I. Introduction

Behavioral biases influence investment decisions. One of the most commonly investigated behavioral biases in investment markets is overconfidence, but it has been challenging to find credible proxies for overconfidence. The early finance papers studied stock market trading by professionals and non-professionals, and used experience and gender as overconfidence proxies (Barber and Odean 2001; Benos 1998; Hirshleifer and Luo 2001).

Malmendier and Tate (2005) studied the effects of managerial overconfidence on corporate investment activity, and developed the proxies that are now broadly seen as the proper ones. These proxies measure how executives treat their stock options and how they trade in their own companies' stocks. The Malmendier and Tate measures are based on the idea that overconfident managers are willing to have more exposure to the specific risks of their corporations than they have to. Rational behavior would predict the avoidance of specific risk where possible.

Using these measures, one can investigate the effects of managerial overconfidence on corporate actions. Recent examples of such studies are Hirshleifer, Low and Teoh (2012) and Campbell et al. (2011). These studies generally show that corporations led by overconfident CEOs are more active in the corporate takeover market, that they tend to be more risk taking – reflected in higher stock volatility – and that they also tend to be more innovative.

In real estate markets, the only study investigating the effect of overconfidence on investment activity and performance is Eichholtz and Yönder (2014). They employ the Malmendier and Tate measures to measure the overconfidence of REIT CEOs, and

find that REITs led by overconfident CEOs purchase more and sell fewer properties than other REITs, depending on their cash stock. They also find that REITs led by overconfident managers perform worse, especially if they have cash on hand. When a CEO is overconfident, a one percent increase in cash to assets decreases the return on assets by 1.5 to 3.1 percent. However, not much is known about the mechanisms that translate managerial overconfidence into weak performance, and we aim to shed more light on this matter in this paper.

To date, there is no evidence of the effects of overconfidence on direct (commercial or residential) property transactions, which is probably related to the fact that overconfidence is very hard to measure in that setting. Databases of commercial and residential property transaction prices are becoming available, but they do not have much, if any, information about those making the investments[1], which seems to rule out the analysis of overconfidence in direct property investments.

Our solution to this problem is to study the direct commercial real estate transactions done by US REITs. This approach allows us to identify overconfident managers using the proxies proposed by Campbell et al. (2011), by analyzing the exercise of stock options by CEOs. Then, we test the impact of overconfidence on transaction prices where REITs are either buyers or sellers, controlling for property and firm characteristics. We develop a hedonic valuation model of commercial properties to generate predicted prices for all the real estate transactions done by REITs, and then relate the actual purchase and sales prices to these predictions, distinguishing the

[1] To investigate the effects of the other main behavioral bias in investment markets, loss aversion, this identification issue is not a problem, since that bias can be measured by looking at the transactions itself. As a result, loss aversion has been investigated for real estate quite extensively, both for residential real estate (Genesove and Mayer 2001; Eichholtz and Lindenthal 2013), for commercial real estate (Bokhari and Geltner 2011), and for REITs (Crane and Hartzell 2011).

transactions of REITs led by overconfident CEOs from others. In order to consider a possible selection bias issue, we also calculate the difference between the actual transaction price and the expected price calculated from a joint regression of REIT transactions and a control sample by other types of buyers and sellers, including REITs for which we cannot determine overconfidence. We then compare the means of the residual transaction prices for REITs with overconfident managers and their non-overconfident counterparts and do a second stage regression analysis.

Besides the relevance for the real estate literature, this approach can also shed new light on the behavioral corporate finance literature. The existing studies in that literature focus on merger and acquisition activity, since it is so very hard to observe day-to-day investment activity in a normal corporation. However, for REITs, data on all the property sales and purchases are available, allowing the researcher to look at firms' "going-concern" activity rather than the special case of M&A. This can lead to new insights into the way overconfidence turns into weak performance.

So our contribution to the literature is twofold. We investigate overconfidence in depth by looking at day-to-day operations and evaluate the source of overconfident managers' weak performance compared to their non-overconfident counterparts (Eichholtz and Yönder 2014; Malmendier and Tate 2008). Additionally, to our knowledge, this is the first study of overconfidence in commercial real estate markets and it is also the first to evaluate the impact of overconfidence on real estate transactions.

We expect that REITs led by overconfident CEOs are prone to pay more when they purchase, possibly pushing up the market prices since they underestimate the risks associated with their decisions and have higher expected value for their investments than

non-overconfident people. Regarding the selling side of the transaction, our expectations are less clear. On the one hand, Eichholtz and Yönder (2014) show that REITs led by overconfident executives perform worse, and that may be caused by the acceptance of low sales prices if overconfidence is associated with low competence. Alternatively, overconfident managers may aim for more portfolio trading activity leading to higher costs that translate to a lower performance. On the other hand, they also find that these REITs with overconfident managers tend to sell their properties less than REITs led by non-overconfident CEOs, which could be caused by relatively high asking prices, ultimately translating into high sales prices for the properties that are sold. But if REITs set their asking prices too high initially, market forces may be pushing the actual sales prices back to the predicted market price.

In line with our hypotheses, we find that REITs led by overconfident managers pay higher prices than their counterparts after controlling for property characteristics and firm characteristics. We find premiums between 7.8 and 8.4 percent, depending on the regression specification. Beyond a direct impact of overconfidence, we also find that the relation between overconfidence and the price is sensitive to cash stock. With more cash stock, overconfident managers pay higher premiums for their property acquisitions. This suggests that the corporate underperformance associated with managerial overconfidence may be caused by overpaying in purchases.

On the sales side, we do find not a significant premium or discount associated with CEO overconfidence, which suggests that overconfidence is not the same as lack of competence, and which also suggests that the market generally disciplines managers when they sell their properties.

However, when the REITs led by overconfident managers are not cash-constrained, we find that they sell with statistically significant premiums. This finding may support the notion that overconfident managers set higher asking prices, especially when they are not forced to sell due to cash constraints, and sell only if the buyer meets their higher target price.

In the remainder of this paper, we will first present data sources and descriptive statistics. In Section III we will discuss the literature regarding overconfidence, and will subsequently develop our hypotheses. Section IV provides results, and we will end the paper with a short concluding section.

II. Data and Sample Statistics

We first obtain data for commercial property transactions from Real Capital Analytics (RCA). The RCA database covers commercial real estate transactions exceeding US$5 million and provides information on the property that can be used in our hedonic models. The specific sample we obtain from this database are all transactions in which a REIT is a buyer or a seller. In total, our sample consists of 11758 transactions. The sample period is from 2001 through 2012.

The RCA database keeps track on the hedonics of the properties. We are able to observe the location of the property by the street address but also by economic region, state, metro area and city, as well. In our analyses, we both control by metro area and also economic region in unreported regressions. There are 98 metro areas in our sample and we create a dummy variable for each of them in order to use in our analyses similar to Bokhari and Geltner (2011). RCA database also contains hedonics of the properties

including the size of the property, the year the property built, the number of stories, the type of the property, information whether the property is renovated at any time and whether the property transaction is a part of a portfolio investment.[2] We limit our sample to main commercial property types: office, apartment, retail and industrial and create a dummy variable for each. We control for all of these property characteristics similar to hedonic regression analyses in the literature such as Eichholtz, Kok and Quigley (2010).

Having identified the REITs that were buying and selling during this time period, we then study SEC filings to identify the CEOs for the same 2001-2012 time period. We then gather data on stock options for each of these REIT CEOs from ExecuComp. We end up with 52 REITs whose CEOs can be classified either as overconfident or not. We explain how we measure overconfidence in details in the next section.

Then, we match the overconfidence data for the REITs available in ExecuComp with the REIT's real estate transactions data from RCA based on the REIT-CEO name and the year of transaction. The number of transactions in the final REIT buyer and seller database after matching the REITs with the ExecuComp database is 2966 for REIT purchases and 4080 for REIT sales.

We also control for firm characteristics in some specifications. We obtain the data on firm characteristics from SNL Financial. We gather total assets, total debt, cash and equivalents, market capitalization, common equity and property type by REIT by year. In our regressions we control for the logarithm of total assets as the firm size, the ratio of total debt to total assets as the debt ratio, the ratio of cash and equivalents as the cash stock. We believe that cash stock is an important variable for REITs as they have to pay out 90 percent of their income to shareholders and accordingly, are limited to cash

[2] For portfolio transactions, RCA reports the price of each of the underlying properties within the portfolio.

availability (Eichholtz and Yönder 2014). Following ofHartzell, Sun and Titman (2006), we control for property type Q in order to capture investment opportunities. We first calculate firm Q as the ratio of market value of assets (total assets plus market capitalization minus common equity) to book value of assets (total assets). Then by property type, by year we calculate the mean of firm Q for all REITs in order to obtain property type Q. By using property type Q instead of firm Q, we avoid possible endogeneity issues. We match the lag of these firm characteristics by the transaction year of the property. For instance, if a REIT purchases a property in year t, in our models we use the firm characteristics at year t-1 in order not to deal with possible causality issues.

A. Overconfidence

We measure overconfidence by looking at the exercise of stock options, following Campbell et al. (2011). We define a CEO as overconfident if he is a holder of an exercisable stock option that is 67 percent in-the-money, i.e. if he postpones exercising a profitable exercisable stock option, possibly with the expectation that he will do better keeping it, and accepting the avoidable specific risk in doing so. We only classify a CEO as overconfident if this behavior is persistent, which we define as occurring at least twice.

The logic behind this is that a CEO can directly increase his wealth at no risk by exercising the in-the-money stock option, but he postpones exercising the option, probably because he believes that the option will do even better as a result of ongoing appreciation of his company's stock price, due to his superior management skills. This can be interpreted as a sign of overconfidence, since the CEO is already overexposed to

company-specific risk. The rational action would be to exercise and diversify the proceeds.

Alternative interpretations of this failure to exercise could be the CEO's access to profitable private information, or loyalty to the company. The former interpretation is unlikely, since Eichholtz and Yönder (2014) show that REITs lead by CEOs who do not immediately exercise their stock options when they can perform worse than other REITs, so if private information would be a driver for the CEO's behavior, this information is not likely to be of the profitable kind. CEO company loyalty could be a motive for the late exercise of corporate stock options. However, as far as we know, this has not been investigated in the literature, and the dominant interpretation of late option exercise is overconfidence. We therefore follow this interpretation in the remainder of the paper .[3]

We follow Campbell et al. (2011) in using the ExecuComp database. ExecuComp does not cover the whole REIT universe, and we identify managers of 52 REITs in ExecuComp for whom we can create an overconfidence measure.

As in Campbell et al. (2011), we first calculate the realizable value per option, which is the ratio of the total realizable value of the exercisable options to the number of exercisable options.[4] We then create the estimated exercise price by subtracting the realizable value per option from the year-end stock price.[5] The average moneyness is calculated by the ratio of the realizable value per option to the estimated exercise price. We define CEOs as overconfident when the average moneyness exceeds 67 percent and

[3] We do not go in deep discussion of possible alternative interpretations of this behavior, such as obtaining private information or tax purposes, since it has been discussed well in the literature and this measure of overconfidence is shown to be robust (Malmendier and Tate 2005; 2008).
[4] ExecuComp variables for the total realizable value of the exercisable options and the number of exercisable options are OPT_UNEX_EXER_EST_VAL and OPT_UNEX_ EXER_NUM, respectively.
[5] ExecuComp variable for stock price is PRCCF.

when this occurs for the same CEO at least twice. We consider such CEOs as overconfident for their entire reign since we assume that overconfidence is consistent as Malmendier and Tate (2005) and Campbell et al. (2011) do.

– Insert Table 1 here –

Table 1 presents descriptive statistics for the average moneyness and the overconfidence measure. We look into 629 CEO-years in order to calculate the average moneyness. The mean of the average moneyness is 55 percent. We also summarize the mean of the overconfidence dummy by different samples. In our sample, there are 88 REIT CEOs, 43 percent of whom are overconfident.

There are 22 REITs managed by overconfident CEOs and 32 REITs managed by non-overconfident CEOs for the REIT purchases. Interestingly, when we observe a CEO change, an overconfident CEO is usually replaced by a new overconfident one, and vice versa. Only in two cases do we see otherwise. So specific REITs seem to have preferences for specific management styles, possibly reflecting a managerial culture that transcends the tenure of any one CEO. Given the board's key role in CEO selection, this could also be a reflection of the boards' tastes.

When we look at the transactions where REIT managers are buyers, we see that 45 percent of the transactions are performed by overconfident CEOs. Overconfident REIT managers perform only 26 percent of the REIT sales. There are 22 and 32 REITs making property purchases that are managed by overconfident CEOs and non-overconfident CEOs, respectively. The average number of purchases per REITs managed

by overconfident buyers is around 61, while this number is 52 for non-overconfident buyers. This indicates that an average overconfident REIT manager makes more purchases than the average non-overconfident REIT manager.

When REITs are sellers, overconfident managers only perform 26 percent of the transactions we observe. The average number of sales done by REITs managed by overconfident sellers is around 59, which is just over half of the average we observe for non-overconfident sellers, which is 101. This might indicate that overconfident CEOs less frequently dispose of the properties in their portfolio and are reluctant to sell, which is in line with Eichholtz and Yönder (2014). There are 18 and 30 REITs making property sales that are managed by overconfident CEOs and non-overconfident CEOs, respectively.

So overall, the REITs led by overconfident CEOs tended to purchase more properties during our time period and they sold less than those led by non-overconfident CEOs.

B. Commercial Real Estate Transactions

Table 2 details the descriptive statistics for the REIT purchases and sales. For both, we compare the statistics for the overconfident subsample with those for the control group.

In Panel A of Table 2 we compare the real estate purchases of REITs managed by overconfident CEOs with those of the REITs in the control sample (which includes REITs for which we cannot identify whether a CEO is overconfident or not). The average transaction price per square foot is $189.82 for a REIT purchase in the overconfidence sample, while that is $183.74 for all REIT transactions. The difference is not statistically

significant. When we look at the hedonics of the average property in our overconfidence sample, we see that these properties are larger in terms of floor space compared to those in the control sample. Additionally, the properties in overconfidence sample are more likely to be renovated. The means of the rest of the hedonics such as age, number of stories and whether the property is purchased within a portfolio are not statistically different across the two sub-samples. Of the REIT purchases in the overconfident sub-sample 37 percent are retail properties, while offices are 22 percent. Among the property types, there are significantly more offices and industrial properties and less apartments in the overconfident sample than in the control sample. In the multivariate analyses in Section IV, we control for possible differences due to time, property types and geographic location and measure the impact of overconfidence on the transaction prices net of such differences.

– Insert Table 2 here –

For the REIT sales in the overconfidence sample, we observe that the mean of the transaction price per square foot is $112.16, which is not statistically different from the mean for the control sample. Although the mean of the property size is not statistically different from the control sample either, other characteristics of the average property in our overconfidence subsample show a few significant differences from the control sample. In the subsample of property sales by REITs managed by overconfident managers, the average property is significantly older (though the difference is less than a year), is approximately 10 percent larger, and is more likely to have been purchased in a

portfolio. Within the overconfidence sample, the property types are almost evenly distributed. For instance 21 percent of the sample consists of offices and 30 percent of the sample is apartments. There are significantly more apartments and less industrial properties in the overconfidence sub-sample than the control sample. Overall, except for the fractions of the different property types, the characteristics of our overconfidence sub-sample are closely in line with those of the larger control sample, which suggests that any possible selection bias is minimal.

– Insert Table 3 here –

Table 3 presents the correlation of the hedonics of the properties with the logarithm of the price per square feet. Normally, we expect a nonlinear negative relation because as the building gets older, the price should go down and the impact should be increasing for higher levels of age. However, the age of the building has a positive correlation with the logarithm of the price per square feet. This is probably due to technological improvements. The buildings constructed earlier have probably higher costs than the new buildings creating a positive pairwise correlation. In the REIT sales subsample, we actually see a negative relation. Property size has a negative correlation with the logarithm of the price per square feet. This is due to economies of scale.

The number of buildings in a portfolio transaction is negatively correlated with the logarithm of the price per square foot. But portfolio transactions overall are positively correlated with price. We also observe a positive correlation with the number of stories. Renovations increase the quality of the property and if a property is renovated at any

point in time after it is built, we expect a positive impact on the price. The correlation confirms our expectation. Last, we would expect that office and retail properties should have higher prices than apartments and industrial properties. The table shows that the correlations of the logarithm of the price per square foot with property type are as expected.

C. Hedonic model

We estimate a hedonic model that we will subsequently use to generate predicted prices for all the REIT property transactions we observe. Table 4 shows the regression results of the hedonic model for 11758 transactions including the REIT control group. The R-squared of the model is 55 percent. We find that all of the coefficients are in line with expectations and the literature. As age of the property increases and the size of the property increases, the transaction price per square foot declines. We have office dummy as the base for the property types. The prices for office buildings are higher than retail, apartment buildings and industrial properties. The price of retail buildings is significantly 12 percent lower than office buildings. If the property is renovated, there is a premium of 14 percent and if the property is a part of a portfolio transaction, there is a significant discount of 13 percent.

– Insert Table 4 here –

The hedonic model is key for interpreting all subsequent results presented in the paper. A biased model could result in faulty conclusions. So we need to judge the validity

of the model. One way to do this is by comparing the model's outcomes with estimation outcomes of hedonic models for commercial real estate in the literature. Doing that shows that the signs of our regression coefficients, as well as the explanatory power of the model, are indeed largely in line with those previously found by Eichholtz, Kok and Quigley (2010) and Fisher et al. (2003).[6] An alternative way to evaluate the performance of our hedonic model is to use it to create a hedonic index based on the time dummies. In Figure 1, we compare our hedonic index with the Moody's/RCA CPPI commercial property index, which is based on a much broader sample of US commercial real estate. We see that our hedonic index from Equation 4 has similar ups and downs to the Moody's/RCA CPPI, but with some more volatility, possibly reflecting the fact that our sample is substantially smaller. The correlation between the two indices is around 77 percent and is significant at one percent level. These findings suggest that the valuations from our hedonic model can be used as comparisons with actual transaction prices in our subsequent analysis.

– Insert Figure 1 here –

III. Predictions on Overconfidence and Empirical Model

[6] Eichholtz, Kok and Quigley (2010) regress the logarithm of price on the hedonics of the properties, where the choice of hedonics is closely in line with ours. The signs of the coefficients are very similar to ours when we also use the logarithm of the price instead of the logarithm of the price per square foot. The R-squared in our model is higher than the R-squared in Eichholtz, Kok and Quigley (2010) in unreported regression of the logarithm of price. Fisher et. al (2003) also estimate the logarithm of the price per square feet but use less hedonics. The impact of the property size is also significantly negative in their model. Similarly, they mix different property types in their model and similar to us control for property type dummies. While they control for year dummies and geographic location by economic region, we use deeper controls: quarterly time dummies and dummies for metro areas.

According to Hirshleifer and Luo (2001), overconfidence leads to overestimation of the precision of private information signals. As a result, overconfident people rely more on private information than on public information. They underestimate the risk associated with their investments (Chuang and Lee 2006). They trade more frequently and are more likely to make riskier investments.

When an overconfident manager receives a positive private information signal on an investment, he is more likely to believe that the information is precise and accordingly, more willing to make that investment compared to his counterparts. It is also possible that his assumptions regarding the expected value and cash flow of the asset he plans to invest in are overly positive, and he may underestimate the risks associated with that investment. If such an overconfident manager has similar expected return patterns to his counterparts, he may be willing to pay more for the investment as he values the asset more than his counterparts due to misinterpretation of the available information.

Eichholtz and Yönder (2014) evaluate the impact of overconfidence REITs' annual property purchases and sales normalized by the real estate portfolio size, net of the effect of company characteristics. They find that overconfident REIT managers invest in properties more frequently than their peers. In order to complete more transactions in an open market, overconfident REIT managers may have to bid up the prices.

Due to both scenarios, we expect that overconfident REIT managers are more likely to pay premiums compared to their non-overconfident counterparts when making investments.

If overconfident people are sellers, we expect two opposite impacts on prices. Firstly, in the literature, it is shown that overconfident people perform worse (Odean 1999, Barber and Odean 2000, 2001, 2002; Malmendier and Tate 2008, for mergers and acquisitions; and Eichholtz and Yönder 2014, for REITs). This lower performance might be due to their suboptimal investment decisions and they can only sell their property investments at a discount.

Secondly, overconfident people invest more frequently (Malmendier and Tate 2005) and dispose less frequently if they are not cash constrained (Eichholtz and Yönder 2014) so they may be only willing to sell with a premium, that is, if there is a buyer willing to pay more than the market price.

One of these effects might dominate the other or they might offset each other. Our expectation on whether there is a premium or discount on overconfidence is not clear. For both cases where overconfident managers are buyers and sellers, we also investigate the cash stock sensitivity as it is evidenced that the impact of overconfidence is sensitive to cash availability (Eichholtz and Yönder 2014; Malmendier and Tate 2005).

In the model, our dependent variable is the logarithm of the transaction price per square foot.[7] On the right hand side, the model includes the CEO overconfidence measure and the property characteristics. Property characteristics include size, age, number of stories, number of buildings within the property, dummies for whether the property is renovated or it is within a portfolio sale, type of the buyer, year dummies and location dummies.[8] We either control for economic region or metro area in different specifications

[7] The results are robust to the use of the logarithm of the transaction price as the dependent variable.
[8] The results are robust to the exclusion of portfolio transactions.

as to control for location of the property similar to Bokhari and Geltner (2011) using RCA data. We always control for property type. The model is as follows:

(1) $lnp_{it} = \theta_0 + \theta_1 OC_i^j + \sum_k \alpha_k X_{ik} + \varepsilon_{it}$

where *i* stands for a transaction of property i, *j* stands for REIT j and *t* stands for quarter t.

In the model *OC* is the overconfidence dummy, *X* is a vector of property characteristics such as property size, age, buyer or seller type, location (either economic region or metro area) and quarterly dummies. We also control for property type. The base is office buildings and we have dummy variables for retail, apartment and industrial buildings. Equation 2 also covers firm characteristics in quarter t-1 and Equation 3 includes and interaction term for the overconfidence dummy and cash stock in quarter t-1.[9] Vector *Y* stands for firm characteristics in quarter t-1. The firm characteristics cover firm size (the logarithm of total assets), debt ratio (the ratio of total debt to total assets), cash stock (the ratio of cash and equivalents to total assets) and property type Q (the average of the ratio of market value of assets to book value of assets by property type). We expect that larger firms are less risky so the impact of firm size on the price of the property purchased is negative and accordingly for the properties sold. The impact of cash stock on purchase price should be positive since firms with higher cash stock have more financial flexibility. Also when REITs with higher cash stock sell, they can sell at higher prices. Those firms might have the financial flexibility to wait until the price

[9] Company characteristics are taken constant across quarters within a year.

offered is high enough. REITs with higher debt ratio are riskier so we expect them to buy with a premium and sell with a discount in order to finance their leverage. We regress all equations for REIT purchases and sales separately, limiting our sample to the transactions of REITs for which we can identify whether the REIT CEO is overconfident or not.

(2) $$lnp_{it}=\theta_0+\theta_1 OC_i^j+\sum_k \alpha_k X_{ik}+\sum_l \beta_l Y_{i,t-1}^j+\varepsilon_{it}$$

(3) $$lnp_{it}=\theta_0+\theta_1 OC_i^j+\theta_2 OC_i^j Cash_{i,t-1}^j+\theta_3 Cash_{i,t-1}^j+\sum_k \alpha_k X_{ik}+\sum_l \beta_l Y_{i,t-1}^j+\varepsilon_{it}$$

We expect the coefficient of the overconfidence dummy in Equation 1 and 2 and the coefficient of the interaction of the overconfidence dummy and the cash stock in Equation 3 to be positive when a REIT is a buyer, since we expect that overconfident managers buy at a higher price than non-overconfident managers if they have enough discretionary cash. We are not clear for the overconfidence coefficients when a REIT is a seller since we can expect two opposing impacts.

In the above specification, we limit our sample to the cases where we can measure overconfidence. As a robustness check, we also follow a second method. Using the whole sample including the REIT purchases and sales and the control group where we cannot measure overconfidence, we regress the logarithm of transaction price per square foot on the hedonics of the property including both the buyer and seller types.

(4) $$lnp_{it}=\alpha_0+\sum_k \alpha_k X_{ik}+\varepsilon_{it}$$

Once we calculate the expected price from Equation 4, we calculate the residual price, ε_i, which is the difference between the actual price and predicted price. The residual price covers the unexplained part by the characteristics of the property calculated from a sample including the control group, as well. If there is any difference between the overconfidence sample and the control group, this will be reflected in the residual price. This way, we add the omitted sample into our estimation process and aim to deal with a possible selection bias. We then calculate the mean of the residual price for both transactions where overconfident managers and non-overconfident managers are buyers (sellers). Finally, we do a difference test in order to evaluate whether REITs led by overconfident managers are paying premiums. We additionally perform a second stage regression of the residual price on overconfidence and firm characteristics.

$$(5)\quad \widehat{\varepsilon_{it}} = \theta_0 + \theta_1 OC_i^j + \sum_l \beta_l Y_{i,t-1}^j + \vartheta_{it}$$

$$(6)\quad \widehat{\varepsilon_{it}} = \theta_0 + \theta_1 OC_i^j + \theta_2 OC_i^j Cash_{i,t-1}^j + \theta_3 Cash_{i,t-1}^j + \sum_l \beta_l Y_{i,t-1}^j + \vartheta_{it}$$

IV. Overconfidence and Transaction Prices

In this section, we evaluate the impact of managerial overconfidence on transaction prices of REIT purchases and sales. In the first part, we estimate regression equations using our full sample of REITs, to determine whether they are managed by overconfident CEOs or not. In the second part, we first regress the logarithm of the transaction price per square foot on the hedonics of the properties using the whole sample including the control group of REITs. Then, we first test whether the means of the residual price from

the whole sample regression differ between the transactions by REITs governed by overconfident CEOs and their counterparts. We additionally perform a second stage regression for the residual price.

A. Overconfidence Sample

The regression results of Equation 1, 2 and 4 for the REIT purchases are presented in Table 5. All regressions include time dummies per quarter, seller type fixed effects and geographic location dummies by metro areas in line with Bokhari and Geltner (2011). In Model 1, we find that REITs led by overconfident CEOs pay 7.8 percent more than their counterparts after controlling for the hedonics of the properties at one percent significance level. In Model 2, we add firm financials by the previous year to the regression. The overconfidence premium goes up slightly to 8.3 percent but is still significant at the one percent level. Since we control for property characteristics, geographic location by 98 metro areas across the US, property type and quarterly time dummies in our hedonic setup similar to Eichholtz, Kok and Quigley (2010), this implies that REITs pay more for a given property if they are led by an overconfident CEO, net of the effects of property characteristics, geographic location, property type and any time effects.

– Insert Table 5 here –

The coefficients of the property characteristics are in line with our expectations. As the property size increases by 1 percent, the price per square foot declines by around

0.17-0.18 percent. As the age of a property increases, the transaction price declines. If a building is renovated, the price increases by around 19-20 percent. If the property is purchased in a portfolio, the discount on the price is around 19-20 percent. The price also increases by the number of buildings within a property portfolio. The number of stories has nonlinearly positive impact on the price as expected and in line with Eichholtz, Kok and Quigley (2010). We also find that cash stock and the level of leverage have a significantly positive impact on purchase prices per square foot, indicating that highly leveraged and cash-rich REITs pay higher prices for a given property. Among the property types, the price for office buildings is significantly more than retail, apartment and industrial buildings.

In the third specification presented in Table 4, we also include the interaction term between CEO overconfidence and cash stock. This variable is statistically and economically very significant, and its inclusion considerably reduces the premium associated with CEO overconfidence alone: to 3.4 percent. The cash stock coefficient is no longer statistically significant. Including this term does not impact the hedonic variables or the other firm controls. This finding implies that CEO overconfidence especially affects purchase prices when these REITs have a lot of free cash at their disposal.

– Insert Figure 2 here –

Using the results of Model 1 presented in Table 4, we create two real estate indices: one for transactions when the buyer has an overconfident CEO and one for the

other transactions. Panel A of Figure 2 provides these two indices. We observe that the line for the index for overconfident buyers is above the line for their peers in 32 quarters out of 48, indicating that overconfident buyers generally pay more than their peers. This seems to hold for varying market conditions. Interestingly, the two indices do not move synchronously. To study this more clearly, we move the index for overconfident buyers 3 quarters ahead.[10] We expect that overconfident managers can time the market as they are more aggressive traders. As Panel B of Figure 2 shows, the ups and downs in the two indices seem to correspond much better this way. This suggests that the buyers led by overconfident CEOs time changes in the market 3-4 quarters earlier than their non-overconfident counterparts but overshoot the market. In the case of market recoveries, this could be associated with optimism from the part of the overconfident CEOs, but we see the same for market downturns, making this finding hard to interpret.

Table 6 represents the regression results for the REIT sales. Again, all regressions include time dummies per quarter, metro area dummies and different buyer type fixed effects. This time, we do not find a statistically significant impact of REIT CEO overconfidence. We find very similar coefficients as in REIT purchases for the characteristics of the properties. Among firm characteristics, we find that smaller REITs – measured by market capitalization – sell their properties at significantly higher prices than our hedonic model would predict.

– Insert Table 6 here –

[10] We also move the index for overconfidence managers backward, as well but do not observe any interesting relation with the other line.

Overall, we find that there is a significant purchase price premium associated with REIT CEO overconfidence after controlling for property and firm characteristics. When they sell, they do not sell with any significant premium. This is likely to be one of the reasons for the underperformance of REITs led by overconfident managers documented by (Eichholtz and Yönder 2014). Overall, they find that overconfident managers have lower operating performance measured by Tobin's Q and the return on assets but the relation is sensitive to cash stock.

B. Residual Price

In the previous subsection, we limit our sample of REIT transactions to those transactions for which we can determine managerial overconfidence. In order to check the robustness of our results, we first regress the logarithm of the transaction price per square foot on the property characteristics using all REIT transactions including the control group, as in Equation 4. We then calculate the residual transaction price, which is the difference between the actual price and the expected price calculated using Equation 4.

Table 7 presents the means of the residual price for both the transactions by REITs led by overconfident CEOs and their peers. We find that the mean of the residual price for the REITs having an overconfident CEO is significantly higher than the mean for those of their counterparts at 5 percent level. However, there is no significant difference for the means between the overconfident and non-overconfident groups for REIT sales. These numbers support our findings in the previous subsection.

– Insert Table 7 here –

We additionally do a second stage regression of residual price on the overconfidence dummy and the firm characteristics using Equation 5 and 6. Table 8 presents the results. The findings are very similar to those presented in the previous subsection. The overconfidence premium in Panel A for the REIT purchases is around 8.1-8.4 percent and statistically significant at 1 percent level in Model 1 and 2. We again find that the impact of overconfidence is sensitive to cash stock, confirming our interpretation that cash availability reinforces the overpaying behavior of overconfident CEOs.

– Insert Table 8 here –

Panel B shows the REIT sales. In the case of property disposals, we again find no significant direct impact of the overconfidence dummy on the residual transaction price. However, in Model 3 of Panel B, where we include the interaction term between cash stock and CEO overconfidence, we find that REITs managed by overconfident CEOs do sell their properties at a higher price if their cash stock increases. This suggests that REITs led by overconfident CEOs set higher reserve prices when they aim to dispose of a property, and that they are able to stick to these prices when they have enough cash at their disposal and are therefore not forced to sell. Our findings are robust to any business cycle effects, due to the inclusion of time fixed effects in the regression model.

V. Concluding Remarks

The finance literature on overconfidence shows that companies led by overconfident CEOs invest more and tend to perform worse (Eichholtz and Yönder 2014; Malmendier and Tate 2005; Malmendier and Tate 2008) However, the reasons for this weak performance are unclear. In addition, in the world of direct real estate transactions, there have been no studies on the behavior of overconfident traders.

This paper aims to fill these gaps. We study commercial property transactions by US REITs, and first determine whether a REIT CEO is overconfident or not by looking at whether or not he exercised his stock options when they were 67% in the money, following Campbell et al. (2011). We subsequently distinguish REITs led by overconfident CEOs from their peers.

To investigate the mechanisms between managerial overconfidence and the performance of a REIT, we then study the property purchases and sales of the REITs managed by overconfident CEOs, and compare those with the outcomes of a hedonic model we employ to generate predicted values for all property transactions in our sample.

After controlling for property characteristics and in some specifications for REIT firm financials, we find a significant price premium when a property is bought by a REIT with an overconfident CEO. Depending on the specification, this premium varies between 8.3 percent and 8.8 percent. The impact of CEO overconfidence is also significantly sensitive to cash availability. A possible interpretation for this finding is that overconfident people misperceive information signals and tend to underestimate risks and/or overestimate the outcomes of their decisions. As a result, they are prone to pay more for their investments.

This finding is also relevant for the interpretation of previous evidence showing that REITs managed by overconfident CEOs invest more (Eichholtz and Yonder, 2013). This may be explained by the fact that they are apparently willing to pay higher prices.

We also analyze property transactions in which REITs with overconfident CEOs are sellers. In most specifications, we do not find any significant price premium or discount associated with managerial overconfidence. However, in one specification, we find that overconfident sellers sell with a premium if they have enough cash stock.

Our interpretation of these findings is that overconfident managers are disciplined by the market if they overvalue their properties in a sale, but that if they have enough discretionary cash, and are therefore not forced to sell, they can wait for an offer from a buyer who is willing to pay more than the market price. The fact that we do not find a price discount suggests that managerial overconfidence should not be mistaken for lack of ability or willingness for active portfolio trading for its own sake.

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Table 1
Descriptive Summary of Moneyness and Overconfidence

Variable	Obs.	Mean	Std. Dev.	Min	Max
Moneyness	629	0.55	0.67	0	4.56
Overconfidence					
REIT CEOs	88	0.43	0.50	0	1
REIT Purchases	2966	0.45	0.50	0	1
REIT Sales	4080	0.26	0.44	0	1
# of Purchases per REITs Managed by					
Overconfident CEOs	22	61.05	56.38	1	196
non-Overconfident CEOs	32	51.88	55.92	2	208
# of Sales per REITs Managed by					
Overconfident CEOs	18	58.83	66.20	1	233
non-Overconfident CEOs	30	101.43	123.74	3	463

Notes: Moneyness represents the average moneyness of the in-the-money exercisable unexercised stock options by CEO-year. The fraction of REIT CEOs, who are overconfident, the fraction of REIT purchases, which are made by overconfident CEOs and the fraction of REIT sales, which are made by overconfident CEOs are summarized. The number of purchases per overconfident CEOs and non-overconfident CEOs are shown, separately. Similarly, the number of sales per overconfident CEOs and non-overconfident CEOs are also shown, separately.

Table 2
REIT Transactions: Comparison to the REIT Control Sample

Panel A - REIT Purchases							
Variable	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Mean Dif.
	All REIT Purchases			REIT Purchases in OC Sample			
Price per sqft	5472	183.74	348.02	2966	189.82	397.11	-6.08
Size (in thousand sqft)	5472	208.81	255.83	2966	228.23	278.26	-19.42***
Age	5472	20.24	17.51	2966	20.76	17.93	-0.53
# of Stories	5472	2.83	5.61	2966	2.92	5.84	-0.08
Office	5472	0.26	0.44	2966	0.22	0.42	0.03***
Retail	5472	0.34	0.48	2966	0.37	0.48	-0.03**
Apartment	5472	0.14	0.35	2966	0.19	0.39	-0.05***
Industrial	5472	0.26	0.44	2966	0.21	0.41	0.04***
Renovated	5472	0.19	0.39	2966	0.21	0.41	-0.02**
Portfolio Transaction	5472	0.44	0.50	2966	0.44	0.50	0.00
# of Buildings	5472	4.29	9.56	2966	4.56	9.92	-0.27
Panel B - REIT Sales							
Variable	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Mean Dif.
	All REIT Sales			REIT Sales in OC Sample			
Price per sqft	6249	112.52	135.90	4080	112.16	142.84	0.36
Size (in thousand sqft)	6249	199.589	206.67	4080	205.15	200.25	-5.56
Age	6249	21.46	14.04	4080	22.15	14.27	-0.69**
# of Stories	6249	2.54	4.95	4080	2.45	4.31	0.09
Office	6249	0.21	0.41	4080	0.21	0.40	0.00
Retail	6249	0.25	0.43	4080	0.23	0.42	0.02*
Apartment	6249	0.23	0.42	4080	0.30	0.46	-0.07***
Industrial	6249	0.31	0.46	4080	0.26	0.44	0.05***
Renovated	6249	0.18	0.39	4080	0.18	0.39	0.00
Portfolio Transaction	6249	0.47	0.50	4080	0.49	0.50	-0.02*
# of Buildings	6249	4.77	10.41	4080	5.26	11.08	-0.50**

Notes: Table 2 compares descriptive statistics of property characteristics for the whole sample including the control group of REIT transactions and the overconfidence sample where we can determine a REIT CEO is overconfident or not. Panel A shows the descriptive statistics when a REIT is a buyer and Panel B presents the descriptive statistics when a REIT is a seller. * indicates significance at the 10 percent level. ** indicates significance at the 5 percent level. *** indicates significance at the 1 percent level.

Table 3
Correlations of Property Characteristics with the Logarithm of the Price per Square Feet

	All REIT Sample	REIT Purchases Sample	REIT Sales Sample
Age	0.0288***	0.1471***	-0.0423***
Property Size	-0.2188***	-0.2506***	-0.1749***
# of Stories	0.2799***	0.3125***	0.3008***
Office	0.2937***	0.3040***	0.3419***
Retail	0.1519***	-0.0001	0.1656***
Apartment	-0.0419***	0.1068***	-0.0984***
Industrial	-0.3995***	-0.4113***	-0.3697***
Renovated	0.0746***	0.0574***	0.0774***
Portfolio	-0.1112***	-0.1625***	-0.1236***
# of Buildings	0.0319***	0.0529**	0.0399**

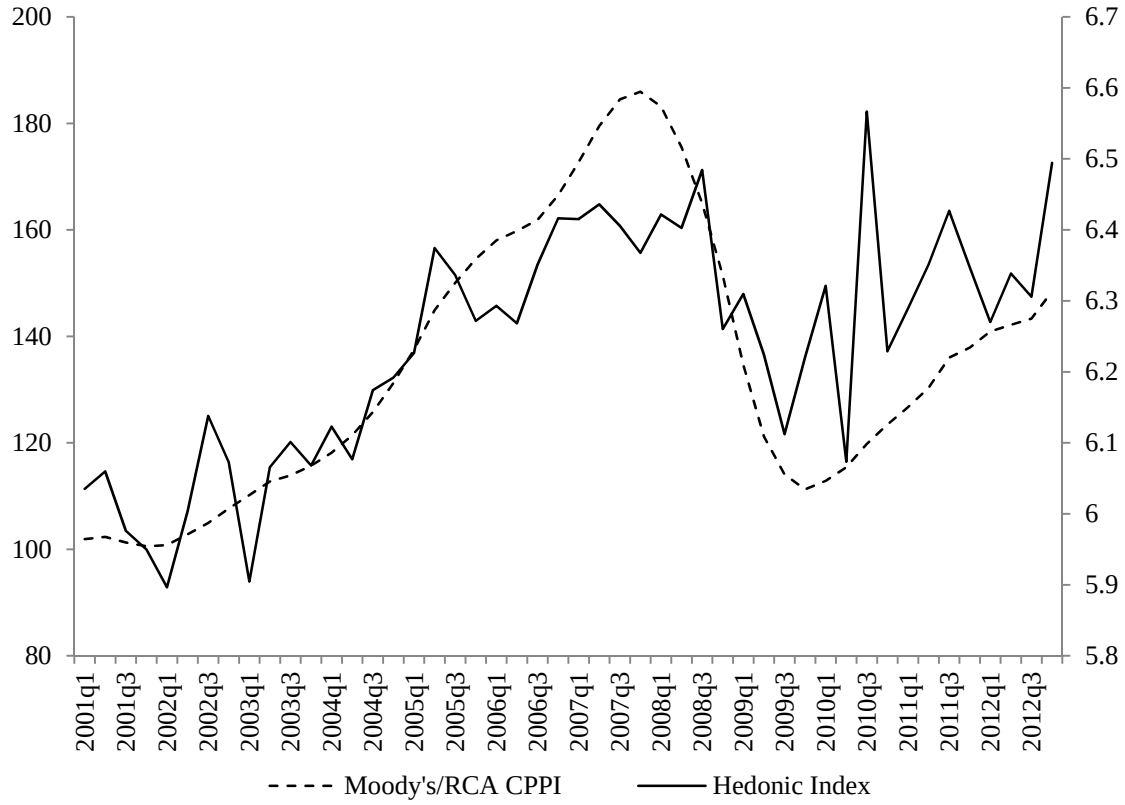
Notes: The table shows the correlations of the property characteristics with the logarithm of the price per square feet. We separately present the correlations for our control sample including all REIT transactions, REIT purchases and REIT sales for the overconfidence sample. * indicates significance at the 10 percent level. ** indicates significance at the 5 percent level. *** indicates significance at the 1 percent level.

Table 4
Hedonic Model for All REIT Transactions
Price per square foot in logs

Variable	Coefficient
Property Size (in logs)	-0.178*** [0.007]
Age 11 to 20	-0.211*** [0.013]
Age 21 to 30	-0.360*** [0.014]
Age 31 to 40	-0.425*** [0.019]
Age 41 to 50	-0.403*** [0.028]
Age 50+	-0.099** [0.041]
Stories 11 to 20	0.398*** [0.033]
Stories 20+	0.054*** [0.013]
Retail	-0.116*** [0.016]
Apartment	-0.259*** [0.016]
Industrial	-0.756*** [0.015]
Renovated	0.143*** [0.015]
Portfolio	-0.133*** [0.011]
# of Buildings	0.004*** [0.000]
Constant	Yes
Buyer Type	Yes
Seller Type	Yes
Metro Area	Yes
Time Dummies	Yes
Observations	11758
R-squared	0.55

Notes: Regression results of the hedonic model for the whole sample including the control group. The dependent variable is the logarithm of the transaction price per square foot. The model includes fixed effects for the buyer types, the seller types, the metro areas in order to control for location and the quarterly time dummies. The base for the property type is office. Heteroskedasticity robust standard errors are in brackets. * indicates significance at the 10 percent level. ** indicates significance at the 5 percent level. *** indicates significance at the 1 percent level.

Figure 1
Comparison of the Index from the Hedonic Model



Notes: The figure presents the hedonic index created from the estimation results presented in Table 3. For comparison, the figure also shows Moody's/RCA CPPI (Geltner, 2013).

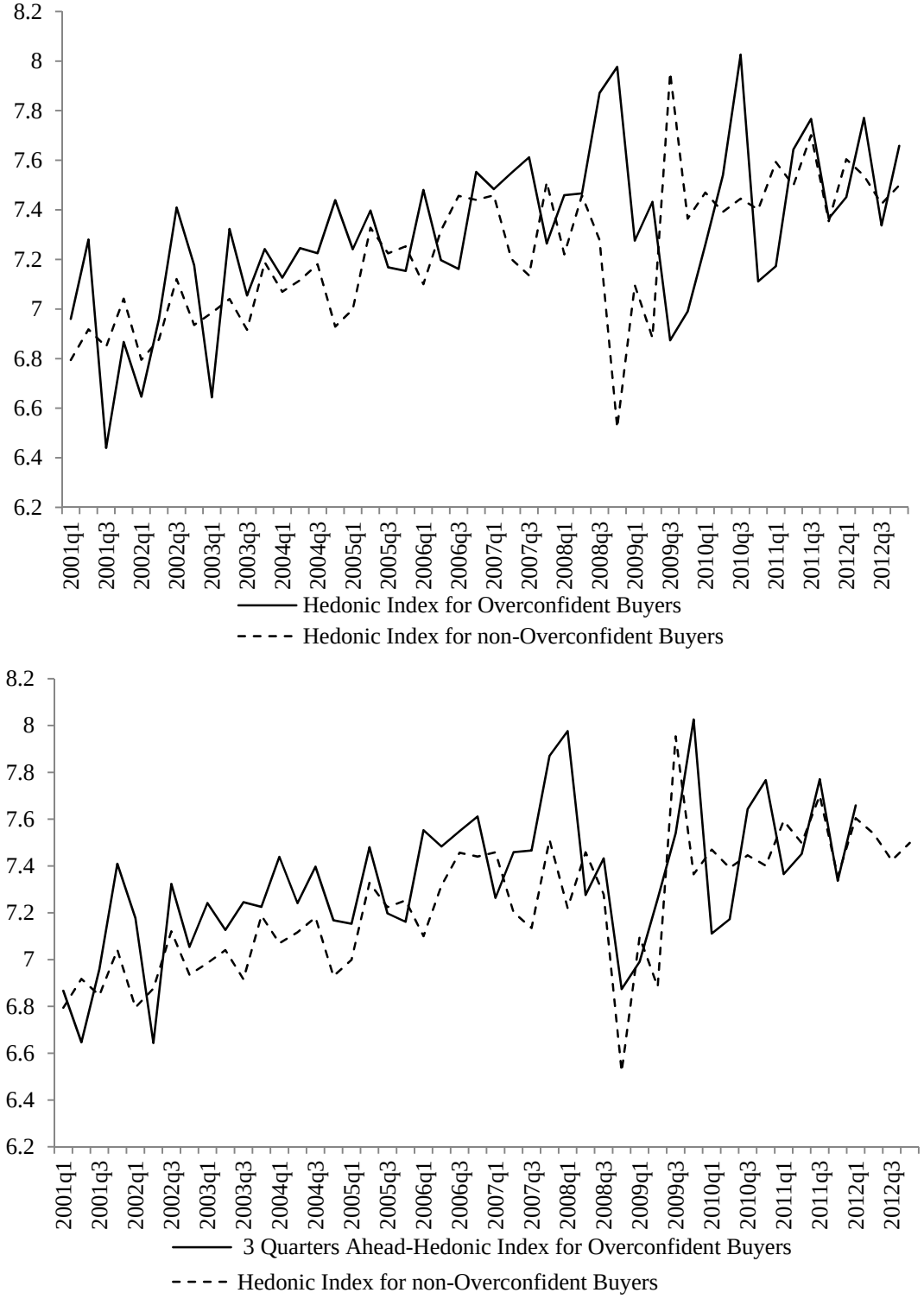
Table 5
Impact of Overconfidence on REIT Purchases

Variable	(1) Price per sqft in logs	(2) Price per sqft in logs	(3) Price per sqft in logs
Overconfidence	0.078***	0.083***	0.034
	[0.025]	[0.027]	[0.032]
*Overconfidence*Cash Stock*			3.162***
			[1.024]
Cash Stock		1.912***	-0.552
		[0.459]	[0.844]
Firm Size		-0.004	-0.007
(in logs)		[0.010]	[0.010]
Debt Ratio		0.359**	0.416***
		[0.144]	[0.146]
Property Type Q		-0.047	-0.023
		[0.140]	[0.139]
Property Size	-0.179***	-0.179***	-0.182***
(in logs)	[0.015]	[0.017]	[0.017]
Age 11 to 20	-0.189***	-0.179***	-0.186***
	[0.027]	[0.028]	[0.028]
Age 21 to 30	-0.325***	-0.343***	-0.346***
	[0.031]	[0.034]	[0.034]
Age 31 to 40	-0.306***	-0.307***	-0.310***
	[0.039]	[0.042]	[0.042]
Age 41 to 50	-0.338***	-0.355***	-0.356***
	[0.051]	[0.056]	[0.056]
Age 50+	-0.083	-0.068	-0.067
	[0.073]	[0.076]	[0.076]
Stories 11 to 20	0.309***	0.339***	0.334***
	[0.077]	[0.087]	[0.087]
Stories 20+	0.064**	0.064**	0.065**
	[0.030]	[0.031]	[0.031]
Retail	-0.148***	-0.187***	-0.196***
	[0.036]	[0.046]	[0.046]
Apartment	-0.279***	-0.288***	-0.296***
	[0.035]	[0.042]	[0.042]
Industrial	-0.873***	-0.860***	-0.855***
	[0.034]	[0.039]	[0.039]
Renovated	0.136***	0.134***	0.133***
	[0.030]	[0.031]	[0.031]
Portfolio	-0.188***	-0.201***	-0.204***
	[0.024]	[0.026]	[0.026]
# of Buildings	0.004***	0.004***	0.004***
	[0.001]	[0.001]	[0.001]
Constant	Yes	Yes	Yes
Seller Type	Yes	Yes	Yes
Metro Area	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes
Observations	2966	2562	2562
R-squared	0.60	0.60	0.60

Notes: Regression results of the hedonic model for REIT purchases. The dependent variable is the logarithm of the transaction price per square foot. Overconfidence dummy gets one if a REIT CEO does not exercise stock options that are exercisable and 67 percent in-the-money at least twice. The models include fixed effects for the seller types, the metro areas in order to

control for location and the quarterly time dummies. The base for the property type is office. Firm financials are lagged for one year. Heteroskedasticity robust standard errors are in brackets. * indicates significance at the 10 percent level. ** indicates significance at the 5 percent level. *** indicates significance at the 1 percent level.

Figure 2
Hedonic Indices for Overconfident Buyers vs. Peers



Notes: The figure presents hedonic indices created from the estimation results presented in Model 1 of Table 4. Two separate indices are created: one for when a buyer is overconfident and one for transactions involving other buyers. In Panel B, the hedonic index for overconfident buyers is moved 3 quarters ahead.

Table 6
Impact of Overconfidence on REIT Sales

Variable	(1) Price per sqft in logs	(2) Price per sqft in logs	(3) Price per sqft in logs
Overconfidence	0.008	0.019	-0.016
	[0.023]	[0.027]	[0.029]
*Overconfidence*Cash Stock*			2.457***
			[0.926]
Cash Stock		1.498***	0.053
		[0.535]	[0.661]
Firm Size		-0.017***	-0.018***
(in logs)		[0.006]	[0.006]
Debt Ratio		-0.275*	-0.264*
		[0.142]	[0.143]
Property Type Q		-0.105	-0.116
		[0.122]	[0.122]
Property Size	-0.145***	-0.137***	-0.136***
(in logs)	[0.012]	[0.014]	[0.014]
Age 11 to 20	-0.200***	-0.187***	-0.189***
	[0.022]	[0.023]	[0.023]
Age 21 to 30	-0.358***	-0.342***	-0.341***
	[0.023]	[0.025]	[0.025]
Age 31 to 40	-0.480***	-0.442***	-0.442***
	[0.030]	[0.032]	[0.032]
Age 41 to 50	-0.456***	-0.461***	-0.461***
	[0.047]	[0.055]	[0.055]
Age 50+	-0.071	-0.021	-0.022
	[0.076]	[0.080]	[0.080]
Stories 11 to 20	0.295***	0.255***	0.250***
	[0.055]	[0.056]	[0.056]
Stories 20+	-0.007	-0.010	-0.011
	[0.019]	[0.019]	[0.019]
Retail	-0.110***	-0.120***	-0.116***
	[0.031]	[0.036]	[0.036]
Apartment	-0.267***	-0.285***	-0.280***
	[0.026]	[0.030]	[0.030]
Industrial	-0.735***	-0.731***	-0.730***
	[0.025]	[0.026]	[0.026]
Renovated	0.102***	0.075***	0.074***
	[0.022]	[0.023]	[0.023]
Portfolio	-0.111***	-0.111***	-0.110***
	[0.018]	[0.019]	[0.019]
# of Buildings	0.003***	0.003***	0.003***
	[0.001]	[0.001]	[0.001]
Constant	Yes	Yes	Yes
Buyer Type	Yes	Yes	Yes
Metro Area	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes
Observations	4080	3550	3550
R-squared	0.58	0.59	0.59

Notes: Regression results of the hedonic model for REIT purchases. The dependent variable is the logarithm of the transaction price per square foot. Overconfidence dummy gets one if a REIT CEO does not exercise stock options that are exercisable and 67 percent in-the-money at least twice. The

models include fixed effects for the buyer types, the metro areas in order to control for location and the quarterly time dummies. The base for the property type is office. Firm financials are lagged for one year. Heteroskedasticity robust standard errors are in brackets. * indicates significance at the 10 percent level. ** indicates significance at the 5 percent level. *** indicates significance at the 1 percent level.

Table 7
Overconfident CEOs vs. Counterparts: Mean Difference Test for Residual Price

Variable	Obs.	Mean	Std. Dev.
	REIT Purchases		
Overconfidence=1	1326	0.021	0.559
Overconfidence=0	1640	-0.029	0.526
Difference		0.050**	
	REIT Sales		
Overconfidence=1	1050	-0.011	0.573
Overconfidence=0	3030	0.004	0.424
Difference		-0.015	

Notes: The table presents the means of the residuals of the logarithm of the transaction price per square foot from the estimation in Table 3. The sample covers the properties both purchased and sold by REITs, where we cannot determine overconfidence, in addition to REITs with managers where we can determine whether a manager is overconfident or not. Overconfidence dummy gets one if a REIT CEO does not exercise stock options that are exercisable and 67 percent in-the-money at least twice. * indicates significance at the 10 percent level. ** indicates significance at the 5 percent level. *** indicates significance at the 1 percent level.

Table 8
Impact of Overconfidence on Residual Price

Variable	(1) Residual Price per sqft in logs	(2) Residual Price per sqft in logs	(3) Residual Price per sqft in logs
Panel A - REIT Purchases			
Overconfidence	0.084***	0.081***	0.044
	[0.022]	[0.023]	[0.028]
*Overconfidence*Cash Stock*			2.190**
			[0.880]
Cash Stock		1.720***	0.057
		[0.419]	[0.704]
Firm Size		-0.008	-0.010
(in logs)		[0.009]	[0.009]
Debt Ratio		0.313**	0.336***
		[0.126]	[0.127]
Property Type Q		-0.091	-0.084
		[0.104]	[0.104]
Constant	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes
Observations	2966	2562	2562
R-squared	0.06	0.06	0.06
Panel B – REIT Sales			
Overconfidence	-0.015	-0.005	-0.037
	[0.020]	[0.024]	[0.027]
*Overconfidence*Cash Stock*			2.187***
			[0.823]
Cash Stock		1.555***	0.340
		[0.476]	[0.568]
Firm Size		-0.018***	-0.019***
(in logs)		[0.006]	[0.006]
Debt Ratio		-0.287**	-0.270**
		[0.119]	[0.120]
Property Type Q		-0.303***	-0.296***
		[0.088]	[0.088]
Constant	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes
Observations	4080	3550	3550
R-squared	0.04	0.05	0.05

Notes: Regression results of the hedonic model for REIT purchases and sales. The dependent variable is the residual of the logarithm of the transaction price per square foot from the estimation in Table 3. Overconfidence dummy gets one if a REIT CEO does not exercise stock options that are exercisable and 67 percent in-the-money at least twice. Firm financials are lagged for one year. Heteroskedasticity robust standard errors are in brackets. * indicates significance at the 10 percent level. ** indicates significance at the 5 percent level. *** indicates significance at the 1 percent level.