007) and MacKinnon and AlZaman (2009) we also incorporate inflation as a state variable. Rehring (2011) stresses the importance of the cap-rate as a predictor. The cap-rate is the log of the income return over the capital appreciation. We thus include five variables as return predictors or so called state variables, the short-term interest rate, the dividend yield, inflation, the cap-rate and the yield spread between long and

[12]Bharati and Gupta (1992), Liu and Mei (1992), Mei and Lee (1994), Mei and Liu. (1994), Li and Wang (1998), Nelling and Gyourko (1998), Liao and Mei (1998), Ling et al. (1992), Chun et al. (2004) and Serrano and Hoesli (1994)

short term bonds. These forecasting variables have been widely used for stock and real estate securities.[13]

For the sake of simplicity, we focus on the real liability returns (RR^L_{t+1}). Following the Fisher hypothesis we decompose the nominal yield into a real return (RR^L_{t+1}) and inflation compensation, where the inflation compensation reflects expected inflation (π_{t+1}) and an inflation risk premium, which for reasons of simplicity we assume to be constant.

$$Y_t^{nom} = Y_t^{real} + E_t[\pi_{t+1}] \tag{2.16}$$

We assume that inflation expectation follows a first order autoregressive function. The coefficients are estimated using rolling regressions and 10 years of history. Thus we assume that for each quarter investors form expectations on the basis of the last 10 years of quarterly observations.

2.9.1 Methodology

Assuming return predictability allows us to condition expectations on the available information at time t.

$$E[R^e_{t+1}|z_t] = E_t[R^e_{t+1}]$$

$$V[R^e_{t+1}|z_t] = V_t[R^e_{t+1}] \tag{2.17}$$

where z_t is a vector that contains all the relevant information. Note that if returns are IID (Independently, Identically Distributed) then z_t does not matter and returns settle to unconditional expectations. The vector z_t includes the continuously compounded quarterly excess returns on all assets (x_{t+1}), the real short-term interest rate, the dividend price ratio, the yield spread between long and short term bonds and realized inflation. We use the short-term interest rate, the dividend price ratio, the yield spread and realized inflation as state variables (s_{t+1}). The state variables allow us to capture the horizon effects on the asset, inflation and

[13]Due to the large number of variables we extend the time period to the last quarter of 2010 to ensure we have sufficient observations to estimate the VAR model.

interest rate risk.

$$z_{t+1} = \begin{bmatrix} r_{f,t+1} \\ r_{t+1} - r_{f,t+1} \\ s_{t+1} \end{bmatrix} = \begin{bmatrix} r_{f,t+1} \\ x_{t+1} \\ s_{t+1} \end{bmatrix} \tag{2.18}$$

where $r_{f,t+1}$ is the log (continuously compounded) real return on the asset that we use as a risk free asset. x_{t+1} is a vector of log excess returns of the asset classes and s_{t+1} is the vector of state variables. For the ALM modeling context the liability return is also included in the x_{t+1}.

In this setting we specify z_t by a simple VAR(1) and assume log excess returns and the conditioning information are linear functions of the past. Each variable $z_{i,t+1}$ included in z_{t+1} depends linearly on a constant, its own lagged value, the lagged value of all other variables in z_{t+1} and a contemporaneous random shock $\varepsilon_{i,t+1}$.

$$z_{t+1} = \phi_0 + \Phi_1 z_t + \varepsilon_{t+1} \tag{2.19}$$

ϕ_0 is a vector of intercepts, Φ_1 is a square matrix of slope coefficients and ε_{t+1} is a vector of zero mean shocks to the returns and the return forecasting variables. Σ_t denotes the matrix of contemporaneous variance and covariance of shocks. Note we assume for the sake of simplicity that Σ_t is time-invariant. Following the calibration of the VAR(1) specification using the historical time series we calculate the k-period ahead predictions by filling in the last available quarter values of the state variables and asset classes in the estimated model. Forecasts from VAR models are made conditional on the potential future paths of specified state variables and asset classes in the model. The VAR(1) predictions are subsequently used in a multi-horizon portfolio optimization.

2.9.2 Term Structure of Risk

Predictability of asset returns alters the optimal portfolio through the effect of the term structure (i.e. variance and covariance) of risk. If returns are unpredictable their risk, return and correlations are constant across investment horizons. Departing from the assumption of independently and identically distributed returns implies that risk, defined as the conditional variance and covariance per period of asset returns, may be significantly different for different investment horizons. Investors will have different return and risk expectations based on the changing state variables. We describe the dynamic behavior of asset returns using a first order vector autoregressive process (VAR(1)) as in Campbell and Viceira (2005). The degree of predictability is reported in Table 2.8. For both direct and indirect real estate the degree of predictability is relatively large, the adjusted R^2 are 37.15% and 26.72% respectively. The coefficients of stocks, corporate bonds and lagged inflation is statistically significant in the equation of indirect real estate. A 1% increase in stock return predicts a 0.33% increase in real estate stocks in the following quarter. A 1% change in corporate bond returns predicts a 4.86% increase in real estate stock returns, while inflation inflation leads to a 7.08% increase for the indirect real estate index in the subsequent quarter.

Furthermore, we see that the indirect real estate market reveals information concerning the direct market and can aid in the forecasting of indirect real estate returns. The direct real estate equation indicates that a increase of 1% in real estate stocks returns at t-1 predicts an increase of 16 bp in the subsequent period for direct real estate. The GPR-index leads the MIT index, a finding previously corroborated by Myer and Webb (1993), Barkham and Geltner (1995), and Glascock and So (2000) who all find that the public market causes changes in the private market.

Table 2.8
Vector Autoregression Estimates

The table reports the estimation output for the VAR(1) model. We include the continuously compounded quarterly excess asset returns, the real short-term interest rate, the dividend price ratio, the yield spread between long and short term bonds, the cap rate and realized inflation. T-statistics are reported in between brackets. MSCI=Morgan Stanley Capital International; GPR=Global Property Research; MIT TBI=Massachusetts Institute of Technology Transaction-Based Index.

	Stocks (MSCI) (1)	RE Stock (GPR) (2)	RE (MIT) (3)	Corp. Bond (4)	Treas. Bond (5)	Real Tbill (6)	Div Yield (7)	Term Slope (8)	Cap Infl. (9)	Real Rate (10)	Liab. (11)
$1_{(t-1)}$	0.15	0.33	0.03	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.46	-0.02
	[1.22]	[2.17]	[0.51]	[0.02]	[0.25]	[0.22]	[-22.28]	[-1.42]	[-0.28]	[-1.93]	[-0.13]
$2_{(t-1)}$	-0.12	0.03	0.16	0.00	0.00	0.01	0.00	0.01	-0.01	0.32	0.10
	[-1.40]	[0.30]	[3.33]	[0.18]	[-0.25]	[1.33]	[0.52]	[1.03]	[-1.23]	[1.91]	[0.96]
$3_{(t-1)}$	0.40	0.34	-0.18	-0.01	-0.04	-0.02	0.00	-0.01	0.02	-0.36	-0.06
	[2.17]	[1.42]	[-1.78]	[-0.24]	[-2.00]	[-1.29]	[1.21]	[-0.38]	[1.63]	[-0.99]	[-0.28]
$4_{(t-1)}$	3.61	4.86	1.17	-0.10	-0.35	-0.03	0.00	0.02	0.05	-1.33	-0.01
	[4.49]	[4.64]	[2.57]	[-0.43]	[-3.90]	[-0.45]	[-1.29]	[0.37]	[0.72]	[-0.82]	[-0.00]
$5_{(t-1)}$	0.07	-0.67	-0.14	0.00	-0.01	-0.03	0.00	0.02	0.01	-0.92	-0.31
	[0.21]	[-1.52]	[-0.71]	[-0.01]	[-0.35]	[-0.96]	[0.71]	[0.66]	[0.42]	[-1.37]	[-0.74]
$6_{(t-1)}$	0.93	1.42	-0.20	-0.22	0.08	0.58	0.00	-0.23	0.36	0.43	1.57
	[0.45]	[0.53]	[-0.17]	[-0.39]	[0.33]	[3.44]	[-0.33]	[-1.38]	[2.15]	[0.10]	[0.63]

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Table 2.8 – continued from previous page

	MSCI (1)	GPR (2)	MIT (3)	Corpo. Bond (4)	Treas. Bond (5)	Real Tbill (6)	Div. Yield (7)	Term Slope (8)	Infl. (9)	Cap Rate (10)	Real Liab. (11)
$7_{(t-1)}$	3.09	-5.84	-3.06	0.12	-0.37	-0.02	1.00	0.45	0.11	-3.36	-1.07
	[1.14]	[-1.65]	[-2.00]	[0.16]	[-1.22]	[-0.11]	[99.71]	[2.03]	[0.49]	[-0.62]	[-0.32]
$8_{(t-1)}$	-2.34	1.68	-0.40	0.56	0.50	-0.07	0.00	0.50	0.02	-3.23	0.97
	[-1.81]	[1.00]	[-0.55]	[1.52]	[3.44]	[-0.65]	[-0.19]	[4.71]	[0.20]	[-1.25]	[0.62]
$9_{(t-1)}$	1.02	7.08	0.20	0.20	0.39	0.72	0.00	-0.33	0.22	0.60	2.73
	[0.46]	[2.51]	[0.16]	[0.32]	[1.58]	[4.05]	[-0.40]	[-1.84]	[1.24]	[0.13]	[1.06]
$10_{(t-1)}$	-0.08	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.07	-0.02
	[-1.45]	[0.07]	[-0.42]	[-0.09]	[0.61]	[-0.50]	[-0.05]	[1.16]	[0.56]	[-0.71]	[-0.28]
$11_{(t-1)}$	-0.78	-0.87	-0.23	0.02	0.31	0.01	0.00	-0.03	-0.02	0.25	-0.01
	[-3.95]	[-3.42]	[-2.04]	[0.41]	[13.91]	[0.87]	[1.05]	[-1.88]	[-1.44]	[0.63]	[-0.03]
C	-0.05	-0.05	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.06	-0.01
	[-2.35]	[-1.91]	[1.93]	[1.34]	[2.78]	[-1.75]	[0.88]	[0.42]	[1.63]	[1.41]	[-0.29]
R^2	29.68%	37.15%	26.72%	5.77%	88.47%	32.69%	99.55%	42.85%	13.57%	11.96%	3.82%
Correlation Matrix for VAR(1) Shocks											
1	1.00	0.55	0.11	-0.24	-0.12	0.03	0.11	-0.03	-0.03	-0.03	-0.20
2	0.55	1.00	0.24	-0.06	-0.06	-0.04	-0.06	0.00	0.01	0.04	-0.08
3	0.11	0.24	1.00	-0.01	-0.01	-0.16	0.23	-0.11	0.18	-0.11	-0.08
4	-0.24	-0.06	-0.01	1.00	0.21	0.35	-0.12	0.38	-0.34	0.11	0.89

Continued on next page

Table 2.8 – continued from previous page

	MSCI	GPR	MIT	Corpo. Bond	Treas. Bond	Real Tbill	Div. Yield	Term Slope	Infl.	Cap Rate	Real Liab.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
5	-0.12	-0.06	-0.01	0.21	1.00	-0.07	-0.14	0.13	0.00	-0.03	0.19
6	0.03	-0.04	-0.16	0.35	-0.07	1.00	0.04	0.21	-0.99	-0.03	0.42
7	0.11	-0.06	0.23	-0.12	-0.14	0.04	1.00	-0.01	-0.03	-0.46	-0.09
8	-0.03	0.00	-0.11	0.38	0.13	0.21	-0.01	1.00	-0.26	-0.05	0.42
9	-0.03	0.01	0.18	-0.34	0.00	-0.99	-0.03	-0.26	1.00	0.05	-0.41
10	-0.03	0.04	-0.11	0.11	-0.03	-0.03	-0.46	-0.05	0.05	1.00	0.06
11	-0.20	-0.08	-0.08	0.89	0.19	0.42	-0.09	0.42	-0.41	0.06	1.00

Figure 2.5 further reveals the standard deviation of the asset returns across various holding periods, the term structure of risk of the asset classes. The expectation and variance of the log excess returns depend on the state variables and on the investment horizon k. If returns are unpredictable their risk per period and correlations are constant across investment horizons. For the real estate asset class the annualized variances increase as the holding period increases. The standard deviation increases from 18% in the first quarter to 31% for a holding period of 25 years, a result similar to Fugazza and Nicodano (2007). Real estate stocks furthermore remain the riskiest asset class across all investment horizons. For direct real estate we see an increase in annualized variances as the holding period increases. A negative shock to the indirect market lowers the return contemporaneously and is then again likely to be followed by a lower return, amplifying the annualized volatility of direct real estate. This result is in contrast to the results of MacKinnon and AlZaman (2009), who find real estate to become less risky over time. Even when using their exact sample period, data and specification, our results show that real estate becomes riskier over time. Rehring (2011) corroborates our findings and attributes the results of MacKinnon and AlZaman (2009) to a programming error.

In accordance with the results of Campbell and Viceira (2005) we see strong mean reverting properties for stocks as the annualized standards deviation decreases from 15% to 9%. Stocks eventually become less risky than direct real estate for holding periods longer than 8 years. T-bills are the least risky asset class, nonetheless the reinvestment risk associate with rolling over the asset class for long investment horizons magnifies the standard deviation of returns.

Figure 2.6 shows the return predictions for the various holding periods on the basis of the VAR model. Real estate stocks are expected to give the highest return, a 17% gross return in the long run. The expected return for direct real estate is increasing in the investment horizon after 3 years, while for stocks the expected return outlook is lower, 5% for long run portfolios.

Figure 2.6 also shows the correlation structure of the asset classes for various holding periods. Interestingly, the correlation coefficient between direct and indirect real estate increases as we hold the asset classes over longer investment periods. At short horizons the correlation between direct and indirect real estate is quite low, namely 0.25. When accounting for return predictability, the correlation coefficient between direct and indirect real estate increases sharply to 0.81 for an investment horizon of 25 years. Indicating that over the long run the asset classes are affected by similar return and risk dynamics. Convergence in correlation between direct and indirect real estate appears to be induced by the predictability of direct real

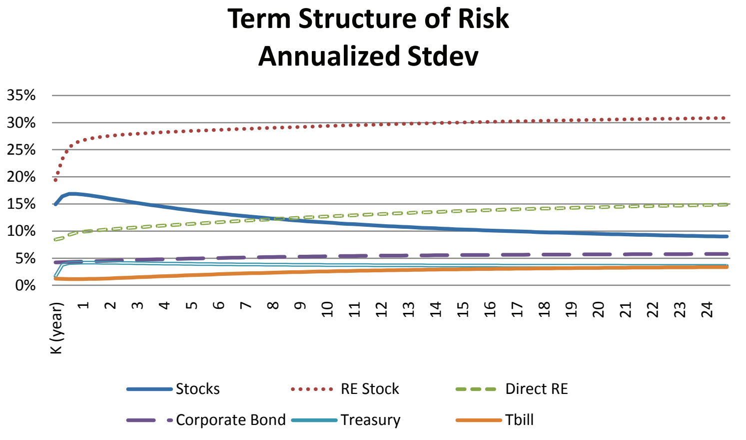


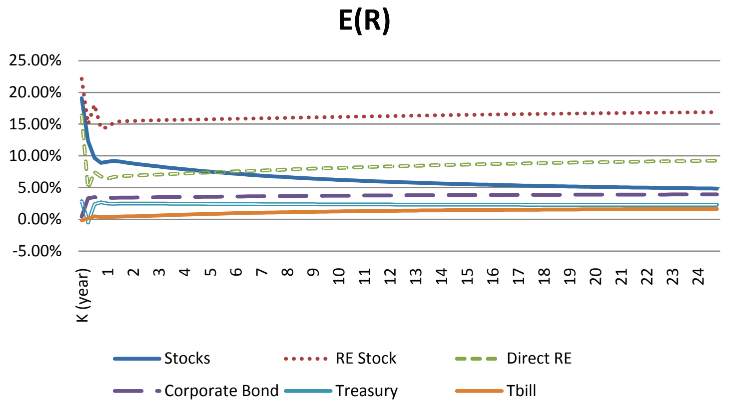
Figure 2.5
Term Structure of Risk
The figure depicts the forecasts of the annualized standard deviation as specified under the VAR(1) model. The standard deviation is depicted as a function of the investment horizon.

estate returns from real estate stock returns.

The diversification potential of real estate also differs depending on the holding period. The correlation of real estate stocks with stocks decreases severely over time. The results are in line with those of Fugazza, Guidolin and Nicadono (2007), who also observe a decrease in correlation between indirect real estate and stocks and an increase with bonds. The results indicate enhanced diversification benefits for real estate stocks with respect to common equity. Direct real estate in contrast correlates more strongly with stocks in the long run.

2.9.3 Liability Hedge

An asset-liability model (ALM) is a model of assets and liabilities that facilitates decision-making with respect to asset allocation and the properties of the liabilities. An important distinguishing feature is the interdependence between assets and liabilities. Figure 2.7 depicts the correlations between pension liabilities and the asset returns in a multi-horizon setting. The interdependence between assets and liabilities represent the hedging qualities of the asset classes with respect to real liabilities of pension funds. The liability returns represent both interest and inflation risk as faced by a typical pension fund with a duration of 17 years.



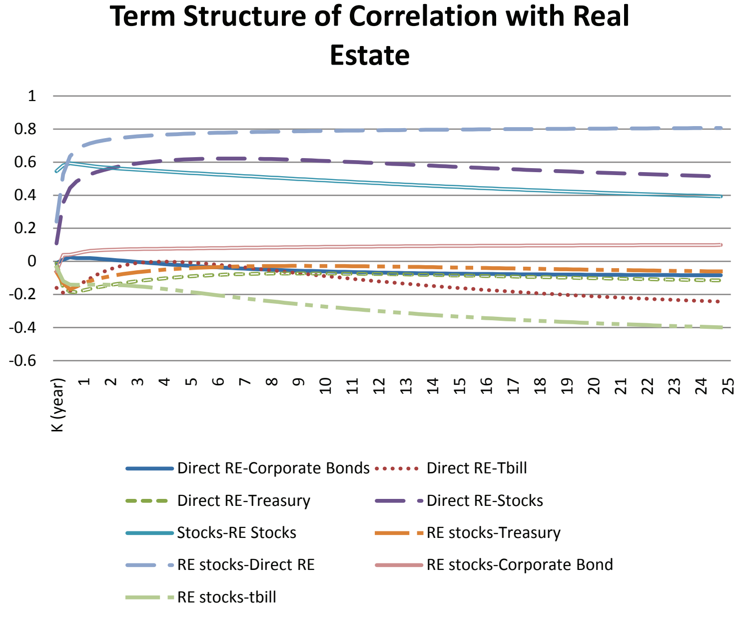


Figure 2.6
Term Structure of Return and Correlation

The top graph is the forecast of gross returns, log returns are adjusted by adding one-half their variance to reflect mean gross returns. The bottom graph depicts the forecasts of the correlation coefficient as specified under the VAR(1) model, as a function of the investment horizon.

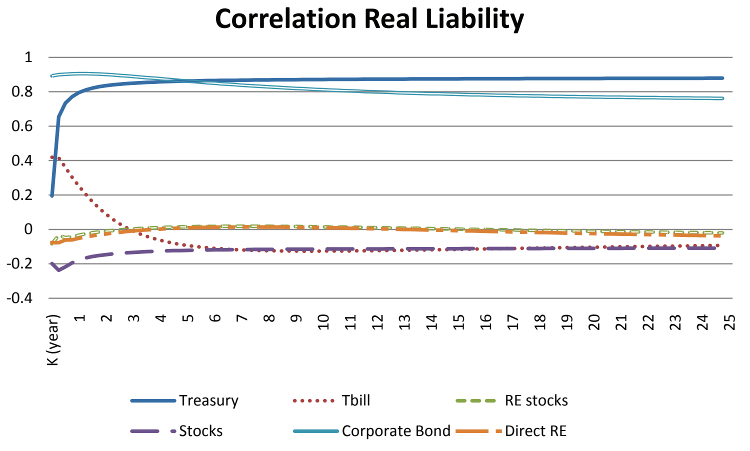


Figure 2.7
Term Structure of Correlation with Real Liability
The figure depicts the forecasts of the correlation coefficient with respect to pension liabilities as specified under the VAR(1) model. The liability return is derived as a function of the log yield of the constant maturity bond, assuming duration of 17 years, the average duration of pension liabilities. Real Liabilities are adjusted for inflation and interest rate risk. We decompose the nominal yield into a real yield and inflation compensation, where the inflation compensation reflects expected inflation (π_{t+1}) and an inflation risk premium, which for reasons of simplicity we assume constant. We further assume that inflation expectation follows a first order autoregressive function.

Both direct and indirect real estate provide a poor hedge for interest and inflation risk in the short and long run, the correlation coefficient remains close to zero for real estate stocks and for direct real estate.

To explore more in depth how the asset classes respond to interest and inflation and liability shocks we perform an impulse response analysis based on the VAR(1). In a VAR system a shock to the i-th variable not only directly affects the i-th variable but is also transmitted to all of the other endogenous variables through the dynamic structure of the VAR, to account for the contemporaneous cross-correlation between shocks we use generalized impulse responses. The impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variable. We set the impulses to one standard deviation of the residuals and trace how interest, inflation and liability shocks affect the returns of stocks, bonds and real estate.

Figure 2.8 depicts the percentage deviations in the asset classes returns over time after a one-time standard deviation increase in liabilities, inflation and interest rates. A shock to liabilities has a positive influence on bonds, but this is relatively short-lived, after 3 quarters the response disappears. For indirect real estate a liability increase has a negative immediate effect which becomes positive as of the fourth quarter although the magnitude of the increase is economically negligible after the sixth quarter. The effect on direct real estate is indistinguishable from zero.

We can further disentangle the liability shock by looking at the response of the asset classes to inflation shocks. Indirect and direct real estate are initially positively affected by inflation shocks, while bonds respond negatively. Following a year both direct and indirect real estate are negatively affected by inflation.

2.9.4 Asset Liability Portfolio using Return Predictability

In terms of portfolio allocation the assets' covariance with the growth rate of the liabilities are key. Other things being equal, an asset whose returns are highly correlated with liabilities provide better liability hedging. This ultimately should result in a higher weight in the ALM portfolio than under the traditional mean variance optimization. For an ALM investor the objective function is formulated in the surplus of assets over liabilities. We again impose short-selling constraints on all assets and portfolios must be fully invested. Results are computed for a level of risk aversion $\gamma = 5$. Portfolio weights are determined by maximizing the objective function given the standard deviation of the asset-only portfolios to enhance the comparability of the results. By contrasting the portfolio composition in the asset-only case with the ALM portfolio under similar risk levels we see the effect of interest and inflation risk on the portfolio allocation problem when assuming return predictability.

Table 2.9 shows the ALM portfolios for various holding periods. The first portfolio is the minimum variance portfolio for various holding periods. To obtain a similar standard deviation as the minimum variance portfolio in the asset-only scenario a fully invested pension fund would need to allocate 0.75% to direct real estate when considering real liabilities versus the 2.32% when focusing on asset returns solely, ignoring return predictability for a holding period of a quarter. For longer holding periods the allocation towards direct real estate decreases in comparison to the asset-only scenario due to the negative hedging utility of direct real estate regarding interest and inflation movements.

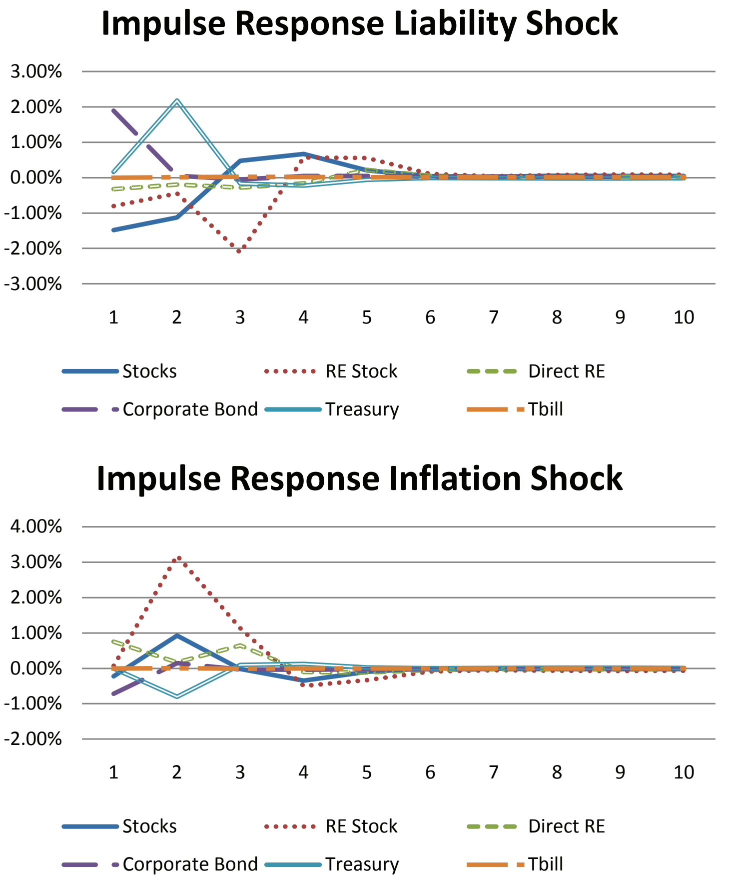


Figure 2.8
Generalized Impulse Response
The impulses are set to one standard deviation of the residuals of the liability return and inflation rate.

The results are much less pronounced for the equivalent maximum Sharpe ratio portfolio. When accounting for liability obligations, the portfolio composition for long term portfolios contains 5.21% direct real estate in an ALM setting (25 year holding period) versus none in an asset-only context.

Real estate stocks, in contrast, get a higher allocation in the minimum variance ALM portfolio and a slightly lower allocaytion in the ALM tangency portfolio.

At very long holding periods (25 years) real estate stocks obtain an allocation of 2.36%. Our results thus corroborate the findings of Hoevenaars et al. (2008) for indirect real estate, yet the total real estate exposure is not minor.

Table 2.9
Asset-Only versus ALM assuming Return Predictability

The table displays the optimal portfolio allocations for both the asset-only as the ALM model. Portfolios were derived using the return and risk characteristics as specified under the VAR(1) model. We again impose short-selling constraints on all assets and portfolios must be fully invested. Portfolio weights are determined by maximizing the objective function given the standard deviation of the asset-only portfolios to enhance the comparability of the results.

Asset-Only Optimization Minimum Variance Portfolio					Asset-Liability Optimization Minimum Variance Portfolio				
Holding period	1 Quarter	5 Year	10 Year	25 Year	Holding period	1 Quarter	5 Year	10 Year	25 Year
Stocks	1.02%	2.98%	6.56%	13.40%	Stocks	0.66%	0.00%	0.00%	2.15%
RE Stocks	0.00%	2.51%	2.63%	2.62%	RE Stocks	0.98%	3.88%	5.20%	6.12%
Direct RE	2.32%	0.00%	0.00%	0.00%	Direct RE	0.75%	0.00%	0.00%	0.00%
Corporate Bond	7.53%	0.00%	0.00%	4.27%	Corporate Bond	5.71%	0.00%	0.00%	0.00%
Treasury	36.73%	31.51%	42.49%	42.98%	Treasury	30.09%	22.78%	32.65%	40.93%
Tbill	52.41%	62.99%	48.31%	36.72%	Tbill	61.81%	73.34%	62.15%	50.80%
Asset-Only Optimization Tangency Portfolio					Asset-Liability Optimization Tangency Portfolio				
Holding period	1 Quarter	5 Year	10 Year	25 Year	Holding period	1 Quarter	5 Year	10 Year	25 Year
Stocks	5.41%	5.47%	6.67%	13.93%	Stocks	4.15%	4.48%	3.53%	5.37%
RE Stocks	0.00%	3.19%	2.65%	2.61%	RE Stocks	0.87%	3.06%	2.68%	2.36%
Direct RE	2.46%	0.00%	0.00%	0.00%	Direct RE	12.39%	0.00%	2.97%	5.21%
Corporate Bond	0.00%	4.32%	0.00%	4.72%	Corporate Bond	67.02%	35.23%	38.12%	36.22%
Treasury	23.82%	33.26%	42.57%	42.83%	Treasury	14.77%	57.23%	51.22%	46.40%
Tbill	68.31%	53.75%	48.10%	35.91%	Tbill	0.79%	0.00%	1.47%	4.43%

In accordance with Chun, Ciochetti and Shilling (2000), Craft (2001), and Booth (2004) and the results in the IID setting we find that direct and indirect real estate warrant inclusion in a mixed-asset portfolio because of their attractive risk-reward properties, their diversification potential with stocks and bonds, but not because of its interest and inflation hedging abilities.

2.9.5 Robustness check

In this section we perform additional exercises to verify our results and to illustrate the sensitivity of the portfolio allocations to the starting values of the state variables and asset classes, and subsequently to changes in parameter uncertainty.

The risk return dynamics as captured by the VAR(1) model were derived using historical return series. The predictions following the VAR(1) specification were calculated using the last available quarter values of the state variables and asset classes. To determine how sensitive the results are to the initial values of the state variables and asset classes we use the 20th percentile return as the starting value for the VAR(1) predictions and create the ALM efficient tangency portfolio. To tackle parameter uncertainty we increase the estimate of the constant parameters of direct and indirect real estate equations downward by one standard deviation, similar to Barberis (2000). The impact of parameter uncertainty and initial value change is substantial for real estate allocations, as can be seen in Table 2.10. Real estate obtains a lower allocation in the short and long horizon portfolios.

Overall, the results are sensitive to parameter uncertainty and the initial value choice. The results are driven by changes in the expected return predictions. The covariance matrix is relatively stable and forecasts similar risk dynamics. The term structure of risk and correlations of the asset classes are robust to the exclusion of cap rates as a state variable and the exclusion of the crises period following 2008 to 2010. The uncertainty surrounds the mean returns. Departing from a worst case scenario results in portfolio allocations in favor of return generating asset classes, especially when considering a surplus optimization.

2.10 Conclusion

The average American pension funds allocate less than 5% of their assets to real estate (Dhar and Goetzmann, 2006). While mean-variance asset-only portfolios predict allocations of 20% to 30%. The actual and suggested weights of real estate in the institutional portfolio are incon-

Table 2.10
Sensitivity Analysis

The first panel is the standard tangency ALM portfolio. The second panel tabulates the tangency ALM portfolio allocation using the 20th percentile return as the starting value for the VAR(1) predictions. The third panel shows the tangency ALM efficient portfolio in the presence of parameter changes. To tackle parameter uncertainty we increase the estimate of the constant parameters of direct and indirect real estate equations downward by 1 standard deviation.

Benchmark ALM portfolios

Tangency Portfolio				
Holding period	1 Quarter	5 Year	10 Year	25 Year
Stocks	4.15%	4.48%	3.53%	5.37%
RE Stocks	0.87%	3.06%	2.68%	2.36%
Direct RE	12.39%	0.00%	2.97%	5.21%
Corporate Bond	67.02%	35.23%	38.12%	36.22%
Treasury	14.77%	57.23%	51.22%	46.40%
Tbill	0.79%	0.00%	1.47%	4.43%

Initial Value Change

Tangency Portfolio				
Holding period	1 Quarter	5 Year	10 Year	25 Year
Stocks	6.21%	8.41%	1.87%	13.77%
RE Stocks	3.82%	3.78%	0.74%	2.70%
Direct RE	11.96%	0.00%	5.45%	0.00%
Corporate Bond	41.73%	17.11%	11.14%	4.54%
Treasury	0.00%	28.05%	26.04%	43.00%
Tbill	36.28%	42.65%	54.76%	35.99%

Parameter Uncertainty

Tangency Portfolio				
Holding period	1 Quarter	5 Year	10 Year	25 Year
Stocks	3.89%	22.66%	21.20%	25.89%
RE Stocks	0.81%	0.00%	0.00%	0.00%
Direct RE	11.60%	0.00%	0.00%	0.00%
Corporate Bond	1.12%	5.30%	46.70%	34.11%
Treasury	64.41%	33.50%	28.90%	31.70%
Tbill	18.18%	38.54%	3.20%	8.30%

sistent against the classic mean-variance framework predicted allocations. We find that this discrepancy is attributable to real estate's poor inflation hedging capabilities. Once accounting for inflation the projected allocations come close to reported ones. Our results further show that real estate offers hedging benefits against interest rates for shorter holding periods, but not for long term institutional portfolios. Commercial real estate is a perverse inflation and interest rate hedge in the long run and offers pension funds no additional advantage beyond its diversification potential and its attractive risk reward characteristics.

Even when departing from the assumption of independently and identically distributed returns and considering the time diversification properties of real estate, the portfolio composition for long term portfolios contains less direct and indirect real estate. We characterized the term structure of risk and showed that the variance and correlation of real estate changes noticeably with the investment horizon. Both direct and indirect real estate are closely correlated at longer horizons. The return series of indirect and direct real estate fluctuate conjointly in a long-run relationship and could act as close substitutes for long term portfolios. Additionally we found an increase in annualized variances of the real estate asset class as the holding period increases. When accounting for liability obligations real estate offers reduced hedging benefits against inflation and interest rates and consequently, the portfolio composition for long term portfolios contains less direct and indirect real estate.

Chapter 3

Short Sales and Fundamental Value: Explaining the REIT Premium to NAV*

3.1 Introduction

Why shares of Real Estate Investment Trusts (REITs) trade at prices that differ from their underlying net asset value (NAV) is not well understood. Moreover, there is substantial variation in share price deviations from NAVs both in the cross-section and over time. For example, firm level NAV premiums for U.S. REITs in 2007 and 2008 ranged from -56% to 70% and from -61% to 31%, respectively.[1]

The variation in NAV premiums is often attributed to firm specific characteristics (e.g. management quality, size, age, expense ratio), market sentiment, and limits to arbitrage. Short sale constraints are a form of limits to arbitrage. According to Miller (1977), differences in investor opinions in the presence of short-sale constraints lead to stock price overvaluation. More specifically, if short selling is constrained, negative information about the firm may not reach the market. Therefore, stock prices may not reflect fundamental values but rather the valuations of the most optimistic investors, instead.

In this chapter, we examine the empirical relation between REIT share price valuations, short sale activity, and short sale constraints. More specifically, we answer the following

*This chapter is based on Brounen et al. (2011). It has benefited from helpful comments by Shaun Bond, David Brown, Mathijs van Dijk, Marie Dutordoir, Evan Dudley, Andy Naranjo, Sugata Ray, Jay Ritter, and seminar participants at MIT Center for Real Estate, University of Cincinatti, University of Florida, RSM Erasmus University, and the AREUEA International meeting in Rotterdam.

[1]Data calculated using SNL mean analyst estimates for the equity REIT sample.

question: How much of the cross-sectional variation in REIT NAV premiums and abnormal returns can be attributed to short sale activity or constraints?

Chen et al. (2011) and Li and Yung (1998) find that heavily shorted REITs experience significantly lower abnormal returns, consistent with an overvaluation story. However, a stock can subsequently decline in price without being overvalued *ex ante* if negative information about future cash flows is revealed. Conversely, according to the limits to arbitrage theory of Shleifer and Vishny (1997), overvaluation may persist, or even increase, in the short run. By using REIT NAV values we extend previous findings to statements about the level of prices and address the importance of relative valuation in the short sale decision.

We use a panel vector autoregression framework to examine how short sale activity and constraints affect the variation in monthly REIT NAV premiums. We complement existing studies by directly linking short sale activity and constraints to valuations using a unique dataset. The short sale data we employ is the quantity of shares currently on loan to short sellers as well as proprietary information on the inventory of shares made available by institutions to short sellers.

Chen et al. (2011) and Li and Yung (1998) argue that REITs with a high short interest are more difficult to short at the margin. That is, potential short sellers are constrained. However, Chen et al. (2002) argue that a stock with high short interest may simply mean that the stock is easy (inexpensive) to short. Thus, it is difficult to assess whether a stock is short constrained by examining the current short interest.

Our primary results can be summarized as follows. First, we find that variation in short sale activity across REITs can account for at least one-third of the variation in NAV premiums. In the short run, short sale constraints amplify fluctuations in NAV premiums. Moreover, the effect of short sale constraints on NAV premiums appears to dominate the influence of investor sentiment. Our results also show that short sale activity (i.e., the percentage of outstanding shares currently shorted) is not an accurate measure of short sale constraints. In fact, short sales effectively increase the supply of shares and therefore reduce prices, all else equal. However, short sale constraints are binding, and therefore may lead to overvaluation, when there is strong demand for shares to borrow and short but a limited inventory (supply) of shares available for shorting. Finally, we perform an abnormal return analysis and find that the correction of the overvaluation pertains only to premium REITs.

This study complements the existing literature by directly linking short sales and short sale constraints to valuation using U.S. Equity REITs, where fundamental value is estimated every month by third party stock analysts. Our results also add to the REIT literature by providing a new explanation for why REIT share prices deviate from NAV. In addition to rational explanations (largely based on firm characteristics) and behavioral (noise trading) explanations, we find that short sale activity and, especially, short sale constraints help explain variation in the cross section of REIT NAV premiums and subsequent abnormal returns.

The remainder of the chapter is organized as follows. Section 3.2 reviews the related literature and conceptualizes our research framework on REIT pricing and short sale constraints. In Section 3.3, we describe our sample and the construction of our key variables. Section 3.5 presents the empirical evidence on the premium to net asset value dynamics. Section 3.7 concludes.

3.2 Literature and Conceptual Framework

Share price deviations from NAV have been examined both in the closed-end fund literature and in the real estate literature using two types of explanations: rational and behavioral. The rational approach hypothesizes that NAV premiums and discounts reflect market or firm-specific factors. For example, Barkham and Ward (1999) and Gentry et al. (2003) posit that potential capital gain taxes are a rational explanation for the existence of discounts to NAVs. A REIT may also trade below its NAV if there are additional costs associated with operating as a REIT versus alternative organizational forms, including the (agency) costs of potential conflicts of interest between managers and investors. Reputation or management skill may also influence valuations as argued by Malkiel (1977) in the context of closed-end funds and by Ling and Ryngaert (1997) in the REIT context. Capozza and Lee (1995) conclude that REIT NAV discounts can be partially explained by agency costs because they are correlated with expense ratios. Barkham and Ward (1999), Clayton and MacKinnon (2001), and Anderson et al. (2001) analyze the cross-section of NAV premiums and discounts and report that larger REITs tend to have lower discounts. Better access to capital markets, economies of scale, and market liquidity are possible explanations for this firm size effect. According to Anderson et al. (2001), leverage is penalized in the public REIT market because it reduces flexibility and increases the volatility of earnings and systematic risk. Finally, Bond and Shilling (2004) find that both systematic and unsystematic risks are associated with REIT NAV premiums.

Besides these rational explanations, an alternative set of behavioral models has been developed to explain NAV premiums and discounts. For example, Lee et al. (1991) posit that discounts and premiums in closed-end funds reflect investor sentiment. Barkham and Ward (1999) find a common REIT sector effect in the cross-section of REIT NAV premiums; moreover, they suggest that investor sentiment is the major component of this common effect. Gemmill and Thomas (2002) use mutual fund flows as an indicator of investor sentiment and find that it predicts changes in closed-end fund discounts. Clayton and MacKinnon (2001) use the bid-ask spread to determine whether noise traders or rational investors dominate the public real estate market. More specifically, they argue that if transaction costs decrease (liquidity increases) discounts to NAV should decrease (premiums increase) as more noise traders enter the market. Their empirical results are consistent with this noise trader theory. Liquidity, however, only partially explains the variation in REIT NAV discounts and premiums. Clayton and MacKinnon (2001) conclude that changes in NAV premiums and discounts are related to fundamentals at turning points of the real estate cycle; however, the magnitude of the swings is exacerbated by noise traders.

Gentry et al. (2004) find that buying stocks trading at large discounts to NAV and, simultaneously, shorting stocks trading at large premiums is a profitable investment strategy. This suggests a behavioral explanation could be justified. However, the feasibility of such an investment strategy depends in part on the ability of informed investors to short premium stocks, suggesting a more rational explanation for the existence of a premium, namely short sale constraints as a limit to arbitrage. Pontiff (1996) and Gemmill and Thomas (2002) provide support for the limits to arbitrage explanation by documenting that closed-end (general equity) funds that are difficult to replicate typically trade at a premium to their counterparts. Thus, variations in short sale constraints across firms and over time may help explain premiums to NAV of REITs.

According to Miller (1977), short sale constraints provide an explanation for why security prices may be upward biased. Suppose an investor is able to purchase one share of a stock and there are N shares available. Shares will end up being owned by the N investors with the highest valuations. The horizontal line (Curve A) in Figure 3.1 depicts investor demand for shares of a company assuming no differences of opinion among investors regarding share value. In the absence of short selling, the supply of shares is fixed at C and the market clears at an equilibrium price of P1. Allowing for dispersion in investor opinions produces a downward sloping demand curve (B). If the supply of shares remains fixed at C, the share price converges to P2. In this new equilibrium, the share price is being determined by the more optimistic investors in the market. Chen et al. (2011) test for this effect in a sample of U.S. REITs.

More specifically, they use variation in the investment focus of shareholders as a proxy for heterogeneous valuations and find that short sale activity affects REIT pricing when valuations are uncertain.

Short sales effectively increase the supply of shares. In Figure 3.1, this is depicted by a rightward shift of the supply curve to D, which reduces the equilibrium prices to P3. In other words, short selling helps to mitigate the effect of optimistic investors on equilibrium share prices. If short selling is constrained (only a small fraction of the shares are available for shorting), the rightward shift in the supply curve will be constrained and informed investors will be unable to undo the upward bias created by optimistic investors. This is depicted in Figure 3.1 by a shift in the supply of shares to E and an increase in the equilibrium price to P4.

Consistent with Miller's (1977) hypothesis, we expect that short-sale constraints, in the presence of heterogeneous valuations, lead to overvaluation. Moreover, we expect increased short sale activity to reduce valuations and thus NAV premiums. However, short sale activity and constraints should not affect pricing when shares are selling at a discount to NAVs.

Several prior papers test the overvaluation hypothesis by focusing on the relation between short sales and subsequent returns; a negative *ex post* calendar time abnormal return is consistent with overvaluation. Figlewski (1981), Brent et al. (1990), Senchank and Starks (1993), Figlewski and Webb (1993), Aitken et al. (1998), Dechow et al. (2001), Asquith et al. (2005), Desai et al. (2002), Boehmer et al. (2008) and Boehmer et al. (2010) document a negative relation between short interest levels and subsequent stock returns. In the REIT literature, Chen et al. (2011) find that REITs in the top quartile of REIT short interest underperform the first quartile by 0.64% per month. Li and Yung (1998) examine equity REITs and also observe a negative relation between short interest and returns in the highest decile of REIT short interest.

We add to the existing literature by directly linking short sales and short sale constraints to valuation using a unique dataset. In contrast to earlier studies that rely exclusively on short interest data, we are able to distinguish between supply and demand effects and determine how strong demand and limited supply affect the relative valuation as measured by the premium to NAV of REITs using a panel vector autoregression.

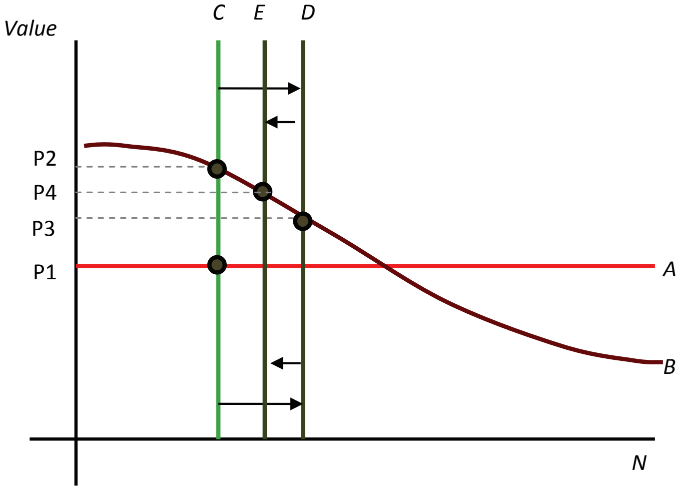


Figure 3.1
Miller Framework

In this figure, we plot demand (curves A and B) against supply (curves C, D, and E) of shares. In curve A, we present investor demand assuming no differences of opinion among investor regarding the stock value. When allowing for a dispersion of investor opinion, curve B depicts investor demand at varying levels of value evaluations. Supply curve C is the base case in which the supply of shares is restricted, and short selling is banned. In case short selling is allowed, the supply curve shifts outwards to D. If short selling is allowed, but constrained, curve E depicts share supply.

3.3 Data

Monthly firm level NAV estimates are obtained from SNL Financial. The daily short sale data are from Dataexplorers Ltd. Dataexplorers tracts the activity of over 100 security lending firms that represent approximately 75 percent of the global securities market. This equates to three million transactions a day from several custodians and prime brokers that lend and borrow securities. The data contain firm level information on the dollar value and quantity of shares available for lending (the inventory) as well as the value and quantity of shares currently on loan to short sellers. Our sample period runs from September 2006 to June 2008. Our sample contains security loan information on 144 equity REITs (SIC code 6798), of which we are able to match 101 of these equity REITs to SNL NAV data.

We examine how short sales and short sale constraints affect variations in monthly REIT NAV premiums using two short sale variables. The first, $Short_{i,t}$, is the quantity of borrowed securities for firm *i* at time *t* as a percentage of shares outstanding, or[2]

$$Short_{i,t} = \left(\frac{\#borrowedsecurities_{i,t}}{shrout_{i,t}}\right) \tag{3.1}$$

As discussed above, Chen et al. (2011) and Li and Yung (1998) argue that REITs with a high short interest are more difficult to short. However, Chen et al. (2002) argue that a stock with a high (low) level of short interest may simply be one that is relatively easy (difficult) to short. Conversely, a low short interest may actually imply that a stock is difficult (costly) to short. Asquith et al. (2005), Nagel (2005), and Cohen et al. (2007) therefore stress the importance of accounting for the supply of shares available to be loaned when determining whether a stock is short sale constrained.

To obtain a measure of the time-varying difficulty or cost of shorting a stock, we introduce $Utilization_{i,t}$ as a second short sale variable. $Utilization_{i,t}$ is defined as the dollar value of shares on loan from beneficial owners (usually institutional investors) relative to the dollar

[2]Note that the number of borrowed securities is not completely equivalent to the short sale position, as not all shorted shares are borrowed. Our definition slightly understates the short sale quantity, nonetheless according to estimates of Ringgenberg (2010) the mean (median) correlation between loan quantity and semi-monthly short interest from Compustat is 0.70 (0.78) and therefore represents a significant portion of the total short volume.

value of the shares available for shorting (i.e., the current inventory of available shares), or

$$Utilization_{i,t} = \left(\frac{valueonloan_{i,t}}{inventoryvalue_{i,t}}\right) \tag{3.2}$$

If $Utilization_{i,t}$ is high, it reflects strong demand for and/or a limited supply of, shortable shares, which would mean it would be difficult and costly to short the stock at the margin.

Based on Miller's (1977) overvaluation theory, we expect high levels of short sale activity to reduce overvaluation, all else equal. Thus, in the cross section, we posit that REITs with relatively high short sale positions should trade closer to their NAV. In contrast, firms with high levels of utilization should be more difficult to short at the margin. Saffi and Sigurdsson (2010) show that increases in the supply of equity shares available for lending relieves short-sale constraints. Therefore, in the cross-section stocks with high utilization should trade at higher premiums to NAV, all else equal.

3.4 Sample Characteristics

Table 3.1 provides NAV premium descriptive statistics for our sample of 101 equity REITs. The mean and median premiums are calculated from the individual responses of analysts reporting to SNL. In the last four months of 2006, the average premium to net asset value was 8.35%, which is obtained from the estimates of 8.25 analysts, on average. In 2007, the REIT market traded at an average discount to estimated NAV of 6.05%. The average discount increased to 13.43% during the first half of 2008. The standard deviation of premium estimates ranges from 13-15% across the sample period. In late 2006, premiums ranged from -32% to 53.01%. The dispersion in premium estimates was even greater in 2007 and 2008. In short, there is substantial variation in NAV premiums both in the cross-section and over time.

Table 3.2 reports the mean end-of-month daily short selling statistics for the REITs in our sample, as well as the corresponding statistics for the universe of public equities. *Short* and *Utilization* are defined above. Interestingly, the mean short selling statistics for our REIT sample are similar to general equities. The data also reveal a significant increase in REIT short sale activity over the sample period. Chen et al. (2011) report a mean short interest of 2.19% among the most highly shorted REITs in their 1990 to 2005 sample. By 2007, however, 7.32% of outstanding REIT shares were shorted, on average, and by the first half of 2008 the

Table 3.1
Descriptive NAV Statistics

Monthly Net Asset Value summary statistics. Sample period September 2006 to June 2008. The NAV estimates were obtained from SNL Financial. Premium is calculated as price over the mean analyst estimate of NAV. The NAV stdev is the dispersion in analyst estimate is calculated as the standard deviation of all net asset value per share estimates placed in the last 120 days, from SNL Financials. The number of analyst estimates is the number of Analyst estimates underlying the mean NAV valuation metric.

Year		Min	Max	Mean	Stdev
2006	Mean Premium	-32.06%	53.01%	8.35%	12.94%
	# Analyst Estimates	1.00	19.00	8.25	3.98
	NAV stdev	0.01%	24.67%	4.33%	3.84%
	Mean Return	-12.77%	17.12%	2.49%	4.78%
2007	Mean Premium	-55.66%	70.33%	-6.05%	14.88%
	# Analyst Estimates	1.00	19.00	8.44	3.88
	NAV stdev	0.18%	25.53%	4.56%	3.92%
	Mean Return	-26.38%	20.27%	-2.03%	7.32%
2008	Mean Premium	-60.69%	30.76%	-13.43%	15.70%
	# Analyst Estimates	1.00	16.00	7.18	3.25
	NAV stdev	0.01%	20.15%	4.00%	3.41%
	Mean Return	-47.35%	32.12%	-0.09%	8.77%

average short interest position had increased to 10.49%. This compares with an average short position in common equities of 7.1%. These relative percentages are larger than those reported by Blau and Wang (2009) who document that REITs are shorted less than general equities in their 2005-2006 sample period.[3]

Table 3.2
Descriptive Statistics

Mean end-of-the month daily short selling statistics for the sample period July 2006-September 2008. *Short* is the total quantity of borrowed securities as a percentage of the shares outstanding. Inventory is the available inventory quantity from beneficial owners as a percentage of the number of outstanding shares. *Utilization* is the value of assets on loan from beneficial owners divided by the total lendable assets in percentages. Panel A consist of all equity REITs. The number of REITs are the total number of REITs within the sample period as obtained from the CRSP/Ziman Real Estate database. Panel B consist of all shares with share code 10 and 11 from CRSP within the Dataexplorers universe.

Panel A: Equity REIT Sample					
year	Obs	N	MCAP	*Short*	*Utilization*
2006	558	95	3,142,976	3.16	17.86
2007	1154	99	3,158,423	7.32	23.63
2008	1022	100	2,6196,918	10.48	27.93
Panel B: Common Equity Sharecode=10 or Sharecode=11					
year	Obs	N	MCAP	*Short*	*Utilization*
2006	10277	4447	2,758,624	3.94	22.69
2007	21526	4819	2,969,551	6.53	27.31
2008	32876	4617	2,315,195	7.07	27.60

In Figure 3.2, panels A and B, we plot monthly averages of daily *Short* and *Utilization* for our full REIT sample (solid lines) versus the corresponding means of *Short* and *Utilization* for REITs trading at premiums to NAV (dashed lines). It is clear from Figure 3.2 that premium REITs are, on average, more heavily shorted and generally have higher utilization levels.

In Panel A of Table 3.3, we provide additional daily short sale descriptive statistics for our sample of equity REITs. The average daily short position is 7.35%, with a minimum value of zero and a maximum of 41.73%. The average utilization is 23.37% while the highest recorded utilization level is 97.36%.

In Panels B through D, we report the corresponding statistics for REITs with relatively

[3]This might also be due to the fact that positions might be closed right before short interest data is recorded to hide the positions. An additional limitation of using short interest data.

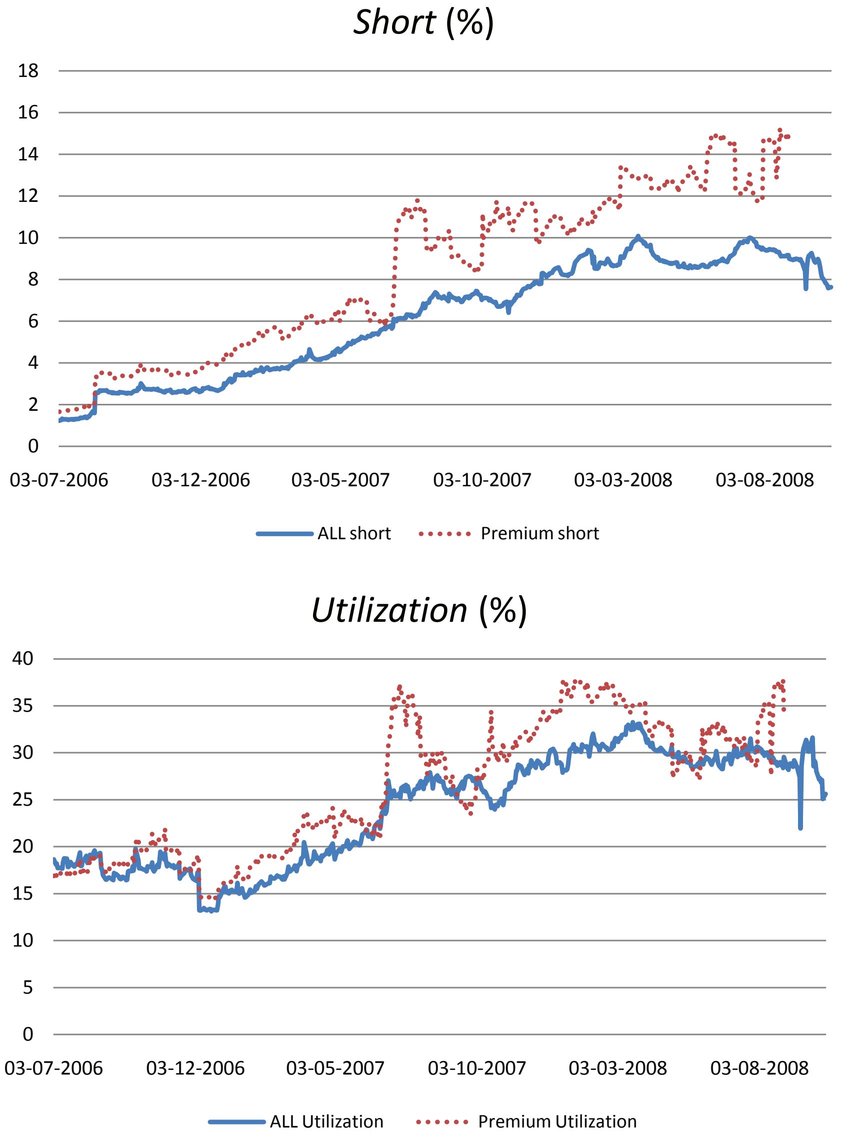


Figure 3.2

Time Series Average Short Sale variables

Daily average short sale variables for REITs trading at a premium in contrast to all equity REITs. Premium REITs are REITs trading above Net Asset Value in the month. NAV estimate refers the mean analyst estimate from SNL Financials. *Short* refers to the average daily quantity of borrowed securities as a percentage of shares outstanding. *Utilization* reflects the value of the borrowed shares relative to the inventory value.

high short positions and utilization levels. The mean NAV premium across the entire sample is -5% (Panel A.) However the average discount is much larger, -10% and -9%, among REITs with relatively high short sale positions, defined as greater than 10% (Panel B) and 20% (Panel C), respectively, of outstanding shares. Nonetheless, for REITs with high utilization levels the mean NAV premium increases. For example, in the subsample of REITs with utilization levels above 70% (Panel E), the average NAV premium is 3%.

3.5 Premium Dynamics: Panel VAR

We examine the variation in monthly NAV premiums over time using a panel vector autoregression framework (PVAR).[4] Although *Short* and *Utilization* are reported daily, we employ the levels of each at the close of the last business day of the month in our panel VAR regressions. Our results are robust to using the average daily *short* and *utilization* throughout the month.

We first perform a Fisher test for unit roots in the panel dataset for the variables used in our VAR analysis.[5] The null hypothesis of the Fisher test is that all the panels contain a unit root. We include panel-specific means (fixed effects). The Fisher test conducts a unit-root test for each panel individually, and then combines the p-values from these tests to produce an overall test using the four methods proposed by Choi (2001). Since the number of panels is finite, the inverse χ^2 P test is applicable. This statistic has a χ^2 distribution with 2N degrees of freedom. Large values of the test statistic result in rejection of the null hypothesis. The test results presented in Table 4 reveal that the null hypothesis of a unit root is rejected.[6]

A significant advantage of using a panel VAR approach is that it is a multivariate simultaneous equation system that treats all variables as endogenous, while allowing for unobserved REIT heterogeneity. We select the number of lags based on the AIC and the maximum likelihood ratio for various lag lengths. The data support the use of one lag and in general terms

[4]The estimation is implemented with the PVAR routine by Inessa Love. See Love and Zicchino (2006) for computational details. We select the lag length following the AIC and the maximum likelihood ratio for various lag lengths.

[5]Other tests such as those developed by Levin and Chu (2002), Harris and Tzavalis (1999), Breitung (2000), Breitung and Das (2005), Im and Shin (2003), and Hadri (2000) require a balanced panel. We select the lag length following the AIC and the maximum likelihood ratio for various lag lengths.

[6]All four of the tests strongly reject the null hypothesis that all the panels contain unit roots, however we report the the inverse χ^2 p-test as it is applicable for finite number of panels.

Table 3.3
Daily Short Sale data

Average daily short sale data for the equity sample of REITs, panel A. The Premium refers to monthly price over the mean analyst estimate of NAV, from SNL Financials. *Short* refers to the average daily quantity of borrowed securities as a percentage of shares outstanding. *Utilization* reflects the value of the borrowed shares relative to the inventory value. In panel B and C we look at the sub sample of REITs with relative short positions of at least 10 to 20 percent. Panel D and E are average short sale statistics for REITs with utilization levels above 50 and 70 percent.

Panel A: $All : REITs$					
N	Obs	Stat	Premium	*Short*	*Utilization*
101	54520	N	54520	54520	54520
101	54520	MIN	-61.00%	0.00%	0.00%
101	54520	MAX	70.00%	41.73%	97.36%
101	54520	MEAN	-5.00%	7.35%	23.37%
101	54520	STD	17.00%	5.78%	15.69%

Panel B: $Short > 10\%$					
N	Obs	Stat	Premium	*Short*	*Utilization*
77	14565	N	14565	14565	14565
77	14565	MIN	-61.00%	10.00%	13.35%
77	14565	MAX	31.00%	41.73%	86.46%
77	14565	MEAN	-10.00%	15.07%	39.79%
77	14565	STD	15.00%	4.83%	12.39%

Panel C: $Short > 20\%$					
N	Obs	Stat	Premium	*Short*	*Utilization*
23	1966	N	1966	1966	1966
23	1966	MIN	-61.00%	20.00%	25.54%
23	1966	MAX	14.00%	41.73%	77.56%
23	1966	MEAN	-9.00%	24.56%	51.65%
23	1966	STD	12.00%	4.86%	10.06%

Panel D: $Utilization > 50\%$					
N	Obs	Stat	Premium	*Short*	*Utilization*
46	3713	N	3713	3713	3713
46	3713	MIN	-61.00%	0.16%	50.01%
46	3713	MAX	42.00%	41.73%	97.36%
46	3713	MEAN	-5.00%	15.79%	60.98%
46	3713	STD	16.00%	8.91%	8.78%

Panel E: $Utilization > 70\%$					
N	Obs	Stat	Premium	*Short*	*Utilization*
16	553	N	553	553	553
16	553	MIN	-36.00%	0.40%	70.01%
16	553	MAX	42.00%	26.82%	97.36%
16	553	MEAN	3.00%	9.03%	76.91%
16	553	STD	15.00%	8.05%	6.42%

Table 3.4
Unit Root test

This table reports a Fisher-type panel unit root test. The Fisher-type (Choi 2001) tests has as the null hypothesis that all the panels contain a unit root. The Fisher test conducts a unit-root tests for each panel individually, and then combines the p-values from these tests to produce an overall test using the four methods proposed by Choi (2001). Since the number of panels is finite, the inverse χ^2 P test is applicable; this statistic has a χ^2 distribution with 2N degrees of freedom, and large values are cause to reject the null hypothesis. We include panel-specific means (fixed effects).

Fisher-type unit root test Based on augmented Dickey-Fuller tests		
Ho: All panels contain unit roots	Number of panels=101	
Ha: At least one panel is stationary	Avg. number of periods = 25.47	
	Inverse χ^2(198)	
Variable	P Statistic	p-value
Premium	345.04	0.00
Short	364.70	0.00
Utilization	458.28	0.00

we specify a first-order VAR model as follows:

$$y_{it} = \Upsilon_0 + \Upsilon_1 y_{it-1} + f_i + d_t + \epsilon_{it} \tag{3.3}$$

where y_{it} is a two variable vector including the premium to NAV and either *Short* or *Utilization*. More specifically, the following VAR system is first estimated for *Premium* and *Short*:

$$Premium_{it} = a_0 + \beta_1 Premium_{t-1} + \gamma_1 Short_{t-1} + f_i + d_t + \epsilon_{1,it}$$

$$Short_{it} = a_1 + \beta_2 Short_{t-1} + \gamma_2 Premium_{t-1} + f_i + d_t + \epsilon_{2,it} \tag{3.4}$$

This is followed by the estimation of the following two-variable one period lag model for *Premium* and *Utilization*:

$$Premium_{it} = a_2 + \beta_3 Premium_{t-1} + \gamma_3 Utilization_{t-1} + f_i + d_t + \epsilon_{3,it}$$

$$Utilization_{it} = a_3 + \beta_4 Utilization_{t-1} + \gamma_4 Premium_{t-1} + f_i + d_t + \epsilon_{4,it} \tag{3.5}$$

f_i represents firm fixed effects and d_t represents period-specific time dummies. The firm fixed effects control for any time-invariant unobservable influences on the NAV premium, such as management skill, expense ratios, and company reputation. The time period fixed effects control for any industry-wide influences on the premium to NAV. Together, the firm and period fixed effects allow us to control for possible omitted variable biases. [7]

The inclusion of the lagged NAV premiums in both the premium and short sale panel regression equations may induce dynamic panel bias. Because the premium is a function, at least in part, of the fixed effects, the lag of premium is correlated with the portion of the error term associated with the firm effects. This bias can be quite large in short panels as discussed by Arellano and Bover (1991), Bond (2002), and Flannery and Hankins (2010). The VAR model is therefore estimated using a system GMM estimator to account for the dynamic dependent variable.

The results of our panel VAR estimations are reported in Table 3.5. The left-hand panel displays the results when *Premium* and *Short* are used as the two dependent variables. The estimated coefficient on $Short_{t-1}$ is negative and significantly related to *Premium*. That is, an increase in short positions predicts a reduction in NAV premiums. More specifically, a 1% increase in *Short* in the previous month is associated with a 0.63% reduction in *Premium* in the following month. Premiums, however, do not appear to influence subsequent short sale positions.

In the right-hand panel of Table 3.5, we report results using *Premium* and *Utilization* as the two dependent variables. Higher levels of *Utilization* predict an increase in premium to NAV. More specifically, a 1% increase in *Utilization* is leads to a 0.74% increase in the premium in the following month. This result is consistent with utilization being a measure of short sale constraints. Simultaneously, increases in the NAV premium predict lower levels of utilization. Given that we do not find a significant relation between lagged premiums and contemporaneous short sale positions, this result appears to be driven by a supply effect; that is, high premiums lead to a larger increase in the supply of shares available for shorting than in the demand for shares to short. Increased premiums could also be associated with an increase in the fee charged by lenders to share borrowers, leading to an increased willingness to lend out securities. Overall, the results reported in Table 3.5 are consistent with the premise that increased short sale activity reduces valuations, all else equal. In contrast, increased utilization is a proxy for the increased difficulty (cost) of shorting shares. This increased cost makes it more difficult for informal investors to eliminate premiums.

[7] There are no perfect controls for omitted variables, our results are biased only if the omitted variables are correlated with the deviations of each included variable from its mean net of its time variation.

Table 3.5
Panel VAR

The panel VAR approach is a multivariate simultaneous equation system that treats all variables as endogenous, while allowing for unobserved fund heterogeneity. The lag length was selected following the AIC and maximum likelihood ratio for various lag lengths. The data support the use of one lag and we specify a first-order VAR model. The specification includes firm fixed effects and period-specific time dummies. The firm fixed effects control for any time-invariant unobservable influences on the NAV premium, such as management skill, expense ratios, and company reputation. The time period fixed effects control for any industry-wide influences on the premium to NAV. Together, the firm and period fixed effects allow us to control for possible omitted variable biases. The introduction of the fixed effects requires the model to be estimated by GMM. Fixed effects are removed using Helmert transformation (See Arellano and Bover (1995)). Estimation is by GMM with untransformed variables used as instruments for Helmert-transformed variables. For the period-specific effects variables are time-demeaned.

Panel VAR analysis					
EQ1: dep.var: $Premium_t$			EQ1: dep.var: $Premium_t$		
	Coefficient	t-statistic		Coefficient	t-statistic
$Premium_{t-1}$	0.67***	10.21	$Premium_{t-1}$	0.91***	17.47
$Short_{t-1}$	-0.63*	-1.96	$Utilization_{t-1}$	0.74**	2.35
EQ2: dep.var: $Short_t$			EQ2: dep.var: $Utilization_t$		
	Coefficient	t-statistic		Coefficient	t-statistic
$Premium_{t-1}$	-0.13	-0.69	$Premium_{t-1}$	-0.23***	-4.60
$Short_{t-1}$	0.90***	8.63	$Utilization_{t-1}$	-0.13	-0.47

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

3.5.1 Response of Premium to Short Sale Constraint

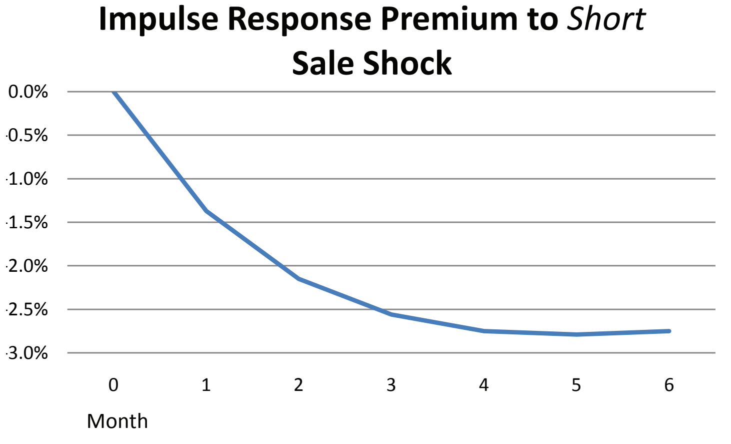
We also explore the dynamic effects of shocks to short sale position and utilization on the premium to NAV through the analysis of impulse-response functions. The impulse-response functions, displayed in Figure 3.3, depict the reaction of the NAV premium to a one standard deviation innovation in *Short* and *Utilization*. The premium to NAV shows an immediate reduction in response to a one standard deviation increase in *Short* (Panel A). Moreover, this premium reduction persists for the following 6 months. The immediate response to an innovation in *Utilization* is a substantial jump in the NAV premium (Panel B). However, this increase occurs only in the following month, after which the premium begins to decline. Six months following the shock to *Utilization* its effect on the premium approaches zero.

3.5.2 Decomposition of Premium Variation

Next, we examine how much of the variation in NAV premiums can be attributed to short sale activity and constraints by performing a panel VAR(1) Variance Decomposition. The variance decomposition quantifies how much of the forecast error variance can be explained by *Short* and *Utilization*. Table 3.6 shows the percent of the variation in the column variable explained by a shock to the row variable, accumulated over one, six, and twelve months. In Panel A, we report the shocks to short sale positions and utilization. Shocks to short sale positions explain 2.08% of the total variation in the NAV premium in the following month, 19.69% in the following six months, and 34.99% in the following 12 months. Shocks to utilization explain 21.02% of the premium variation in the short run and 32.83% over the following year. The results are even stronger if *utilization* is measured in share quantities instead of share values (untabulated results).

Lee et al. (1991) posit that discounts and premiums in closed-end general equity funds reflect investor sentiment. Similarly, Barkham and Ward (1999) document a common REIT sector effect in the pricing of individual REITs relative to their NAVs and suggest that investor sentiment is the major cause of the common variation in REIT NAV premiums and discounts.

To gauge the potential influence of sentiment we also include proxies for investor sentiment. Following Baker and Wurgler (2006) we construct both a real estate and stock market sentiment index. Appendix A contains details on the construction of our sentiment indices; in Appendix B we report both sentiment indices. To control for sentiment's influences on deviations from fundamental values, we calculate for each firm in our sample the sensitivity of the



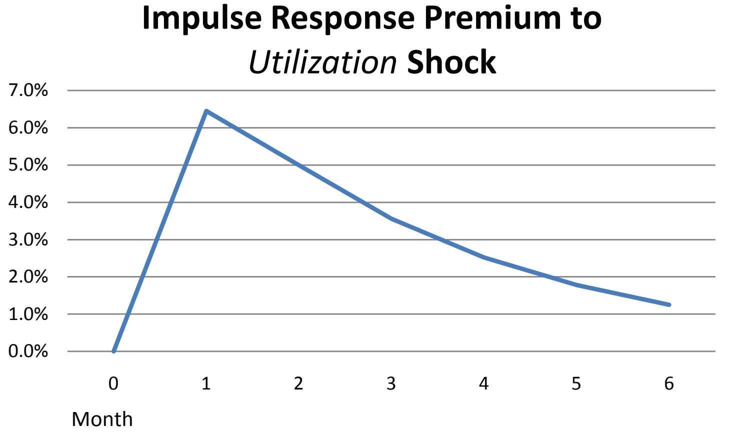


Figure 3.3
Impulse Response Function Premium

Impulse-response functions describing the reaction of the premium to NAV to a standard deviation shock in *Short* and *Utilization* in the following 6 months. The impulse-response functions follow from a a first-order VAR model specification, including premium to NAV and one of the respective variables and fund and period-specific fixed effects. Fixed effects are removed using Helmert transformation (See Arellano and Bover (1995)). Estimation is by GMM with untransformed variables used as instruments for Helmert-transformed variables. For the period-specific effects variables are time-demeaned.

firm's returns to the respective sentiment index. The betas with respect to the sentiment index are estimated using 20 month rolling regressions.

As can be seen in Panel A of Table 3.6, real estate market sentiment explains about 20.18% of the variation in the premium 1 year ahead, and is of more economic significance than stock market sentiment, which explains only 13.89% of the variation in premiums. Clayton and MacKinnon (2001) suggest that noise traders can have an important influence on the variation in premium. We approximate the influence of noise traders indirectly look at institutional investor presence and the spread. The spread adds no incremental explanatory power. However, institutional ownership explains 4.76% of the variation in premium in the following 12 months.

In panel B, we report a corresponding set of results obtained after orthogonalizing the NAV premium with respect to a set of control variables. Barkham and Ward (1999), Clayton and Mackinnon (2001), and Anderson, Conner and Liang (2001) find that larger REITs tend to have lower discounts. According to Anderson, Conner and Liang (2001), leverage is penalized in the public REIT market because it reduces flexibility and increases the volatility of earnings and systematic risk. Bond and Shilling (2004) find that both systematic and unsystematic risk are associated with NAV premiums. To control for the potential influence of these additional variables, we add accounting information and other REIT characteristics to our panel VAR specification, such as firm size, performance (past returns), leverage, systematic risk, idiosyncratic risk (volatility), liquidity, market-to-book ratio, institutional ownership, the fraction of closely held shares, the number of analyst estimates of NAV, and the dispersion in analyst estimates, next to the period and fund fixed effects already in place.

The use of residual premiums allows us to investigate the marginal influence of short sale activity and constraints on NAV premiums. After controlling for REIT characteristics, utilization still explains a significant 7.76% of the residual variation in REIT premiums in the next month and almost all of the residual variation over the next year. However, the economic magnitude of premium variation explained by the level of short sale activity is slightly reduced relative to the results reported in Panel A. Nevertheless, short sale positions still explain 13.02% of the residual variation in premiums over the next 12 months. Real estate market sentiment explains 5.70% of the variation in the premium 1 year ahead, and remains more economically significant than stock market sentiment, which explains only 0.37% of the variation in premiums.[8] The level of institutional ownership adds little explanatory power. The

[8]The orthogonalized premium is with respect to the remaining controls, excluding the variable of interest.

spread, which proxies for the influence of noise traders as in Clayton and Mackinnon (2001), is slightly more significant in the longer run; however, it remains less important than short sale constraints and real estate market sentiment.

In Panel C of Table 3.6, we also orthogonalize the short sale variables with respect to our set of control variables to control for the common variation in the short sale variables due to REIT characteristics. This in combination with the fixed effects significantly reduces the economic magnitude of the explained variation, suggesting short sales and utilization are related to firm characteristics. Although the influence of short sale activity and constraints on NAV premiums is reduced, it remains larger than the rational and behavioral factor explanations proposed in the literature.[9]

3.6 Return Analysis

To further substantiate that higher utilization leads to an increase in overvaluations and NAV premiums, we examine the *ex post* relation between *Short*, *Utilization* and subsequent REIT returns. The expectation is that if high *utilization* leads to overvaluation, we should observe a negative alpha in the following month as prices revert toward their fundamental values. Chen, Downs and Patterson (2011) construct calendar time portfolios by assigning the cross-section of REITs to quartiles based on monthly short interest. To retain cross-sectional variation and given our limited sample period, we employ pooled, cross-sectional regressions. More specifically, we first estimate a single-factor abnormal return for each REIT in each quarter using a rolling window of 20 months and the CRSP Ziman REIT index as the benchmark market return to determine whether REITs with high utilization levels underperform the general REIT market. We then explain abnormal returns using the previous month daily utilization in a Fama-Macbeth regression. The Fama-Macbeth regression accounts for the cross-sectional correlations of the individual REITs by re-sorting the REITs into quartiles each period. In the first step, a cross-sectional regression is estimated for each month and in the second we then report the average of the first step coefficient estimates. This approach allows us to test how much of the correction is related to the presence of a short sale constraint and whether it pertains to premium REITs.

In Table 3.7, we report the abnormal return results using *Utilization* as our measure of short sale constraints. In the first specification, the estimated coefficient on $Utilization_{t-1}$

[9] Untabulated as they are zero.

Table 3.6
Variance Decomposition

Variance Decompositions following the PVAR(1). The variance decomposition determines how much of the forecast error variance of each of the premium to NAV can be explained by exogenous shocks to *short* and *utilization*. The table reports the percent of variation in the column variable explained by row variable, accumulated over time. In Panel B we first orthogonalize the premium with respect to REIT specific control variables. We control for accounting information and REIT characteristics, such as size, performance (past returns), leverage, systematic risk and volatility, liquidity, market-to-book ratio, institutional ownership and the fraction of closely held shares, the number of analyst estimates and the dispersion in analyst estimate. Additionally, we include sentiment measures, which are the beta's with respect to the real estate and stock market sentiment indices. The variance decomposition of sentiment, the spread and ownership follow the orthogonalization excluding these variables from the control set.

Panel A: Variance Decomposition Premium						
		Premium		Premium		Premium
	Months		Months		Months	
Short	1	2.08%	6	19.69%	12	34.99%
Utilization	1	21.02%	6	32.30%	12	32.83%
RE Sent	1	1.75%	6	13.63%	12	20.18%
Stock Sent	1	0.81%	6	7.73%	12	13.89%
Spread	1	0.00%	6	0.01%	12	0.01%
Institutional Ownership	1	1.23%	6	4.76%	12	4.76%

Panel B: Variance Decomposition Premium orthogonalized wrt controls						
		Premium		Premium		Premium
	Months		Months		Months	
Short	1	0.09%	6	2.09%	12	13.02%
Utilization	1	7.76%	6	99.63%	12	99.67%
RE Sent	1	0.62%	6	4.02%	12	5.70%
Stock Sent	1	0.02%	6	0.20%	12	0.37%
Spread	1	2.46%	6	2.45%	12	2.45%
Institutional Ownership	1	0.09%	6	0.75%	12	1.21%

Panel C: Variance Decomposition Premium and short sale measures orthogonalized wrt controls						
		Premium		Premium		Premium
	Months		Months		Months	
Short	1	0.01%	6	0.02%	12	0.02%
Utilization	1	0.12%	6	0.29%	12	0.29%

is negative and highly significant. More specifically, a correction of 1.48 basis points per month is associated with a 1% increase in utilization. In the second specification, we add the lagged NAV premium along with an interaction term to determine whether the return correction is increasing in the level of NAV premium. Interestingly, the estimated coefficient on $Premium_{t-1}$ is positive and significant, suggesting our results are not driven by a mean reverting pattern in NAV premiums (as found by Gentry et al. (2004)), but by the presence of a short constraint. The interaction term indicates that for every 1% increase in the premium the correction increases by four basis points.

In the third specification, we include firm size, the market-to-book ratio (MTB), and the past 12 month returns as controls.[10] Both the estimated coefficient on $Utilization_{t-1}$ and the $Utilization_{t-1} * Premium_{t-1}$ interaction variable increase in magnitude. For example, for every 1% increase in the premium the abnormal return decreases by six basis points per month. Finally, in our fourth specification we exclude the premium level but include an indicator variable that is set equal to one if the REIT trades at a premium to its estimated NAV. The results from this fourth specification show that the magnitude of the price correction is increasing in the level of the premium. The return correction is 1.27% greater for REITs trading above NAV. Economically, the correction is large only for premium REITs. That is, for a 1% increase in *Utilization* there is only a one basis point return correction, on average, in the following month for REITs trading at a discount to their estimated NAVs.

Table 3.8 reports the abnormal return results using *Short* in place of *Utilization*. The results from the first specification show that increases in short sale activity are associated with lower abnormal returns. More specifically, every 1% increase in short sale activity leads to a correction of 0.5 basis points per month. In the second specification, we add an interaction term to determine whether the return correction is increasing in the level of NAV premium. Increased short sale activity leads to a three basis point reduction in abnormal returns. However, the reduction is not increasing in the NAV premium. This suggests that the level of short sale interest is not a constraint to potential arbitrageurs. Rather, it serves to help align prices to fundamentals. This result is robust to the inclusion of characteristic control variables and to the inclusion of an indicator variable that is set equal to one if the REIT is currently trading above its estimated NAV value.

To determine how and when the price correction takes place, we run the specification for

[10]The results are similar to first estimating a four-factor abnormal return in the first stage, we opt for this approach as in the construction of the Fama French factors REITs are excluded.

Table 3.7

Return Analysis *Utilization*

We first estimate the abnormal return of each REIT using a rolling window of 20 months and the CRSP Ziman index as market return. Then we explain the abnormal returns using the previous month daily utilization in a Fama-Macbeth regression. The Fama-Macbeth regression accounts for the cross-sectional correlations of the individual REITs by forming a portfolio for each period. It involves two steps, in the first step, a cross-sectional regression is estimated for each month and in the second we then report the average of the first step coefficient estimates. The reported results are in percentages.

Variables	(1) AR_t	(2) AR_t	(3) AR_t	(4) AR_t
$Utilization_{t-1}$	-0.01***	-0.02***	-0.02***	-0.01***
	(-14.39)	(-9.72)	(-7.98)	(-3.32)
$Premium_{t-1}$		0.02***	0.01**	
		(4.49)	(2.66)	
$Utilization_{t-1} * Premium_{t-1}$		-0.04**	-0.06***	
		(-2.09)	(-3.56)	
$Positive_{t-1}$				0.24**
				(2.76)
$Positive_{t-1} * Utilization_{t-1}$				-1.27***
				(-2.81)
Controls				
Size			-0.00***	-0.00***
			(-3.16)	(-3.63)
MTB			0.00	0.00
			(0.99)	(1.00)
Past 12m Ret			0.29***	0.28***
			(25.09)	(25.95)
Constant	-0.00***	0.00***	0.01***	0.01***
	(-4.33)	(3.37)	(2.85)	(2.89)
Observations	1,978	1,978	1,828	1,828
R-squared	6.90	17.60	33.32	33.33

t-statistics in parenthesis

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 3.8
Return Analysis *Short*

We first estimate the abnormal return of each REIT using a rolling window of 20 months and the CRSP Ziman index as market return. Then we explain the abnormal returns using the previous month daily short sale quantity in a Fama-Macbeth regression. The Fama-Macbeth regression accounts for the cross-sectional correlations of the individual REITs by forming a portfolio for each period. It involves two steps, in the first step, a cross-sectional regression is estimated for each month and in the second we then report the average of the first step coefficient estimates. The reported results are in percentages.

Variables	(1) AR_t	(2) AR_t	(3) AR_t	(4) AR_t	(5) AR_t
$Short_{(t-1)}$	-0.00**	-0.03***	-0.03***	-0.05*	-0.04**
	(-2.77)	(-5.18)	(-4.78)	(-1.98)	(-2.19)
$Premium_{(t-1)}$		0.01***	-0.00		
		(2.81)	(-0.15)		
$Short_{(t-1)} * Premium_{(t-1)}$		0.04	-0.05		
		(0.78)	(-1.35)		
$Positive_{(t-1)}$				0.46**	0.14
				(2.07)	(0.71)
$Short_{(t-1)} * Positive_{(t-1)}$				-0.67	-2.04
				(-0.18)	(-0.62)
Controls					
Size			-0.00**		-0.00**
			(-2.18)		(-2.37)
MTB			0.00		0.00
			(0.79)		(0.94)
Past 12m Ret			0.33***		0.31***
			(30.44)		(31.52)
Constant	-0.00***	-0.00**	0.00	-0.00***	0.00
	(-21.27)	(-2.08)	(1.27)	(-3.64)	(1.39)
Observations	1,998	1,978	1,828	1,978	1,828
R-squared	2.00	10.40	28.00	5.50	28.61

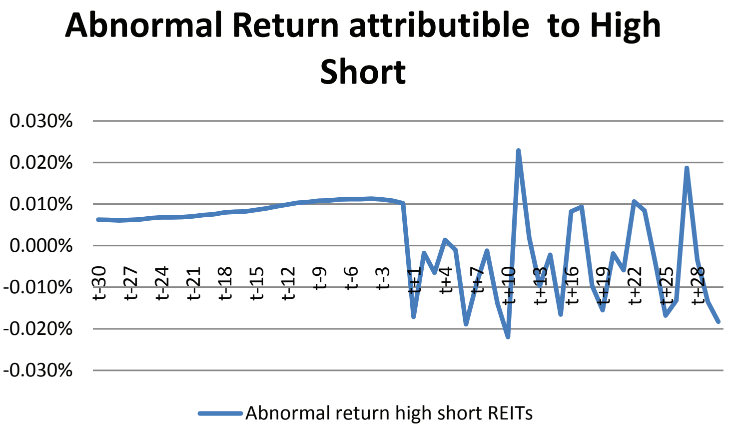
t-statistics in parenthesis
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

each day beginning 30 days before to 30 days after the classification of high relative utilization and short levels. The first graph in Figure 3.4 represents the coefficient of the daily single factor abnormal returns on the dummy variable of a REIT being classified at time *t* to belong to the highest short sale tercile. The dummy variable coefficient compares the abnormal returns in the period prior and following the high short sale classification with the abnormal return of stocks that are not classified as having high short sale levels. Alternatively, it can be interpreted as the single factor abnormal return attributable to the presence of high relative short sale levels at time *t*. The second graph depicts the cumulative abnormal return differential.

In the days leading to high short sale quantities, the abnormal returns are positive. In the days following the high short sale quantity returns are negative. The pattern in the days leading to high relative short sale quantity the abnormal returns are positive but flat, suggesting short sellers position themselves in stocks that have done reasonably well. This result is also documented by Diether, Lee and Werner (2009) and Jones and Lamont (2002). The pattern suggests that as REITs become overpriced, they are identified by short sellers. Short sales, in turn, increase the supply of shares leading to a price reduction and correction of the mispricing.

Figure 3.5 represents the coefficient of the single factor abnormal returns on the dummy variable of a REIT being classified at time *t* to belong to the highest utilization tercile. The dummy variable coefficient compares the abnormal returns in the period prior to and following the high utilization classification with the abnormal return of stocks that are not classified as having high utilization levels. Single factor abnormal returns attributable to the presence of high relative utilization levels at time *t* are presented in Panel A. The graph in Panel B is the cumulative abnormal return differential.

The time pattern of abnormal returns lines up with the overpricing hypothesis. In the days leading to high utilization levels, the abnormal returns are positive and increasing. In the days following the high utilization quantity returns are negative. The increase in the abnormal returns in the days leading to high utilization, suggest that utilization leads to more overpricing. This is also found in the panel VAR analysis. The pattern suggests that utilization leads to overpricing; however, once these overpriced REITs are identified by short sellers, returns subsequently decline as the mispricing is corrected.



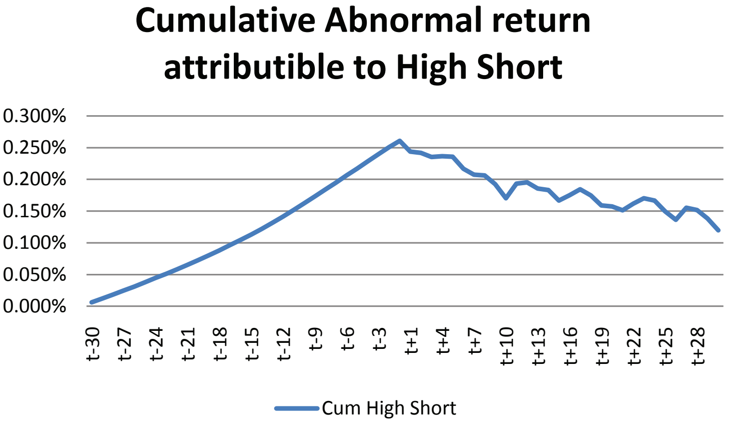
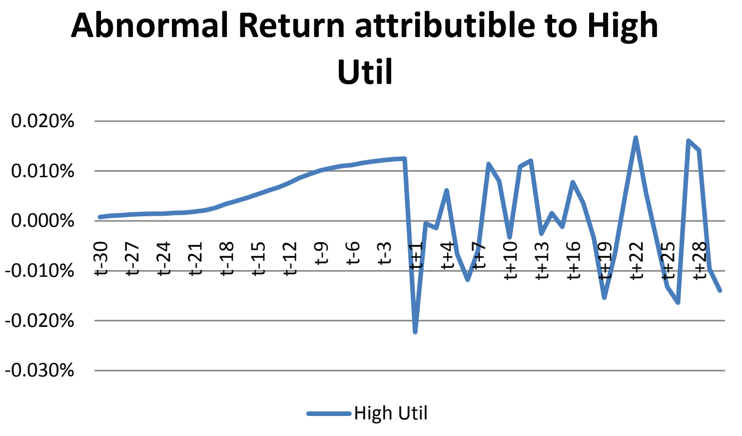


Figure 3.4
Abnormal Return High Short

The first graph represents the coefficient of the daily single factor abnormal returns on the dummy variable of a REIT being classified at time *t* as the highest short sale tercile. The dummy variable coefficient compares the abnormal returns in the period prior and following the high short sale classification with the abnormal return of stocks that are not classified as having high short sale levels. Single Factor Abnormal Returns attributable to the presence of high relative short sale levels at time *t*. The second graph is the cumulative abnormal return differential.



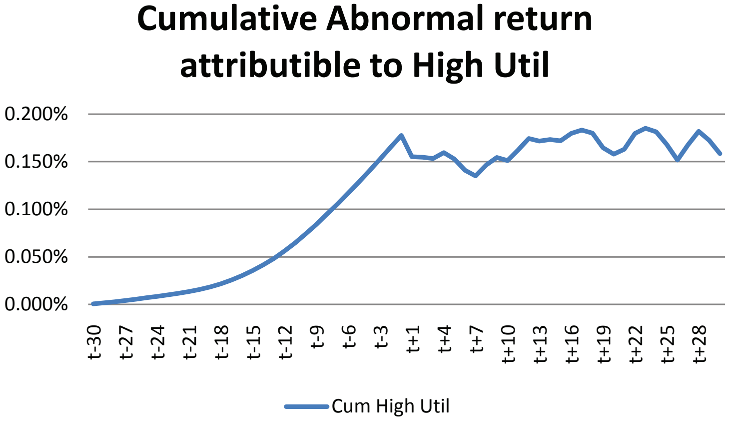


Figure 3.5
Abnormal Return High Utilization

The graphs plot the coefficient of the single factor abnormal returns on the dummy variable of a REIT being classified at time *t* to the highest utilization tercile. The dummy variable coefficient compares the abnormal returns in the period prior and following the high utilization classification with the abnormal return of stocks that are not classified as having high utilization levels. Single Factor Abnormal Returns attributable to the presence of high relative utilization levels at time *t*. The second graph is the cumulative abnormal return differential.

3.7 Conclusion

In this paper, we examine the role short sale activity and short sale constraints play in explaining the cross sectional variance of REIT premiums to NAV. In accordance with Miller's (1977) framework, we expect that differences of investor opinion in the presence of short-sale constraint result in stock price overvaluation. If short selling is banned or constrained, it is more difficult for negative information and opinions to reach the market; thus, stock prices may be set by the most optimistic investors. Testing Miller's (1977) framework with REIT data offers the opportunity to measure overvaluation with respect to fundamental value. For REITs, fundamental value can be proxied for by the consensus estimate of the REIT's net asset value provided monthly by stock analysts that follow the firm.

For a sample of 101 U.S. Equity REITs, we study the monthly Price over NAV evolution and assess the effects of both short sale activity and short sale constraints, using a panel vector autoregression. We find that the variation in short sale activity across individual REITs can account for at least one-third of the variation in NAV premiums. Short sale constraints amplify fluctuations REIT NAV premiums and the influence is of greater importance than market sentiment. Our results also show that short sale activity is not, in itself, a constraint measure. Short sales increase the supply of shares and therefore reduce prices. Short sale constraints are binding when there is strong demand and limited supply. High demand relative to low supply leads to overvaluation. Finally, we perform a return analysis and find that the correction of the overvaluation occurs only for premium REITs.

This study complements the existing literature in several ways. First, we add to the literature on short sales by directly linking short sales and short sale constraints to valuation using U.S. Equity REITs, where fundamental value is estimated every month by third party stock analysts. Our results also add to the REIT literature by providing a new explanation for why REIT share prices deviate from NAV. In addition to rational explanations (largely based on firm characteristics) and behavioral (noise trading) explanations, we find that short sale activity and, especially, short sale constraints help explain variation in the cross section of REIT NAV premiums and subsequent abnormal returns.

Stock Characteristic Variables	**Definition**
Size (MCAP)	Price*shares outstanding from the CRSP monthly file
Turnover	Volume over shares outstanding
Leverage	ratio of total debt (item 34, debt in current liabilities+ item 9, long-term debt) to item 6, assets
Market Value Assets (MVA)	MVA is obtained as the sum of the market value of equity (item 199, price-close*item 54, shares outstanding) + item 34, debt in current liabilities + item 9, long term debt + item 10, preferred-liquidation value, - item 35, deferred taxes and investment tax credit.
Market-to-book ratio	MTB is the ratio of market value of assets (MVA) to Compustat item 6, assets
Spread	Spread is the difference between the closing bid and ask quotes for a security over the security price
Amihud illiquidity	Amihud illiquidity measure is calculated as the daily average of absolute value of return divided by dollar volume for asset *i* in a month
Systematic risk (Beta)	Systematic risk was calculated on a rolling window basis of 25 months with respect to the CRSP/Ziman value weighted index
Standard deviation (stdev)	Volatility, measured as the standard deviation of the monthly returns over 20 months
Past returns	moving average returns over 3 (MVAreturn3month), 6 (MVAreturn6month) and 12 months (MVAreturn12month) as well as the last months return (Return(t-1)) Price information from CRSP/Ziman
Institutional Ownership	Compilation of the holdings of institutional investors from 13-f filings
Closely Held Shares (Clsheld)	Clsheld represents shares held by insiders. The fraction of closely held shares we obtained from Thompson.
Premium (P/NAV)	Premim to Net Asset Value is calculated as the price over NAV: ((P/NAV)-1). The NAV is the mean analyst estimate from SNL Financials
NAV stdev	The dispersion in analyst estimate is calculated as the standard deviation of all net asset value per share estimates placed in the last 120 days. Source: SNL Financial
# Estimates	The number of Analyst estimates underlying the mean NAV valuation metric.

(Continue on next page)

Stock Market Sentiment	**Definition**
Stock Market Sentiment	To correct for sentiment influences in the deviations from fundamental value we calculate for each firm in our sample the sensitivity of the firm to the respective sentiment index. The beta's with respect to the sentiment index are estimated on the basis of rolling window regressions of 20 months. The Stock market sentiment index is constructed as the first principal component of six sentiment proxies following Baker and Wurgler, (2006), dividend premium, closed-end fund discount, the number and first-day return on IPOs and the equity share in new issues. We use the monthly data as used and described in Baker and Wurgler (2007). We update the data until June 2008. The dividend premium is defined following Baker and Wurgler (2004) as the log difference in the value weighted average market to book of payers and the value weighted market to book of nonpayers. The updates were obtained from Compustat. IPO volume and first-day returns and updates are from Jay Ritters website. Closed-end fund discount from from CRSP (general equity funds only). Issue information was obtained from SDC. Lagged one year NYSE turnover from NYSE Factbook, detrended using past five-year average. The sentiment variables were orthogonalized wrt macro variables to remove the influence of economic fundamentals. We regress, using a 50 month rolling window, each proxy on macro variables; changes in industrial production, employment and the NBER recession indicator. The macro variables were obtained from econstat.com and the NBER website. Long run S&P stock data were obtained from Shillers website. The first principal component explains 40% of the sample variance. In line with Baker and Wurgler (2006), closed-end fund discount and the dividend premium load negatively on the sentiment index,while IPO activity and turnover load positively on sentiment.The correlation of our sentiment index with that of Baker and Wurgler (2007) over 1969-2005 is 0.74.

(Continue on next page)

Real Estate Sentiment	**Definition**
Real Estate Sentiment	We use four sentiment proxies related to the real estate industry to extract a principal component: the average market turnover ratio of REITs (TR), the average volume of Initial Public Offerings of REITs (IPO), the lagged average price-to-earnings ratio of REITs (PE), and the average relative market capitalization between the REIT sector and the stock market (RMC). The real estate IPO data was obtained from SDC, while PE ratios and market capitalization were obtained from CRSP and Compustat. In order to control for the effect of business-cycle factors and fundamentals, we regress each proxy on the development of the REIT market, as proxied by the FTSE/NAREIT index (We also performed a similar analysis using the direct property MIT Transaction Based index, the results were comparable.)and the economy-wide factors (growth in industrial production, growth in employment, and an NBER recession indicator). The Real Estate Sentiment index is constructed as the first principal component of the residual series. The sentiment index explains 32.5% of the sample variance. Figure in Appendix A.II exposes both the stock market and real estate sentiment indices.

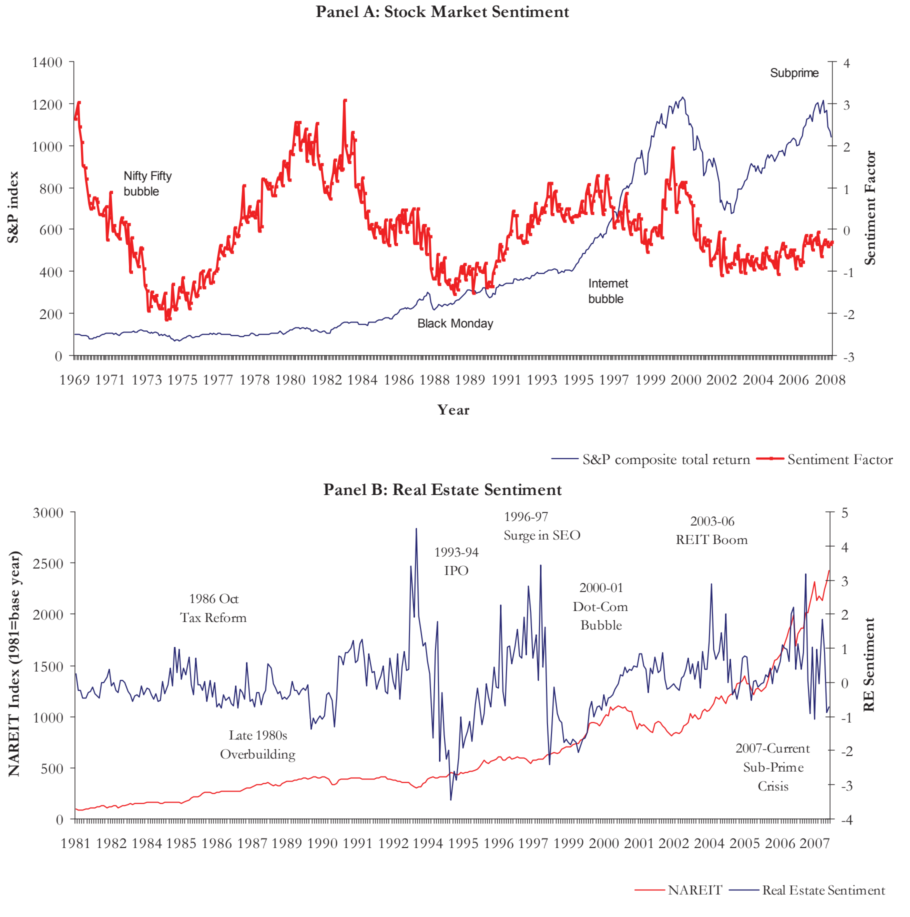


Figure 3.6
Appendix A.II Sentiment Index

Sentiment is constructed as the first principal component of six sentiment proxies following Baker and Wurgler, (2006), dividend premium, closed-end fund discount, the number and first-day return on IPOs and the equity share in new issues. We use the monthly data as used and described in Baker and Wurgler, (2007), available at http://pages.stern.nyu.edu/ jwurgler/. We update the data until June 2008. Panel B depicts the Real Estate Sentiment index. We use four sentiment proxies related to the real estate industry to extract a principal component: the average market turnover ratio of REITs (TR), the average volume of Initial Public Offerings of REITs (IPO), the lagged average price-to-earnings ratio of REITs (PE), and the average relative market capitalization between the REIT sector and the stock market (RMC). The real estate IPO data was obtained from SDC, while PE ratios and market capitalization were obtained from CRSP and Compustat. In order to control for the effect of business-cycle factors and fundamentals, we regress each proxy on the development of the direct real estate market (MIT transaction based index). The MIT index was obtained from the MIT website. The Real Estate Sentiment index is constructed as the first principal component of the residual series.

Chapter 4

The Price of Prospective Lending: Evidence from Short Sale Constraints*

4.1 Introduction

The securities lending market has grown dramatically in the past decade. In July 2008, short interest on the New York Stock Exchange reached a peak of 18.6 million shares, equal to 4.7% of the total shares outstanding.[1] The US equity lending market grew in size to $320 billion in 2009.[2] Greater short sale volume led to increased lending income for institutional investors. According to Data Explorers Ltd, investment companies earned almost $1.4 billion in 2008 from lending their securities. Mutual funds reported $1 billion in lending revenue and pension funds added $500 million to their overall portfolio returns. Through lending shares to short sellers, institutional investors benefit by generating lending income. Kaplan et al. (2010) conduct a lending experiment for an anonymous money manager and estimate the returns per year of lending high-fee stocks to be around 2.78 to 4.64% for the trial period September 5th to 18th, 2008.

In this study, I show that this lending income is capitalized into prices. I build on the theoretical research by Duffie et al. (2002), who present a dynamic model of asset valuation in which short selling requires searching for security lenders and bargaining over the lending

*This chapter is based on Porras-Prado (2011). It has benefited from helpful comments by Dirk Brounen, Bruce Grundy, David Ling, Nimalendran Mahendrarajah, Andy Naranjo, Husza'R Zsuzsa Reka, Jay Ritter, Pedro Saffi, Elvira Sojli, Marta Szymanowska, Mathijs van Dijk, Manuel Vasconcelos and Marno Verbeek. I also acknowledge the financial support of Erasmus Trustfonds.

[1] http://www.nyse.com/press/1219746761185.html

[2] Source: Securities Lending Yearbook 2009, Data Explorers

fee. They argue that investors are willing to pay more than their valuation of the share, if they expect to profit from lending it in the future when the opportunity arises.

To understand how lending expectation can play a role in pricing, consider the example of Duffie et al. (2002). Suppose there are two groups of optimistic and pessimistic investors and two rounds of trades. The optimists assign a value of 100 to a security; the pessimistic investors assign a value of 90. In the final round of lending, the pessimistic investors would be willing to pay up to 10 in lending fee to short the asset. The optimists anticipate this lending fee and are willing to buy the security for 100+10=110. The prospect of lending fees increases prices above even the most optimistic buyer's valuation of the security's future dividends. In other words, the stock price is the expected future income associated with the potential to lend the asset, plus the expected valuation of the marginal investor.

In this study, I address the following question: are investors willing to pay a premium associated with lending income? The purpose is to examine whether security prices incorporate lending income. To determine whether institutional investors anticipate lending profits, I examine how prices behave following a failure-to-deliver in the equity lending market. The search for a counter party is the mechanism that affects asset values as described by Duffie, Gârleanu and Pedersen (2002, 2007). Failure-to-deliver represents situations in which it is difficult to locate securities available for borrowing, resulting increased bargaining power for the lender and prospective increases in lending profits which, in turn, should lead to higher prices. I examine whether the capitalization of future lending income leads to price inflation by using the deviations from intrinsic value as measured by price to Net Asset Value (NAV) of closed-end funds. If lending income is capitalized in prices there should be a positive correlation between the occurrence of a failure-to-deliver on the closed-end fund and the premium to NAV, after accounting for both rational and sentiment driven influences on deviations from NAV.

The results show that closed-end funds with reported delivery failures trade at a 2.63% premium. More specifically, a 1% of shares outstanding uncovered short sale position leads to a 3.05% increase in premium to NAV. The results are robust to variations in failure measurement, to alternative estimation techniques and to endogeneity concerns. The failure premium is related to future lending fee and loan quantity. The failure premium decreases with the availability of inventory and the number of active lending agents, consistent with lower bargaining power among lenders when demanding higher future lending fees. As additional support for the fee capitalization hypothesis, I also find that the premium associated with a failure is less pronounced during the low fee period and failures lead to increased institutional ownership.

Second, I contrast the pricing of funds with reported failures to the pricing of funds with other measures of short sale constraints in place. I look at the dynamic relation between prices, lending fees and short sales and relate the cross-sectional variation in the pricing of various measures of short sale constraints to the cross-sectional variation in lending expectation arising from these constraints. The empirical pattern in the pricing of the various measures of constraints is consistent with the lending income expectations that arise from the short sale constraint measures.

This study contributes to the literature on short sale constraints and valuation and to the literature on the information content of short sales. Seneca (1967), Miller (1977), Figlewski (1981), and Morris (1996), among others, argue that security prices are upward biased when short sale constraints exist because negative information is not fully released in prices. The results of this study suggest that overpricing is not solely due to restriction on negative information but also partly a result of capitalized lending income.

The study provides new insights into the dynamic relation between search frictions, prices, lending fees and short sales. Evans et al. (2009) show that the incidence of failing is related to high equity loan costs. I find that failure-to-deliver predicts a higher probability of higher future fees and increased short sale frequency, as measured by the amount of shares on loan. This suggest that failures-to-deliver proxy for increased lending revenue and that the capitalization of lending profit drives prices up.

Additionally, evidence on the evolution of short sale price and frequency, following the occurrence of other constraints, provides an interesting outlook on how constraints differ in terms of future short sale activity. The analysis further stresses the large cross-sectional pricing differences among various measures of short sale constraints. Most prior research looks at the pricing implications of one constraint at a time. This study shows that various constraints can have different pricing implications. Importantly, this study shows that pricing differences originate from heterogeneous lending expectations following constraints. Failure-to-deliver gives rise to lender expropriation and utilization and short sales lead to an increase in lending frequency. The differences in the pricing of the constraints line up with future lending outlook. The fact that lending expectations mirror pricing is consistent with the premise that lending income plays a role in pricing.

The results have important implications for existing studies. Several papers conclude that short sales predict abnormally low future returns.[3] However, there is no consensus conclusion as to why short sales predict abnormally low future returns. Ringgenberg (2010) shows that short sales increase the supply of shares outstanding, which leads to lower prices in the presence of a downward sloping demand curve. Boehmer et al. (2011) suggest that short sellers are informed and impound information in prices. Engelberg et al. (2010) claim short sellers trading advantage comes largely from their ability to analyze publicly available information. According to Duffie et al. (2002) price reflects that a given share can potentially be lent several times in the future. Their model predicts that as short interest accumulates over time, the quantity of unfilled positions declines, so that the expected lending frequency for each share is reduced, depressing the lending fee as well as the price. This suggests that the reduction of lending income eventually accounts for the underperformance of stocks. In line with lending income playing a role in the stock performance I report significantly higher abnormal returns for stocks with reported failures than for stocks subject to other short sale constraints measures. The future lending profits attenuate the correction and the reduction of lending income accounts for the underperformance of stocks.

The capitalization of lending income explains Autore et al. (2010)'s finding that stocks reaching threshold levels of failures with low short interest become more overvalued than threshold stocks with high short interest. Lending income could also explain Boehmer, Huszár and Jordan's (2009) finding that stocks with low short interest experience positive abnormal returns, given that D'Avolio (2002) shows that the mean loan fee is also high for the first short interest portfolio decile of portfolios. Especially considering that for the low short interest decile there is the potential to be lent in the future.

The results from this study imply that short selling constraints can cause prices to deviate from the intrinsic value due the capitalization of future lending income. To the best of my knowledge, this study is the first to empirically show that future lending expectation plays a role in equity pricing.[4]

The remainder of the chapter is organized as follows. Section 4.2 discusses the general

[3] E.g. Brent et al. (1990), Senchank and Starks (1993), Aitken et al. (1998), Aitken et al. (1998), Dechow et al. (2001), Danielsen and Sorescu (2001), Asquith et al. (2005), Desai et al. (2002), Geczy et al. (2002), Jones and Lamont (2002), D'Avolio (2002), Angel et al. (1998), Lamont (2004), Diether, Werner and Lee (2009), Boehmer et al. (2008) and Boehmer et al. (2010).

[4] In the context of the Treasury repo market, Duffie (1996) documents that special repo rates increase the equilibrium price of the underlying instrument. In Duffie et al. (2002) the theoretical relation is extended to equity and fixed income security lending. In Duffie et al. (2007) they provide a theory of dynamic asset pricing that treats search and bargaining in over-the-counter markets.

issues of short sale constraints and reviews related literature. In Section 4.3, is the description of the loan data and the closed-end fund sample. Section 4.4 presents the empirical relation between failure-to-deliver and valuation and explores the dynamic relation between the incidence of a failure and future loan quantity and prices. Section 4.4.5 takes advantage of the cross-sectional variation in various forms of short sale constraints and jointly explains the response of future short sale fee, and loan quantity to the presence of the various constraints. In section 4.5, I show the pricing implications for future common equity stock returns. Finally, section 4.6 concludes.

4.2 Literature Review

Short selling frictions are important in asset pricing. Seneca (1967), Miller (1977), Harrison and Kreps (1978), Figlewski (1981), Morris (1996), Chen et al. (2002), and Duffie et al. (2002), among others, argue that security prices are biased upward when short sales constraints exist. In static models, the price is as high as the valuation of the most optimistic investor (e.g., Miller (1977), and Chen et al. (2002)). In a dynamic setting short sale constraints can cause prices to be higher than the valuation of all investors. In Harrison and Kreps' model (1978), differences of opinion, together with short sale constraints, create a speculative premium in which stock prices are higher than even the most optimistic investor's assessment of their value. When short sale constraints exist, an asset owner has the option to sell to more optimistic investors, which leads to high turnover, overpricing and even to bubbles as reported in Scheinkman and Xiong (2003) and Hong et al. (2006). Duffie et al. (2002) attribute price inflation to capitalization of future lending fees. They present a dynamic model of asset valuation in which short selling requires searching for security lenders and bargaining over the lending fee. Search frictions allow for lender expropriation, and the expectation of lending fees, in turn, increases the equilibrium price.

Loan income can be economically significant. Securities lending returns comprise the securities lending (fee) return and the reinvestment (cash collateral) return. Securities lending involves the temporary transfer of securities by one party, the lender, to a borrower. The securities borrower is required to provide collateral to the securities lender in the form of cash or other securities. Legal title passes on both sides of the transaction so that borrowed securities and collateral can be sold or relent. Typically, borrowers are required to post collateral of 102 to 105 cents per dollar of security. If the borrower provides securities as collateral to the lender, he pays a fee to borrow the securities. If the borrower provides cash as collateral, the lender pays interest to the borrower, the rebate rate, and reinvests the cash at the current short term rate. The fee is then the difference between the short-term rate and the rebate rate, expressed in basis points per annum. Stocks are considered on special if the loan fee is excess of the short term rate.

During April 2000 till September 2001, D'Avolio (2002) documents that lending fee can be as high as 79% per annum. In this time period the aggregate market is easy to borrow, with the value-weighted cost to borrow a sample loan portfolio being about 25 basis points per annum. However 1% of stocks on loan become extremely special, demanding negative rebate rates. Since 2007, securities lending income and loan volumes have reached new highs. Aggarwal et al. (2011) document that during 2007 to 2009, almost 10% of the stocks are on special, with fees greater that 100 basis points. Average loan spreads widened from 20-30 basis points in 2005-2006, to over 60 basis points in 2008. Kaplan et al. (2010) conduct a lending experiment for an anonymous money manager during 2008 and 2009 in which two thirds of high loan fee stocks are lend out. The average loan fee is 7.3% during September 5 to 17, 2008 and 4.1% during June 5, 2009 till October 1, 2009. They estimate the total revenue from lending to be about 1.5 to 2% per annum.

One of the most important determinants of loan fees is according to Kolasinski et al. (2010), search costs. Kolasinski et al. (2010) study the equity loan fee across twelve lenders from September 2003 through May, 2007. They find that the loan fee as well as the change in loan fee is positively related to various proxies for search costs. The difficulty to find shares gives lenders the ability to set high prices, in accordance with Duffie et al. (2002). In a perfect market there should be no lending fee but with the friction of imperfect competition and having to locate shares, the lending fee is the outcome of a bargaining game. The effect of short sale frictions on the presence of the lending fee in turn explains the overpricing. The stock price is the expected future income associated with the potential to lend the asset, plus the expected valuation of the marginal investor.

In this chapter, I look at the dynamic relation between prices, lending fees and short sales to examine whether short selling constraints cause prices to be biased due the capitalization of future lending gains next to alternative explanation of the loss of information. This chapter builds on the prior theoretical research of Duffie et al. (2002) by investigating empirically whether security prices incorporate prospective security lending income.

4.3 Data and Variable Definitions

4.3.1 Data

Failure-to-deliver is the frequency and quantity, as a fraction of shares outstanding, in which short-sellers fail to locate shares. At the time a short position is initiated, the short seller has three days to locate and borrow the shares from a security lender. Short sellers that have not located shares from owners by that time are said to have failed-to-deliver. See Evans et al. (2009) for the details regarding deliveries.

The advantage of using the occurrence of a failure to determine whether security lenders discount expected lending income in their valuation is that it is forward-looking in the sense that it is an important determinant of lending fees. Kolasinski et al. (2010) show that the difficulty of finding shares leads to a significant increase in lending fee. Moreover, in Duffie et al. (2002) the search for a counter-party is the mechanism through which lending fees increase and affect asset value. In the model, frictions in securities lending explain the fee of short selling and overpricing. The total lending fee is essentially equal to the gains from a lending transaction, multiplied by the number of times a given share is lent, and further multiplied by the lenders' bargaining power. Failure-to-deliver represents situations in which it is difficult to locate securities available for borrowing, resulting increased bargaining power for the lender and prospective increases in lending profits which, in turn, should lead to higher prices.

Failure-to-deliver data are available from the SEC, and include total number of fails-to-deliver (i.e., the balance level outstanding) recorded in the National Securities Clearing Corporation's (NSCC) Continuous Net Settlement (CNS) system aggregated over all NSCC members.[5] Data prior to September 16, 2008 include only securities with a balance of total fails-to-deliver of at least 10,000 shares as of a particular settlement date whereas data on or after this date include all securities with a balance of total fails-to-deliver as of a particular settlement date.

I construct two variables based on the failure-to-deliver data. The first is an indicator variable ($FAIL_{i,t}$) that equals one if a failure has been reported for fund *i* at time *t*, and zero otherwise, and the second is the quantity of reported fails as a fraction of shares outstanding ($Failure_{i,t}$).

[5] Available at http://www.sec.gov/foia/docs/failsdata.htm

$$FAIL_{i,t} = \begin{cases} 1 & \text{if } failures - to - deliver > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$Failure_{i,t} = \left(\frac{\#failures{-}to{-}deliver_{i,t}}{shrout_{i,t}} \right) \tag{4.1}$$

I match the failure-to-deliver data from the SEC with lending data from Data Explorers Ltd., which collects data from custodians and prime brokers that lend and borrow securities. The data comprise daily stock level information on the dollar value and quantity of shares available for lending, and the value and quantity of shares of borrowed securities for the sample period July 2006 to December 2008. Saffi and Sigurdsson (2010) use the same data source to study how price efficiency and the return distribution are affected by loan supply. For more information regarding the equity lending data from Data Explorers I refer to their paper.

4.3.2 Closed-end Funds

I use closed-end funds to capture the full bias in pricing following the incidence of a failure-to-deliver. These funds offer several advantages, one of which is that the intrinsic value of these funds is known. This is the total value of all the securities in the fund divided by the number of shares in the fund, the so called net asset value (NAV) per share. This study is not the first to study arbitrage bounds in the context of closed-end funds. Both Pontiff (1996) and Gemmill and Thomas (2002) underpin the validity of using closed-end funds to study the influence of arbitrage on fundamental valuation. In a similar spirit, I identify deviations from the intrinsic value, the Net Asset Value (NAV), and determine whether there is a positive association between the occurrence of a failure-to-deliver on the fund level and the premium to NAV, accounting for both rational and sentiment driven influences on the deviations from NAV.

The number of closed-end funds (sharecode=14) within the CRSP database with the Net Asset Value Data from the Compustat PDE file from June 2006 through to December 2008 totals 388. I am able to match 297 of these to the loan data from Data Explorers. The sample used appears to be slightly larger funds that are also and more actively traded, the two samples do not significantly differ in terms of premium to NAV or returns.

I merge the loan data from Data Explorers and the SEC with information from a variety of sources. These include data on stock returns, shares outstanding, and volume from CRSP and institutional holdings from CDA/Spectrum. I match the monthly NAV to the daily loan data on the last trading day of the month.

Table 4.1 shows the cross-sectional variation in closed-end fund pricing during the sample period. On average, closed-end funds trade at a discount to NAV. The average discount over the sample period is 5.38%. In 2006 it stands at 2.20% which steadily increases to a 7.38% average discount in 2008. However, there is considerable cross-sectional variation in the discounts. The number of premium and discount funds is displayed in panel B of Table 4.1. Although premium funds are a minority, 53 funds trade at a premium to NAV in a given month in 2006, 76 in 2007 and 81 in 2008. In contrast, 99 funds traded at a discount in 2006, 201 in 2007 and 265 in 2008. Premium and discount funds differ considerably in terms of fund and loan characteristics. In panel C, I distinguish between funds trading above NAV (premium) and funds trading below (discount) NAV. As can be seen from panel C, premium funds are slightly larger and institutional investors appear less inclined to hold premium funds. Inventory quantities among beneficial owners willing to lend out their shares are significantly lower for premium funds. The lower inventory records might be the reason underlying the higher utilization levels and possibly the larger frequency and size of the number of reported failures for premium funds. Closed-end funds trading at a premium also have higher short sale fees, as captured by a fee score. The fee score is a value weighted fee classification expressed in undisclosed fee bucket, where 0 represents no fee (general collateral), a fee score of 1 is relatively cheap and a fee score of 6 is the most expensive category.

Table 4.2 presents summary statistics of the failure-to-deliver data for both the common equity universe as for the closed-end fund sample. The frequency of reported failures is greater for the closed-end funds sample than that of the common equity. The failure quantity relative to shares outstanding is lower for the closed-end funds. On average 21.77% of the closed-end fund observations have a reported failure and the average failure quantity is 0.05% of shares outstanding. For the common equity sample the average number of failure incidents is only 14.69% but the average failure quantity relative to shares outstanding is larger, 0.37%. Over time, the number of failures increased in 2007 from 20% in 2006 to 25.52%, for the closed-end fund sample. In 2008, the average failure incidents decreased as regulation sought to curtail naked shorts. A similar dynamic is apparent for the common equity stocks.

In panel C, I compare funds with reported failures at a given point in time to funds without reported failures. Funds with reported failures are larger, and more interestingly trade at a premium to NAV in comparison to funds without reported failures. Funds with a failure have a larger fraction of their shares outstanding on loan, lower inventory and therefore higher utilization levels. Funds with reported failures also have higher loan fees.

4.4 Failure and the Premium to NAV

4.4.1 Hypothesis

Miller (1977), argues that in the presence of differences of opinions security prices are biased upward when short sales constraints exist. Negative information is kept out of the market and the prices will be set by the most optimistic majority. Duffie, Gârleanu and Pedersen's model would further suggest an increase in prices following higher expected lending profits. The prospect of lending fees should increase prices above the most optimistic buyer's valuation of the security's future dividends. This suggests that short selling constraints can cause prices to deviate from the intrinsic value due to loss of information and capitalization of future lending gains.

The first testable hypothesis is therefore:
H1: Failure-to-deliver leads to overvaluation as measured by an increased premium to NAV of closed-end funds.[6]

For future lending expectation to play a role in prices, the premium associated with a failure should be related to future lending profits.
H2: Failure-to-deliver positively predicts an increase in lending frequency and/or lending fee.

Failure-to-deliver represents situations in which it is difficult to locate securities available for borrowing, resulting increased bargaining power for the lender and prospective increases in lending profits which, in turn, should lead to higher prices. However, the failure premium should decrease with the availability of inventory and the number of active lending agents, consistent with lower bargaining power among lenders when demanding higher future lending fees.

H3: The premium is decreasing in the level of inventory and the number of active lending

[6]Important to note is that security lending income is aggregated at the fund level and reported under investment income in the annual report, as such the presence of the expected loan income in the price can be found at the fund level.

agents.

If lending profits are capitalized into prices then the premium associated with the occurrence of a failure, should be lower in a low fee period. According to Data Explorers, the average total return from security lending increased from 20 bp in 2006-2007 to 1.1% in 2008. If lending fees do play a role in pricing, their effects should be less pronounced in the 2006-2007 period.

H4: The premium is less pronounced during the 2006-2007 low fee period.

Finally, for expected future income associated with the potential to lend the asset to be capitalized in prices, institutional investors need to be willing to pay a premium associated with lending fees. I therefore expect that the occurrence of a failure would trigger the interest of institutional investors and lead to increased institutional ownership.

H5: The incidence of a failure leads to increased institutional ownership.
Alternatively, if the short sale bias is solely due to the withholding of negative information, then I would expect a reduction in institutional ownership following the occurrence of a failure.

4.4.2 Specification

To study the relation between valuation and search frictions, I regress the premium to NAV on failure-to-deliver and on the fund specific control variables. I estimate a panel regression using monthly NAV data from June 2006 to December 2008 matched to the end of the month daily loan data.[7] I include firm and period fixed effects, and panel corrected standard errors clustered by fund to control for heteroskedasticity and within-fund serial correlation.

The premium is serially correlated and to recover consistent estimates of the parameters, I include lags of the dependent variable.[8] Simultaneity problems arise as conceivably short sales could be determined simultaneously along with the premium to NAV. The main hypothesis is failures lead to an increase in lending profits, which, in turn, should lead to higher prices. However, it is not possible to rule out that the premium and short-selling constraints are endogenous, i.e. it could be the case that premium funds stocks attract short-sellers, thus increasing short sale quantity and the likelihood of a failure-to-deliver to occur. I attempt to mitigate these concerns with Arellano-Bond dynamic panel instrumental-variables (IV) regressions,

[7] I first ascertain whether all the variables are stationary. I conduct a panel Augmented Dickey Fuller test and reject that the series are non-stationary.

[8] The inclusion of the lagged dependent variable also mitigates the effects of possible stale NAV estimates.

treating failure and the premium as endogenous variables. The estimation also accounts for the dynamic dependent variable. The Arellano-Bond dynamic panel estimator is designed for panels with short time dimension and larger firm dimension, independent variables that are not strictly exogenous, fixed effects and with heteroscedasticity and autocorrelation within funds. The estimation relies on the first-differences to eliminate unobserved fund-specific effects and then uses lagged level and difference values of the endogenous variables as instruments for subsequent first-differences.[9]

The regression specification for the relation between the incidence of a failure and the premium to NAV is as follows:

$$Premium_{it} = \alpha_i + \beta_1 FAIL_{it} + \gamma' x_{it} + \beta_2 Premium_{it-1} + \beta_3 Premium_{it-2} + \delta_t + \epsilon_{it} \quad (4.2)$$

where $Premium_{it}$ is the premium to NAV, for fund *i* at time *t*. The premium is calculated as the price over net asset value minus one. δ_t are period-specific time dummies. The Arellano-Bond test for autocorrelation dictates two lags. The necessity for lagged levels of the endogenous variables reduces the sample size from 297 to 168 funds. $x_{i,t}$ is the vector of control variables. Additionally, I measure the relation between the failure-to-deliver quantity relative to shares outstanding and the premium to NAV, using the failure variable $Failure_{i,t}$ in place of $FAIL_{i,t}$.

4.4.3 Control variables

To isolate the bias in prices created by the occurrence of a failure, I first need to account for possible factors that might influence the deviation from NAV.

The central puzzle about closed-end funds is that the fund share prices differ from the per share NAV. NAV premiums or discounts are considered a puzzle because they appear to contradict the no-arbitrage implication of an efficient market. Because two assets, which appear to offer a claim to the same risk-return distribution, trade at different prices. The existing explations on why closed-end funds pricing differs from NAV are related to tax considerations, Malkiel (1977), agency costs, Barclay et al. (1991), noise, Lee et al. (1991), and the trade-off between management fees and certain benefits that come from investing in a closed-end fund. In Berk and Stanton (2007)'s model, the benefit to investors is the manager's ability, whereas Cherkes et al. (2009) suggest that liquidity is the main benefit.

[9]For more information I refer to Arellano and Bover (1991).

I control for fund specific variables such as size, performance in the last 12 months, systematic risk, volatility and liquidity. Fund size and past performance are used as a proxy for management skills. I also include fund fixed effects to control for any time-invariant unobservable influences on the premium such as expense ratios, fund reputation, and dividend.[10] In addition, I follow Pontiff (1996) and include a replication risk measure, which captures the difficulty in replicating the fund's holdings.

Lee et al. (1991) propose that discounts and premiums in closed-end funds may reflect investor sentiment. To account for the influence of market-wide sentiment on the premium to NAV, I include period fixed effects in the panel specification. In addition, I include a systematic noise factor as in Gemmill and Thomas (2002). I follow Baker and Wurgler (2006) in constructing a stock market sentiment index to capture sentiment. To correct for sentiment influences in deviations from NAV, I calculate the sensitivity of the fund to the sentiment index for each fund in the sample. This approach allows me to directly measure the interaction between short selling activity, sentiment and the valuation of the closed-end funds. The variable description appendix contains the details of data sources and variable definition and construction.

4.4.4 Results

Failure-to-deliver and the Premium to NAV

Table 4.3 reports the results of regressing the premium to NAV on the failure-to-deliver variables and fund specific control variables. The inclusion of fund, period fixed effects and the lags of the premium to NAV render most controls insignificant. Size and the beta are the only significant coefficients. With regards to the valuation effect of the failure-to-deliver variables, funds with uncovered short sale positions trade at a 2.63% premium, as can be seen from the first specification in Table 4.3 column 1. The relation between the continuous failure-to-deliver variable and the premium (column 2) is also statistically and economically significant. Funds with uncovered short sale position equal to 1% of their shares outstanding have a 3.05% higher premium to NAV. The average failure position as a fraction of shares outstanding is 0.05%, with a standard deviation of 0.03%. Economically, a one standard deviation increase in failure translates into an increase in premium of 0.09%.

[10] I include the dividend ratios, however the period and fund fixed effects make this variable redundant.

Table 4.3
Failures and Premium

Panel regression of premium to NAV on failure-to-deliver, fund specific control variables and period dummies. Results are reported in percentages. Period dummies are not reported. Panel data are U.S. equity closed-end funds (share code=14) followed from June 2006 to December 2008. The model is estimated using Arellano-Bond (1991) system dynamic panel model (GMM), t statistics clustered by fund in parenthesis. The Arellano-Bond test for autocorrelation and difference-in-Sargan/Hansen tests for the validity of instruments p-values are reported. The Appendix contains the details of data sources and variable definitions.

	(1)	(2)
Variables	Premium	Premium
FAIL	2.63***	
	(5.10)	
Failure		3.05**
		(2.46)
Control Variables		
Size	0.01**	0.01**
	(2.29)	(2.29)
Turnover	0.00	0.00
	(-0.11)	(-0.54)
Noise Beta	0.14*	0.12
	(1.90)	(1.44)
Replication	-0.27	-0.26
	(-0.59)	(-0.58)
Beta Sentiment	2.94	0.595
	(0.70)	(0.13)
Stdev	-0.01	0.05
	(-0.06)	(0.58)
Past 12M return	-0.04	-0.04
	(-1.10)	(-1.23)
Beta	0.86*	0.79*
	(1.86)	(1.69)
Institutional Own	0.02	0.02
	(0.66)	(0.47)
Amihud	0.00	0.00
	(1.13)	(0.47)
Spread	-0.03	0.01

Continued on next page

Table 4.3 – continued from previous page

	(-0.18)	(0.05)
Lagged Dependent variable		
Premium (t-1)	0.71***	0.72***
	(12.30)	(12.15)
Premium (t-2)	0.23***	0.23***
	(3.85)	(4.00)
Constant	-0.130***	-0.176***
	(-4.00)	(-4.72)
Tests		
AR(1)	0.00	0.00
AR(2)	0.17	0.28
Sargan	0.00	0.00
Hansen	0.25	0.18
Difference-in-Hansen	0.37	0.20
Obs	1466	1466
# Funds	168	168
# Instruments	131	131
Fixed Effects	Yes	Yes
Period Effects	Yes	Yes

Robust t-statistics in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

The results in Table 4.3 are robust to the estimation technique used. The results using fixed effects, the between estimator and pooled OLS with period effects are reported in 4.4. Additionally, I test the GMM results for robustness with respect to reductions in the instrument set by presenting the results using 1 lag, collapsing the instrument count, using a two-step estimation, and estimating in differences and levels. These alternative estimations produce results that are very similar to the results in Table 4.3.

The results are also robust to alternative failure measurements, as is shown in panel B Table 4.4. First I calculate the average relative failure position in the week leading up to the last trading day of the month. The results are even stronger, a 1% increase in failure relative to the shares outstanding increases the premium with 9.12%. Similarly, if I measure failure as the average monthly failure position relative to shares outstanding. In the third and fourth column of panel B, the number of days in which the threshold level of fails is reached throughout the last week leading up to the last trading day of the month and the number of days in which the threshold level of fails is reached throughout the month. The reporting of the threshold level of fails increases the premium with 0.33 per day during the last trading week of the month and 0.09% for each occurrence during the month. In the last column failure and premium are measured in changes and a 1% increase in failure increases the premium with 2.30%.

An important concern is that of endogeneity. The use of lagged values of failure as instruments mitigates some of these concerns. Nonetheless, I also attempt to mitigate these concerns with instrumental-variables (IV) regressions, treating failure-to-deliver and premium as endogenous variables. Although it is difficult to obtain truly exogenous instruments, I use the total number of lending agents (intermediaries) as reported to Data Explorers, as instrument.[11] The validity of this measure as an instrument requires that the number of intermediaries not impact the fund premium except through its effect on failure-to-deliver. Empirically, the number of lending agents correlates with the failure-to-deliver variable, but it does not relate to the premium to NAV. Agents typically include asset managers, custodians, specialist securities lending agents and brokers. A priori it is unlikely that lending agents decide on facilitating security lending on the basis of the existence of a premium to NAV for closed-end funds. Providing lending services requires set-up costs, rooted relationships with the industrys largest lenders and investment in inventory. Usually investment banks have long-established lending programs, making entering or exiting the loan intermediation market on the basis of temporary valuation unlikely.

To test whether the instrument affect failure-to-deliver and premium, I run the following two panel data regressions:

$$Failure_{it} = \alpha_i + \beta_1 ln(\#Agents)_{it} + \gamma' x_{it} + \delta_t + \epsilon_{it} \tag{4.3}$$

$$Premium_{it} = \alpha_i + \beta_1 ln(\#Agents)_{it} + \gamma' x_{it} + \delta_t + \epsilon_{it} \tag{4.4}$$

where $Failure_{it}$ is the quantity of reported fails as a fraction of shares outstanding at the end of the month, for fund *i* at time *t*. $Premium_{it}$ is the premium to NAV, for fund *i* at time *t*. δ_t are period-specific time dummies. $x_{i,t}$ is the same vector of control variables. I also include fund fixed effects to control for any time-invariant unobservable influences. I find that the number of lending agents does not have a statistically significant effect on the premium at even the 10% significance but is strongly related to failure-to-deliver variable at a 1% significance level.

[11] I look at the total number of lending agents for each fund, not the number of custodians with open transactions. The decision to make inventory available is likely endogenous to the lending fee and in turn the premium.

As can be seen in the column 10 of Table 4.4, using the total number of lending agents as an instrument, I still find a positive and significant relation between failure and the premium to NAV. To rule out that the premium and failure are endogenous, in that premium funds stocks attract short-sellers, thus increasing short sale quantity and the likelihood of a failure-to-deliver to occur, I also include loan quantity as control variable. As can be seen in the last column, the results are also robust to the inclusion of loan quantity as additional control variable.

Table 4.1
Closed-end fund descriptive Statistics

Panel A contains mean monthly Net Asset Value (NAV) statistics for the closed-end fund sample. Premium is calculated as (price/nav)-1. Sample period September 2006 to December 2008. Panel B reports the number of funds trading above (premium) or below (discount) their NAV value, in a particular month during the year. Panel C shows the test of equality of the means ($t-$test) and medians (Wilcoxon) for premium and discount funds. Failure represents the aggregate net balance of shares that failed to be delivered as of settlement date at the end of the month relative to shares outstanding and the number of failures is the frequency of reported failures relative to the total number of months. Loan is the total quantity of borrowed securities as a percentage of the shares outstanding. Inventory is the available inventory quantity from beneficial owners as a percentage of the number of outstanding shares. Utilization is the value of assets on loan from beneficial owners divided by the total lendable assets. Fee score is the value weighted average fee score over 30 days. 0 represents no fee, a fee score of 1 is relatively cheap, while 6 is the most expensive category. The description of the rest of the variables are in the appendix.

Panel A Descriptive Statistics per year						
	Year	Obs	Mean	Stdev	Min	Max
Premium	2006-2008	3642	-5.38%	10.22%	-48.84%	84.11%
	2006	575	-2.20%	9.57%	-29.90%	50.76%
N=297	2007	1407	-4.08%	9.61%	-38.82%	84.11%
	2008	1885	-7.38%	10.45%	-48.84%	48.45%

Panel B: # Obs per year			
	Year	Obs	N
# Premium Funds	2006	177	53
	2007	312	76
	2008	299	81
# Discount Funds	2006	398	99
	2007	1095	201
	2008	1586	265

Panel C: Comparison Premium Discount Funds					
	Discount	Premium	Difference	Diff. of means t-test (p-value)	Wilcoxon test (p-value)
Premium	-9.43%	9.27%	-18.70%	(0.00)***	(0.00)***
Size (thousands)	417,431	462,807	-45,376	(0.04)**	(0.07)*
Institutional Own	15.43%	5.75%	9.67%	(0.00)***	(0.00)***
Turnover	72.88%	76.81%	-3.93%	(0.24)	(0.00)***
Inventory	1.57%	0.57%	1.00%	(0.00)***	(0.00)***
Utilization	6.77%	8.68%	-1.90%	(0.02)**	(0.29)
Loan	0.36%	0.36%	0.00%	(0.95)	(0.00)***
# Failure	15.59%	45.94%	-30.35%	(0.00)***	(0.00)***
Failure	0.04%	0.11%	-0.08%	(0.00)***	(0.00)***
Fee Score	3.48	4.51	-1.04	(0.06)*	(0.00)***
N	284	122			

Table 4.2
Failure Descriptive Statistics

Mean end of the month failure statistics for the sample period July 2006-December 2008. The sample consists of all equity closed-end funds (share code=14) and common equity stocks (share code=10, 11) in the Data Explorers data. The common equity sample consist of all common equity stocks in CRSP and averages 4630 stocks. Failure represents the aggregate net balance of shares that failed to be delivered as of settlement date at the end of the month relative to shares outstanding and the number of failures is the frequency of reported failures relative to the total number of months. Panel B shows loan descriptive statistics for the closed-end fund and common equity sample. Loan is the total quantity of borrowed securities as a percentage of the shares outstanding. Inventory is the available inventory quantity from beneficial owners as a percentage of the number of outstanding shares. Utilization is the value of assets on loan from beneficial owners divided by the total lendable assets. Fee score is the value weighted average fee score over 30 days. 0 represents no fee, a fee score of 1 is relatively cheap, while 6 is the most expensive category. Panel C shows the test of equality of mean ($t-$test) and medians (Wilcoxon) for funds with reported failures and funds without.

Panel A: Failure Descriptive Statistics Closed-end and Common Equity

		Closed-end funds		Common Equity	
		# Failures	Failure	# Failures	Failure
Sample period	Mean	21.77%	0.05%	14.69%	0.37%
(2006-2008)	Stdev	10.70%	0.03%	8.47%	0.09%
	Min	0.00%	0.00%	0.00%	0.25%
	Max	50.00%	0.12%	25.49%	0.52%
Mean per year	2006	20.00%	0.03%	0.95%	0.53%
	2007	25.52%	0.07%	16.57%	0.33%
	2008	19.81%	0.04%	17.84%	0.39%

Panel B: Loan Descriptive Statistics Closed-end and Common Equity

Sample period		Loan	Inventory	Utilization	Fee Score
(2006-2008)	Closed end funds	0.36%	1.33%	7.18%	3.65
	Common Equity	4.55%	14.38%	22.85%	3.13

Panel C: Comparison Funds with reported Failures and funds without

	Funds with Failures	Funds without Failures	Difference	Diff. of means t-test (p-value)	Wilcoxon test (p-value)
Size (thousands)	489,705	409,113	80,592	(0.00)***	(0.00)***
Premium	1.23%	-7.19%	8.42%	(0.00)***	(0.00)***
Institutional Own	10.83%	14.13%	-3.30%	(0.00)***	(0.00)***
Turnover	79.48%	72.06%	7.42%	(0.01)**	(0.41)
Loan	0.58%	0.30%	0.28%	(0.00)***	(0.00)***
Inventory	1.02%	1.46%	-0.43%	(0.00)***	(0.00)***
Utilization	12.53%	5.67%	6.86%	(0.00)***	(0.00)***
Fee Score	4.33	3.65	0.68	(0.00)***	(0.01)**
N	202	283			

Table 4.4
Sensitivity Estimation

Panel regression of premium to NAV on failure-to-deliver variables, fund specific control variables and period dummies. The results are reported in percentages. Controls, period dummies and lagged dependent variable (2) not reported. t-statistics clustered by fund in parenthesis. Panel A reports various specifications of the regression of premium on the failure variables. The Arellano-Bond dynamic panel estimator is designed for panels with short time dimension and larger firm dimension, independent variables that are not strictly exogenous, fixed effects and with heteroscedasticity and autocorrelation within funds. The estimation relies on the first-differences to eliminate unobserved fund-specific effects and then uses lagged values of the endogenous variables as instruments for subsequent first-differences. The first specification reports the dynamic panel-data estimates by limiting the instrument count to using 1 lag. The second specification invokes the collapse option to restrict the instrument count and reduce the risk of overfitting the data. The third specification perform the two-step system GMM, with the finite sample correction of Windmeijer. The following two columns report the GMM estimation in levels and differences respectively. Column 6, 7 and 8 report the two-way fixed effects regression results, the between estimator and a pooled OLS regression with fund clustered standard errors. The final two colums report the GMM estimation using the log of the number of lending agents as an instrument and including the loan quantity as control. In Panel B are the dynamic regression results using alternative ways to measure failure. The weekly average failure measures the average failure threshold level relative to shares outstanding over the week prior to the NAV date. The monthly average failure is the average failure threshold level relative to shares outstanding over the month prior to the NAV date. The weekly and monthly # of fails are the number of days with a reported threshold level of failures during the respectively week or month prior to the NAV. Specification 5 measures the relation in changes.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Robustness Estimation										
	Max Lag 1	Collapse	(Wind meijer) 2 Step	Level	Arellano Bond Diff.	Fixed Eff.	Between Est.	OLS	IV # Agents	IV with loan
FAIL	2.67***	2.40***	2.64***	2.67***	1.03**	3.08***	1.54***	7.71***	2.42***	2.92**
	(6.07)	(5.31)	(5.61)	(6.07)	(2.42)	(6.59)	(4.82)	(6.80)	(4.03)	(2.51)
Failure	2.90**	5.79***	2.88**	2.90**	3.29**	6.99***	23.58**	11.22***	2.95**	2.42***
	(2.59)	(2.75)	(2.49)	(2.59)	(2.12)	(3.86)	(1.97)	(3.97)	(2.41)	(4.10)

Continued on next page

Table 4.4 – continued from previous page

Panel B: Alternative Failure Measures					
	(1)	(2)	(3)	(4)	(5)
	Prem	Prem	Prem	Prem	Change Prem
Weekly	9.12***				
Average Failure	(4.29)				
Monthly		9.58***			
Average Failure		(3.58)			
Weekly			0.33***		
# Fails			(3.45)		
Monthly				0.09***	
# Fails				(4.43)	
Change					2.30**
in Failure					(2.05)

Robust $t-$statistics in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

The economic magnitude of the premium associated with a failure seems large, but considering that stocks on special can have large fees it is possible for a failure to lead to a premium of above 2%. D'Avolio (2002) shows that the aggregate market is easy to borrow during April 2000 till September 2001. The value-weighted cost to borrow the sample loan portfolio is 25 basis points per annum, however 1% of stocks (roughly seven per month) on loan become extremely special, demanding negative rebate rates (i.e., loan fees in excess of the risk-free rate). Kolasinski et al. (2010) corroborate that the difficulty of finding shares leads to an increase in borrowing costs and therefore failures are expected to lead to these exceptional 1% cases.

Table 4 in D'Avolio (2002) provides a partial list of those negative rebate stocks and their highest measured loan fee in the loan database. The fees that short sellers pay for these stocks are 79% per annum for CNH Global, 63% for General Motors, and 55% for Krispy Kreme. While not a lot of stocks are on special, when they are the fee can be substantial, especially considering that during that time period the average fee is only 25 basis points.

Considering the reported special fees by D'Avolio (2002), if a fee of 70% lasts for 5 days the premium could be as large as 1.05%, at a discount rate of 10%. For the fee to lead to a premium of at least 2,5% a loan fee of at least 67% needs to last 30 days. A fee of 35% can lead to a 1.30% premium if it last for a month or 0.53% if it last for only 5 days. This excludes the security lending income earned on re-investing cash collateral.

Since 2007, securities loan volumes and lending income have increased sharply. Average loan spreads widened from 20-30 basis points in 2005-2006, to over 60 basis points in 2008.[12] Just in a year, the U.S. equity lending market grew in size from $270 billion in 2008 to $320 billion in 2009. The business of securities lending became lucrative business for funds with large portfolios of stocks. Dimensional Advisors for example earned $182 million in net lending revenue for the fiscal year 2008. The resulting performance enhancement ranged from 0.04% for US Large Company Portfolio to 0.66% for Japanese Small Company Portfolio. Kaplan et al. (2010) estimate the total revenue from lending out the full potential of all high fee stocks for a money manager to be about 1.5 to 2%. Based on their first phase (September 5 to 18, 2008) results, they estimate lending revenue to add between 2.78% to 4.64% per year with median fees ranging from 83 to 129 basis points.

Aggarwal et al. (2011) find that during 2005-2009 the maximum annualized fee is 19.25% and the average number of days for which stocks are on loan is 16 days. Given these numbers it could explain a 0.6% premium, a quarter of the observed premium.

[12] 110 basis points including reinvestment return.

The premise is that failure-to-deliver leads to a deviation from the intrinsic value due to loss of information and capitalization of future lending gains. So the premium need not be fully explained by future lending profits, all though these back of the envelop calculation show that if the fee is large enough the reported premiums are possible.

Lending Expectation

The previous results show that a failure-to-deliver shares leads to an increased premium to NAV. If future lending profits are capitalized into prices then the premium associated with the occurrence of a failure should be related to future lending profits, as measured by future loan fees and quantity.

In Table 4.5 are the transition probabilities of the change in fee score over time of closed-end funds with no reported failures vis-à-vis funds with a reported threshold level of fails. The fee classification is expressed in undisclosed fee buckets 0-6, where 0 represents no fee, a fee score of 1 is relatively cheap, while 6 is the most expensive category. Of the closed-end funds with no reported failures 94.90% has no fee, against 94.65% of funds with reported failures. Funds with reported failures are more likely to fall in the higher fee categories. 9.74% of the funds with a reported failure have a high fee of 6 against 5.19% of funds with no failures. They are also much more likely to shift from a low fee classification into a high fee category, and stay in the high fee category. Funds with reported failures have higher fees.

To test whether failure-to-deliver positively predicts an increase in lending fee, I first estimate the following daily generalized ordered logistic regression considering the fee categories:

$$g(PR(Fee_{it+n} \leq \mid x)) = \alpha_i + \beta * FAIL_{it} + \beta' z_{it} + \epsilon_{it+n} \qquad i = 0, \cdots, 6 \tag{4.5}$$

where Fee_{it+n} is value weighted fee classification expressed in undisclosed fee bucket *i*, which runs from 0-6 in the following *n* days. $\alpha_{0 \cdots 6}$ are k intercept parameters, and $FAIL_{it}$ is the occurrence of failure-to-deliver. z_{it} is the vector of control variables. D'Avolio (2002) finds that the likelihood of higher short sale fees decreases with size, but increases with differences of opinion. He uses institutional ownership as a proxy for loan supply and finds that it decreases the likelihood of higher fees. I include the inventory quantity as a percentage of shares outstanding as a more direct measure of supply. An additional benefit is that inventory is also measured daily, while institutional ownership is only available at a quarterly frequency. The vector of explanatory variables also includes fund characteristics such as size and turnover as

Table 4.5
Failure and Fee Score

The table reports daily transition probabilities in percentages of the change in Fee score over time for funds without reported failures (top panel) and funds with reported failures (bottom panel). Fee score is the value weighted average fee score over 30 days. 0 represents no fee, a fee score of 1 is relatively cheap, while 6 is the most expensive category.

	Transition Probabilities							
No Failure (FAIL=0)				Fee score				
Fee score	0	1	2	3	4	5	6	Total
0 (no fee)	94.90	2.21	0.34	0.35	0.60	0.58	1.02	100
1 (cheap)	23.55	73.08	1.10	0.38	0.37	0.67	0.83	100
2	27.55	12.16	50.97	3.36	3.88	0.65	1.42	100
3	19.79	2.11	5.19	67.05	3.17	1.54	1.15	100
4	18.77	1.00	0.65	1.55	70.79	5.14	2.10	100
5	18.54	1.78	0.42	1.03	4.40	69.01	4.82	100
6 (expensive)	16.19	0.87	0.33	0.45	0.52	2.34	79.30	100
Total	79.94	7.60	0.95	1.28	2.46	2.59	5.19	100
With Failure (FAIL =1)								
				Fee score				
Fee score	0	1	2	3	4	5	6	Total
0 (no fee)	94.65	1.44	0.22	0.23	0.76	0.86	1.84	100
1 (cheap)	13.16	83.32	0.92	0.17	0.42	1.17	0.84	100
2	20.69	8.28	64.14	3.45	1.38	0.00	2.07	100
3	15.19	1.90	4.43	69.62	6.96	0.00	1.90	100
4	15.56	0.68	0.34	1.37	76.75	2.74	2.56	100
5	14.89	1.40	0.42	0.56	3.93	74.72	4.07	100
6 (expensive)	14.12	0.61	0.12	0.43	0.55	1.84	82.32	100
Total	73.42	7.24	0.87	0.98	3.57	4.18	9.74	100

a measure of differences of opinions. In addition, the specification includes systematic risk and volatility to control for short selling motivated by hedging.[13]. The unknown parameters β are estimated by maximum likelihood. ϵ is assumed to have a standard logistic distribution, i.e $g(\epsilon_{it+n}) = \frac{1}{1+e^{-\epsilon_{it+1}}}$.

[13]The addition of the controls rejects the the parallel lines assumption, which is the requirement that the β's be the same for each value of the categories, only the α's differ across the categories and the regression lines are parallel. To overcome this limitation I use a generalized ordered logit, which is less restrictive than the parallel-lines model but more parsimonious and interpretable than a non-ordinal method such as multinomial logistic regression. I refer to **?** for more information on the generalized ordered model.

Table 4.6 reports the marginal effects of the generalized ordered logit results of the fee score on the occurrence of a failure for the following day and panel B for the following 5, 30, 60, and 90 days.[14] The marginal effect is the change in the predicted probability associated with the incidence of a failure.

The first column represents the likelihood of having a fee, while the remaining are probabilities of a particular fee score conditional on having a fee. A reported failure increases the likelihood of having a fee by 1.44%. Conditional on having a fee a failure incidence reduces the likelihood of having a low fee classification by 24.80% and it increases the odds of ending up in a high fee category. The occurrence of a failure makes it 12.30% more likely that the fund will have the highest fee score in the following day. As can be seen in panel B, the results persist for at least 90 days, although at t+90 the likelihood of having a fee is significantly reduced.

The expected future income associated with the potential to lend the asset is not only a function of the lending fee, but also the lending frequency. Subsequently, I run predictive regressions to test whether failures-to-deliver lead to an increase in lending frequency. I estimate the following daily panel regression:

$$Loan_{it+n} = \alpha_i + \beta'_{it} FAIL_{it} + \beta'_{it} z_{it} + \epsilon_{it+n} \tag{4.6}$$

where $Loan_{it+1}$ is the future loan quantity relative to shares outstanding, for fund *i* in the following *n* days *t+n*. $FAIL_{it}$ is the indicator variable which equals one following the incidence of a failure. The vector of explanatory variables, z_{it}, includes fund characteristics such as size, past 12-month return, and turnover as a measure of differences of opinions. These controls reflect findings of Dechow et al. (2001), Asquith et al. (2005) and Boehmer et al. (2010) that short interest is related to market capitalization and momentum. Karpoff and Lou (2010) find that short interest increases with share turnover and institutional ownership. Since at a daily frequency institutional ownership is not available, I therefore include inventory as a supply variable. In addition, the specification includes systematic risk and volatility to control for short selling motivated by hedging. The results are reported in Table 4.7.

The occurrence of a failure-to-deliver predicts an increase in loan quantity in the following days up to even two months. Funds with a reported failure experience an increase of 0.42% in loan quantity in the following day. The fact that failures lead to an increase in loan quantity

[14] The signs of the estimated coefficients are cumulative probabilities. In order to be able to derive more information from the estimated coefficients I calculate the derivatives of the six probabilities at the sample means of the independent variables.

Table 4.6
Predictive Fee score Ordered Logit

The table reports the percentage marginal effects of the generalized ordered logit regression of the occurrence of a failure on fee score, controls and period fixed effects. The marginal effects are calculated as the derivatives of the six probabilities at the sample means of the independent variables and represent the daily change in the predicted probability associated with a discrete change of the failure dummy variable from 0 to 1. Panel A show the marginal effects of the occurrence of a failure on the fee score in the following day. Panel B show the marginal effects of the occurrence of a failure on the fee score, controls and fixed effects for n days ahead. Controls are not reported. t-statistics are reported in brackets and are calculated using fund clustered standard errors. The details of data sources and variable definitions are in the appendix.

Panel A: Marginal effects of the generalized Ordered Logit regression (t+1)							
	Fee vs No Fee (t+1)	Fee Score= 1 (t+1)	Fee Score= 2 (t+1)	Fee Score= 3 (t+1)	Fee Score= 4 (t+1)	Fee Score= 5 (t+1)	Fee Score= 6 (t+1)
FAIL_t	1.44***	-24.80***	1.78*	0.56	5.07***	5.03***	12.30***
	(2.68)	(-6.78)	(1.96)	(0.77)	(2.64)	(4.19)	(4.32)
Size_t	0.01	-0.04	0.02***	0.00	0.01	0.01*	-0.01
	(0.98)	(-1.24)	(2.68)	(0.64)	(1.06)	(1.90)	(-0.88)
Div rate_t	-0.00	-0.01	0.00	-0.00	-0.01**	0.01**	0.02*
	(-0.50)	(-0.58)	(0.24)	(-0.09)	(-2.04)	(2.40)	(1.73)
Turnover_t	0.28	-8.24***	2.36***	1.84**	-0.35	1.67	2.72*
	(0.48)	(-3.07)	(2.86)	(2.47)	(-0.37)	(1.39)	(1.94)
Stdev_t	-0.23***	-2.11***	0.39**	0.45***	-0.56**	0.79***	1.03***
	(-3.18)	(-3.75)	(1.98)	(2.99)	(-2.00)	(3.92)	(4.94)
Beta_t	-1.27***	-1.45	1.28*	-0.55	1.73***	-0.51	-0.50
	(-3.54)	(-0.75)	(1.75)	(-1.36)	(2.60)	(-0.87)	(-0.55)
Inventory_t	0.32**	1.24	1.15***	-0.08	0.24	-0.85**	-1.69***
	(2.00)	(1.09)	(2.70)	(-0.34)	(0.71)	(-2.49)	(-2.88)
Panel B: Long Horizon (t+n days)							
	(t+5)	(t+5)	(t+5)	(t+5)	(t+5)	(t+5)	(t+5)
FAIL_t	1.64***	-21.80***	1.21	1.23	0.44	3.94***	15.00***
	(3.19)	(-6.09)	(1.32)	(1.57)	(0.34)	(3.18)	(5.52)
FAIL_t	(t+30)	(t+30)	(t+30)	(t+30)	(t+30)	(t+30)	(t+30)
	1.82***	-18.90***	1.47*	0.41	2.88**	3.50***	10.60***
	(3.57)	(-4.85)	(1.80)	(0.48)	(2.36)	(2.60)	(3.95)
FAIL_t	(t+60)	(t+60)	(t+60)	(t+60)	(t+60)	(t+60)	(t+60)
	1.60***	-16.60***	-0.47	1.99**	3.03***	3.10***	8.99***
	(3.25)	(-4.64)	(-0.49)	(2.26)	(3.31)	(2.66)	(3.29)
	(t+90)	(t+90)	(t+90)	(t+90)	(t+90)	(t+90)	(t+90)
FAIL_t	-5.30	-18.80***	-0.69	-1.51**	1.80	3.81***	15.41***
	(-14.45)***	(-10.15)	(-0.93)	(-2.37)	(1.61)	(3.21)	(9.42)

Robust $t-$statistics in parentheses
$***p < 0.01$, $**p < 0.05$, $*p < 0.1$

long after the initial failure indicates that the failure premium cannot be attributed to a short squeeze or closing of the fail position. A short squeeze leads to a forced coverage of the short sale position leading to a reduction not an increase in the number of borrowed shares. Funds with reported failures trade at a premium with respect to funds with no failures and the failure premium is related to future lending fee and loan quantity.

Table 4.7
Predictive Loan Quantity Regression

Predictive regression of the daily occurrence of a failure on loan quantity over shares outstanding, including controls and period fixed effects. The results are reported in percentages. $t-$statistics are reported in brackets and are calculated using fund clustered standard errors. The details of data sources and variable definitions are in the appendix.

	(1) Loan (t+1)	(2) Loan (t+5)	(3) Loan (t+30)	(4) Loan (t+60)	(5) Loan (t+90)
FAIL_t	0.42***	0.42***	0.35***	0.27**	0.18
	(3.18)	(3.11)	(2.62)	(2.07)	(1.35)
Size_t	0.00	0.00	0.00	0.00	0.00
	(1.00)	(0.99)	(1.11)	(1.00)	(0.89)
Div rate_t	0.00***	0.00***	0.00***	0.00***	0.00***
	(3.52)	(3.53)	(3.47)	(3.30)	(3.36)
Turnover_t	0.33***	0.35***	0.33***	0.31***	0.28***
	(5.19)	(5.39)	(4.95)	(4.01)	(3.85)
Stdev_t	-0.01	-0.01	-0.01	0.01	0.02**
	(-0.84)	(-1.44)	(-0.96)	(1.29)	(2.19)
Beta_t	0.04	0.05	0.01	-0.04	-0.03
	(0.99)	(1.08)	(0.15)	(-0.87)	(-0.79)
Inventory_t	0.30***	0.29***	0.28***	0.26***	0.24***
	(9.76)	(9.75)	(9.51)	(8.36)	(7.15)
Past 12m ret_t	0.03**	0.02**	0.02**	0.00	0.01
	(2.54)	(2.12)	(2.34)	(0.12)	(0.90)
Constant	-0.99*	-0.96*	-0.86	-0.69	-0.58
	(-1.92)	(-1.87)	(-1.65)	(-1.22)	(-0.97)
Observations	94167	94163	94138	94108	94078
R-squared	0.56	0.55	0.48	0.41	0.35

Robust $t-$statistics in parentheses
*** $p < 0.01$, **$p < 0.05$, *$p < 0.1$

Interaction Effect

To illustrate that search frictions play a role in prices and that the price inflation cannot solely be attributed to a reduction in the information content of prices, I rerun the GMM specification, with an interaction effect between the occurrence of a failure variable and inventory. The availability of inventory from beneficial owners should lower the bargaining power of lenders and decrease lending fees.[15] To test this premise, I interact the failure variable with three inventory measures in the following regression specification.

$$Prem_{it} = \alpha_i + \beta_1 FailID_{it} + \beta_2 I_{it} * FailID_{it} + \beta_3 I_{it} + \gamma' x_{it} + \beta_4 Prem_{it-1} + \beta_5 Prem_{it-2} + \delta_t + \epsilon_{it} \tag{4.7}$$

where $Prem_{it}$ is the premium to NAV, for fund *i* at time *t*. I_{it} is the interaction variable. δ_t are period-specific time dummies. The first interaction variable is the available inventory quantity from beneficial owners relative to the shares outstanding. The second represents the number of inventory accounts held by beneficial owners and the third is the number of active lending agents. Since the interactions are also assumed to be endogenous, I set a lag limit of two and collapse the instrument count as suggested by Roodman (2008) to reduce the risk of overfitting the endogenous variables.

As shown in the first specification in Table 4.8, a reported failure leads to 2.70% increase in NAV premiums. The interaction term, however, is not statistically significant though of the correct sign. However, when allowing for a larger instrument set, the coefficient on the interaction variable is statistically significant, this suggest that larger inventories reduce the bargaining power of lenders. The number of active agents significantly reduces the premium associated with failures, both in the collapsed as using the full instrument set. An additional active agent reduces the premium by 0.91%. The number of active agents give rise to a stronger effect, since more lending agents equates to lower bargaining power or decreased possibility of lender expropriation. In fact, Kolasinski et al. (2010) and Saffi and Sigurdsson (2010) find that inventory and especially, concentrated ownership leads to an increase in lending fees.

[15] Inventory at the occurrence of a constraint can best be interpreted as a reduction in bargaining power in extracting higher fees from lenders. Alternatively, inventory might also indirectly relax the binding nature of the constraints. Inventory can, a priori, mitigate the occurrence of a constraint, but it is not clear that once a constraint is in place, inventory would relax the binding nature of the constraint. The latter is a more indirect effect than the former.

As additional support for the fee capitalization hypothesis, I interact the incidence of a failure with a period indicator variable set to one for the 2006-2007 period. During 2006 and 2007, the average fee and total return from lending shares was considerably lower. According to Data Explorers, the average total return from security lending increased from 20 bp in 2006-2007 to 1.1% in 2008. If lending fees do play a role in pricing, their effects should be less pronounced in the 2006-2007 period. As can be seen from the fourth specification, the interaction term of failure and the low fee indicator is indeed negative. A failure in 2008 is associated with a 1.72% lower premium. The fact that the coefficient of the failure indicator variable is larger in the fifth specification can be attributed to the higher reported threshold quantity. Data prior to September 16, 2008 include only securities with a balance of total fails-to-deliver of at least 10,000 shares as of a particular settlement date whereas data on or after this date include all securities with a balance of total fails-to-deliver as of a particular settlement date.

Finally, for expected future income associated with the potential to lend the asset to be capitalized in prices, institutional investors need to be willing to pay a premium associated with lending fees. To measure whether the occurrence of a failure would trigger the interest of institutional investors and lead to increased institutional ownership in the following quarter I look at how the occurrence of a failure in the past quarter affects the change in institutional ownership. In column 5 of Table 4.8 you can see that the occurrence of a failure leads to a 0.87% increase in institutional ownership, consistent with a failure triggering the interest of institutional investors. In the last column I also examine whether institutional investors respond to high loan fees by looking at the relation between funds with a fee in the previous month and the change in subsequent institutional ownership. A fee score leads to a 0.68% increase in institutional interest per increase in fee category. For a fund that goes from a low (fee score=1) to a high fee score of 6 that means that institutional ownership increases with 3.40%.[16]

[16] I also estimated the results using a monthly frequency and Arellano bond system GMM and the results are robust.

Table 4.8
Interaction Failure

Interaction effects of the the occurrence of a failure on the premium. The specification includes the failure-to-deliver variable, fixed effects, the controls, lagged (2) dependent variables and period dummies. Results are reported in percentages. Period dummies, lagged dependent variables and controls are not reported. The first interacting inventory variable is the available inventory quantity from beneficial owners relative to the shares outstanding. Inventory accounts variable is the number of inventory accounts held by beneficial owners. The number of active lending agents is the number of custodians with open transactions. The details of data sources and variable definitions are in the appendix. The model is estimated using Arellano-Bond (1991) system dynamic panel model (GMM), $t-$statistics clustered by fund in parenthesis. The Arellano-Bond test for autocorrelation and difference-in-Sargan/Hansen tests for the validity of instruments p-values are reported. Regression 5 and 6 examine the quarterly change in institutional ownership in response to a occurrence of a failure (t-1) and in response to an increase in fee (t-1). The last two regressions are standard panel fixed effects regression using period and fund fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Prem (%)	Prem (%)	Prem (%)	Prem (%)	Change Instit. Own (%)	Change Instit. Own (%)
FAIL	2.70***	2.87***	2.96***	3.44***		
	(5.17)	(4.96)	(5.85)	(4.41)		
Inventory	0.33					
	(0.79)					
FAIL*Inventory	-0.31					
	(-1.08)					
FAIL*Inventory Accounts		-0.17				
		(-1.53)				
Inventory		0.21***				
		(3.07)				
FAIL*Active Agents			-0.91**			
			(-1.99)			
Active Agents			-0.43			
			(-0.68)			
FAIL*Lowfee				-2.10**		
				(-2.39)		
Low Fee				3.09***		
				(3.12)		
$FAIL_t$					0.87**	
					(2.25)	
Fee $Score_t$						0.68**

Continued on next page

Table 4.8 – continued from previous page

						(2.28)
Tests						
AR(1)	0.00	0.00	0.00	0.00		
AR(2)	0.21	0.28	0.32	0.22		
Sargan	0.18	0.22	0.03	0.31		
Hansen	0.57	0.51	0.64	0.57		
Difference-in-Hansen	0.48	0.79	0.90	0.75		
Obs	1466	1466	1466	1466	694	109
# Funds	168	168	168	168	159	63
# Instruments	40	40	40	40		
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Period Effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust $t-$statistics in parentheses						
*** $p < 0.01$, **$p < 0.05$, *$p < 0.1$						

The premise is that failure-to-deliver leads to a deviation from the intrinsic value due to loss of information and capitalization of future lending gains. Consistent with the premise, the failure premium is related to future lending fee and loan quantity, and it decreases with availability of inventory and active lending agents. The premium associated with a failure is less pronounced during the low fee period and triggers institutional investor interest. The combination of effects suggests that failure-to-deliver premium cannot solely be driven by a reduction in the information content of prices. To explore this latter premise, I contrast the pricing of the premium associated with a failure-to-deliver to the pricing of other forms of short sale constraints in the following section.

4.4.5 Other Short Sale Constraint Measures

In this chapter, I test the hypothesis that security prices are biased when short sales constraints exist. For one short sale constraints restrict information but also because future lending expectations play a pricing role. To test that effect I take advantage of the cross-sectional variation of short sale constraints.

I focus on the constraints that have been found to lead to overvaluation. Several studies confirm that stocks with high short interest, short quantity relative to shares outstanding, experience low subsequent returns.[17]

The first additional measure of short sale constraints will be a proxy for short sale quantity, namely number of borrowed securities a fraction of shares outstanding. According to estimates of Ringgenberg (2010) the mean (median) correlation between loan quantity from Data Explorers and semi-monthly short interest from Compustat is 0.70 (0.78).

$$Loan_{i,t} = \left(\frac{\#borrowedsecurities_{i,t}}{shrout_{i,t}} \right) \tag{4.8}$$

Cohen et al. (2007) identify demand shifts using price-quantity pairs and find shorting demand to be an important predictor of future stock returns. Stocks that have experienced at least an outward demand shift (DOUT), have seen both their loan fees and their loan quantities rise. According to their findings, following a demand shift, stocks have a negative abnormal return of 2.98% in the following month.

The second measure therefore follows the methodology proposed by Cohen et al. (2007) to identify demand shifts using price-quantity pairs. Funds that experienced an outward demand shift (DOUT), see a rise in both their loan fees and their loan quantities.

$$DOUT_{i,t} = \begin{cases} 1 & \text{if } \Delta Fee\ score > 0 \text{ and } \Delta Short\ Sale\ Quantity > 0 \\ 0 & \text{if } \Delta Fee\ score \leq 0 \text{ or } \Delta Short\ Sale\ Quantity \leq 0 \end{cases} \tag{4.9}$$

I use the fee score as price variable. This is the value weighted average of all applicable loan fees weighted by loan value.

The final measure is short utilization, which is the value of assets on loan from beneficial owners (beneficial owner value on loan) relative to the total lendable asset value (beneficial owner inventory value).

$$Utilization_{i,t} = \left(\frac{value\ on\ loan_{i,t}}{inventory\ value_{i,t}} \right) \tag{4.10}$$

The regression specification for the relation between short sales constraints and the premium to NAV is as follows:

$$Premium_{it} = \alpha_i + \beta_1 CONST_{it} + \gamma' x_{it} + \beta_2 Premium_{it-1} + \beta_3 Premium_{it-2} + \delta_t + \epsilon_{it} \tag{4.11}$$

[17] Figlewski (1981), Senchank and Starks (1993), Aitken et al. (1998), Dechow et al. (2001), Asquith et al. (2005), Desai et al. (2002), Aitken et al. (1998), Angel et al. (1998), Diether, Werner and Lee (2009), Boehmer et al. (2008) and Boehmer et al. (2010)

where $Premium_{it}$ is the premium to NAV, for fund *i* at time *t*. The premium is calculated as the price over net asset value P/NAV-1. $x_{i,t}$ is the vector of control variables and $CONST_{it}$ is the corresponding constraint variable; failure-to-deliver and subsequently short sale quantity, demand shift (DOUT), and utilization. δ_t are period-specific time dummies. Kolasinski et al. (2010) examine the shape of the share loan supply curve and show that the average loan supply schedule is non-monotonic and that supply curves tend to become steep at high levels of short sale quantity. To account for this non-monotonicity, funds are ranked high if they are assigned to the highest tercile in terms of utilization and short sale quantity. The Arellano-Bond test for autocorrelation again dictates a lag length of two.

The results in table 4.9 show that the relation between demand shifts and NAV premiums and the loan quantity and premiums is not statistically significant. High level of borrowed securities, as measured as the fund belonging to the highest tercile, lead to a 1.01% increase in premium. Utilization, in turn, has a significant relation to the NAV premium of closed-end funds. For every increase in utilization of 10%, the premium increases by 0.17%. Funds with high utilization levels, belonging to the top tercile, trade at a 0.76% premium, although this is not significant except when collapsing the instrument count. The premium associated with failures is economically significantly higher than that associated with other forms of short sale constraints. I standardize the continuous variables to facilitate comparison. A one standard deviation increase in failure raises the premium by 0.52%, while a one standard deviation increase in utilization leads to a 0.33% premium. The occurrence of a failure causes a 2.63% premium, while high relative loan positions, lead to increases of 1.01%.

Table 4.9
Short Sale Constraints and Premium

Panel regression of premium to NAV on short sale constraint measures, fund specific control variables and period dummies. Results are reported in percentages. Period dummies are not reported. Panel data are U.S. equity closed-end funds (sharecode=14) followed from June 2006 to December 2008. The details of data sources and variable definitions are in the appendix. Funds are ranked high if they are assigned to the highest tercile in terms of utilization and short sale quantity. The model is estimated using Arellano-Bond (1991) system dynamic panel model (GMM). The Arellano-Bond test for autocorrelation and difference-in-Sargan/Hansen tests for the validity of instruments p-values are reported. The $t-$statistics clustered by fund are reported in parenthesis.

Variables	(1) Premium (%)	(2) Premium (%)	(3) Premium (%)	(4) Premium (%)	(5) Premium (%)	(6) Premium (%)	(7) Premium (%)
FAIL	2.63***						
	(5.10)						
Failure		3.05**					
		(2.46)					
Loan			0.00				
			(0.00)				
High Loan				1.01**			
				(2.00)			
Utilization					0.02*		
					(1.66)		
High Utilization						0.76	
						(1.32)	
DOUT							-1.01
							(-1.14)
Controls							
Size	0.01**	0.01**	0.01***	0.01**	0.01***	0.01**	0.01***

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Table 4.9 – continued from previous page

	(2.29)	(2.29)	(2.61)	(2.48)	(2.67)	(2.27)	(2.72)
Turnover	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00
	(-0.11)	(-0.54)	(-0.11)	(-0.12)	(-0.11)	(-0.09)	(0.26)
Noise Beta	0.14*	0.12	0.15**	0.17**	0.15**	0.15**	0.16**
	(1.90)	(1.44)	(2.21)	(2.36)	(2.12)	(2.19)	(2.22)
Replication	-0.27	-0.26	-0.23	-0.25	-0.26	-0.26	-0.23
	(-0.59)	(-0.58)	(-0.53)	(-0.55)	(-0.57)	(-0.58)	(-0.53)
Beta Sentiment	2.94	0.60	3.06	2.92	2.64	3.69	3.58
	(0.70)	(0.13)	(0.70)	(0.71)	(0.61)	(0.87)	(0.83)
Stdev	-0.01	0.05	0.02	0.01	0.02	0.02	0.01
	(-0.06)	(0.58)	(0.26)	(0.07)	(0.25)	(0.19)	(0.12)
Past 12M return	-0.04	-0.04	-0.06	-0.06	-0.06	-0.06	-0.06
	(-1.10)	(-1.23)	(-1.51)	(-1.42)	(-1.54)	(-1.58)	(-1.45)
Beta	0.86*	0.79*	0.76*	0.63	0.67	0.67	0.67
	(1.86)	(1.69)	(1.68)	(1.26)	(1.36)	(1.36)	(1.37)
Institutional Own	0.02	0.02	0.01	0.01	0.01	0.01	0.01
	(0.66)	(0.47)	(0.44)	(0.25)	(0.35)	(0.20)	(0.27)
Amihud	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(1.13)	(0.47)	(0.94)	(0.92)	(1.08)	(0.99)	(1.18)
Spread	-0.03	0.01	0.03	0.05	0.05	0.05	0.03
	(-0.18)	(0.05)	(0.20)	(0.31)	(0.31)	(0.31)	(0.18)
Lagged Dependent variable							
Premium (t-1)	0.71***	0.72***	0.73***	0.72***	0.73***	0.73***	0.73***
	(12.30)	(12.15)	(13.03)	(12.43)	(12.22)	(12.58)	(12.60)
Premium (t-2)	0.23***	0.23***	0.23***	0.22***	0.23***	0.23***	0.22***
	(3.85)	(4.00)	(3.78)	(3.50)	(3.56)	(3.64)	(3.54)
Constant	-0.13***	-0.18***	-0.17***	-0.17***	-0.17***	-0.16***	-0.18***
	(-4.00)	(-4.72)	(-4.67)	(-4.61)	(-4.63)	(-4.02)	(-4.62)

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Table 4.9 – continued from previous page

Tests							
AR(1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AR(2)	0.17	0.28	0.32	0.42	0.33	0.33	0.38
Sargan	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hansen	0.25	0.18	0.13	0.32	0.16	0.13	0.37
Difference-in-Hansen	0.37	0.20	0.10	0.42	0.37	0.32	0.11
Obs	1466	1466	1466	1466	1466	1466	1466
# Funds	168	168	168	168	168	168	168
# Instruments	131	131	131	131	131	131	126
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The analysis reveals large pricing differences for the various short sale constraints. One plausible explanation for these differences is that each constraint gives rise to different lending expectation and that the lending profits increase the premium as predicted by Duffie et al. (2002). Both D'Avolio (2002) and Boehme et al. (2006) use proprietary lending data to show that shorting demand is related to the cost of lending and find that stocks with high levels of short interest have high lending fees. Kolasinski et al. (2010) document that an increase in demand triples the abnormally high lending fees for stocks with high short sale demand. The lending income, in turn, might explain the premium for high short sale funds.

Alternative explanations for the large cross-sectional differences in the prices of the various forms of constraints do not seem to hold. The short sale constraints can differ in terms of risk of shorting, recall risk or arbitrage risk. When controlling for arbitrage risk in the general specifications by including sentiment, replication and noise proxies, the results persist. Moreover intuitively, recall risk should lead to a lower premium (risk premium). I find that the constraint that would be subject to recall risk as failure-to-deliver is not associated with lower premiums. In the following analysis, I explore the dynamic relation of the various constraints and future lending profits in more depth.

4.4.6 VAR Analysis

The premise is that the short sale constraints give rise to different lending expectations and are therefore priced differently. If future lending plays a role in pricing, I expect the differences in premiums across the constraints to be related to the variation in the relation between the constraints and future loan fees and quantity. To jointly explain the response of future loan fee, and quantity to the presence of the various constraints, I use a panel vector autoregression approach (VAR).[18] This is a multivariate simultaneous equation system that treats all variables as endogenous, while allowing for unobserved fund heterogeneity.

First, to capture the fee development as a function of shocks to the short sale constraints, I specify a first-order VAR model as follows:

$$y_{it} = \Upsilon_0 + \Upsilon_1 y_{it-1} + f_i + d_t + \epsilon_{it} \tag{4.12}$$

where y_{it} is a vector including premium to NAV, fee score and one of the respective constraint variables: loan quantity, demand shift (DOUT), utilization or failure-to-deliver. f_i introduces

[18] The estimation is implemented with the PVAR routine by Inessa Love. See Love and Zicchino (2006) for computational details.

fund fixed effects and d_t period-specific time dummies. The particular ordering of the specification is important. The variables that appear earlier in the system are assumed to be more exogenous while the later ones are assumed to be more endogenous. I also assume that the constraints are endogenous to the premium and the fee score in the short run.

I will focus on the impulse-response functions. Theses functions describe the reaction of the premium, short sale fees, and loan quantity to the innovations in the constraints, while holding all other shocks at zero. Figure 4.1 illustrates the response of the premium to the respective short sale constraint shock. The premium to NAV shows an immediate reduction in response to a demand shift shock and this persists for 6 months. A demand shock is accompanied by a reduction in fee score that persists up to two months and subsequently reverts. The premium to NAV increases following an innovation in loan quantity, utilization and failure-to-deliver.

The second graph depicts the impulse-response functions with the reaction of the fee score to the innovations in constraints. The response of the fee score to a shock in failure-to-deliver reduces the fee score at immediate horizons, but raises it in the following months. As depicted in panel B, an innovation in fee score in turn, has a negative influence on utilization and DOUT, but a positive influence on failure-to-deliver. Higher fees increase the likelihood of a failure-to-deliver. In line with Evans, Geczy, Musto and Reed's (2009) findings, short sellers strategically fail-to-deliver shares when borrowing costs are high although the results also show that failures, in turn, increase future lending fees. A demand shock has a negative influence on future short sale fees, while shocks to utilization and failure-to-deliver positively influence future lending fees.

The third graph in 4.1 shows the impulse responses to illustrate the differing influences of the short sale constraints on loan quantity. A demand and utilization shock translates into an immediate reduction in short sales, as measured by the number of borrowed securities. In contrast, failure-to-deliver innovations increase in lending frequency in the short run. The impulse-response analysis illustrates that a demand shock has a negative influence on future short sales. Demand shocks reduce future loan quantity and fees and therefore future lending gains and prices. Utilization predicts a reduction in loan quantity. Failure-to-deliver, in turn, leads to a short run increase in loan quantity, holding all other influences constant.

The predictive regressions and the impulse-response functions show that the various short sale constraints give rise to different future lending expectation in terms of lending fees and loan quantity. DOUT predicts a reduction in fees and loan quantity, high utilization forecasts

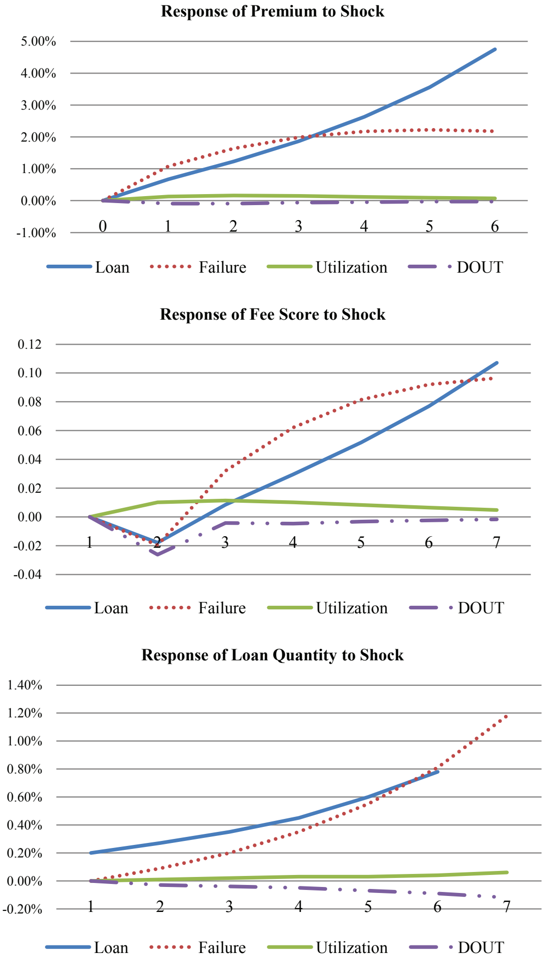

Figure 4.1
Impulse Response Function Premium, Fee Score and Loan Quantity

Impulse-response functions describing the reaction of the premium to NAV, fee score and loan quantity to a one standard deviation innovation in the constraints: DOUT, Loan, Utilization and Failure-to-deliver. The impulse-response functions follow from a first-order VAR model specification, including premium to NAV, fee score, and one of the respective constraint variables and fund and period-specific fixed effects. Fixed effects are removed using Helmert transformation (See Arellano and Bover (1995)). Estimation is by GMM with untransformed variables used as instruments for Helmert-transformed variables. Variables are time-demeaned for the period-specific effects.

an increase in fees, but a reduction in future loan quantity and loan quantity and failure-to-deliver lead to a persistent increase in fees. The differences in the pricing of the constraints line up with future lending outlook. The fact that lending expectation mirrors pricing is consistent with the premise that lending income plays a role in pricing.

Intuitively, the information restriction hypothesis on its own cannot account for the large pricing differences across the constraints. The variation in short sale constraints pricing is consistent with the variation in lending expectation.

Economic Significance

To gauge the economic significance of the short sale constraints in influencing the pricing of closed-end funds, I present variance decompositions. Table 4.10 shows the percent of the variation in the row variable explained by a shock to the column variable, accumulated over time. The variance decomposition indicates the amount of information each variable contributes to the other variables in the VAR model. I report the accumulated effect from 1 month to 1 year. Demand shifts (DOUT) only account for 0.4% of the total variation in premium 1 year ahead, while utilization explains 0.14% of the variation. Loan quantity and failure-to-deliver account for 25.91% and 17.74% respectively of the variation 6 months ahead, which accumulates to 87.43% for loan quantity and 31.56% for failure-to-deliver for a horizon of a year. Loan quantity explains a large fraction of the variation at the expense of the fee score, which accounts for about 20% of the variation in the other specifications. Short sale constraints are economically significant in explaining the variation in premium.

According to Chopra et al. (1993), the variation in closed-end fund discount is related to investor sentiment. In panel B, I also report the variance decomposition including sentiment as opposed to the constraint variables. While sentiment explains almost 12% of the total variation in premium 1 month ahead, this reduces to 8% for a 6-month horizon. In the short-run, sentiment has an economically significant influence but in the long-run short sale constraints explain a significant part of the variation in the premium to NAV.

4.5 Portfolio Analysis

The capitalization of future lending income has important implications for future common equity stock returns. Empirical evidence confirms that binding short sale constraints are associ-

Table 4.10
Variance Decomposition

The variance decompositions resulting from the first-order vector autoregression, including premium to NAV, fee score, and one of the respective constraint variables and fund and period-specific fixed effects. The table reports the percent of variation in the row variable explained by column variable. The variance decompositions show the magnitude of the total effect for monthly (t) horizons.

Panel A: Variance Decomposition Short Sale Constraints												
	(t)	Premium	Fee score	DOUT	(t)	Premium	Fee score	DOUT	(t)	Premium	Fee score	DOUT
Premium	1	100.00%	0.00%	0.00%	6	78.27%	21.70%	0.03%	12	77.88%	22.08%	0.04%
Fee score	1	5.73%	94.27%	0.00%	6	9.10%	90.87%	0.02%	12	9.20%	90.77%	0.02%
DOUT	1	0.17%	2.02%	97.81%	6	1.10%	2.29%	96.61%	12	1.13%	2.31%	96.56%
		Premium	Fee score	Utilization		Premium	Fee score	Utilization		Premium	Fee score	Util
Premium	1	100.00%	0.00%	0.00%	6	78.88%	20.99%	0.13%	12	78.53%	21.33%	0.14%
Fee score	1	5.82%	94.18%	0.00%	6	9.24%	90.75%	0.01%	12	9.34%	90.64%	0.02%
Utilization	1	3.31%	0.20%	96.49%	6	4.47%	6.45%	89.08%	12	4.58%	6.49%	88.93%
		Premium	Fee score	Loan		Premium	Fee score	Short		Premium	Fee score	Loan
Premium	1	100.00%	0.00%	0.00%	6	59.70%	14.39%	25.91%	12	10.57%	2.01%	87.43%
Fee score	1	6.34%	93.66%	0.00%	6	9.78%	89.91%	0.31%	12	9.34%	78.32%	12.33%
Loan	1	1.45%	0.00%	98.55%	6	3.93%	0.32%	95.76%	12	4.36%	0.41%	95.23%
		Premium	Fee score	Failure		Premium	Fee score	Failure		Premium	Fee score	Failure
Premium	1	100.00%	0.00%	0.00%	6	61.76%	20.51%	17.74%	12	50.73%	17.71%	31.56%
Fee score	1	6.73%	93.27%	0.00%	6	10.45%	88.91%	0.64%	12	10.34%	87.60%	2.06%
Failure	1	35.99%	0.20%	63.82%	6	9.88%	6.52%	83.60%	12	9.32%	5.11%	85.57%
Panel B: Variance Decomposition Sentiment												
		Premium	Fee score	Sentiment		Premium	Fee score	Sentiment		Premium	Fee score	Sentiment
Premium	1	100.00%	0.00%	0.00%	6	84.57%	15.16%	0.26%	12	84.32%	15.38%	0.30%
Fee score	1	6.57%	93.43%	0.00%	6	11.49%	88.09%	0.42%	12	11.60%	87.98%	0.43%
Sentiment	1	11.69%	0.81%	87.50%	6	7.33%	12.95%	79.72%	12	7.75%	12.74%	79.51%

ated with low future returns. Figlewski (1981) finds evidence that heavily shorted firms underperform less heavily shorted firms.[19] More recently, Boehmer et al. (2008) and Boehmer et al. (2010) show that stocks with minimal short interest have higher abnormal returns than their heavily shorted counterparts. The positive abnormal returns on intensively traded stocks with low short interest are much larger and persistent. Heavily shorted stocks underperform lightly shorted stocks by a risk-adjusted average of 1.16% over 20 trading days. Aitken et al. (1998), Angel et al. (1998), Diether, Werner and Lee (2009) study daily short sales and subsequent returns and find that high daily short sales are followed quickly by negative abnormal returns. Boehme et al. (2006) find that underperformance of stocks with high short interest ratios is concentrated among small stocks with high dispersion of investor opinions.[20] Cohen et al. (2007) find shorting demand to be an important predictor of future stock returns. An increase in shorting demand (DOUT) leads to a negative abnormal return of 2.98% in the following month. The consensus conclusion reached by the literature is that short sale constraints predict abnormally low future returns. The common interpretation is that short selling constraints lead to overvaluation which in turn leads to low returns. However, there is still a debate regarding where the overvaluation comes from. Seneca (1967), Miller (1977), Harrison and Kreps (1978), Figlewski (1981), and Morris (1996), among others, argue that security prices are upward biased when short sale constraints exist because negative information is not fully released in prices. Nonetheless, if prices are biased upward due to the capitalization of lending profits I would expect that the reduction in lending income accounts for the underperformance of stocks.

Given that future lending expectations varies across the short sale constraint measures, I take advantage of the cross-section of short sale constraint measures to see whether stocks with low lending income expectation underperform stocks with high lending income expectation. I perform a calendar time portfolio analysis on all the common equity stocks in the Data Explorers data. Due to the limited time series available, I study daily and weekly portfolio returns to maintain statistical validity of the results.[21] Each day (week), I sort the common equity

[19]Many studies, Brent et al. (1990), Senchank and Starks (1993), Aitken et al. (1998), Dechow et al. (2001), Asquith et al. (2005), Desai et al. (2002) confirm that stocks with high short interest experience low subsequent returns.

[20]The relation between short selling activity and future stock returns is found to be even stronger when there are no exchange-traded stock options Figlewski and Webb (1993), Senchank and Starks (1993), Christophe et al. (2004), if institutional ownership is larger D'Avolio (2002), Nagel (2005), Boehmer et al. (2008), if analyst coverage is low Pownall and Simko (2005), and following earnings announcements Reed (2003), Berkman et al. (2009)

[21]Note that I am not presenting a viable portfolio strategy, as first the data is not publicly available and second, daily horizon portfolios are not practical for re-balancing reasons. The sole purpose of this analysis is to illustrate

stocks into a portfolio based on the short sale constraint considered. After assigning funds to the portfolios, I calculate the value weighted return over the subsequent day (week). The one and four-factor alpha are calculated using the market and factor returns available in French's data library. The four-factor alpha controls for the market, size, value, and momentum factor returns.

The prediction, following the intuition as discussed by Miller (1977), is that when constraints inhibit the market's ability to impound relevant information, future returns decrease as the correction of the bias sets in. However, if short sale constraints also represent an increase in future lending profits, as failure for example does, the correction caused by the bias will be attenuated. The advantage of examining the pricing implications in the cross-section of short sale constraint measures is that the inferences are drawn by comparison of lending expectations.

Consistent with this hypothesis, the portfolio of reported failures and the portfolio of high short sales have the lowest underperformance, while the high fee portfolios and demand shifts lead to the highest reduction in prices. These results, presented in Table 4.11, cannot be explained by differential exposure to risk factors. The four-factor alpha of the highest loan portfolio is -0.15% lower in the following day than that of the low short sale portfolio. Similarly, I observe a -0.51% return in the following day for stocks that experience a demand shift. There is a 34 bp difference in performance between stocks which have experienced a demand shift and stocks which have not. Utilization follows the ranking of producing the subsequent largest discrepancy in performance, with the highest utilization portfolio underperforming the lowest by 14 bp. There is a monotonically decreasing relation between returns and fees; the higher the fees, the lower the following day's performance. Finally, the return difference for failure-to-locate shares is only 8 bp.

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the differential returns associated with the various short sale constraints.

Table 4.11
Daily Portfolio Analysis

Portfolio Analysis of the common equity sample in the Data Explorers universe. Each day I sort the common equity stocks into a portfolio based on the short sale constraint considered. After assigning funds to the portfolios, I calculate the value weighted return over the subsequent day. The CAPM alpha and four-factor alpha are calculated using the market and factor returns available in French's data library. The four-factor alpha controls for the market, size, value, and momentum factor returns. The number of stocks represents the count of stocks classified as falling into the respective category during the sample period June 2006-December 2008.

		Raw Return	CAPM Alpha	Four factor Alpha	# Stocks	MKT	SMB	HML	UMD
Short Sale	Low	-0.12%	-0.09%	-0.10%	9045	0.91	0.00	-0.10	0.10
			-3.41	(3.59)		50.17	0.02	1.93	2.99
	Medium	-0.20%	-0.17%	-0.17%	9982	0.94	0.14	-0.10	-0.02
			-6.55	-6.53		52.55	3.45	-2.02	-0.56
	High	-0.30%	-0.26%	-0.25%	7453	1.06	0.65	0.04	-0.22
			-7.38	-8.67		54.83	15.23	0.82	-6.39
	Difference	-0.18%	-0.17%	-0.15%					
	(T-Stat)		-4.33	-5.02					
Util	Low	-0.14%	-0.11%	-0.12%	9461	0.91	0.03	-0.17	0.06
			-4.66	-4.85		55.64	0.76	-3.78	2.02
	Medium	-0.24%	-0.21%	-0.21%	10117	0.99	0.26	-0.02	-0.07
			-7.30	-7.38		51.94	6.14	-0.28	-1.96
	High	-0.31%	-0.27%	-0.26%	9064	1.04	0.60	0.00	-0.22
			-7.60	-8.61		51.06	13.37	0.05	-6.10
	Difference	-0.17%	-0.16%	-0.14%					
	(T-Stat)		-4.71	-5.74					

Continued on next page

Table 4.11 – continued from previous page

		Raw Return	CAPM Alpha	Four factor Alpha	# Stocks	MKT	SMB	HML	UMD
Failure	No (Failid=0)	-0.17%	-0.14%	-0.14%	7497	0.99	0.17	-0.12	0.02
			-7.16	-7.41		77.89	5.95	-3.45	0.84
	Yes (Failid=1)	-0.25%	-0.22%	-0.21%	6670	0.89	0.24	0.02	-0.12
			-4.38	-4.33		26.01	3.20	0.19	-1.87
	Difference	-0.08%	-0.08%	-0.08%					
	(T-Stat)		-2.04	-1.94					
DOUT	No (DOUT=0)	-0.20%	-0.17%	-0.17%	14139	0.96	0.20	-0.08	-0.02
			-7.01	-7.06		59.36	5.51	-1.73	-0.85
	Yes (DOUT=1)	-0.53%	-0.51%	-0.51%	560	0.71	0.35	0.09	0.08
			-2.02	-2.02		11.95	2.69	0.53	0.74
	Difference	-0.33%	-0.34%	-0.34%					
	(T-Stat)		-4.00	(-4.03)***					
Fee Score	Fee Score=1	-0.28%	-0.27%	-0.27%	4197	0.61	0.07	0.05	0.02
			-5.18	-5.17		17.10	0.94	0.49	0.27
	Fee Score=2	-0.19%	-0.17%	-0.17%	2277	0.79	0.16	-0.42	0.12
			-1.68	-1.70		11.64	1.09	-2.17	0.97
	Fee Score=3	-0.29%	-0.28%	-0.28%	2047	0.73	0.24	0.01	0.20
			-3.79	-3.88		14.49	2.21	0.06	2.21
	Fee Score=4	-0.21%	-0.20%	-0.20%	2504	0.55	0.05	0.01	0.11
			-3.10	-3.15		12.49	0.55	0.09	1.38
	Fee Score=5	-0.38%	-0.37%	-0.37%	2831	0.55	-0.06	0.15	0.02
			-6.43	-6.46		14.05	0.72	1.35	0.31
	Fee Score=6	-0.37%	-0.36%	-0.35%	2618	0.63	-0.07	0.00	-0.07

Continued on next page

Table 4.11 – continued from previous page

	Raw Return	CAPM Alpha	Four factor Alpha	# Stocks	MKT	SMB	HML	UMD
		-6.20	-6.16		15.97	0.79	0.03	-0.99
Difference	-0.09%	-0.09%	-0.09%					
(T-Stat)		-1.32	-1.28					

In Table 4.12, I extend the horizon to a week. Here again, demand shifts and utilization show the lowest abnormal returns. Stocks that have experienced a demand shift during the week, earn a -0.45% lower excess return in the following week. The results are consistent with Cohen et al. (2007), who find that shorting demand is an important predictor of future stock returns. Demand shifts measure the extent of overpricing but do not lead to an increase in future loan quantity and loan fees, and as such the correction of the overpricing is the largest as compared to the other short sale constraints.

Table 4.12
Weekly Portfolio Analysis

Portfolio Analysis of the common equity sample in the Data Explorers data. Each week I sort the common equity stocks into a portfolio based on the short sale constraint considered. After assigning funds to the portfolios, I calculate the value weighted return over the subsequent week. Funds are classified according to whether a demand shift (DOUT=1), failure-to-deliver (FAIL=1) or high fee, special, (Fee score$>=5$) has taken place. Funds are classified as ranking high if they are assigned to the highest tercile in terms of utilization and loan quantity. The four-factor alpha is calculated using the market and factor returns available in French's data library.

	Horizon: Week		
	Raw Return	Four-Factor Alpha	$t-$stat
High Loan	-0.49%	-0.28%***	-3.38
High Util	-0.51%	-0.31%***	-3.77
Failure	-0.45%	-0.27%***	-3.88
DOUT	-0.63%	-0.45%**	-2.16
Special	-0.49%	-0.40%	-1.45

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

The negative abnormal returns for those constraints that represent an increase in future lending profits, are lower than the other constraints. The largest corrections are for those constraints that do not lead to future lending profits. Both the difference in prices of the various constraints as well as the return analysis suggest that information restriction capacity is not the only dimension on which these constraints differ. The findings are consistent with future lending profits being capitalized into prices.

4.5.1 The 2008 Ban on Short Sales

One of the predictions by Duffie et al. (2002) is that a higher price can be obtained in the presence of binding short sale constraints than during a short sale ban. The 2008 ban on short selling of financial stocks provides an opportunity to test these predictions. From September 19 through October 8, 2008, the Securities and Exchange Commission (SEC) halted short sales on 797 financial stocks.[22] On September 21, the SEC modified the list by including additional stocks, bringing the list up to 827 companies.

If expected lending fees capitalize into prices, the presence of binding short sale constraints would lead to greater overvaluation than a complete short sale ban. At the onset of the ban, the restricted financial stocks would be expected to have lower positive abnormal returns during the ban period than banned stocks that also fall under the short sale constraint classification. Put differently, one would expect the abnormal returns of the banned stocks that are also in high short sale, utilization, fees or have reported failures-to-deliver to have higher abnormal returns than banned stocks without these short sale constraints.

To test the premise that higher prices occur for stocks with tighter constraints ex-ante, I sort the banned stocks into a portfolio based on the short sale constraint and track their performance with respect to the total banned portfolio of stocks. The portfolio returns are the average value weighted four-factor abnormal returns of the classified stocks on the particular day.

On September 18, 2008, the about-to-be-banned stocks are ranked according to the short sale constraints. The banned stocks fall into the high short sale portfolio and into the banned utilization portfolio respectively if they are in the highest loan tercile on September 18. They are placed in the special portfolio if the fee score is above or equal to five on this date. Banned stocks with a reported failure on this date are assigned to the fail portfolio. The DOUT portfolio, consists of the stocks in the ban portfolio experiencing an increase in loan fees and loan quantities, a so called demand shift.

On September 18, 2008, the about-to-be banned stocks have an average abnormal return of -1.05%. On the first day of the ban, the average abnormal return of the banned stocks increases to 2.07%. In contrast, the banned stocks with high levels of loans increase by 2.20%. Banned stocks with reported failures have an average abnormal return of 2.38%. Stocks on

[22] The official announcement (release no. 34-58592) was made Thursday, September 18, 2008, after the U.S. market closed for the day.

special experience the highest increase of 4.87%. The banned stocks with high reported utilization earn 3.05% in the same day. The presence of the short sale constraints lead to greater overvaluation than during the complete short sale ban.

During the ban period, the banned portfolio with failures has the highest abnormal return of 1.31%. When the ban is lifted on October 8, 2008, the banned stocks show a much lower correction than the other banned stocks with the short sale constraints in place the day prior to the ban. The correction is highest for the failure portfolio.

This result corroborates Duffie, Gârleanu and Pedersen's (2002) prediction that a higher price can be obtained in the presence of binding short sale constraints than during a ban on shorting.

4.6 Conclusion

By lending shares to short sellers, institutional investors benefit by generating lending income. In this chapter, I show that the expectation of lending income increases the premium to NAV of closed-end funds. To determine whether investors are willing to pay a premium associated with lending fees, I look at how prices behave following a failure-to-deliver in the equity lending market. Failure-to-deliver represents situations in which it is difficult to locate securities available for lending, leading to high bargaining power for the lender and prospective increases in lending profits. High prospective lending gains, in turn, translate into higher prices.

The results show that closed-end funds with reported failures trade at a 2.63% premium. A 1% of shares outstanding uncovered short sale position leads to a 3.05% increase in premium to NAV. The results are robust to variations in failure measurement, to alternative estimation techniques and to endogeneity concerns. The failure premium is related to future loan quantity and price and is decreasing in the level of inventory and the number of active lending agents, consistent with lower bargaining power of lenders when demanding higher future lending fees. As additional support for the fee capitalization hypothesis, I also find that the premium associated with a failure is less pronounced during a period in which the average fee was low and leads to increased institutional ownership.

The premium associated with failures is economically and statistically significantly higher than the premium associated with other measures of short sale constraints. The empirical pattern in the pricing of the various measures of constraints appear to be related to the reduced

Table 4.13
Ban Portfolio

Daily portfolio analysis of the banned equity sample. The banned portfolio contains all the stocks that are subject to the ban, from September 19 through October 8, 2008, the Securities and Exchange Commission (SEC) halted short sales on 797 financial stocks. On September 21, the SEC modified the list by including additional stocks, bringing the list up to 827 companies. The other portfolios include a two-way sort of the banned equity stocks, also based on the short sale constraint considered. The ranking of the constraint is of the relative positions on September 18, 2008. The banned stocks fall into the high short sale portfolio if they are in the highest short sale tercile on September 18. This is the same for the banned utilization portfolio. The banned stocks are in the special portfolio if the fee score on the 18th was above or equal to four. Banned stocks with a reported failure or demand shift on September 18, are assigned to the fail or DOUT portfolio respectively. The portfolio returns are the average value weighted four-factor abnormal returns of the stocks on the particular day. The four-factor returns are taken from French's data library.

Four-Factor abnormal returns			Two-way sort Ban				
	Date	Ban	Loan	DOUT	Fail	Special	Util
	18-09-2008	-1.06%*	-0.23%	-1.52%	0.87%	0.26%	0.98%
	t-stat	-1.78	-0.19	-1.08	0.36	0.16	0.87
Ban in place	19-09-2008	2.07%***	2.10%*	2.07%**	2.38%	4.87%***	3.05%**
	t-stat	3.48	1.76	3.48	0.97	3.00	2.72
Ban removal	08-10-2008	-1.49%**	-0.86%	-1.49%**	-3.64%	-3.69%**	-0.95%
	t-stat	-2.51	-0.72	-2.51	-1.48	-2.27	-0.85
	09-10-2008	-3.04%***	-3.83%***	-3.40%***	-8.82%***	1.85%	-3.41%***
	t-stat	-5.11	-3.20	-5.11	-3.59	1.14	-3.05
During ban	CAAR	0.54%	1.46%	0.54	1.31%	0.31%	1.23%
(19-09-2008 till 07-10-2008)	t-stat	0.91	1.23	0.91	0.53	0.19	1.10
Post ban	CAAR	-0.40%	-0.76%	0.11	-1.22%	0.39%	-0.64%
(09-10-2008 till 23-10-2008)	t-stat	-0.67	-0.64	0.08	-0.50	0.24	-0.57

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

lending income expectation.

The results from this study imply that short selling constraints can cause prices to deviate from the intrinsic value due to the loss of information *and* the capitalization of future lending gains.

Appendix Variable Description

Fund Characteristic Variables	**Definition**
Noise Beta	Following Gemmill and Thomas (2002), noise beta is the individual fund sensitivity to the value-weighted average discount of the funds in the sample.
Replication Risk	Following Pontiff (1996), replication risk is the residual error from a regression of NAV returns on the CRSP value weighted index
Size (MCAP)	Price*shares outstanding from the CRSP monthly file.
Turnover	Volume over shares outstanding
Spread	Spread is the difference between the closing bid and ask quotes for a security over the security price
Amihud illiquidity	Amihud illiquidity measure is calculated as the daily average of absolute value of return divided by dollar volume for asset *i* in a month in logs
Systematic risk (Beta)	Systematic risk was calculated on a rolling window basis of 25 months with respect to the CRSP value weighted index
Standard deviation (stdev)	Volatility, measured as the standard deviation of the monthly returns over 20 months
Past returns	Average returns over 3 (return3month), 6 (return6month) and 12 months (return12month) as well as the last months return (Return(t-1)). Price information from CRSP
Institutional Ownership	Compilation of the holdings of institutional investors from 13-f filings
Premium	Premium to Net Asset Value is calculated as the price over NAV: ((P/NAV)-1). The Closed-end fund NAV information comes from CRSP (general equity funds only).

Stock Market Sentiment	**Definition**
Stock Market Sentiment	To correct for sentiment influences in the deviations from NAV, I calculate for each closed-end fund in the sample the sensitivity of the fund to the sentiment index. The betas with respect to the sentiment index are estimated on the basis of rolling window regressions of 20 months. The Stock market sentiment index is constructed as the first principal component of four sentiment proxies following Baker and Wurgler (2007), dividend premium, the number and first-day return on IPOs and the equity share in new issues. I use the monthly data as used and described in Baker and Wurgler (2007), I exclude the closed-end fund aggregate premium and update the data until December 2008. The dividend premium is defined following Baker and Wurgler (2004) as the log difference in the value weighted average market to book of payers and the value weighted market to book of nonpayers. The updates were obtained from Compustat. IPO volume and first-day returns and updates are from Jay Ritters website. Issue information was obtained from SDC. Lagged one year NYSE turnover from NYSE Factbook, detrended using past five-year average. The sentiment variables were orthogonalized wrt macro variables to remove the influence of economic fundamentals. I regress, using a 50 month rolling window, each proxy on macro variables; changes in industrial production, employment and the NBER recession indicator. The macro variables I obtained from econstat.com and the NBER website. Long run S&P stock data were obtained from Shillers website. The correlation of the sentiment index with that of Baker and Wurgler (2007) over 1969-2005 is 0.74.

Short Sale Variables	**Definition**
Loan	The quantity of borrowed securities as a percentage of shares outstanding
Utilization	The value of assets on loan from beneficial owners relative to the lendable asset value.
Fee Score	Value weighted average fee score over 30 days. Zero being the cheapest to borrow and 5 being the most expensive.
Special	Fee Score>=4.
DOUT	Indicator variable equal to 1 in the advent of a demand shift. Demand shift identification follows the methodology proposed by Cohen et al. (2007).
Failure	Total fails-to-deliver, represents the aggregate net balance of shares that failed to be delivered as of settlement date. Data obtained from the Federal Reserve website: http://www.sec.gov/foia/docs/failsdata.htm
FailID	Indicator variable equal to 1 when a share failed to be delivered.
Inventory	The available inventory quantity from beneficial owners as a percentage of shares outstanding.
Inventory Accounts	Total number of inventory accounts. Separate count for each row of inventory held by each underlying beneficial owner or fund that owns the security.
SL Tenure	Weighted average number of days from start date of the short position to date for all open transaction.
#Open Loan	Number of open transactions from beneficial owners only.
Active Agents	Number of custodians with open transactions.
Inactive Agents	Number of custodians and lending agents with inventory but without open transactions.

Chapter 5

Summary and Conclusion

This thesis consists of three studies in the investments field, which look at the interaction between long and short positions and their impact on market participants, prices and portfolio allocations. In Chapter 2, we start examining the optimal ”long” portfolio choice of institutional investors. The needs of the institutional investors differ from those of a small individual. Institutional investors like pension funds are not solely aspiring for maximum returns at a selected level of risk in their portfolio choice. Their focus in making asset allocation decisions is on considering risk on a relative basis versus liabilities to optimize their risk adjusted surplus. When taking pension liabilities as the starting point and coordinating the management of assets and liabilities in order to maintain a surplus of assets beyond liabilities the role for real estate in a portfolio seems much more limited.

Particularly, we examine the liability hedging characteristics of both direct and indirect real estate, in the advent of fair value accounting obligations for pension funds. We explicitly model pension obligations as being subject to interest and inflation risk to analyze the ability of real estate investments in hedging the fair value of pension liabilities and to quantify its role in an asset liability management (ALM) portfolio. we find that the portfolio composition differs depending on the definition of liability return. When liability returns solely follow actuarial changes, the mean variance efficient portfolio allocations towards direct real estate and fixed income decrease compared to the asset-only optimization. When accounting for nominal liability obligations real estate offers hedging benefits against interest rates for short holding periods, but not for long-term institutional portfolios. The inclusion of inflation risk renders a limited role for direct real estate in an ALM portfolio while indirect real estate obtains no allocation. Inflation is at the heart of the discrepancy between reported and predicted pension plan allocations. Once accounting for inflation the projected allocations come close to reported ones.

In Chapter 3, we turn to the impact of short positions of market participants on prices by showing that limits to shorting lead to biased prices. In particular, we find that the presence of short sale constraints can explain the existence of a premium to NAV for REITs. The relation between public and private market pricing of real estate assets exhibits substantial variation and the question why investors would be willing to pay these large premium remains a daunting question. Traditionally, time and cross-sectional varying price divergence is often attributed to firm specific characteristics (e.g. management quality, firm size, age, expense ratio), market sentiment, and limits to arbitrage. Pontiff (1996) and Gemmill and Thomas (2002) support the limits to arbitrage explanation by showing that closed-end funds that are difficult to replicate trade at a premium to their counterparts. Another form of limits to arbitrage are short sale constraints. According to Miller (1977), differences of investor opinion in the presence of short-sale constraints lead to stock price overvaluation. More specifically, if short selling is constrained, negative information is kept out of the market. Stock prices will not reflect fundamental value but rather the valuation of the most optimistic investors.

We use proprietary information on short sales between June 2006 and September 2008, with which we study how short sales and short sale constraint affect the variation in monthly NAV premium of REITs using a panel vector autoregression. We find that the variation in short sale activity across individual REITs can account for at least one third of the variation in NAV premiums. Short sale constraints are binding when there is strong demand and limited supply. High demand relative to low supply leads to overvaluation and the correction of the overvaluation pertains to premium REITs.

Alternatively to the traditional long portfolio choice, institutional investors benefit by generating lending revenue through lending shares to short sellers. Securities lending involves the temporary transfer of securities by one party, the lender, to a borrower. The securities borrower is required to provide collateral to the securities lender in the form of cash or other securities. Legal title passes on both sides of the transaction so that borrowed securities and collateral can be sold or relent. If the borrower provides securities as collateral to the lender, he pays a fee to borrow the securities. If the borrower provides cash as collateral, the lender pays interest to the borrower and reinvests the cash at a higher rate, earning a spread. Typically, borrowers are required to post collateral of 102 to 105 cents per dollar of security. Furthermore, borrowers are willing to pay a short sale fee for highly demanded stocks.

In Chapter 4, I show that securities lending is a cash flow stream capitalized into prices. I build on the theoretical research by Duffie et al. (2002), who present a dynamic model of asset valuation in which the search for a counter party is the mechanism through which lending fees increase and affect asset value. To determine whether institutional investors anticipate lending profits, I look at price behavior following a failure-to-deliver in the equity lending market. Failure-to-deliver represents situations in which it is difficult to locate securities available for borrowing, resulting in high bargaining power for the lender and prospective increases in lending profits. I use closed-end funds to measure how failures influence deviations from intrinsic value. The results show that the prospect of future lending profits pushes the price of closed-end funds above its NAV. Closed-end funds with reported failures trade at a 2.63% premium with respect to their NAV. The failure premium is positively related to future loan quantity and price. The results of this study imply that overpricing caused by the presence of short sale constraints is not solely due to the restriction of negative information but also partly a result of rational capitalized lending revenue.

Nederlandse samenvatting (Summary in Dutch)

Dit proefschrift bestaat uit drie studies op het gebied van investeringen. Hierin wordt gekeken naar de interactie tussen ’long’ en ’short’ posities en hun invloed op de markt deelnemers, prijzen en samenstelling van beleggings portefeuilles.

In hoofdstuk 2 starten we het onderzoek naar de optimale samenstelling van een portefeuille voor institutionele beleggers. De behoeften van de institutionele beleggers verschillen van die van een individuele belegger. Institutionele beleggers, zoals pensioenfondsen, streven niet alleen naar het behalen van maximale rendement ten opzichte van risico. Zij maken allocatie beslissingen op basis van het risico ten aanzien van de verplichtingen waaraan ze moeten voldoen.

In dit hoofdstuk nemen we pensioenverplichtingen als uitgangspunt voor het bepalen van de optimale beleggingsmix van vastgoed, vastgoed-aandelen en effecten in *één* Asset Liability Management (ALM)-portefeuille. De ALM-studie verschaft inzichten in de onderlinge afhankelijkheden in de ontwikkeling van de activa en de pensioenverplichtingen. Pensioenverplichtingen worden onderworpen aan rente-risico en inflatie-risico en we kijken expliciet of vastgoed, vastgoed-aandelen en effecten die afhankelijkheden in de ontwikkeling van de pensioenverplichtingen kunnen afdekken.

De portefeuilleconstructie verschilt door hoe we de verplichtingen definiëren. Wanneer de verplichtingen uitsluitend actuariële wijzingen volgen, bevat de optimale beleggingsmix in een ALM-analyse meer vastgoed en obligaties. Zodra rente en inflatie meewegen, is de allocatie naar vastgoed veel beperkter en vinden we een portefeuille-samenstelling die dichtbij de realiteit komt.

In hoofdstuk 3 gaan we in op de rol van short posities van marktpartijen op prijzen. Dit doen we door te laten zien dat short sale-beperkingen leiden tot overwaardering van vastgoed-aandelen. De waarde-relatie tussen de publieke en de private vastgoed-markt vertoont aanzienlijke variatie. De vraag is dan ook waarom vastgoed aandelen afwijken van de fundamentele waarde, de 'Net Asset Value' (NAV). Traditioneel worden de prijsverschillen vaak toegeschreven aan fonds-specifieke kenmerken (bijvoorbeeld kwaliteit van het management, de fondsgrootte, leeftijd, kosten), marktsentiment, en de arbitrage mogelijkheden. Een mogelijke vorm van arbitrage limitaties zijn short sale-beperkingen. Volgens Miller (1977), kunnen short sale-beperkingen leiden tot overwaardering. Als short selling wordt beperkt, wordt negatieve informatie niet verwerkt in aandelen-koersen. De aandelen-koers zal dan worden bepaald door de waardering van de meest optimistische beleggers en dus afwijken van de fundamentele waarde.

In hoofdstuk 3 bestuderen we of short sale-belemmering de variatie in de maandelijkse premie ten opzichte van NAV van vastgoed-aandelen kan uitleggen. De variatie op korte termijn kan ten minste een derde van de variatie in NAV-premies verklaren. Short sale-belemmering vindt voornamelijk plaats als er veel vraag is ten opzichte van het aanbod in de effecten-lening-markt en leidt dan tot overwaardering.

In hoofdstuk 4 laat ik zien dat de prijs-inflatie verder kan worden toegeschreven aan verwachte toekomstige inkomsten in verband met het potentieel om aandelen uit te lenen. Institutionele beleggers kunnen aandelen uitlenen aan short sellers en daarbij inkomsten genereren. Het uitlenen van effecten betreft de tijdelijke overdracht van effecten door een partij, de bezitter van de aandelen, aan een lener, de short seller. De effecten lener is verplicht om onderpand te verstrekken aan de effecten bezitter in de vorm van contanten of andere waardepapieren. Indien de lener voorziet van effecten als onderpand, betaalt hij een vergoeding om de effecten te lenen. Indien de lener contanten aanreikt als onderpand, betaalt de eigenaar van de aandelen rente aan de short seller en herinvesteert die geld tegen een hoger tarief. Daarbij behoudt de eigenaar het marge-verschil. De beloning kan in sommige gevallen matrieel zijn. In hoofdstuk 4 toon ik aan dat institutionele beleggers bereid zijn om een toeslag te betalen voor deze vergoeding betreffende effecten-lening.

Om te bepalen of institutionele beleggers anticiperen op toekomstige kas-stromen door effectenleningen, kijk ik naar de prijs ontwikkeling van beleggingsfondson na een zogenoemde failure-to-deliver in de uitleen markt voor aandelen. Failure-to-deliver vertegenwoordigt situaties waarin het moeilijk is een aandeel te lokaliseren, wat resulteert in hoge onderhandelingspositie voor de aandelenbezitter. Volgens het theoretisch model van Duffie et al. (2002) zou dit kunnen leiden tot een hogere prijs als toekomstige vergoedingen voor effectenleningen worden verdisconteerd in prijzen.

Ik gebruik closed-end beleggingsfondsen om te kunnen meten of failures leiden tot een toeslag ten opzichte van de intrinsieke waarde. De resultaten tonen aan dat het vooruitzicht van de toekomstige leningen de prijs verhoogt boven de intrinsieke waarde van closed-end beleggingsfondsen. Fondsen met gemelde failures zijn met 2.63% overgewaardeerd. De resultaten in deze studie geven verder aan dat deze overwaardering te wijden is aan de verwachtingen ten aanzien van toekomstige kas-stromen door effectenleningen. Deze studie is de eerste die empirisch aantoont dat vergoedingen voor effectenleningen worden verdisconteerd in prijzen.

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Born in Rotterdam on June 5, 1983, Melissa Porras Prado, obtained her pre-university education (VWO) diploma from the Rotterdamsch Lyceum in 2001. Melissa went on to study International Business Administration at Erasmus University Rotterdam (EUR). She completed the CEMS MIM program in 2005 and attended ESADE on exchange. Melissa received a Master's degree in Business Administration (cum laude) from EUR in 2006. After graduating, Melissa joined the ERIM PhD program to carry out doctoral research at the Department of Financial Management of the Rotterdam School of Management, Erasmus University. Her research interests are in empirical asset pricing, with a focus on short sales and real estate. The article version of Chapter 2 is published in Real Estate Economics. During her PhD. program Melissa presented at many international conferences, including FMA-Doctoral Student Consortium in Singapore, XVIII Finance Forum in Spain, and at the Netspar, ERES, and AREUEA meetings. She also completed a three-month research visit at the University of Florida. At the Rotterdam School of Management, Melissa has taught corporate finance, real estate finance and portfolio management and supervised Bachelor's and Master's theses. Melissa is currently working as an assistant professor at NOVA business school in Lisbon, Portugal.

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THE LONG AND SHORT SIDE OF REAL ESTATE, REAL ESTATE STOCKS, AND EQUITY

This thesis consists of three studies in the investments field, which examines the interaction between long and short positions and their impact on market participants, prices and portfolio allocations. In chapter 2, I examine the optimal portfolio composition for institutional investors when considering liabilities. Institutional investors, by taking into account their short positions, which in effect are their liabilities, make different asset allocation decisions (long positions). Important in the optimization in excess of liabilities is the role of the asset classes in hedging the market value of liabilities. In chapter 3, I turn to the impact of short positions of market participants on prices by showing that limits to shorting lead to biased prices. In particular, I find that the presence of short sale constraints can explain the existence of a premium to Net Asset Value for Real Estate Investment Trusts. Miller (1977) argues that as short-sale constraints keep more pessimistic investors out of the market, prices tend to reflect a more optimistic valuation than they otherwise would. The results of 4 suggest that overpricing caused by the presence of short sale constraints is not solely due to restriction on negative information but also partly a result of capitalized lending income. I show that revenue associated with security lending is capitalization in prices, as investors are willing to pay a premium associated with lending fees.

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