Unexpected inflation, capital structure and real risk-adjusted firm performance

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Abstract

Managers can improve real risk-adjusted firm performance by matching nominal assets with nominal liabilities, thereby reducing the sensitivity of real risk-adjusted returns to unexpected inflation. We model these returns as a function of nominal and real assets and liabilities and illustrate our proposition using a simulation. We test the empirical implications of our model in a sample of listed US equity real estate investment trusts (REITs), enabling simple identification and measurement of real and nominal contracts. We find evidence that our sample firms observe the proposed matching relationship between nominal assets and liabilities. Moreover, we find that real risk-adjusted performance and inflation hedging qualities are inversely related to deviations from the proposed matching relationship. We infer that corporate debt holdings reflect attempts to manage real risk-adjusted performance by modifying equity exposure to unexpected inflationary shocks. We further conclude that variation in inflation hedging qualities is related to capital structure.

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Key words: REITs, leverage, inflation hedging, real risk-adjusted performance
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1 Introduction

In the traditional Merton (1969) framework, investors maximise expected utility over immediate consumption and terminal wealth to fund future consumption. However, the ability to consume out of wealth is determined by the real purchasing power of wealth. The purchasing power of wealth depends on the prevailing price level and is thus a real, rather than a nominal concept (Ritter, 2002). As a result, firm managers may be incentivised to maximise real, rather than nominal, risk-adjusted performance. Managers can arguably influence real risk-adjusted firm performance through alternative means, especially the pursuit of a suitable investment policy that determines the firm's asset structure. We argue that, conditional on a given asset structure, a firm can optimise its real risk-adjusted performance through the choice of an appropriate financing policy. We employ a simple model of real risk-adjusted returns to equity as a function of the firm's capital structure, consisting of nominal and real assets and liabilities, to show that managers can optimise these returns by matching the holdings of nominal liabilities with nominal assets.

Real risk-adjusted performance is difficult to optimise partly due to the variation in the general price level. In an efficient market, the returns on nominal contracts account for expected inflation (Bach and Stephenson, 1974; Fama, 1970). However, the uncertainty surrounding unexpected inflation is more difficult to manage. Figure 1 shows that expected US CPI inflation averaged 0.2% per month between 1989 and 2011. However, over the same time period, the volatility of monthly unexpected inflation also averaged 0.2%. These statistics suggest that under a Normal distribution, there is a c. 15% chance that inflation was more than twice as high, in a given month, as expected. Furthermore, unexpected inflation has increased over the last 22 years, peaking at 0.6% per month in 2008. This observation suggests that the risk of unexpected inflation is of growing importance, especially given the uncertain longer-term consequences of recent expansionary monetary policy measures.

We model real risk-adjusted returns to equity as a function of the firm's nominal and real assets and liabilities. In our model, the net balance of nominal assets and liabilities influences the real return to equity as well as its volatility by modifying the exposure of equity to expected and unexpected inflation risks. We show that, everything else being equal, real risk-adjusted performance is conditionally maximised when nominal liabilities are matched with nominal assets in an increasing, monotonic fashion. The appropriate choice of nominal liabilities for a given level of nominal assets reduces the volatility of the real return to equity by attenuating the impact of unexpected inflation, thereby improving the risk efficiency of an investment in the firm's equity.

Some empirical studies have found it difficult to adequately identify and distinctly measure nominal and real assets and liabilities (Amihud, 1996; French, Ruback, and Schwert, 1983). We test the empirical implications of our model using a sample of US Real Estate Investment Trusts (REITs). These firms follow a regulated business model of almost exclusively investing in and deriving income from operating real estate assets, which simplifies the composition of their balance sheet. This characteristic allows for a straight-forward distinction between real and nominal assets and liabilities that reduces potential measurement errors and thus increases the power of our empirical tests. Further, the straight-forward identification of nominal assets in the case of REITs combined with the detailed firm-level information available from a REIT-specific data provider allows us to develop a set of relevant, strong and valid instruments for nominal assets, enabling us to ensure valid identification of our econometric model.

We find empirical evidence consistent with the proposed positive linear relationship between nominal assets and liabilities. While larger firms may generally have larger total borrowings, we control for this argument in a number of ways. First, we test our hypothesis using an instrumental variable approach. In addition, we employ a scaled model specification. Our evidence is robust to these alternative tests. We also explore whether real risk-adjusted firm performance and the strength of a firm's inflation hedging qualities decline in the deviation from the proposed match between nominal assets and liabilities. Our results support the suggested links between capital structure, real risk-adjusted performance and inflation hedging qualities.

Our results have several implications for managers and investors. We offer a simple capital structure rule that allows firm managers to maximise real risk-adjusted performance and hedge unexpected inflation. Further, our results imply that investors can infer inflation hedging capabilities of equity investments from the firm's capital structure. In addition, we contribute to two questions that are prominent topics in the literature specific to REITs. Our findings suggest a novel rationale why regulated, tax-exempt REITs may persistently hold significant levels of leverage. [1]

[1] For evidence consistent with low traditional incentives for REITs to employ leverage, see Alcock, Steiner, and Tan (2012); Boudry, Kallberg, and Liu (2010); Brown and Riddiough (2003); Feng, Ghosh, and Sirmans (2007); Harrison, Panasian, and Seiler (2011); Howe and Shilling (1988); Shilling (1994).

Specifically, REIT leverage choices may partly be a function of efforts to manage the exposure of equity to unexpected inflation risks and improve real risk-adjusted performance. Our results also contribute to the debate about the inflation-hedging qualities of REITs as a securitised form of real estate investments. We suggest that variation in these qualities may be a function of firm capital structure.

We proceed as follows: Section 2 presents the model alongside a set of simulation results to derive testable implications. Section 3 presents data, method and descriptive statistics, Section 4 discusses our empirical results, and Section 5 concludes.

2 Hypothesis development

Consider a simple, mature firm that holds a combination of assets and liabilities that are all classified as either nominal or real. Assume that the values of nominal contracts are fixed in currency terms. Further assume that the values of real contracts fluctuate with the price level. In addition, assume that the firm's asset structure is determined by its investment policy. Now consider the problem of a manager whose objective it is to maximise the real risk-adjusted return to firm equity, conditional on a given asset structure. The manager's objective is then to identify an appropriate liability structure. Within our simplified framework, the manager will focus on the choice of nominal versus real liabilities. By implication then, we assume that all other factors that may influence capital structure are held constant.

Consider the following simple one-period framework. Let E_0 denote the value of firm equity at time $t = 0$, defined as the sum of real and nominal assets and liabilities:

$$E_0 = (A_0^R - L_0^R) + (A_0^N - L_0^N) \tag{1}$$

where A_0^R and L_0^R are the values of the firm's real assets and liabilities at time $t = 0$. A_0^N and L_0^N are the corresponding values of the nominal assets and liabilities. We assume $E_0 > 0$. At $t = 1$, unexpected inflation has caused the general price level to change at rate e^u, $u \sim N(0, \sigma_u^2)$. The total value of firm equity at $t = 1$, E_1, is then:

$$E_1 = \left(A_0^R e^{\kappa} - L_0^R\right) e^{r+u} + \left(A_0^N e^{\kappa} - L_0^N\right) e^{r+\alpha} \tag{2}$$

where $r \sim N(\mu_r, \sigma_r^2)$ is the premium for real corporate debt L_0^R over the risk-free rate measured at time $t = 1$. The variable $\kappa \sim N(\mu_\kappa, \sigma_\kappa^2)$ is the premium that differentiates the return on assets from that on liabilities. The variable $\alpha \sim N(\mu_\alpha, \sigma_\alpha^2)$

represents the premium for expected inflation that differentiates the returns on nominal assets and liabilities from those on their real counterparts. As u is unexpected inflation, we assume that $cov(r,u) = cov(\alpha,u) = cov(\kappa,u) = 0$. The total, one-period, continuously compounded excess return on firm equity, R, is then given by:

$$R = \ln\left[\frac{E_1}{E_0}\right] = \ln\left[\frac{\left(A_0^R e^{\kappa} - L_0^R\right) e^{r+u} + \left(A_0^N e^{\kappa} - L_0^N\right) e^{r+\alpha}}{\left(A_0^R - L_0^R\right) + \left(A_0^N - L_0^N\right)}\right] \tag{3}$$

Accounting for inflation, the one-period real excess return on firm equity, R^R, is:

$$R^R = \ln\left[\frac{\left(A_0^R e^{\kappa} - L_0^R\right) e^{r} + \left(A_0^N e^{\kappa} - L_0^N\right) e^{r+\alpha-u}}{\left(A_0^R - L_0^R\right) + \left(A_0^N - L_0^N\right)}\right] \tag{4}$$

We measure the real risk-adjusted return on firm equity using the real Sharpe ratio, as it is consistent with optimising the trade-off between risk and return in the mean-variance framework (Sharpe, 1966, 1994). This measure, denoted SR^R, is defined as the ratio of the expectation and the standard deviation of R^R:

$$SR^R = \frac{E\left[R^R\right]}{SD\left[R^R\right]} \tag{5}$$

In the one-period framework of our model, we propose that, everything else being equal, managers are able to conditionally maximise real risk-adjusted performance, measured as SR^R, by choosing the appropriate amount of nominal liabilities to match a given amount of nominal assets.

Our proposition implies that investors delegate the management of capital structure choices to the firm. The Modigliani and Miller (1963) irrelevance proposition is derived from the assumption that investors can employ home-made leverage to replicate the financing strategy of the firm. However, Frazzini and Pedersen (2011) argue that there are leverage-constrained investors, such as pension funds, who cannot or choose not to employ home-made leverage. Consistent with this view, we argue that these leverage-constrained investors benefit from delegating the management of capital structure choices to the firm. On the other hand, unconstrained investors are still in a position to leverage and de-leverage in order to manage capital structure, performance and inflation hedging objectives independently at no extra cost. On balance therefore, the firm in our model is able to increase the supply of its capital, and accordingly reduce its cost of capital, by expanding the potential investor base to include leverage-constrained investors.

Simulation results

We employ a set of simple simulations to illustrate the evolution of the components of SR^R as a function of nominal assets and liabilities. These simulations allow us to explore the optimal relationship between nominal assets and liabilities that conditionally maximises SR^R. For each combination of nominal assets and liabilities along a range of possible values, we calculate $E\left[R^R\right]$ and $SD\left[R^R\right]$ over the distribution of r, u, α and κ. We choose parameter values to identify a general trend.

Figure 2(a) shows the results for $E\left[R^R\right]$. This expectation increases in nominal assets. Nominal assets contribute positively to the return on equity as they earn the premium for expected inflation, α. For a given level of nominal assets, $E\left[R^R\right]$ is a linear, decreasing function of nominal liabilities. Increasing nominal liabilities for a given level of nominal assets reduces the net nominal position ($A_0^N - L_0^N$), and thus the exposure of equity to the return benefits of α. The constant negative slope of the relationship between $E\left[R^R\right]$ and nominal liabilities suggests that a unit-change in nominal liabilities results in a constant rate of change in $E\left[R^R\right]$, irrespective of the current level of nominal assets. This occurs because equity is the residual of assets and liabilities.

Figure 2(b) shows the results for $SD\left[R^R\right]$. For positive shifts in the level of nominal assets, $SD\left[R^R\right]$ generally increases. The reverse occurs at very high levels of nominal liabilities. Then $SD\left[R^R\right]$ decreases in the level of nominal assets. The non-linear evolution of $SD\left[R^R\right]$ reflects the interactions between nominal assets and liabilities in determining the exposure of equity to unexpected inflation risks. More specifically, the sensitivity of the real return on equity to unexpected inflation risk depends upon the net nominal position of the firm. When nominal liabilities are low, then increasing nominal assets increases the net nominal position and thus the sensitivity of the real return on equity to unexpected inflation. As a result, $SD\left[R^R\right]$ increases. When nominal assets and liabilities are approximately equal so that the net nominal position of the firm is balanced, then this sensitivity is minimised. However, as the level of nominal liabilities increases further, the net nominal position drifts out of balance again. Consequently, the exposure of equity to unexpected inflation risks increases, and so does the standard deviation of the real return to equity. When nominal liabilities are high, an increase in nominal assets helps rebalance the net nominal position, reduces the exposure to unexpected inflation risks and thus results in a lower $SD\left[R^R\right]$.

To illustrate the volatility-minimising relationship between nominal assets and liabilities, consider the sensitivity of real equity returns to unexpected inflation, S, as the partial derivative of R^R with respect to u:

$$S = \frac{\partial R^R}{\partial u} = \frac{-e^{-u}\left(A_0^N e^{r+\alpha+\kappa} - L_0^N e^{r+\alpha}\right)}{E_1} \tag{6}$$

Setting S to zero and solving for the level of nominal liabilities yields:

$$S = 0 \implies L_0^N = A_0^N e^{\kappa} \implies L_0^N \propto A_0^N \tag{7}$$

Figure 3 shows the simulation results for the real Sharpe ratio SR^R as a function of nominal assets and liabilities. The real Sharpe ratio is the product of the overall trade-off between the costs and benefits of nominal assets and liabilities, namely, the exposure to the return benefits of α and the exposure to unexpected inflation risks.

Higher levels of nominal assets increase the maximum SR^R achievable. This finding reflects the return-enhancing effect of nominal assets as these assets capture the return benefits of α. For a given level of nominal assets, SR^R is a concave function of nominal liabilities. This finding reflects the non-linear relationship between $SD\left[R^R\right]$ and the net nominal position. When nominal liabilities are low, for a given level of nominal assets, an additional unit of nominal liabilities reduces $SD\left[R^R\right]$ by more than it detracts from $E\left[R^R\right]$. On balance then, this additional unit of nominal liabilities increases the real Sharpe ratio. For low levels of nominal liabilities, the marginal effect of a reduction in the return sensitivity to unexpected inflation from an additional unit of nominal liabilities outweighs that of the reduction in the expected return on equity from foregoing some of the return benefits of α.

The figure further suggests that, for a given level of nominal assets, the amount of nominal liabilities can be chosen so as to maximise SR^R. Beyond the maximum SR^R however, an additional unit of nominal liabilities reduces $SD\left[R^R\right]$ by less than it detracts from $E\left[R^R\right]$. The negative effect of nominal liabilities on the numerator of SR^R from foregoing the benefits of α outweighs the positive effect on the denominator from lower sensitivity to unexpected inflation. Recall that, as suggested in Figure 2(b), this volatility-reducing effect is actually reversed when nominal liabilities become large. This reversal is also reflected in the increasing downward slope of SR^R as a function of nominal liabilities. On balance then, beyond the optimum of SR^R, an additional unit of nominal liabilities decreases the real Sharpe ratio.

The plot suggests that the optimal amount of nominal liabilities that maximises SR^R is where the differentials of $E\left[R^R\right]$ and $SD\left[R^R\right]$ are equal. At this point, the marginal volatility-reducing effect of an additional unit of nominal liabilities is equal to the marginal return-reducing impact from this additional unit. However, the figure suggests that the Sharpe ratio-maximising amount of nominal liabilities is lower than the amount that minimises $SD\left[R^R\right]$. This difference is due to the fact that, on average, a unit-increase in nominal liabilities reduces $SD\left[R^R\right]$ by less than it reduces $E\left[R^R\right]$. This occurs because beyond the minimum of $SD\left[R^R\right]$, an additional unit of nominal liabilities increases $SD\left[R^R\right]$ again. Therefore, the ratio between $E\left[R^R\right]$ and $SD\left[R^R\right]$ is maximised before $SD\left[R^R\right]$ is minimised.

This plot further suggests that the optimal, Sharpe-ratio maximising amount of nominal liabilities is a positive linear function of nominal assets. For $SD\left[R^R\right]$, the optimal trade-off between the costs and benefits of nominal assets and liabilities is achieved by linearly matching these items, as illustrated in (7). For the real Sharpe ratio, which is a direct function of $SD\left[R^R\right]$, this optimal trade-off is still achieved by maintaining a linear matching relationship between nominal assets and liabilities. However, the constant of proportionality appears to be smaller. The reason for this difference is again that, as observed, on average, a unit increase in nominal liabilities reduces $SD\left[R^R\right]$ by less than it reduces $E\left[R^R\right]$. This differential impact shifts the optimal amount of nominal liabilities to the left.

Figure 4 illustrates the suggested linear relationship between nominal assets and liabilities that maximises SR^R. For each level of nominal assets along a range of possible values, we identify the maximum real Sharpe ratio and plot it against the corresponding value of nominal liabilities that generates this ratio. The comparative statics suggest that the amount of nominal liabilities that maximises SR^R is indeed a monotonically increasing, linear function of nominal assets that is robust to variation in all other components of our model.

Testable implications

The central prediction of our model is that, everything else being equal, managers who aim to maximise real risk-adjusted performance conditional on a given asset structure, will match nominal assets with nominal liabilities in a monotonically increasing, linear fashion. Therefore, we anticipate a positive linear relationship between these two items.

A related implication is that matching nominal assets and liabilities improves real risk-adjusted returns. We expect that deviations from the optimal match between nominal assets and liabilities are inversely related to the firm's real Sharpe ratio.

Our model also implies that the improvement in real risk-adjusted performance is partly driven by a stronger hedge against unexpected inflation. In other words, our model suggests an inverse relationship between deviations from the optimal match between nominal assets and liabilities and unexpected inflation hedging qualities of an investment into the firm's equity.

As a result of this discussion, we test the following hypotheses.

Hypothesis 1: A firm's nominal liabilities are positively related to the amount of nominal assets held.

Hypothesis 2: A firm's real Sharpe ratio is inversely related to the deviation from the optimal match between nominal assets and liabilities.

Hypothesis 3: A firm's unexpected inflation hedging qualities are inversely related to the deviation from the optimal match between nominal assets and liabilities.

3 Data and method

3.1 Data and proxies

We study all listed US REITs (SIC code 6798), with the exception of mortgage REITs (GIC Code 40402030), in the cross-section of SNL and $Compustat$ from the inception of SNL in 1989 to 2011. All balance sheet data is from SNL and $Compustat$. Firm returns are from the Center for Research in Security Prices ($CRSP$). Inflation data is from the Bureau of Labor Statistics. Bond yields are from the Federal Reserve. Data on the market, size and value factors as well as the risk-free rate are from Kenneth French's database.

We discard observations where the ratio of long-term debt to total debt, nominal assets to all assets or nominal liabilities to all liabilities lies outside the interval $[0, 1]$. All continuous variables are winsorised at the 1^{st} and 99^{th} percentiles. We measure earnings volatility and abnormal earnings contemporaneously to the observation of the dependent variable. We measure all other variables at the fiscal year-end prior to that (Billett, King, and Mauer, 2007; Johnson, 2003).

We use the REIT's Net Asset Value (NAV) as a proxy for nominal assets. A nominal asset may be thought of as one with cash flows fixed in nominal terms over the life of the asset. Equity REITs mainly derive income from leasing real estate assets (Lehman and Roth, 2010). Rental payments under existing leases may be fixed for considerable periods of time, if not the duration of the lease. Leases may reflect inflation through indexation clauses that periodically adjust the rent to the currently prevailing price level. However, given the discrete nature of these reviews, rental payments significantly lag changes in the price level. Therefore, leases are often considered a nominal asset (Hoesli, Lizieri, and MacGregor, 2008; Zarowin, 1988).

The NAV reflects the value of the REIT's leases as it is calculated by discounting the expected rental income derived from these leases at an appropriate rate and deducting any debt employed in the acquisition of the underlying properties (Chan, Erickson, and Wang, 2003). Consistent with the characteristics of nominal contracts in efficient markets (Bach and Stephenson, 1974; Fama, 1970), the rental income projected on the basis of the leases may reflect expected inflation. However, these projections cannot account for unexpected inflation. Therefore, in line with the definition of nominal assets, the REIT's NAV does not reflect unexpected inflation.

We employ the firm's holdings of fixed-rate debt as a proxy for nominal liabilities, following Flannery and James (1984). *SNL* provides detailed panel data on REIT NAV and fixed-rate debt.

3.2 Empirical method

The relationship between nominal assets and liabilities

We formally examine the empirical evidence for the hypothesised linear relationship between nominal assets and liabilities by considering the natural logarithm of nominal debt ($LNFRDT$) as a function of the natural logarithm of nominal assets ($LNNA$). Both variables are deflated by the Producer Price Index (constant in August 1982). We estimate the following random effects panel model:

$$\begin{aligned} LNFRDT_{it} = \beta_0 + \beta_1 LNNA_{it} + \beta_2 LNSIZE_{it} + \beta_3 PROFIT_{it} + \beta_4 MB_{it} \\ + \beta_5 ABEARN_{it} + \beta_6 VOL_{it} + \beta_7 DNOL_{it} + u_{it} \end{aligned} \tag{8}$$

where u_{it} is the residual and standard errors are clustered by firm (Petersen, 2009; Thompson, 2011). We include year dummies to capture the effect of latent economic shock factors. We control for a set of common capital structure determinants. Our selection of control variables largely follows Harrison, Panasian, and Seiler (2011) and the literature discussed therein. $LNSIZE$ is the natural log of firm size measured as the market value of the firm's assets. $PROFIT$ is profitability, measured as the ratio of EBITDA to book value of assets. MB is the market-to-book ratio. $ABEARN$ is abnormal earnings measured as the change in earnings per share divided by the share price, as a proxy for firm quality. VOL is the volatility of earnings growth as a measure of credit risk. $DNOL$ is a dummy for the presence of alternative tax shields, measured as operating losses carried forward. See Table 1 for details on variable definitions and measurements. As per Hypothesis 1, we expect a positive sign on β_1 in (8).

Our model specification in (8) includes a control variable for firm size in order to account for the argument that larger firms may generally have larger total borrowings. However, for robustness we employ a number of alternative techniques.

First, we employ an instrumental variable approach. We determine the log of the rental revenue per property, $LNRPP$, alongside a set of year dummies, as our instrument for nominal assets. We choose this instrument as it arguably primarily influences the NAV, but not directly firm size, any other exogenous predictor, or immediately the way in which the underlying assets are financed. The table below summarises the diagnostics on the suitability of our instrument for $LNNA$. The model statistics show that the estimation over 421 firm-year observations yields a partial R^2 of the excluded instrument and the year dummies of c. 19%. Our instrument passes the diagnostic tests for relevance, strength and validity.

Model diagnostics for first-stage regression of $LNNA$ on IV $LNRPP$ and controls

Observations	421	Weak identification test (Strength)	37.124
Partial R-squared	0.1854	5% maximal IV relative bias	21.230
Underidentification test (Relevance)	37.233	Overidentification test (Validity)	23.594
P-value	0.0012	P-value	0.0513

We re-estimate (8) using 2SLS where the first stage is employed to predict $LNNA$ as a function of our proposed excluded instrument and the controls:

$$\begin{aligned} LNNA_{it} = \gamma_0 + \gamma_1 LNRPP_{it} + \gamma_2 LNSIZE_{it} + \gamma_3 PROFIT_{it} + \gamma_4 MB_{it} \\ + \gamma_5 ABEARN_{it} + \gamma_6 VOL_{it} + \gamma_7 DNOL_{it} + e_{it} \end{aligned} \tag{9}$$

where e_{it} is the residual. Here, we also include year dummies to capture latent economic shocks. The second stage estimates the main relationship of interest between the predicted $\hat{LNNA}$ and $LNFRDT$, accounting for the capital structure controls:

$$LNFRDT_{it} = \beta_0 + \beta_1 \hat{LNNA}_{it} + \beta_2 LNSIZE_{it} + \beta_3 PROFIT_{it} + \beta_4 MB_{it} + \beta_5 ABEARN_{it} + \beta_6 VOL_{it} + \beta_7 DNOL_{it} + u_{it} \quad (10)$$

Our chosen identification strategy ensures that evidence consistent with Hypothesis 1 does not simply reflect that larger firms have larger borrowings. Nevertheless, for additional robustness, we estimate a scaled specification of our model. We model the ratio of nominal liabilities to the book value of equity as a function of the ratio of nominal assets to the book value of equity, employing the set of controls described. A common denominator between the outcome and a predictor may introduce an artificial correlation between these variables and produce misleading inference. We mitigate this potential bias by assessing the statistical significance of the nominal assets to equity ratio against the adjusted standard errors in Barraclough (2007).

Despite the fact that we employ a one-period model to develop our initial hypotheses, we nevertheless control for debt maturity in the empirical analysis of Hypothesis 1. In order to reflect the potential relationship between debt maturity and the amount of debt held (Alcock, Finn, and Tan, 2012; Barclay, Marx, and Smith, 2003; Johnson, 2003; Leland and Toft, 1996), we augment (10) with a proxy for debt maturity, the ratio of long-term debt to total debt (Barclay, Marx, and Smith, 2003).

Further, we might expect that long-maturity nominal assets are matched with nominal liabilities of the appropriate maturity. We control for this asset maturity matching principle by treating debt maturity as endogenous. We use the log of asset maturity (Myers, 1977), the term structure (Diamond, 1991; Sharpe, 1991; Titman, 1992) and a debt rating dummy (Brick and Ravid, 1985) as instruments for debt maturity. As per Hypothesis 1, we expect a positive sign on β_1 in all specifications.

Liability matching and real risk-adjusted performance

Next, we explore the relationship between real risk-adjusted performance and the optimal match between nominal assets and liabilities. To do so, we relate a firm-year panel of the annual real Sharpe ratios (SR^R) of the REITs to a proxy for their annual deviations from this optimal match (DEV). We obtain the annual real Sharpe ratios of the sample firms on the basis of monthly $CRSP$ return data.

We argue that the Sharpe ratio-maximising amount of nominal liabilities is proportional to nominal assets. The optimal constant of proportionality may differ for each firm in each year, depending on the actual prevailing values of the parameters in our model. For the empirical implementation, we examine a number of alternatives for the parameter characterising the relationship between nominal assets and liabilities. First, we assume direct proportionality. Additionally, we parametrise the optimal proportional relationship between nominal assets and liabilities using the empirical coefficient values from the analysis of Hypothesis 1. As a result, we measure the deviation from the optimal match between nominal assets and liabilities for each firm-year, DEV, by computing the annual squared differences between actual nominal liabilities and assets and, alternatively, between actual nominal liabilities and the amounts of nominal assets derived from the analysis of Hypothesis 1. We estimate the following fixed-effects panel model:

$$\begin{aligned} SR^R_{it} = \beta_0 + \beta_1 DEV_{it} + \beta_2 LNSIZE_{it} + \beta_3 PROFIT_{it} + \beta_4 MB_{it} + \beta_5 FAR_{it} \\ + \beta_6 ABEARN_{it} + \beta_7 VOL_{it} + \beta_8 DNOL_{it} + \beta_9 MAT_{it} + u_{it} \end{aligned} \quad (11)$$

where u_{it} is the residual and standard errors are clustered by firm (Petersen, 2009; Thompson, 2011). Real risk-adjusted performance may be viewed as a function of the firm's investment decisions and, as we suggest, its financing policy. We include dummies for the firm's property sector as a proxy for the firm's investment strategy. The property sector of a REIT arguably determines the type of leases, including indexation clauses. Therefore, the property sector may have an immediate impact on real risk-adjusted performance. We also control for the set of capital structure controls from Table 1. We account for latent economic shock factors using year dummies. Consistent with Hypothesis 2, we expect a negative sign on β_1 in (11).

In order to explore the relative sensitivity of changes in the real Sharpe ratio to changes in the deviation from the optimal match between nominal assets and liabilities, we re-estimate equation (11) in first differences.

Liability matching and inflation hedging qualities

In order to examine the relationship between the unexpected inflation hedging qualities of an investment into the firm's equity and the optimal match between nominal assets and liabilities, we relate the annual sensitivity of monthly nominal firm returns to unexpected inflation to the deviation variable, DEV. In the calculation of DEV, we assume direct proportionality between nominal assets and liabilities.

A stock is considered an inflation hedge if an inflationary shock does not affect real returns, or, equivalently, if an inflationary shock results in a positive change in nominal returns (Alchian and Kessel, 1959; Bodie, 1976; Branch, 1974; Fama and MacBeth, 1974; Lintner, 1973; Oudet, 1973). It is not possible to provide statistical evidence for the absence of a relationship between real returns and inflation. Therefore, we examine the relationship between nominal returns and inflation. We estimate each firm's unexpected inflation hedging qualities using annual regressions of the nominal monthly excess firm returns ($NRET$) on monthly unexpected inflation ($UINFL$) and a set of controls. We compile a firm-year panel of the annual coefficients measuring the sensitivity of nominal firm returns to unexpected inflation. A higher positive coefficient value suggests stronger unexpected inflation hedging qualities.

We measure unexpected inflation as the residual from filtering monthly logged CPI figures using an ARIMA(0,1,1) specification (Fama and Gibbons, 1984; Vassalou, 2000), and expected inflation as the predicted values from this exercise. [2]

In this regression, we control for the excess return on the market (MKT), size (SML) and value (HML) factors, expected inflation ($EXPIN$) and variation in the interest rate proxied by changes in the federal funds rate ($CFFR$):

$$\begin{aligned} NRET_{it} &= \gamma_0 + \gamma_1 UINFL_t + \gamma_2 MKT_t + \gamma_3 SMB_t + \gamma_4 HML_t \\ &\quad + \gamma_5 EXPIN_t + \gamma_6 CFFR_t + e_{it} \end{aligned} \tag{12}$$

where e_{it} is the residual. We collect the γ_1 coefficients to compile a firm-year panel of unexpected inflation sensitivities $UINFLS$. We then regress these $UINFLS$ on our proxy for the deviations from the optimal match between nominal assets and liabilities (DEV). We control for the usual set of capital structure determinants, including maturity, as well as property type and year dummies. We estimate the following fixed-effects panel model:

$$\begin{aligned} UINFLS_{it} &= \beta_0 + \beta_1 DEV_{it} + \beta_2 LNSIZE_{it} + \beta_3 PROFIT_{it} + \beta_4 MB_{it} \\ &\quad + \beta_5 ABEARN_{it} + \beta_6 VOL_{it} + \beta_7 DNOL_{it} + \beta_8 MAT_{it} + u_{it} \end{aligned} \tag{13}$$

where u_{it} is the residual. We remedy the bias in the standard errors from heteroskedasticity potentially introduced by the estimated dependent variable in (13) using heteroskedasticity-robust standard errors clustered by firm (Lewis and Linzer, 2005; Petersen, 2009; Thompson, 2011). Consistent with Hypothesis 3, we expect a

[2] We choose this proxy for unexpected inflation since TIPS as a potential alternative, market-based proxy are only available for maturities in excess of five years.

negative sign on β_1 in (13).

In order to explore the relative sensitivity of changes in the firm's inflation hedging characteristics to changes in the deviation from the optimal match between nominal assets and liabilities, we re-estimate this specification in first differences.

3.3 Descriptive statistics

Table 2 presents the descriptive statistics for the period 1989-2011. The mean nominal debt (assets) to equity ratio is 1.91 (2.41). The mean firm size is US$1.28bn (in constant August 1982 US$, deflated using PPI). The mean debt maturity, measured as the ratio of long-term debt to total debt, is 49%. Asset maturity averages 33 years, supporting the notion that the useful life of real estate assets is relatively long. The profitability of the sample firms averages 8%. The mean market-to-book ratio is 1.24. This value is broadly consistent with Alcock, Steiner, and Tan (2012). This observation suggests that the stable REIT business model of owning and operating real estate assets offers low growth opportunities.

The volatility of earnings is relatively low at 2%. This observation supports the notion that REITs focus on a stable business model as suggested in (Boudry, Kallberg, and Liu, 2010). Approximately 9% of all firm-year observations have losses carried forward. Almost 48% of firm-year observations have debt ratings present.

Table 3 presents the pairwise Pearson correlation coefficients between the main predictors. Correlations are generally low with the exception of the log of nominal assets and firm size. This observation validates our range of alternative measures that we employ in order to control for the effect of firm size in the analysis of Hypothesis 1.

Figure 5 shows a histogram with descriptive statistics for the unexpected inflation sensitivity coefficients we estimate. The mean inflation sensitivity of the nominal returns of our sample firms is significantly positive. This observation suggests that on average for our study period, US listed equity REITs offer some inflation hedging qualities. However, the histogram shows considerable dispersion around the mean. Some firm-year observations have significantly positive values of unexpected inflation sensitivity, while others have significantly negative values. This range of values implies substantial variation in inflation hedging qualities. Our empirical results, discussed below, suggest that this variation may be related to capital structure choices.

4 Results

Table 4 presents the results for Hypothesis 1 over the study period 1989 to 2011.[3] Our empirical evidence supports the prediction of our model that nominal liabilities are a positive linear function of nominal assets (Column 1). Our findings are robust to the modifications of our empirical analysis. Specifically, our result holds in the instrumental variable estimation (Column 2), it is robust to including debt maturity (Column 3) and to controlling for the asset matching principle (Column 4). Our result also holds in the scaled model specification (Column 5).[4]

Our results suggest that REITs hold nominal debt to match nominal assets. Our findings thus contribute to the debate about the potential drivers of REIT leverage choices. This debate is driven by the difficulty to reconcile the theoretical lack of incentive for REITs to use debt with the empirical observation that these firms tend to hold significant levels of leverage, and often more than unregulated firms in a comparable line of business (Alcock, Steiner, and Tan, 2012; Harrison, Panasian, and Seiler, 2011).[5] Against this background, several authors suggest potential alternative explanations for the determinants of REIT leverage choices. Brown and Riddiough (2003) report that REITs appear to target leverage in order to maintain an investment-grade debt rating. Ooi, Ong, and Li (2010) and Boudry, Kallberg, and Liu (2010) suggest that REIT debt issuance decisions are consistent with the market timing theory (Baker and Wurgler, 2002). Further, Feng, Ghosh, and Sirmans (2007) suggest that REITs trade off the lack of incentive for debt and the adverse selection cost of equity. Alcock, Steiner, and Tan (2012) find that REITs use debt to signal firm quality and optimise transaction costs. Alcock, Glascock, and Steiner (2013) suggest that REITs employ leverage to manage market exposure and modify

[3] In unreported results, we find that our evidence is robust to excluding the period prior to 1992, marking the introduction of the UPREIT legislation and thus the beginning of the modern REIT era, sometimes considered a structural break in the REIT history. Our evidence is also robust to excluding the period after 2007, marking the onset of the recent global financial crisis.

[4] For robustness, we estimate an analogous set of regressions where we replace our chosen proxy for nominal assets, the NAV of the REIT, with the log of the Gross Asset Value (GAV), or the ratio of GAV to equity, respectively. The NAV is adjusted for any debt, nominal or real, employed in the acquisition of the underlying properties. The GAV is equivalent to the NAV before deducting any debt used to purchase the assets. In these unreported results, our finding regarding the relationship between nominal liabilities and nominal assets is robust to using the GAV as alternative proxy for nominal assets.

[5] The interest in REIT capital structure decisions is particularly fuelled by the limited explanatory power of traditional leverage theories given the tax exemption of REITs, their strict pay-out requirements and straight-forward business model. Howe and Shilling (1988) assert that in the absence of tax benefits, REITs cannot compete for debt and will favour equity. Shilling (1994) argues that REIT value is maximised for equity-only financing. Boudry, Kallberg, and Liu (2010) argue that, given their simple business model of owning and operating real estate, REITs are a fairly transparent investment vehicle, limiting asymmetric information problems and thus the relevance of the traditional pecking order theory. Pecking order also assumes discretion over earnings, debt and equity. However, REIT pay-out requirements (Lehman and Roth, 2010) largely restrict funding choices to debt and equity.

risk-adjusted performance. In spite of these numerous suggestions for the drivers of REIT capital structure decisions, Harrison, Panasian, and Seiler (2011) conclude that a closer investigation and better understanding of the leverage choices of these firms is needed. Our results offer a novel rationale why REITs may hold significant levels of leverage. Specifically, our findings suggest that REITs hold debt to match nominal assets in an effort to improve real risk-adjusted performance by managing unexpected inflationary shocks.

Our findings resonate studies on REIT lines of credit, suggesting that REIT financing strategies are market-driven in the sense that they reflect investor preferences, with stronger firm performance generally related to higher amounts of lines of credit available but lower amounts utilised (Hardin, Highfield, Hill, and Kelly, 2009; Hardin and Hill, 2011; Riddiough and Wu, 2009).

Further, we find that firm size is positively related to the holdings of nominal debt. Our finding resonates the view that larger firms with more assets in place have more total borrowings. Our evidence also suggests that the firms in our sample follow the pecking order theory (Donaldson, 1961; Myers and Majluf, 1984). Pecking order predicts that firms prefer debt as a less informationally sensitive source of funding over other funding sources such as equity that are more prone to adverse selection costs. The characteristics of nominal debt contracts, especially the fixed interest rate, suggest that this funding type is relatively less informationally sensitive, rendering it preferable relative to equity. Furthermore, the market-to-book ratio seems inversely related to the amount of nominal debt. Our result aligns with the view that the market-to-book ratio as a proxy for growth opportunities is inversely related to borrowings in order to mitigate the underinvestment problem (Myers, 1977).

We also find that firm quality, measured as abnormal earnings, is inversely related to nominal debt holdings. Ross (1977) suggests that higher quality firms signal their type by taking on more debt when mimicking such a strategy is too costly for low-quality firms. However, our dependent variable is fixed-rate debt. In the context of the signalling hypothesis, our result suggests that higher quality firms may signal their type by taking on the interest rate risk embedded in variable-rate debt.

Our model predicts a relationship between the firm's liability structure and its real risk-adjusted performance, giving rise to Hypothesis 2. Table 5 presents the corresponding regression results. Our results support this hypothesis. We find an inverse linear relationship between the deviation from the optimal match between nominal assets and liabilities and the real Sharpe ratio, after controlling for a set of variables reflecting that real risk-adjusted performance is the product of the firm's investment decisions and its financing choices. Our evidence is robust to different parameter choices for the constant of proportionality characterising the optimal matching relationship between nominal assets and liabilities (Columns 1 to 3). Our result is consistent with our model's implication that capital structure choices and real risk-adjusted performance are related. Our finding suggests that, everything else being equal, a firm that adheres to the optimal matching relationship between nominal assets and liabilities achieves a higher real Sharpe ratio. [6]

However, our result also suggests that the relationship between the real Sharpe ratio and deviations from the optimal match between nominal assets and liabilities is not strictly linear. Column 4 of Table 5 presents the effect of changes in the deviation from the optimal amount of nominal liabilities on changes in the real Sharpe ratio. [7] The corresponding coefficient is significantly negative. Larger deviations from the optimum appear to have a decreasing relative negative impact on the real Sharpe ratio. The marginal effect of an additional small shift away from the optimal amount of nominal liabilities appears to be decreasing. As a result, managers have a strong incentive to make small adjustments towards the optimal balance of nominal assets and liabilities when the current deviation is small. As this deviation becomes larger, the incentive to make more significant adjustments appears to become stronger.

Our model further implies a relationship between the firm's liability structure and its characteristics as a hedge against unexpected inflation. Table 6, Column 1, presents the regression results of the firms' annual unexpected inflation betas on the deviation from the optimal match between nominal assets and liabilities. [8] Our results hold when controlling, amongst others, for the property sector of the REITs that we employ as a proxy for the investment strategy of the firm. This sector arguably determines the structure of the leases and thus the terms under which rents adjust to inflation. Our finding suggests that the liability structure of the firm has a significant impact on unexpected inflation hedging qualities that is separate from the influence

[6] For robustness, we also explore the possibility of asymmetric consequences on real risk-adjusted performance of firms holding either excess or insufficient amounts of nominal liabilities. We augment the relevant regressions by an indicator for the sign of the raw deviation before squaring the difference in the construction of DEV. We find no evidence for such asymmetries, suggesting that any deviations from the optimal amount of nominal liabilities reduce real risk-adjusted performance, irrespective of their sign.

[7] Given the robustness of our results to the different parameter choices for the constant to proportionality, we focus here on the directly proportional case.

[8] Given the robustness of our results up to this point to the different choices for the constant of proportionality characterising the linear matching relationship between nominal assets and liabilities, from now on, we focus our discussion on the results for the directly proportional case.

of the asset and lease structures determined by the investment strategy of the firm.

More specifically, we find that deviations from the optimal match between nominal assets and liabilities reduce the firm's unexpected inflation beta. In our empirical setting, a higher inflation beta stands for a higher sensitivity of the firm's nominal return to unexpected inflation. Therefore, a higher beta implies a superior hedge against unexpected inflation. Our results suggest that observing the linear relationship between nominal assets and liabilities modifies the sensitivity of the nominal return on equity to unexpected inflationary shocks. Consequently, it appears that matching nominal assets and liabilities reduces the adverse effects of unexpected inflation. In combination, our findings suggest a conceptual link between capital structure choices, inflation hedging qualities and real risk-adjusted firm performance.

Further, we find that the firm's unexpected inflation hedging qualities are inversely related to debt maturity. This finding suggests that, everything else being equal, an increase in the holdings of long-term debt appears to attenuate the inflation sensitivity of the firm's nominal returns. Our results also suggest that the firm's unexpected inflation hedging qualities are negatively related to the market-to-book ratio. The market-to-book ratio reflects the extent to which the market value of the firm is backed by assets in place. A higher market-to-book ratio suggests that the firm has growth opportunities that have not materialised into nominal or real assets in place yet. The inflation hedging qualities we explore relate to the extent to which nominal assets in place are financed with nominal debt. A higher market-to-book ratio, suggesting fewer assets in place relative to the market value of the firm, appears to leave equity more exposed to unexpected inflation and, as a result, to attenuate the inflation hedging qualities of investments into the firm's equity.

Column 2 of Table 6 presents the effect of a change in the deviation from the optimal match between nominal assets and liabilities on the change in the firms unexpected inflation beta. The sign on the coefficient is negative, resonating the result for changes in real risk-adjusted performance, but here the coefficient is not statistically significant. Our evidence suggests that the marginal effect on inflation hedging qualities of an additional small shift away from the optimal match between nominal assets and liabilities is constant. Our result implies that the incentives for firm managers to correct deviations from the optimal match in order to improve the unexpected inflation hedging qualities of investments into their firm's equity do not appear to vary by the magnitude of the current deviation.

Our findings imply that inflation hedging qualities of REITs may vary across firms as a function of their capital structure. Several studies find evidence against the suitability of listed REITs as an inflation hedge, consistent with results commonly established for industrial stocks. [9] Darrat and Glascock (1989) consider the role of monetary policy, real economic and financial indicators. Subsequently, Glascock, Lu, and So (2002) argue that monetary policy drives the spurious negative relationship between REIT returns and inflation. Simpson, Ramchander, and Webb (2007) distinguish between positive and negative changes in expected and unexpected inflation and present evidence consistent with the suitability of equity REITs as an inflation hedge. Hardin, Jiang, and Wu (2012) argue that inflation illusion may drive the observation that in the short-term, REIT returns often appear to be negatively related to expected inflation. However, many studies to date focus on the index level and thus implicitly assume that inflation hedging properties are equal across firms or exogenously determined. Our findings provide a fundamental economic rationale behind potential variation in inflation hedging properties across REITs that is related to the capital structure choices of these firms.

Further, Case and Wachter (2011) postulate that if firms are net debtors, they will benefit from unexpected changes in the price level through the redistribution effects of inflation. They argue that REITs holding relatively large amounts of fixed-rate debt should on average have relatively stronger returns, all else equal, during periods of high inflation. However, these authors stop short of exploring the empirical evidence for their argument. We present empirical evidence in favour of their argument.

More generally, our findings explore the relationship between the balance of a firm's nominal assets and liabilities and the sensitivity of its equity returns to unexpected inflation. First, firms may not on average be net (nominal) debtors but, as our evidence suggests, match nominal liabilities to nominal assets. The resulting cross-sectional variation in nominal liabilities that is difficult to incorporate into analyses on the index level may be partly responsible for the lack of strong evidence for REITs as an inflation hedge. Further, firms may not universally benefit from simply holding more nominal debt. Instead, the exact choice of the amount and term of nominal debt that has to be matched with the amount and maturity of nominal assets appears to matter. This explains why on average, a relationship between total nominal liabilities

[9] See, for instance, Brueggeman, Chen, and Thibodeau (1984); Chan, Hendershott, and Sanders (1990); Chatrath and Liang (1998); Ewing and Payne (2005); Goebel and Kim (1989); Gyourko and Linneman (1988); Park, Mullineaux, and Chew (1990); Titman and Warga (1986); Yobaccio, Rubens, and Ketcham (1995).

and the inflation sensitivity of REIT returns may seem weak.

5 Conclusion

In this study, we model the real risk-adjusted return on firm equity as a function of nominal as well as real assets and liabilities. We show that, everything else being equal, firms can choose a capital structure to improve real risk-adjusted performance by matching nominal assets with nominal liabilities in a monotonically increasing, linear fashion. We illustrate that in doing so, firms reduce the sensitivity of real risk-adjusted returns to unexpected inflation, improving the risk efficiency of investments into their equity. Overall, our study establishes a simple interrelationship between capital structure, real risk-adjusted performance and the inflation hedging qualities of REITs.

In our empirical analysis, we find that US listed equity REITs tend to observe the hypothesised matching relationship between nominal assets and liabilities. Furthermore, firms that adhere to the suggested match appear to outperform their peers in terms of the real Sharpe ratio. Increasing deviations from the optimal match between nominal assets and liabilities also appear to reduce the unexpected inflation hedging qualities of investments into the firms' equity.

Our study contributes to the debate about the drivers of REIT leverage choices given the limited explanatory power of many of the traditional motivations for holding debt. We provide evidence consistent with the hypothesis that REITs choose debt holdings so as to improve real risk-adjusted performance via the modification of equity exposure to unexpected inflationary shocks.

Our results also contribute to the debate about inflation hedging characteristics of REITs as a securitised form of direct real estate. We provide evidence that REITs may be able to offer inflation hedging qualities if they follow the optimal matching relationship between nominal assets and liabilities. In doing do, we explore an additional dimension of this debate relating to the potential firm-level variation in inflation hedging characteristics. We illustrate how these characteristics may relate to capital structure choices via the management of the match between nominal assets and liabilities.

Our findings have a number of practical implications. Financial managers are able to employ our findings in the development of strategies to enhance real risk-adjusted performance, conditional on a given asset structure. For investors, our finding suggests that they are able to utilise information on the firm's liability structure to draw inferences about the firm's potential to deliver strong real risk-adjusted performance. Our results therefore have the potential to assist investors in improving the basis of their decision-making process and help promote more efficient investment decisions.

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6 Figures and tables

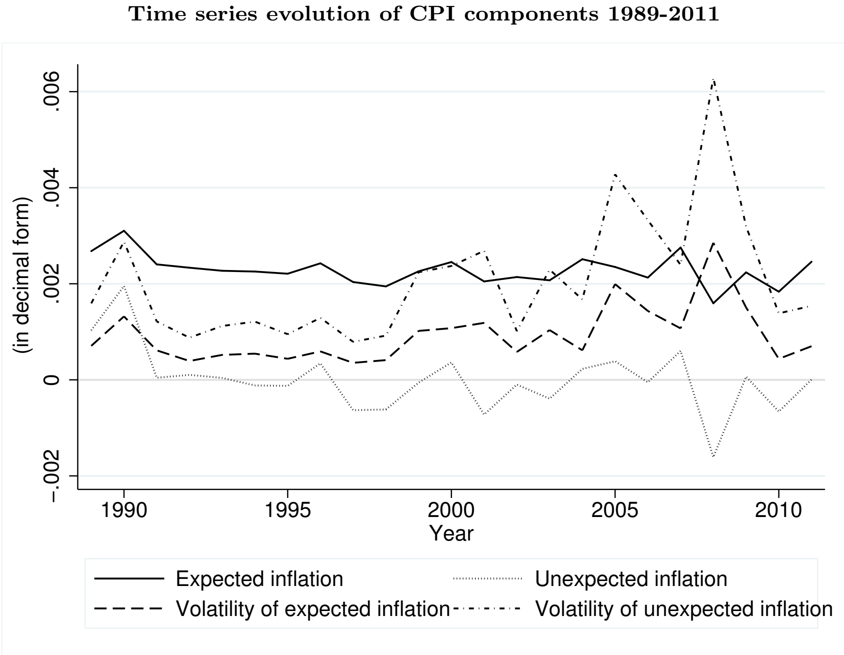
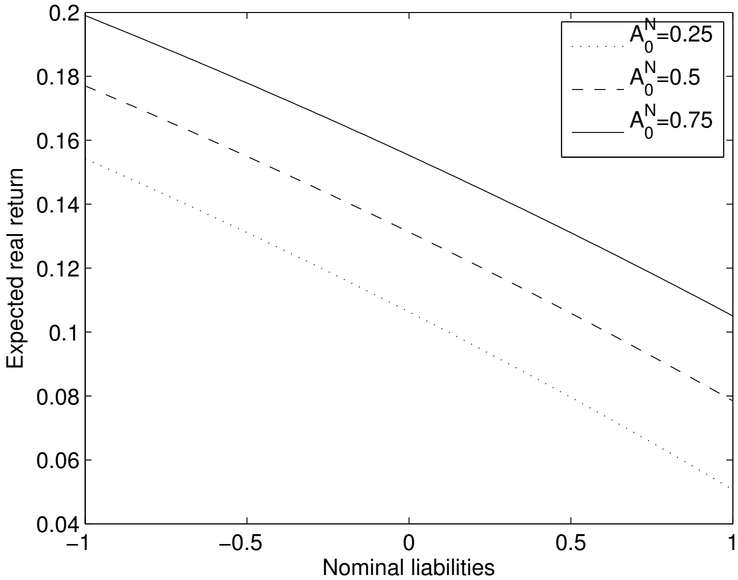
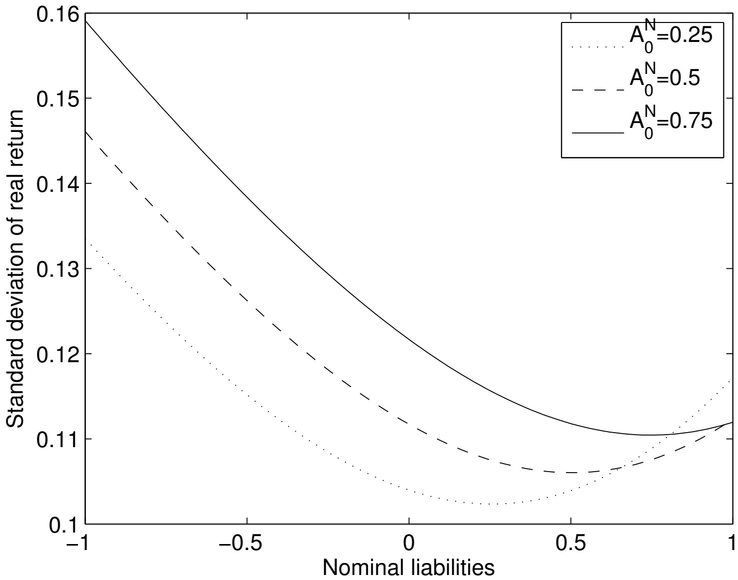


Fig. 1. The figure shows the time series evolution of different aspected of US CPI inflation over the study period. We measure unexpected inflation as the residual from filtering monthly logged CPI figures using an ARIMA(0,1,1) specification (Fama and Gibbons, 1984; Vassalou, 2000), and expected inflation as the predicted values from this exercise. We measure unexpected (expected) inflation uncertainty as the annual standard deviation of monthly unexpected (expected) inflation figures over 12 months to year-end.

Simulation for the real excess return to firm equity and its standard deviation



(a) Expectation of real excess return



(b) Standard deviation of real excess return

Fig. 2. The figure shows the results from the simulation of the real excess return to firm equity, in Figure 2(a), and its standard deviation, in Figure 2(b). The vectors for nominal assets and liabilities, A_0^N, L_0^N, are 101×1 each. The vectors for the normal random variables are $1,000 \times 1$ each. Nominal assets are defined as $A_0^N \in [0, 1]$. We impose that $A_0^N \geq 0$ for going concern. The values for nominal liabilities L_0^N are not restricted. Nominal liabilities are $L_0^N \in [-1, 1]$. Initial equity is $E_0 = 1$. Real assets are $A_0^R = 0.1$. Real liabilities are the residual modelled as a linear function of the remaining asset, liability and equity positions, $L_0^R = E_0 + A_0^N - L_0^N + A_0^R$. This structure allows us to focus on nominal liabilities, conditional on a given asset structure and initial equity. The random variables are drawn from a normal distribution. The real return on L_0^R in excess of the risk free rate is $r \sim N(0.05, 0.1)$. The return differential between real and nominal items is $\alpha \sim N(0.05, 0.05)$. The return differential between assets and liabilities is $\kappa \sim N(0.05, 0.04)$. Unexpected inflation is $u \sim N(0, 0.05)$.

Simulation for the real Sharpe ratio

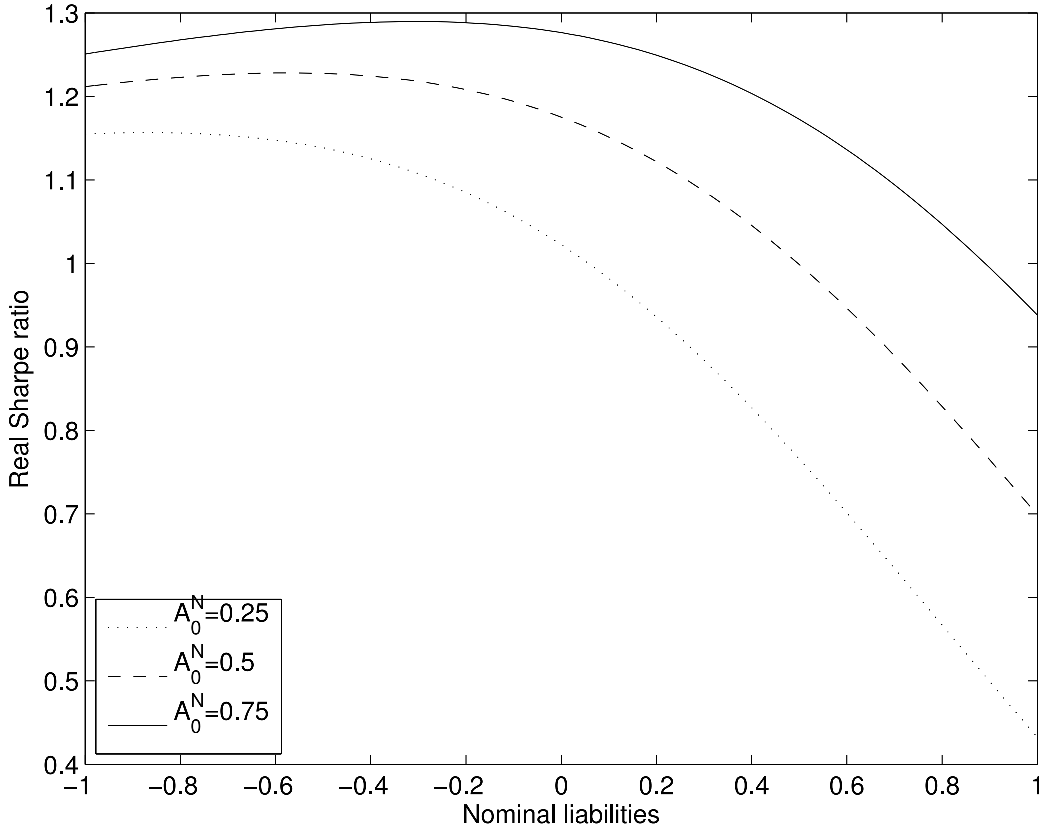


Fig. 3. The figure shows the results from the simulation of the real Sharpe ratio. The vectors for nominal assets and liabilities, A_0^N, L_0^N, are 101×1 each. The vectors for the normal random variables are $1,000 \times 1$ each. Nominal assets are defined as $A_0^N \in [0, 1]$. We impose that $A_0^N \geq 0$ for going concern. The values for nominal liabilities L_0^N are not restricted. Nominal liabilities are $L_0^N \in [-1, 1]$. Initial equity is $E_0 = 1$. Real assets are $A_0^R = 0.1$. Real liabilities are the residual modelled as a linear function of the remaining asset, liability and equity positions, $L_0^R = E_0 + A_0^N - L_0^N + A_0^R$. This structure allows us to focus on nominal liabilities, conditional on a given asset structure and initial equity. The random variables are drawn from a normal distribution. The real return on L_0^R in excess of the risk free rate is $r \sim N(0.05, 0.1)$. The return differential between real and nominal items is $\alpha \sim N(0.05, 0.05)$. The return differential between assets and liabilities is $\kappa \sim N(0.05, 0.04)$. Unexpected inflation is $u \sim N(0, 0.05)$.

Comparative statics

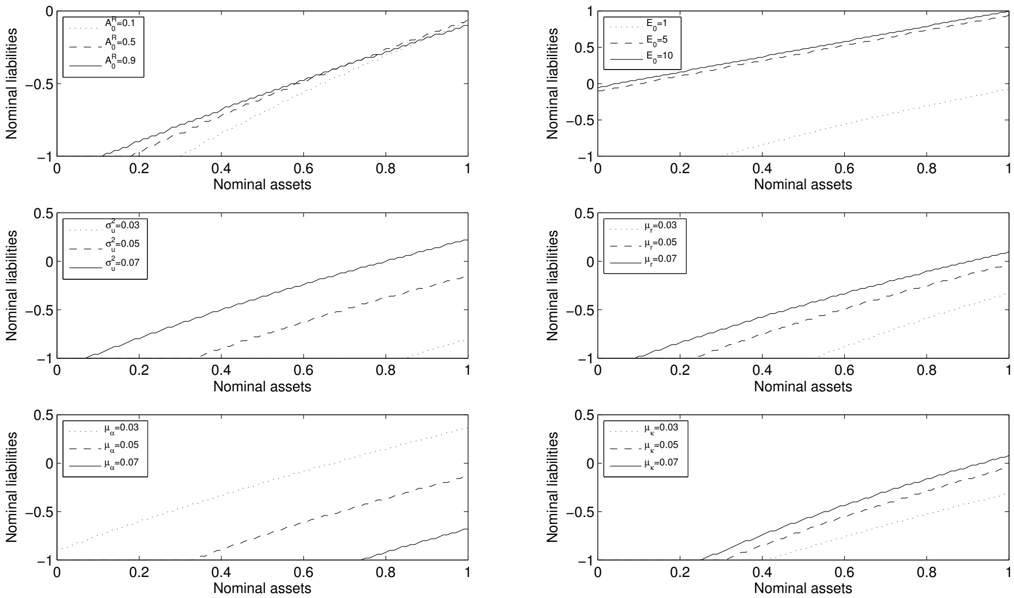
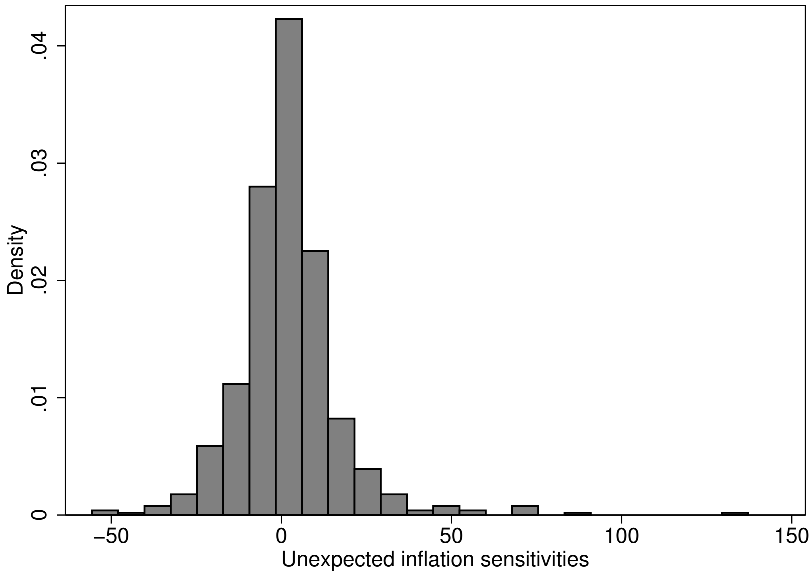


Fig. 4. The figure shows the comparative statics of the model. The vectors for nominal assets and liabilities, A_0^N, L_0^N, are 101×1 each. Nominal assets are defined as $A_0^N \in [0,1]$. We impose that $A_0^N \geq 0$ for going concern. The values for nominal liabilities L_0^N are not restricted and are $L_0^N \in [-1,1]$. Initial equity is $E_0 = 1$. Real assets are $A_0^R = 0.1$. Real liabilities are the residual modelled as a linear function of the remaining asset, liability and equity positions, $L_0^R = E_0 + A_0^N - L_0^N + A_0^R$. This structure allows us to focus on nominal liabilities, conditional on a given asset structure and initial equity. The random variables are vectors of $1,000 \times 1$ and drawn from a normal distribution. The real return on L_0^R in excess of the risk free rate is $r \sim N(0.05, 0.1)$. The return differential between real and nominal items is $\alpha \sim N(0.05, 0.05)$. The return differential between assets and liabilities is $\kappa \sim N(0.05, 0.04)$. Unexpected inflation is $u \sim N(0, 0.05)$. The scenarios modify elements of the basic structure one by one as follows: Scenario 1 varies $A_0^R = [0.1, 0.5, 0.9]$. Scenario 2 varies $E_0 = [1, 5, 10]$. Scenario 3 varies $u \sim N(0, \sigma_u^2), \sigma_u^2 = [0.03, 0.05, 0.07]$. Scenario 4 varies $r \sim N(\mu_r, 0.1), \mu_r = [0.03, 0.05, 0.07]$. Scenario 5 varies $\alpha \sim N(\mu_\alpha, 0.05), \mu_\alpha = [0.03, 0.05, 0.07]$. Scenario 6 varies $\kappa \sim N(\mu_\kappa, 0.05), \mu_\kappa = [0.03, 0.05, 0.07]$.

Histogram and descriptive statistics of unexpected inflation sensitivities of listed US equity REITs over the full study period 1989-2011



	Percentiles	Smallest	Statistics	
1%	-33.513	-55.653	Mean	2.008
5%	-19.396	-50.552	Standard deviation	15.313
10%	-13.201	-41.234	Standard error	0.595
25%	-4.754	-39.822	**95% conf. interval**	
			Lower	0.840
50%	0.642		Upper	3.177
		Largest	t-stat	3.375
75%	7.873	72.019	N	662
90%	15.997	74.747	Variance	234.477
95%	22.975	86.595	Skewness	1.903
99%	56.177	137.200	Kurtosis	16.220

Fig. 5. The figure shoes a histogram alongside a set of descriptive statistics for the unexpected inflation sensitivities of the listed US equity REITs in our sample over the full study period. These estimates are obtained using annual regressions of the nominal monthly firm excess returns ($NRET$) on monthly unexpected inflation ($UINFL$) and a set of controls to obtain the annual coefficients measuring the sensitivity of nominal firm returns to unexpected inflation. We measure unexpected inflation as the residual from filtering monthly logged CPI figures using an ARIMA(0,1,1) specification (Fama and Gibbons, 1984; Vassalou, 2000), and expected inflation as the predicted values from this exercise. In this regression, we control for the excess return on the market (MKT), size (SML) and value (HML) factors, expected inflation ($EXPIN$) and variation in the interest rate proxied by changes in the federal funds rate ($CFFR$). We collect the coefficients on the unexpected inflation variable to compile a firm-year panel of unexpected inflation sensitivities.

Control variables and proxies

Variable	Measurement	References
MAT: Debt maturity	Ratio of long-term debt maturing in more than 3 years to total debt	Leland and Toft (1996)
LNSIZE: Firm size	Log of market value of the firm's assets	Myers and Majluf (1984)
PROFIT: Profitability	Ratio of EBITDA to book value of assets	Donaldson (1961); Myers and Majluf (1984)
MB: Market-to-book ratio	Book value of assets minus book value of common equity plus market value of common equity relative to book value of assets	Myers (1977)
ABEARN: Abnormal earnings	Change in earnings per share relative to share price	Ross (1977)
VOL: Earnings volatility	Standard deviation of 1st diff. in EBITDA over 4 years, scaled by average assets over these years	Bradley, Jarrell, and Kim (1984)
DNOL: Alternative tax shields	Dummy for operating loss carried forward, 1 in presence of alternative tax shield	DeAngelo and Masulis (1980)
IV for debt maturity	**Measurement**	**Reference**
AMAT: Asset maturity	Log of gross depreciable assets to depreciation expense	Myers (1977)
DRATED: Debt rating	Dummy, 1 in presence of debt rating	Diamond (1991); Sharpe (1991); Titman (1992)
TERM: Term structure	Yield on 10-yr. relative to 6-month government bond	Brick and Ravid (1985)
IV for nominal assets	**Measurement**	**Reference**
LNRPP: Log of rental revenue per property	Ratio of rental revenue to average properties	Suggested here

Table 1

The table shows the main capital structure control variables employed in our regression, alongside their proxies and measurement as well as the reference to the original theory. Where possible, our proxy choices follow the suggestions by the original authors. All firm-level and balance sheet data is obtained from *SNL* and *Compustat*. Bond yields have been obtained from the Federal Reserve Bank of St. Louis's Economic Database.

Descriptive statistics for the sample firms over the full study period 1989-2011

VARIABLES	**Mean**	**Median**	**Min**	**Max**	**S.D.**	**N**
Nominal debt to equity ratio	1.908	1.369	-161.407	67.389	8.762	533
Nominal assets to equity ratio	2.410	2.147	-97.228	56.342	6.312	533
Firm size	1277.819	668.664	0.440	16801.184	1954.373	533
Debt maturity	0.486	0.496	0.000	1.000	0.201	533
Asset maturity	33.097	31.430	14.306	124.528	10.142	533
Profitability	0.080	0.084	-0.160	0.212	0.034	533
Market-to-book ratio	1.236	1.190	0.576	2.457	0.287	533
Abnormal earnings	-0.021	-0.002	-3.065	2.818	0.283	533
Volatility	0.024	0.014	0.001	0.201	0.029	533
Proportion of firm years with						
Loss carried forward	0.090	0.000	0.000	1.000	0.287	533
Debt rated dummy	0.475	0.000	0.000	1.000	0.500	533
Term structure	1.852	2.160	-0.350	3.610	1.345	533

Table 2
The table reports descriptive statistics the REITs in our final sample between 1989 and 2011 from *Compustat* and SNL database. Variables are defined as: Nominal debt to equity is the ratio of fixed-rate debt to book value of equity. Nominal assets to equity is the ratio of the firm's NAV to book value of equity. Log of Firm Size is measured by the natural logarithm of the market value of the firm's assets (in millions of August 1982 US$, deflated by PPI). Debt Maturity is measured by the proportion of long-term debt relative to total debt. Log of Asset Maturity is measured by the natural logarithm of the ratio of depreciable assets to depreciation. Profitability is measured as the ratio of EBITDA to book value of assets. Market-to-book ratio is measured by the market value of assets divided by the book value of assets. Abnormal Earnings is the difference between earnings per share in year $t+1$ minus earnings per share in year t, divided by the year t share price. Earnings volatility is measured by the standard deviation of first differences in EBITDA over the four years preceding the sample year, scaled by average assets for that period. Term Structure is the difference between the month-end yields on a 10-year government bond and a 6-month government bond, matched to the month of a firm's fiscal year end. Bond yields are from the Federal Reserve Bank of St. Louis's economic database. Each of the dummy variables (operating loss carried forward and debt rating) equals 1 if the firm has its respective items, 0 otherwise.

Pairwise Pearson correlation coefficients

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Log of nominal assets	1.000											
(2) Log of firm size	0.902	1.000										
(3) Debt maturity	-0.004	-0.006	1.000									
(4) Asset maturity	-0.148	0.066	0.054	1.000								
(5) Profitability	0.321	0.235	0.124	-0.175	1.000							
(6) Market-to-book	0.419	0.597	0.049	0.022	0.264	1.000						
(7) Abnormal earnings	-0.007	0.054	0.053	0.098	0.272	0.079	1.000					
(8) Volatility of earnings	-0.252	-0.331	-0.059	-0.023	-0.165	-0.175	-0.068	1.000				
(9) Loss carried forward	-0.199	-0.164	0.001	-0.142	0.060	-0.011	0.032	-0.003	1.000			
(10) Debt rating dummy	0.502	0.490	0.079	0.023	0.170	0.244	-0.007	-0.203	0.120	1.000		
(11) Term structure	-0.003	-0.051	-0.146	-0.075	-0.182	-0.175	-0.072	-0.011	0.027	0.035	1.000	
(12) Log of rent per property	-0.007	-0.054	0.042	-0.026	0.164	0.148	0.117	-0.039	0.019	0.020	-0.058	1.000

Table 3: The table reports the pairwise Pearson correlation coefficients between the main capital structure control variables employed in our analysis. Variables are defined as: Nominal debt to equity is the ratio of fixed-rate debt to book value of equity. Nominal assets to equity is the ratio of the firm's NAV to book value of equity. Log of Firm Size is measured by the natural logarithm of the market value of the firm's assets (in millions of August 1982 US$, deflated by PPI). Debt Maturity is measured by the proportion of long-term debt relative to total debt. Log of Asset Maturity is measured by the natural logarithm of the ratio of depreciable assets to depreciation. Profitability is measured as the ratio of EBITDA to book value of assets. Market-to-book ratio is measured by the market value of assets divided by the book value of assets. Abnormal Earnings is the difference between earnings per share in year $t+1$ minus earnings per share in year t, divided by the year t share price. Earnings volatility is measured by the standard deviation of first differences in EBITDA over the four years preceding the sample year, scaled by average assets for that period. Term Structure is the difference between the month-end yields on a 10-year government bond and a 6-month government bond, matched to the month of a firm's fiscal year end. Bond yields are from the Federal Reserve Bank of St. Louis's economic database. Each of the dummy variables (operating loss carried forward and debt rating) equals 1 if the firm has its respective items, 0 otherwise.

Regression results for Hypothesis 1, 1989-2011

	Log of nominal assets based on NAV				Nominal assets (NAV) scaled by equity
	(1)	(2)	(3)	(4)	(5)
VARIABLES	LNFRDT	LNFRDT	LNFRDT	LNFRDT	FRDTOEQ
Nominal assets	0.255***	0.479***	0.514***	0.565***	0.517***
	(0.08)	(0.18)	(0.18)	(0.20)	(0.15)
Debt maturity			0.287	0.707	-0.104
			(0.28)	(0.76)	(0.70)
Log of firm size	0.441***	0.465***	0.438***	0.399**	-0.167
	(0.08)	(0.14)	(0.14)	(0.17)	(0.14)
Profitability	-1.288*	-1.185	-1.738	-2.545	-9.264
	(0.74)	(2.15)	(2.00)	(2.38)	(5.93)
Market to book	-0.702***	-0.510**	-0.480**	-0.435*	-0.53
	(0.13)	(0.23)	(0.23)	(0.26)	(0.58)
Abnormal earnings	-0.023	-0.120**	-0.132***	-0.150***	-0.423*
	(0.06)	(0.05)	(0.04)	(0.05)	(0.24)
Volatility of earnings	-1.489	-1.105	-1.2	-1.338	-4.852
	(1.04)	(1.90)	(1.85)	(1.89)	(3.64)
Loss carried forward	-0.04	0.127	0.135	0.146	-0.044
	(0.11)	(0.38)	(0.37)	(0.38)	(0.99)
Constant	1.69	-1.872*	-1.928*	-2.012*	5.265**
	(1.13)	(1.04)	(1.03)	(1.17)	(2.65)
Observations	462	438	438	438	462
R-squared	0.822	0.826	0.829	0.826	0.267
Firm clusters	78	73	73	73	78

Table 4

The table presents the regression results for our final sample of REITs over the full period 1989-2011. Column (1) shows a random effects panel regression of the log of nominal liabilities ($LNFRDT$) on the log of nominal assets (proxied by NAV) and a set of control variables, see Table 1. Column (2) shows the 2SLS regression of $LNFRDT$ on $LNNA$ and the controls. Here, we estimate $LNNA$ in a first stage as a function of the log of rental revenue per property and year dummies. Column (3) further controls for debt maturity. Column (4) treats maturity to be endogenous also, and determined in a first stage as a function of the log of asset maturity, a debt rating dummy and the term structure. Columns (5) shows a scaled version of our model and replace the log of nominal liabilities with the ratio of nominal liabilities to the book value of equity. Here, we model this variable as a function of the ratio of nominal assets (proxied by NAV) to the book value of equity. In the presence of a common denominator, the critical value for the t-statistic at a 5% level of significance for a sample size of $n = 500$ is approximately 2.7 (Barraclough, 2007). The t-statistic of the coefficient for the main predictor of interest (NAV to equity ratio) is greater than 3.3. In all regressions, we include year dummies to capture the effects of latent economic shock factors. Robust standard errors (clustered by firm) in parentheses, significance is indicated as follows: *** p<0.01, ** p<0.05, * p<0.1.

Regression results for Hypothesis 2, 1989-2011

VARIABLES	(1) SR^R	(2) SR^R	(3) SR^R	(4) D.SR^R
Deviation (proportion = 0.255)	-0.022***			
	(0.00)			
Deviation (proportion = 0.565)		-0.034***		
		(0.01)		
Deviation (proportion = 1)			-0.015***	
			(0.00)	
D.Deviation (proportion = 1)				-0.063***
				(0.01)
Debt maturity	0.159	0.141	0.127	0.829
	(0.15)	(0.15)	(0.15)	(0.74)
Log of firm size	-0.042	-0.044	-0.045	0.243
	(0.07)	(0.07)	(0.07)	(0.28)
Profitability	0.019	-0.001	0.126	-5.703
	(0.82)	(0.83)	(0.82)	(6.39)
Market to book	0.245	0.222	0.236	-1.279
	(0.22)	(0.23)	(0.23)	(1.18)
Abnormal earnings	-0.011	-0.012	-0.010	-0.001
	(0.03)	(0.03)	(0.03)	(0.11)
Volatility of earnings	1.189	1.147	1.045	1.616
	(0.85)	(0.84)	(0.83)	(2.77)
Loss carried forward	0.024	0.033	0.033	-0.273
	(0.07)	(0.07)	(0.07)	(0.37)
Constant	0.394	0.456	0.427	-3.461
	(1.22)	(1.24)	(1.25)	(3.87)
Observations	451	451	451	439
R-squared	0.307	0.301	0.298	0.077
Firm clusters	78	78	78	76
Property type dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes

Table 5
The table presents the results from a set of fixed effects panel regression models for our final sample of REITs over the full period 1989-2011. We estimate the firm's annual real Sharpe ratio (Columns 1 to 3) and the change in the annual real Sharpe ratio (column 2) as a function of the deviation (DEV) from its optimal nominal liability holdings (column 1) and the change in this deviation (Column 4). We obtain the annual real Sharpe ratio of a firm by computing its average annual real excess return over the risk-free rate and dividing by the volatility of this return. We measure DEV by computing the annual squared differences between nominal assets and liabilities (both deflated by the Producer Price Index constant in August 1982, in millions of US$). In Column (1), DEV is calculated using the constant of proportionality obtained from Table 4, Column (1). In Column (2), DEV is calculated using the constant of proportionality obtained from Table 4, Column (4). In Columns (3) and (4), DEV is calculated using a constant of proportionality of unity. We control for the commonly employed capital structure determinants as well as property type and year effects, using dummy variables. Robust standard errors (clustered by firm) in parentheses, significance is indicated as follows: *** p<0.01, ** p<0.05, * p<0.1.

Regression results for Hypothesis 3, 1989-2011

	(1)	(2)
VARIABLES	Inflation sensitivity	D.Inflation sensitivity
Deviation (proportion = 1)	-0.468*	
	(0.26)	
D.Deviation (proportion = 1)		-0.484
		(0.33)
Debt maturity	-21.963***	-11.655
	(6.11)	(8.18)
Log of firm size	0.610	-3.681
	(1.88)	(3.19)
Profitability	24.811	129.220
	(26.33)	(85.43)
Market to book	-13.935***	-1.090
	(3.75)	(8.60)
Abnormal earnings	1.826	3.956
	(2.67)	(3.53)
Volatility of earnings	55.758	-58.427
	(38.50)	(56.12)
Loss carried forward	3.240	1.477
	(3.69)	(6.67)
Constant	15.521	49.710
	(35.13)	(57.22)
Observations	440	427
R-squared	0.075	0.270
Firm clusters	75	73
Property type dummies	Yes	Yes
Year dummies	Yes	Yes

Table 6
The table presents the results from a set of fixed effects panel regression models for our final sample of REITs over the full period 1989-2011. We estimate the firms' sensitivity to unexpected inflation as a function of the deviation (assuming a constant of proportionality of unity) from their optimal nominal liabilities (column 1) and present the results from an identical regression considering annual changes in the unexpected inflation beta as a function of changes in this deviation (column 2), controlling for the usual set of capital structure determinants, including maturity, as well as property type and year dummies. We measure the firm's sensitivity to unexpected inflation using annual regressions of the nominal monthly firm excess returns ($NRET$) on monthly unexpected inflation ($UINFLS$). We measure unexpected inflation as the residual from filtering monthly logged CPI figures using an ARIMA(0,1,1) specification (Fama and Gibbons, 1984; Vassalou, 2000), and expected inflation as the predicted values from this exercise.[10] In this regression, we control for the excess return on the market (MKT), size (SML) and value (HML) factors, expected inflation ($EXPIN$) and variation in the interest rate proxied by changes in the federal funds rate ($CFFR$). We collect the coefficients on $UINFL$, resulting in a firm-year panel of unexpected inflation sensitivities $UINFLS$. We remedy the bias in the standard errors from heteroskedasticity potentially introduced by the estimated dependent variable using robust standard errors clustered by firm (Lewis and Linzer, 2005). Robust standard errors (clustered by firm) in parentheses, significance is indicated as follows: *** p<0.01, ** p<0.05, * p<0.1.