# Tenant Satisfaction and Commercial Building Performance

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*Customer satisfaction is a leading indicator of their demand and the companies' performance, however, limited evidence research on how the satisfaction of tenant-customers of commercial offices, could contribute economic value to the building. The tenant survey provides us with the opportunity to research this question. Using the Kingsley tenant survey dataset collected from 2,965 U.S. office buildings and 55,951 corporate tenants, matched to the building characteristics data and financial performance data from the Costar database, and green certificate data from USGBC, we estimate the impact of tenant satisfaction on tenant's following leasing decision and the performance of the building. We document that 1 point higher overall satisfaction (on a scale of 1 to 5) is positively related to 8.36% higher willingness to renew the lease, 11.03% higher building recommendation, and 19.40% lower probability of actually moving out. In addition, analysis of the financial performance found that after controlling for the current period performance, 10% higher building level average overall satisfaction is related to 0.17% higher growth of gross rents, 0.66% higher growth effective gross rent, and 2.32% lower growth of vacancy rate. Besides, this beneficial effect is more significant for those tenants who have already stayed in the building for a long time, for the properties that are located in the submarkets with high occupancy rates, and for properties that have lower initial satisfaction levels. Further analysis using the mediation model documents that putting in sustainability and better property management company could improvement to tenants' satisfaction and the performance of the building. Our research provides a shred of evidence for the financial implication of good customer relationship management in the real estate sector.*

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## I. Introduction

The economic shock triggered by the COVID-19 pandemic and the widespread availability of remote work alternatives is disrupting commercial real estate markets across the US and Europe(Aksoy et al., 2022; van Dijk, Geltner and van de Minne, 2020; Gupta, Mittal and Van Nieuwerburgh, 2022). Firms are reconsidering the amount and purpose of their office spaces(Fiorentino et al., 2022), creating a shift in their demand away from pre-pandemic traditional workplaces. However, little is known about how firms decide where to locate their operations, despite their implications for local economic activity and the returns to commercial real estate operators (Gupta, Mittal and Van Nieuwerburgh, 2022) (a market that is estimated to be over USD 10 trillion globally).

This paper provides the first micro-econometric evaluation of corporate tenants' decision-making. In particular, we focus on the role of satisfaction in the demand for office space. Marketing literature has already proved the importance of consumer satisfaction, which represents a major determinant of demand for goods and services(Fornell, Rust and Dekimpe, 2010; Bolton and Drew, 1991), higher satisfaction means free advertisement and recommendation from the customer and higher willingness of paying a premium for the product(Homburg, Hoyer and Koschate, 2005). Besides, higher customer satisfaction usually accompanies by better financial performance, including operational measures such as lower cost of sales(Lim, Tuli and Grewal, 2020), higher market share(Rego, Morgan and Fornell, 2013), higher profitability(Anderson, Fornell and Lehmann, 1994), higher cash flow(Gruca and Rego, 2005), better gross sales and net profits for the company, and the better stock market–based measures of firm valuation(Aksoy et al., 2008).

Motivated by the role of customer satisfaction for a firm operating, it's reasonable to expect that in the real estate sector, there is also a similar pattern in terms of the relationship between customer satisfaction, customer demand, and performance of the company: whether the customer of the building, the tenant, is satisfied with the building might also have some connection with their decision of space demand and finally the financial performance of the building. In fact, practitioners of the real estate market are already taking customer relationship management (CRM) and tenant satisfaction–a common measure of the building's performance, into concern for their operating strategy(JLL, 2022). But whether the connection exists and what is the magnitude of the effect? These questions have not yet been answered in the real estate sector because of the lack of data. In this paper, using tenant satisfaction as the starting point for this research, we try to fill this blank by studying a large sample of tenant-level granular time series survey data from major corporate tenants in the U.S. and build a link between the tenant's self-reported satisfaction level and their actual moveout status. We will provide the first micro-evidence of the connection between customer satisfaction and space demand in the real estate sector.

We compiled a unique longitudinal survey dataset, including 55,951 tenants

surveyed from 2009 to 2022. In total, the dataset has 108,627 survey responses and covers over 2,965 office buildings located in major metropolitan areas across the US. We link annual tenant satisfaction indices for each building and match them to multiple financial performance metrics of the building.

Our results show that 1 point higher tenant overall satisfaction (on a scale of 1 to 5) is positively related to 8.36% higher willingness to renew the lease, 11.03% higher building recommendation, and 19.40% lower probability of actually moving out. In addition, analysis of the financial performance found that after controlling for the current period performance, 10% higher building level average overall satisfaction is related to 0.17% higher growth of gross rents, 0.66% higher growth effective gross rent, and 2.32% lower growth of vacancy rate.

The predictability of the building's financial performance is robust to controlling for cross-sectional differences using building characteristics, and the time-varying regional difference using time and cities fixed effects. Our results indicate that the effects are driven by improvements in the quality of property management, as described by changing from an ordinary property management company to a good reputation property management company; and improvements in the environmental quality of the building, as described by incorporating green attributes into the building(i.e., green certification). The results are robust when we are using the achieved rents of the leasing contracts, or when the tenant and properties are initially at different satisfaction levels when we control for the building fixed effects and use the overall satisfaction proxy constructs using PCA. Finally, results from our heterogeneity analysis show that the positive implication of improving satisfaction will be higher if those properties are located in a sub-market with a lower vacancy rate, and if the tenants have already stayed in the building for a long time.

Our study is mainly related to two strains of literature. The first one is the research by Verbrugge et al. (2017), which investigates the determinants of differential rent changes in the U.S. residential market using rent growth of 18,000 rental units during 2001–2004 and during 2004–2007. They found that those houses with higher initial prices tend to have slower rent growth, and location and the age of the property are also a powerful predictor. Our paper is different from their research in that our research field is the commercial building sector, and we proposed a novel value-adding factor–tenants' satisfaction with the rents growth of the building, which hasn't been researched before.

Another one is the paper by Sanderson and Devaney (2017), which investigates the capitalization of tenant satisfaction into the property value, by using consultant company RealService survey data from 240 UK building investments ranging from different building types, with the value of survey answers based on the similar Likert scale of 1-5, and the building appraised value data from a consultant company named MSCI, and comparing the appraised value of the building with the benchmark portfolio building as the abnormal return, they found that with a 1 unit higher tenant satisfaction, the annual excess return will

be nearly 3% points higher. But their measurement of financial performance is based on the appraised value, which cannot provide sufficient and consecutive observations due to the infrequent data source characteristics, and they fail to control for a variety of factors and didn't take into account the heterogeneity of tenants' characteristics and building attributes, but just doing a correlation analysis of the satisfaction value and abnormal return, which will pose challenges to the inference of the effect of tenant satisfaction, which might have some endogenous problem.

Our research contributes to the current literature from two aspects: Firstly, we complement the previous handful of literature that tries to quantify the impact of tenants on pricing and the operation of real estate. Sanderson, Edwards et al. (2014) uses satisfaction survey data obtained from 2500 interviews from RealService Ltd., and capital appreciation determined by appraisal values, income return as a percentage of the appraised capital value as an indicator of building performance, they found that the performance of the building will be affected by tenant satisfaction level with the quality of property management. And a paper by Liu, Liu and Zhang (2019) indicates that a tenant's credit quality is an important factor in the valuation of the building. But these studies didn't investigate the building level mechanism, such as variation of the rent level and renewal rates of the building in the investment portfolio. Another group of research that studying this topic just emphasizes the importance of tenant quality, for example, Zheng and Zhu (2021) found that tenant concentration structures of the REITs will affect the operating efficiency of REITs such as gross rental income, net operating income, and eventually the market valuations. Work by Lu-Andrews (2017) indicates that a financially healthy tenant would lower the additional liquidity held by the REITs. More recent work by Wang and Zhou (2021), found that after the outbreak of Covid-19, those REITs holding properties with corporate tenants that are more resilient to social distancing are performing better. These kinds of literature only emphasize the importance of tenants' certain attributes, but they did not investigate the importance of tenant experience and the implication of retaining tenants, which ignores the fact that the tenant will generate good cash flow for the building only when they are willing to stay in the building. In this paper, we research the implication of tenants' perceptions on the building's direct financial performance, such as rents and vacancy, which fill the blank of the literature that tries to improve the operating efficiency of the building.

Secondly, our paper contributes to the literature that researches the determinants of rent growth variation. There are already a great number of research trying to answer this question in the residential sector, such as the work by Verbrugge et al. (2017), which studies the rents growth of 18,000 rental units from the data of the Bureau of Labor Statistics (BLS) Consumer Price Index (CPI) rental housing sample, they found that the initial relative rent level compared with the local market is significantly related to the rent growth, also the location, age and

occupancy duration. Saiz (2007) using immigration inflows data from the Immigration and Naturalization Service (INS), and rents data in MSAs from the Department of Housing and Urban Development's (HUD) Fair Market Rent series (FMR), they found that the city-level rent growth of the U.S. housing market is positively related to the inflow of immigrants. Research in the commercial real estate sector mainly focuses on the role of the cap rate, market expectation, and the auto-correlation of rent change. For example, Shilling, Sirmans and Corgel (1987) using the rents data of 17 cities in the U.S., indicate the level of the rent is related to the vacancy level. Wheaton and Torto (1988) using the national level rents data found a similar conclusion. use the London office market data, estimate Another strand of the rental adjustment model is ECM(Error Correction Model), such as the paper by Hendershott, MacGregor and Tse (2002), which could allow the rents level and employment to predict the rents growth besides the vacancy level,Brounen and Jennen (2009*a*,*b*) make some improvement to this model by incorporating variables that symbol the office building activities and lagged rental change and geographic aggregation. De Francesco (2008) using ECM model and data of office market in Australia market and found that the future rents change is related to the lagged rent change, lagged rent level, lagged vacancy rate, and lagged vacancy change. Plazzi, Torous and Valkanov (2008) using the metropolitan level rents data in the U.S., found that the level of the cross-sectional dispersion of MSA level rent growth of commercial real estate is related to the macroeconomic variables, such as the term and credit spreads, inflation, and the short rate of interest. Work by Plazzi, Torous and Valkanov (2010) using metropolitan-level rent, prices, and cap rates data on a quarterly basis, they found that the cap rate could not explain the expected return, but could forecast the rents growth of office buildings. Ibanez and Pennington-Cross (2013) indicates that the rents of office buildings are slow to the change of demand and supply shock, but the good quality buildings' reaction is faster. An et al. (2016) develop a rent index for commercial real estate by analyzing the quarterly rental income data from 9,000 properties from 2001 to 2010 from NCREIF, using a dynamic panel data model, they found that market-wide rent growth and age of the building are better indicators of the rent growth. Evidence shows that the growth of the former period usually affects the growth of the next periodGarriga, Gete and Tsouderou (2022); Ibanez and Pennington-Cross (2013); Brounen and Jennen (2009*a*,*b*), and also the former period rents levelHendershott, MacGregor and White (2002), the current vacancy rateHendershott, Lizieri and MacGregor (2010). Wheaton, Torto and Evans (1997) using the index of rents of the whole office market in London, they found that the rents level of the next period is correlated with the rents level of the current period. Wheaton and Torto (1994) indicates that the growth of rent level is the function of the vacancy rate, absorption rate, and rental level of the current period. But this research hasn't explored the effect of the intangible characteristics inside the building: tenant experience. We introduce a new factor that affects the dynamics of rents in the commercial

real estate sector: tenant satisfaction level, which will affect the demand for office space but cannot be explained by the factors that incorporate into the literature before.

Thirdly, our paper contributes to the research that tries to explore the determinants of the vacancy rate of commercial office buildings. Grenadier (1995) discompose the variance of vacancy rate of 20 U.S. office markets into two parts, the time-varying part, and the city heterogeneity part, and also the persistence term-the lagged specific city level vacancy, they indicate that random shocks are the reason why vacancy of the city deviates from the long-term equilibrium. Chau and Wong (2016) found that information asymmetry affects the negotiation between landlord and tenant to find out the new equilibrium rents level, which will lead to a deviation of vacancy rate from the natural vacancy rate, and the vacancy rate high-quality properties show slower adjustment to new information shock. In this paper, we incorporate the role of a new factor, tenant satisfaction level, as a proxy of information shock, on the demand and dynamic of vacancy change of the commercial building.

We organize the remainder of this paper as follows: Section II discusses our data sources and presents the descriptive statistics. Section III is the methodology. Section IV is the empirical results. Section V is the robustness check. Section VI is the heterogeneity analysis. Section VII is the possible solution for improving it, and section VIII concludes.

## II. Data and Descriptive Statistics

In this section, we describe the data sources and provide descriptive statistics of the variables in our analysis.

### *A. Tenant Survey Data*

Our tenant satisfaction micro-data is retrieved from "Kingsley", a survey program run by Grace Hill to inform building owners and property management companies about the experience and needs of their corporate tenants[1]. The Kingsley survey data hasn't been used in any academic research before.

In this study, we use their annual monitoring survey of corporate tenants[2]. The survey is sent to facilities/office managers involved in the decision to renew the lease every year through an online questionnaire. At the beginning of the survey will be stated that the survey results would not be anonymous and will be shared with the property management office to resolve any immediate concerns and improve service delivery. The survey is administered throughout the entire

[1]The Grace Hill group (https://gracehill.com/) is a solution provider for the real estate sector that aims to improve the operating efficiency of the building. Their clients are mainly real estate investment companies, real estate management companies, and other real estate sector participants.

[2]Kingsley also designs specific surveys according to the need of the client (e.g. evaluation of the performance of the new investment in the building, tenant's satisfaction with ESG compliance).

year. After receiving the invitation to complete the survey, tenants have a survey window from 4 to 6 weeks to complete the survey, giving them enough time to consider their responses and fill out the questionnaire. The survey is always voluntary for tenants. The response rate of the official survey is high, around 70%, reducing concerns of attrition and self-selection bias in our sample.

The standard survey has 116 questions in total. There are five key blocks in the questionnaire: (1) Overall satisfaction; (2) Perceptions of building features; (3) Satisfaction with management, leasing, and maintenance service; (4) Current needs and priorities; (5) Renewal intention and the likelihood of building recommendation. The questionnaire asks the tenant to rate their experience inside the building with a limited choice: Likert scales from 1-5[3].

For each of the topics above, there are some sub-component questions about that specific aspect of the building. For example, for tenant's perception of the quality of property management, there are overall questions such as "Overall satisfaction with management", and sub-component of different aspects of property management, such as "Accessibility", "Communication", "Response time", etc al.[4]

Our database contains 2,965 office buildings across the US that with building characteristics could be specified in the Costar database, located among 74 MSAs and 392 cities. Approximately 90% of the observations are located in the 50 largest MSAs. It includes answers from 55,951 corporate tenants from 2009 to 2022, with 108,627 survey observations in total. All the office buildings are tracked over multiple years. On average each tenant fills out around 3 surveys. These office buildings are a representative sample of commercial properties in the U.S., skewed towards prime 'Class A' and 'Class B' offices, and the occupiers are representative samples of the U.S. companies[5].

### *B. Costar Building Data*

This study relies on Costar for the assessment of the financial performance of the building, as well as the collection of building characteristics. Costar is

[3]For example, for the overall satisfaction questions, the survey will ask "Please rate your overall satisfaction as a tenant", then the answer "1" means "Poor", "2" means "Fair", "3" means "Average", "4" means "Good" and 5 means "Excellent". These questions require tenants to rate their satisfaction with a specific aspect of their experience as a tenant has similar forms of answers. For example, for the building service, the survey will ask "Please rate your overall satisfaction with the following building services.", for the leasing process, the survey will ask "Please rate your overall satisfaction with the leasing experience.". For categorical questions such as renewal intention, the question will ask "If the renewal decision had to be made today, how likely would your company be to renew the lease?", the answer "1" means "definitely would not", "2" means "probably would", "3" means "unsure", "4" means "probably would" and 5 means "definitely would". For building recommendation, the questionnaire asks individuals to report "How likely would you be to recommend this building to others?", and the answers are from scores 1 to 5.

[4]There are also some questions that could take verbal answers, such as what is the specific need of the corporate tenant.

[5]The dataset covers a bunch of the subsidy and branches of the most famous companies around the world such as Apple., Morgan Stanley, et al, and also many middle and small size companies. This dataset also includes the most famous office properties in the U.S. including the empire state building, the Morgan Chase building, etc al.

the biggest data provider of commercial building information in the U.S., which maintains a database of more than 6 million properties[6].

For each building in our sample, we get physical information including location, building class, last renovation year, construction year, the number of stories, building size, and amenities. In addition, we collect information about the building owner, property management company, and leasing company.

We also retrieve the following financial performance data for each building: The historical asking rents data, historical vacancy rate data, and each leasing contract data. CoStar reports the weighted average asking rent of each season for each leasing type (sublease, direct lease, and total of the sublease and direct lease) if there is space available in the building, otherwise, the asking rent information will be displayed as missing. The asking rent represents the average of the "asking rent" of the available space weighted by the size of the listing space. Costar also reports the vacancy rate of each season of the building, CoStar defines vacancy as space that is not physically occupied by a tenant, "Demand" denotes the total occupied space in a market, and the vacancy rate is 1 - (Demand / Stock). For each leasing contract, we get detailed information on the contract terms including the agreed rent, sign date, start date, move-in date, expiration date, space leased, free rent period, lease type, contract service type, tenant company, and tenant industry.[7]

### C. *Green Certificate Data*

Green certification data are from The U.S. Green Building Council (USGBC)[8] and Delos[9]. We use LEED and WELL as a measurement of sustainability attributes for office buildings. For each green certification, we collect information on the building address, date of registration, date of certification, and level of certification.

### D. *Final Dataset*

We match the Kingsley survey data with Costar building characteristics data and green certificate data based on building address. We excluded observations where the building age is smaller than or equal to zero[10], with missing information of specific building characteristics[11]. For those company tenants that have more than one respondent for a specific survey year, we take the average of the

[6] https://www.costar.com/about

[7] Data on commercial office buildings provided by Costar includes liquid commercial office space only, those owner-occupied headquarters buildings are underrepresented.

[8] https://www.usgbc.org/

[9] https://delos.com/

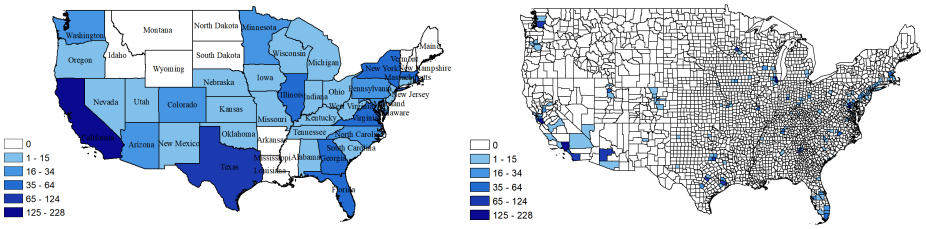
[10] There were 10 survey data from 1 building with the age of the building smaller than zero.

[11] There were 96 survey data are from 7 building with missing the built year data, 3 survey data from 1 building with missing building class data.

response value[12]. We also exclude those properties with building type is not related to "Office"[13]. Finally, we have 108,627 surveys in 2,965 office properties with both building characteristics that can be specified in the costar data set, and survey data could be identified in Kingsley.

### *E. Descriptive Statistics*

Figure 1 depicts the geographical distribution of the observations. From Figure (a) we can see that most of our observations are concentrated in California, and Texas, followed by New York, the District of Columbia, Illinois, and Florida, which are the most economically developed area in the U.S. Figure (b) indicates that the distribution of the surveyed office is not evenly distributed within the state, mostly concentrated in the central county of the state, such as Manhattan, Los Angels, San Fransico, and Washinton D.C.




(a) State Level (b) County Level

FIGURE 1. GEOGRAPHIC DISTRIBUTION OF KINGSLEY PROPERTIES BETWEEN YEARS 2009 TO 2021

Figure 2 depicts the means of the overall satisfaction value by states, with most of the states with overall satisfaction values between 4.20 to 4.50. But given the building level average overall satisfaction is 4.30(scale of 1 to 5), with a standard deviation of 0.44, we can observe some meaningful heterogeneity in overall satisfaction across geographic locations[14], for example, company tenants in Alabama are happier than those company tenants in West Virginia(1.5 point out of 1 to 5). But this phenomenon could be the result that in those under-developed areas, only those well-perform properties will enter the investment portfolio of the institutional investors and have tenant surveys, so the satisfaction level might be over-represented by good properties in these areas.

[12]There were 1,327 survey data observations from those companies with more than 1 respondent.

[13]The office building in our research sample incorporate all the office with different usages, such as Office, Community Center Office, Lifestyle Center Office, Neighborhood Center Office, Office Park, Strip Center Office, and Super Regional Mall Office

[14]In the empirical analysis, we control for the location fixed effect to account for the influence of those geographical characteristics which will affect tenant's satisfaction level but didn't change over time

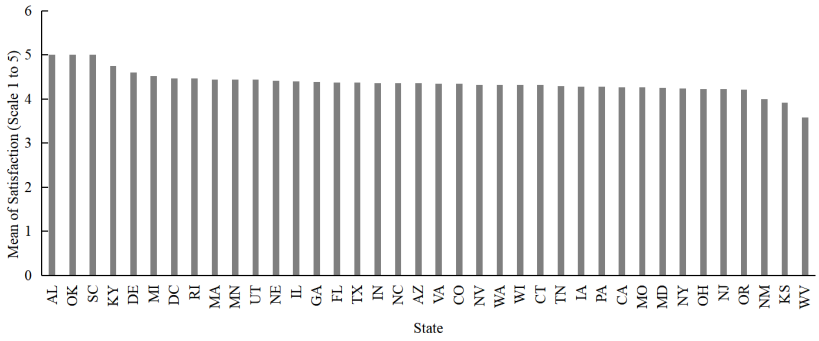



FIGURE 2. GEOGRAPHIC DISTRIBUTION OF SATISFACTION BETWEEN YEARS 2009 TO 2021

*Note:* The state-level average overall satisfaction is the arithmetic average of the overall satisfaction score of all the respondents in the corresponding state.

In Figure 3 we document the time trend of the main dependent variables by building class for the past 5 years (2017 to 2021). Figure 3 (a) is the overall satisfaction level, the overall satisfaction is relatively stable over the past 5 years and shows a slightly upward trend. This increasing trend partially indicates that overall the tenant's experience is improving for the Kingsley clients, the property manager has realized the importance of a happy tenant. Another reason is the growth in the number of properties committed by the property management company to the Kingsley survey program to do the tenant surveys, and those newcomers have higher satisfaction levels and better quality, especially after the outbreak of Covid-19 more properties owners started to worry about the status of their building which is formerly those well-perform properties that the property management didn't worry about before the Covid. But there is some heterogeneity in the time trend across the properties with different qualities. Firstly, tenants tend to have better perception levels in "class A" properties throughout the period, followed by the "class B" properties and "class C" properties. Secondly, the time trend of satisfaction are different since the outbreak of the covid, while "class B" properties show a small drop, and the "class C" properties show a big drop and rebound slightly to the level before covid, the "class A" properties show a stable and even consistent upward trend instead.

Figure 3 (b) is the time trend of the renewal intention which shows some homogeneity, with all building types experiencing a big drop in 2020 and rebounding slightly in 2021. But it also shows meaningful heterogeneity across building classes. Firstly, the magnitude of the drop is "Class C" more severe than "class B" and "Class A", but the magnitude of the rebound is also bigger than the higher quality peer properties. Secondly, renewal intention in those "class C" properties shows a drop sign earlier than those "class B" and "class A" buildings. It could be because those "class C" properties are usually the choice of

medium and small-size companies, which are more sensitive to the shock of the pandemic in terms of their operations and have more flexibility in their demand for office space.

Figure 3 (c) is the trend of direct gross rents[15], the "Class A" building with the best performance, which shows a stable upward trend even after the outbreak of covid-19. Followed by the "class B" properties, which also show some resilience after the covid outbreak. But the "Class C" properties experience a big drop in direct gross rents of around 20%, which was consistent with the findings from Gupta, Mittal and Van Nieuwerburgh (2022), which observe a fall of 13.16% in the rents on newly-signed leases between 2020 to 2021 on average but with heterogeneity.

Figure 3 (d) is the trend of the vacancy rate, which shows an upward trend since covid across all properties class. But those "class A" properties tend to have lower vacancy rates throughout the period, and after the outbreak of Covid-19, the vacancy rate also raises slower than its peers, "flight to quality" trend is also consistent with the evidence from Gupta, Mittal and Van Nieuwerburgh (2022).

Figure 3 (e) is the trend of effective rent, which is the combined effect of gross rents and vacancy rate showing a similar trend with the gross rents. For "class A" and "class B" properties it's rather stable but for "Class C" properties there is a big drop in 2020 and following a slight rebound in 2021.

The descriptive statistics are displayed in Table 1. Regarding building performance in terms of the tenant decision, the average scale on renewal intention is 3.83 out of a maximum scale of 5, with a relatively big standard deviation of 0.93 compare with other survey questions, and the average building recommendation is 4.27 also out of a scale of 1 to 5. Of all respondents from 2009 to 2021, around 48.80% of those old tenants have moved out.

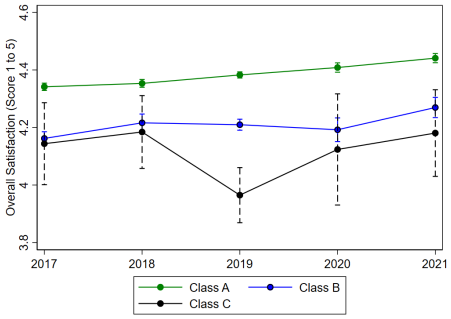
As for tenant perception, on a scale of 1 to 5, the company-level average overall satisfaction score is 4.32, and the building-level average satisfaction is 4.30. This is consistent with the findings of Palacios, Eichholtz and Kok (2020); Loewenstein and Ubel (2008); Galiani, Gertler and Undurraga (2018) about people's hedonic adaptation phenomenon.

In terms of building quality, nearly 66.00% of the buildings are designated as "class A", and 31.50% are "class B". The average age of these office properties is 38.07 years. Around 29.00% of buildings were surveyed after renovation. The average size of a typical floor for the properties in our samples is 24197.39 Square feet. 60% of the office building in our sample have on-site amenities[16].

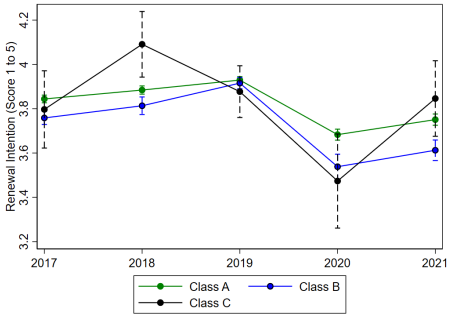
The average growth of rents is 1.6%, the average growth of effective rents is

[15]We use the direct gross rents, which is the listing price directly from the landlord, instead of the subletting rents or overall rents combining both the direct rents and subletting rents. This measure could partially eliminate the influence of those noise transactions made by the sub-renting transaction of the company because of reasons other than the performance of the building itself, such as because of the financial performance or operating problem of the tenant company.

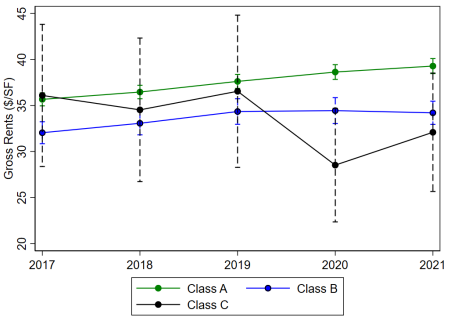
[16]If the building has one or more of the following amenities available then it was defined as having on-site amenities, the dummy variable Amenities is equaled to 1, 0 otherwise: banking, convenience store, dry cleaner, fitness center, food court, food service, restaurant.



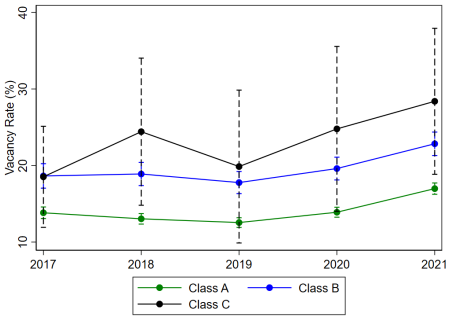

(a) Overall Satisfaction(Score 1 to 5)



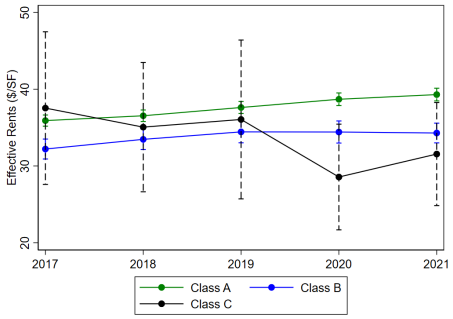

(b) Renewal Intention(Score 1 to 5)




(c) Gross Rents($/SF)




(d) Vacancy Rate(%)




(e) Effective Rents($/SF)

FIGURE 3. TIME TREND OF MAIN DEPENDANT VARIABLES

*Note:* Satisfaction, Renewal intention, Vacancy rate, Rental level, and Effective rents are the arithmetic average. Dash lines are the upper and bottom of 95% confidential interval. The effective rent is calculated by multiplying the Building Level rental rate by the occupancy rate. For the statistics of the vacancy rate, gross rents, and effective rents, we preserve the rents and vacancy samples in years that didn't have observations of survey responses.

1.2%, and the average vacancy growth is 2.2%, which are similar to the statistics of An et al. (2016), which found the average rents growth rate of 9,000 NCREIF commercial properties is 1.2% during 2001-2010. The average asking rent is 36.35$/SF, the average vacancy rate is 31.52$/SF, and the average vacancy rate is 13.75%. Similar to the asking rents, the average contract rent is 33.81$/SF, the average on-market time is 2.18 years, the average contract length is 4.59 years, and the average free rent period is 0.017 years.

## III. Methodology

This section describes the empirical models linking tenant satisfaction to two key performance indicators of properties:(1)tenant decision and (2) building financial outcomes.

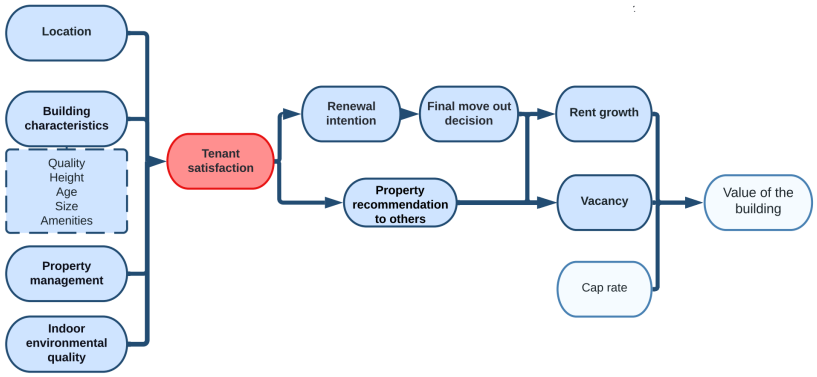



FIGURE 4. RESEARCH FRAMEWORK

The following expression describes the model linking tenant satisfaction to the three tenant decision indicators: (1) renewal intention, (2)building recommendation, and (3) move-out status of the tenant. The model includes all traditional hedonic characteristics of the building, to control for any unobservable characteristics that might be correlated with higher tenant satisfaction.

Following Eichholtz, Kok and Quigley (2013), we use hedonic models which are commonly used in literature that researches the pricing of buildings to estimate the increment effect of tenant satisfaction. Expressions (1) is the predictive regressions model that relates tenant's satisfaction level to and tenant's renewal intention, and their decision[17]:

[17]In this equation, both the tenant decision variables and tenant satisfaction variables are tenant company-level data.

TABLE 1—DESCRIPTIVE STATISTICS

| Variable | Obs. | Mean | Std. | Min | Max |
|---|---|---|---|---|---|
| Panel A: Tenant Decision (Company Level) | | | | | |
| $RenewalIntention_{i,b,t}$ (score 1-5) | 85,057 | 3.827 | 0.93 | 1.00 | 5.00 |
| $BuildingRecommendation_{i,b,t}$ (score 1-5) | 61,273 | 4.270 | 0.77 | 1.00 | 5.00 |
| $FinalMoveOut_{i,b}$ (YES=1) | 55,951 | 0.470 | 0.499 | 0.00 | 1.00 |
| Panel B: Tenant Perception | | | | | |
| $OverallSatisfaction_{i,b,t}$ (score 1-5)(Company Level) | 108,627 | 4.324 | 0.78 | 1.00 | 5.00 |
| $AverageOverallSatisfaction_{b,t}$ (score 1-5)(Building Level) | 9,067 | 4.300 | 0.44 | 1.00 | 5.00 |
| Panel C: Building Characteristics (Building Level) | | | | | |
| $Green_b$ (YES=1) | 2,965 | 0.456 | 0.49 | 0.00 | 1.00 |
| Building Class(percent): | | | | | |
| $ClassA_b$ (YES=1) | 2,965 | 0.660 | 0.47 | 0.00 | 1.00 |
| $ClassB_b$ (YES=1) | 2,965 | 0.315 | 0.46 | 0.00 | 1.00 |
| $ClassC_b$ (YES=1) | 2,965 | 0.024 | 0.16 | 0.00 | 1.00 |
| $Age_b$ (Years) | 2,965 | 38.068 | 25.65 | 1.00 | 165.00 |
| Built Year (percent): | | | | | |
| $Before1970_b$ (YES=1) | 2,965 | 0.154 | 0.36 | 0.00 | 1.00 |
| $1970-1979_b$ (YES=1) | 2,965 | 0.099 | 0.30 | 0.00 | 1.00 |
| $1980-1989_b$ (YES=1) | 2,965 | 0.323 | 0.47 | 0.00 | 1.00 |
| $1990-1999_b$ (YES=1) | 2,965 | 0.148 | 0.35 | 0.00 | 1.00 |
| $After2000_b$ (YES=1) | 2,965 | 0.275 | 0.45 | 0.00 | 1.00 |
| Stories (percent): | | | | | |
| $Low_b$ (<10 floors) (YES=1) | 2,965 | 0.629 | 0.48 | 0.00 | 1.00 |
| $Medium_b$ (10<and<20 floors) (YES=1) | 2,965 | 0.204 | 0.40 | 0.00 | 1.00 |
| $High_b$ (>20 floors) (YES=1) | 2,965 | 0.167 | 0.37 | 0.00 | 1.00 |
| $Renovated_{b,t}$ (YES=1) | 10,338 | 0.290 | 0.45 | 0.00 | 1.00 |
| $Typicalfloorsize_b$(thousand SF) | 2,965 | 28.034 | 18.99 | 2.70 | 356.75 |
| $Amenities_b$ (YES=1) | 2,965 | 0.596 | 0.491 | 0.00 | 1.00 |
| Panel D: Financial Indicators (Building Level): | | | | | |
| Performance: | | | | | |
| $\Delta Rents_{b,t+1,t}$ (%) | 5,395 | 1.839 | 6.53 | -21.64 | 32.68 |
| $\Delta EffectiveRents_{b,t+1,t}$ (%) | 4,987 | 2.223 | 13.98 | -40.20 | 61.66 |
| $\Delta VacancyRate_{b,t+1,t}$(%) | 6,797 | 1.293 | 1.29 | 0.00 | 9.19 |
| Level data: | | | | | |
| $Rents_{b,t}$ (\$/SF yr) | 5,880 | 36.333 | 14.91 | 8.00 | 121.69 |
| $EffectiveRents_{b,t}$ (\$/SF yr) | 5,553 | 31.561 | 14.67 | 0.00 | 120.00 |
| $VacancyRate$(%) | 7,479 | 13.608 | 14.16 | 0.00 | 100.00 |
| Panel E: Leasing Contract Characteristics (Contract Level): | | | | | |
| $Rents_{g,b,t}$(\$/SF yr) | 6,211 | 33.814 | 21.30 | 1.70 | 758.12 |
| $EffectiveRents_{g,b,t}$(\$/SF yr) | 5,620 | 29.164 | 19.16 | 0.00 | 691.07 |
| $MonthsonMarket_{g,b,t}$(Years) | 6,211 | 2.182 | 2.52 | 0.00 | 20.42 |
| $ContractLength_{g,b,t}$(Years) | 6,211 | 4.592 | 3.85 | 0.08 | 65.00 |
| $FreeRent_{g,b,t}$(Years) | 6,211 | 0.017 | 0.11 | 0.00 | 2.17 |
| $Log(SizeLeased_{g,b,t})$(SF) | 6,211 | 8.439 | 1.09 | 5.13 | 13.11 |

*Note:* Data Source: Grace Hill, CoStar, USGBC, and Delos. The summary statistics displayed above consider the full sample period(from 2009 to 2022). For the summary statistics of financial variables, we only keep those years with survey observations. For those tenants with subsidies in different buildings, we regard it as different tenants in the descriptive statistics.

$$(1) \qquad RenLease_{i,b,t} = \alpha + \beta Satisfaction_{i,b,t} + \gamma X_b + \mu_t * \lambda_c + \tau_i + \varepsilon_{i,b,t}$$

Where the dependent variable $RenLease_{i,b,t}$ describes the likelihood of tenant $i$ to renew its lease in building $b$ in year $t$. The survey allows testing for measuring the renewal of leases in different ways. First, every year the tenant is asked explicitly for their intention to renew the lease. In addition, we can observe the likelihood of a tenant recommending the building to others. Finally, we observe whether the tenant exited or remained in the building[18].

The key variable of interest is $Satisfaction_{i,b,t}$, which describes the reported level of satisfaction that tenant $i$ has with building $b$ in year $t$ on a scale from 1 (least satisfied) to 5 (most satisfied). The coefficient $\beta$ captures the influence of tenant satisfaction intention on a tenant's decision to renew the lease. Vector $X_b$ describes the set of controls for building characteristics, including the following hedonic building characteristics: building class, vintage, number of floors, whether experienced a renovation in the building when the building was surveyed, size of the building, and whether there are on-site amenities in the building.

All regressions include interactive fixed effect of time($\mu_t$) and city($\lambda_c$), and tenant fixed ($\tau_i$) effects.[19] $\varepsilon_{i,b,t}$ is the error term, which might be auto-correlated in building level, thus the standard errors are clustered at the building level.

Next, we explore the relationship between tenant satisfaction and the financial performance of the building. Following Eichholtz, Kok and Quigley (2013), the model includes all traditional hedonic characteristics of the building, to control for any unobservable characteristics that might be correlated with better financial performance, or will affect tenant satisfaction and financial performance at the same time. Equation (2) describes the one-period hedonic model connecting the average tenant satisfaction of tenants in the building to the average financial performance of the building, measured by the growth of the average rental levels, growth of the effective rental levels, and growth of the vacancy rates in the building:

$$(2) \qquad \Delta Log(Performance_{b,t+1,t}) = \alpha + \beta Log(Satisfaction_{b,t}) + \theta Log(LaggedLevel_{b,t}) + \gamma X_b + \mu_t * \lambda_c + \varepsilon_{b,t}$$

[18] We use the fixed effects logit models to estimate Equation (1) and investigate the effect of tenant satisfaction on tenants' final staying status. For the logit regression, we didn't control for the tenant fixed effect because of too many dummy variables(55,951 unique tenants), and those tenants who have no subsidies only have one status of staying or had left.

[19] Costar provides information on the current tenant at the time point user searching the database inside the building, including the current tenant name, and tenant industry. In addition, we cross-verify the tenant staying status using the Google Maps database. If the tenant is shown by Google Maps as "operating" in the building then we regard it as "existing", and is "move out" otherwise.

$\Delta Log(Performance_{b,t+1,t})$ is the change of the financial performance of building $b$ between year $t+1$(i.e., the year after the tenant completed the tenant satisfaction survey) and year $t$(i.e., the year when the tenant completed the tenant satisfaction survey). We include three separate financial indicators of the performance of building $b$ between year $t+1$ and year $t$: (1) The change of the logarithm of the gross rent per square foot of building $b$ between year $t+1$ and year $t$, (2) the change of the logarithm of listing direct effective gross rent per square foot commanded by building $b$ between year $t+1$ and year $t$, and (3) the change of the logarithm of vacancy rate of building $b$ between year $t+1$ and year $t$[20].

The key variable of interest, $Log(Satisfaction_{b,t})$, describes the average overall satisfaction level of all tenants filling the tenant satisfaction survey for building $b$ in year $t$. $\beta$ describes the sensitivity of the financial performance indicators. The coefficient describes whether there are differences in vacancy rates or rents in buildings with comparable hedonic characteristics that have higher tenant satisfaction on average [21]. Following Verbrugge et al. (2017), which studies the dynamics of rents of individual properties, indicates that the relative rents level can predict the rents growth of the next period. Similar to Wheaton, Torto and Evans (1997); Gabriel and Nothaft (2001), which explores the mechanism of market-level rent dynamics by developing a general specification, which indicates that the vacancy incidence possibility, vacancy length, tenant inflow, and current rents level are all having an impact on the rental price adjustment. Similarly, research by Grenadier (1995)on the determinants of the vacancy rate of the U.S. office market also finds a significant impact of the current vacancy rate on the vacancy dynamics. Thus, besides the hedonic controls listed in Equation (1), we also include the lagged financial performance $Log(LaggedLevel_{b,t})$ of building $b$ in year $t$: (1) The logarithm of listing gross rent per square foot of building $b$ in year $t$. (3) The logarithm of effective rent of building $b$ in year $t$. (3) The logarithm of vacancy rate of building $b$ in year $t$.

The control variables vector is the same in equation (1). Finally, since the rent levels and growth are affected by local economic conditions (Eichholtz, Kok and Quigley, 2013) and demographic characteristics of the city, these geological differences might change over time. Thus, we control for the cross term of city and time-fixed effect[22].

Compared with contract rents, one significant advantage of using asking rents

[20]Costar provides with three types of performance measurement for rents and vacancy level, the direct, sublease and overall. For example, the gross rents including the direct gross rents, sublease gross rents, and overall gross rents. Rules for the vacancy rate are similar. Here we use the direct rents and direct vacancy rate for the financial performance measurement. Because the sublease transaction might not reflect the market average situation but is more influenced by the company's financial status and operating strategies that offer the listing.

[21]It is important to note that the increment effect in rent growth we estimated is coming from the new listing, but will not affect the rent level of the existing leasing contract, which is the "updating activity" of the landlord by changing the asking price of the listing space according to the market condition.

[22]In this equation, both the financial performance variables and tenant satisfaction variables are building-level average data.

is that asking rents can reflect the current sentiment of the market(Ibanez and Pennington-Cross, 2013), it's a proxy of the landlord's expectation of the market value of the available space given the market condition during the listing[23]. Another advantage of using asking rent is that asking rent usually has more observations compared with leasing contract rents, but there may not be a newly signed leasing contract every year.

## IV. Empirical Results

### *A. Tenant Satisfaction and Tenant Decision*

Table 2 presents the results of estimating Equation (1), with the tenant's decision as the dependent variable. The coefficients of control variables are dropped due to space constraints(the full table is available in Appendix A1 and A2), and so does the coefficient of interaction terms of time and city fixed effects, and tenant fixed effects. Columns (1) - (3) are the results on renewal intention, adding control variables, time and city fixed effects, and tenant fixed effects respectively. Column (1) indicates that 1 point higher overall satisfaction will lead to 0.43 point higher renewal intention, the magnitude and sign of coefficient are similar when adding time and city fixed effects. After adding the tenant fixed effect, Column (3) indicates that 1 point higher overall satisfaction will lead to a statistically strong 0.32 score increase in the willingness to renew the leasing contract.

Columns (3) to (6) are the results of the building recommendations. After adding the control variables, time and city fixed effects and tenant fixed effects, Column (6) shows that 1 score improvement of satisfaction is related to a 0.47 point increase in the willingness of recommending over their counterparts. The results in column (1) - (6) indicates a strong positive relationship between tenants' satisfaction and their self-reported leasing decision.

Column (7) - (8) shows the results of conditional logit estimation results for the impact of satisfaction on tenants' actual move-out status. Column (8) indicates that, on average, 1 point higher overall satisfaction will lead to an 18.0% lower probability of actually leaving. This means that satisfaction not only affects tenants' oral commitment but is also a strong predictor of their actual leasing behavior[24].

[23] Although the asking rents are set before if the building owner thinks the price is unreasonable, the landlord will adjust it to a satisfactory level based on their best knowledge of the market. If they do not change it means that they think the price is reasonable. And the contract rents would always be the same as the existing asking rents at a certain time point, which contributes to the reliability of our conclusion.

[24] For Column (3), we preserve all the responses for each tenant to research the connection between satisfaction and move-out status, the results are similar if we only preserve the latest reply of the tenant, or if we take the average value of response of the tenant.

TABLE 2—TENANT SATISFACTION AND TENANT DECISION

| | Renewal Intention$_{i,b,t}$ (score 1-5) | | | Building Recommend$_{i,b,t}$ (score 1-5) | | | Finally Move Out$_{i,b,t+1}$ (1=YES) | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Overall Satisfaction$_{i,b,t}$ | 0.427*** | 0.428*** | 0.321*** | 0.598*** | 0.593*** | 0.471*** | -0.230*** | -0.180*** |
| (Score 1-5) | (0.005) | (0.005) | (0.008) | (0.005) | (0.005) | (0.008) | (0.015) | (0.031) |
| Constant | 2.075*** | 1.858*** | 2.287*** | 1.321*** | 1.253*** | 2.102*** | 0.177 | 2.245 |
| | (0.116) | (0.125) | (0.225) | (0.086) | (0.094) | (0.169) | (0.608) | (2.224) |
| Control$_b$ | YES | YES | YES | YES | YES | YES | YES | YES |
| Time * City FE | NO | YES | YES | NO | YES | YES | NO | YES |
| Tenant FE | NO | NO | YES | NO | NO | YES | NO | NO |
| Observations | 85,198 | 85,094 | 70,921 | 61,781 | 61,709 | 48,206 | 54,321 | 21,851 |
| R-squared | 0.124 | 0.157 | 0.553 | 0.373 | 0.393 | 0.670 | 0.013 | 0.227 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Column (1) has 2,854 buildings, Column (2) has 2,819 buildings, Column (3) has 2,490 buildings, Column (4) has 2,183 buildings, Column (5) has 2,160 buildings, Column (6) has 1,944 buildings, Column (7) has 2,937 buildings, Column (8) has 1,930 buildings. The dependent variable in columns (8)-(9) is a binary variable that takes one if the tenant is no longer in the building today and zeroes otherwise. Column (8)-(9) is the fixed effects logit regression model, we didn't control for the tenant fixed effect because most of the tenants who have no subsidies only have either status of staying($MoveOut_{i,b}$=0) or had left($MoveOut_{i,b}$=1). The full table with the estimation of all control variables is in Appendix A1. For the logit regression, we only preserve the last survey the tenant filled out to avoid over-represent by those tenants who have filled out more surveys, and the opinion of the tenant about the building is closer to their final staying status in terms of the time point, for example, a tenant might have filled the survey during 2015-2019, then we only preserve the survey in 2019 to explain their occupancy status. We didn't control for the tenant fixed effects because tenants who have no subsidies, one tenant only has either status of staying or had left, control for tenant fixed effects will delete all the tenants that have no subsidies. The results of keeping all the tenant's responses are similar in terms of coefficient significance level and magnitude. For the tenant fixed effect, if the tenant has subsidies in different buildings, we regard it as the same tenant in the grouping.

Table 3 presents the estimates of the rental rate change models in Equation (2), based on the weighted average asking rents per square foot of the building. Column (1) - (3) is the impact of satisfaction on the logarithm growth of the gross rents. On average, 10% higher building level average overall satisfaction is related to 0.17% higher growth of gross rents. Column (4) - (6) is the impact of satisfaction on the logarithm growth of the effective gross rents. The results mirror those in column (1) but the magnitudes of the coefficient are larger, 10% improvement in satisfaction will lead to 0.66% higher growth effective gross rent. Column (7) - (9) presents the analysis of the vacancy rate. A 10% improvement in satisfaction is related to a 2.32% lower growth of vacancy rate next year.

These results indicate that buildings with more satisfied tenants might give landlords more bargaining power to increase the rental rates for the new listing. Tenants' willingness to renew their leasing contract and recommend the building to their peers might improve the demand for the building and lower the vacancy rate. This incremental effect cannot be explained by the observable building characteristics and the city-level heterogeneity across time.

TABLE 3—TENANT SATISFACTION AND BUILDING FINANCIAL PERFORMANCE

| | $\Delta Log(Rent_{b,t+1,t})$ ($/SF) | | | $\Delta Log(EffectiveRent_{b,t+1,t})$ ($/SF) | | | $\Delta Log(VacancyRate_{b,t+1,t})$ (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Log(Average Overall Satisfaction$_{b,t}$) | 0.005 | 0.006 | 0.017* | 0.065*** | 0.056** | 0.069** | -0.290*** | -0.243*** | -0.232*** |
| (Score 1-5) | (0.007) | (0.007) | (0.009) | (0.024) | (0.025) | (0.028) | (0.065) | (0.067) | (0.080) |
| Constant | 0.060*** | 0.070*** | 0.161*** | -0.131*** | -0.061 | -0.066 | 0.970*** | 1.255*** | 1.552*** |
| | (0.014) | (0.026) | (0.042) | (0.042) | (0.071) | (0.106) | (0.101) | (0.202) | (0.251) |
| Lagged Level$_{b,t}$ | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Control$_b$ | NO | YES | YES | NO | YES | YES | NO | YES | YES |
| Time * City FE | NO | NO | YES | NO | NO | YES | NO | NO | YES |
| Observations | 4,570 | 4,570 | 3,962 | 4,225 | 4,225 | 3,659 | 6,134 | 6,134 | 5,467 |
| R-squared | 0.007 | 0.011 | 0.238 | 0.040 | 0.045 | 0.270 | 0.119 | 0.127 | 0.288 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Column (1) have 1,672 buildings, Column (2) have 1,672 buildings, Column (3) has 1,500 buildings, Column (4) has 1,573 buildings, Column (5) has 1,573 buildings, Column (6) has 1,409 buildings, and Column (7) has 2,134 buildings, and Column (8) has 2,134 buildings, and Column (9) has 1,963 buildings. Explained variables are winsorized at their respective 1st and 99th percentiles to reduce the influence of outliers. The full table with the estimation of all control variables is in Appendix A1. The regression model applied for this table is Equation (2).

## V. Robustness Check

### A. Performance of Achieved Rents

Although using weighted average asking rents for analysis of the change of rental level has some advantages such as a larger dataset, and the high correlation of asking rents and transaction rents(Jennen and Brounen, 2009), which is more predominant for the regression of hedonic pricing models in existing studies, there are some problems with it, such as it's the rental level that the landlord asking for but cannot guarantee to be realized in any future leasing activities, and it was over-represents by those leasing spaces in buildings that always have space available which might be because of poor functionality of the building(Jaffee, Stanton and Wallace, 2019) and under-represent those well-performing properties which are fully occupied. Considering these problems regarding the asking rent data, in this section, we use the leasing contract data to estimate Equation (2), to investigate the effect of satisfaction on achieved rents.

Similar to the analysis in Table 3, the explained variable $Log(ContractRent_{g,b,t+1})$ is the logarithm of the rental level of the next period, but different in that it is the contract rent of the leasing contract $g$ in building $b$ in year $t+1$(The year after tenant have filled the survey.). We also control for the current period financial performance indicator: $Log(AverageContractRent_{b,t})$, which is the logarithm of the current period average contract rent of building $b$ in year $t$(The year tenant filled the survey.) weighted by the size of realized leased space. For the analysis of the effective rents, the explained variable $Log(EffectiveContractRent_{g,b,t+1})$ is the logarithm of effective rents of leasing contract $g$ in building $b$ in year $t+1$[25], and $Log(EffectiveAverageContractRent_{b,t})$ is the logarithm of current period average effective contract rent of building $b$ in year $t$ weighted by the size of leased space. The explanatory variable $Log(AverageOverallSatisfaction_{b,t})$ is the same as the analysis in Table 3, which is the building level average of overall satisfaction of building $b$ in year $t$.

Following Eichholtz, Kok and Quigley (2013), we control for the influence of rental contract features such as lease length, the square of lease length to account for the impact of non-linearity, and the impact of the rent-free period, size of leased space, and days on market. The building characteristics control variables and fixed effects are the same as those in the analysis before. But we incorporate the leasing contract services type fixed effect to account for the different rental levels that attribute to the leasing contract type.

Table 4 shows the analysis of Equation (2) using leasing contract data. Column (1) and (2) shows the results of the relationship between building level overall satisfaction and the contract rent per square foot in the next period. Column (1) is the results of controlling building characteristics, current period average contract rents level, and time-city fixed effects, the coefficient of the satisfaction

[25]Effective rents are the contract rents multiply the occupancy rate.

TABLE 4—PERFORMANCE OF ACHIEVED RENTS

| | Log(Contract Rent$_{g,b,t+1}$)($/SF$) | | Log(Effective Contract Rent$_{g,b,t+1}$)($/SF$) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log(Average Overall Satisfaction$_{b,t}$)($score1-5$) | 0.046 | 0.097 | 0.450*** | 0.619*** |
| | (0.072) | (0.103) | (0.106) | (0.133) |
| Contract Characteristics: | | | | |
| Time on Market$_{g,b,t+1}$($Years$) | | 0.002 | | -0.001 |
| | | (0.002) | | (0.003) |
| Contract Length$_{g,b,t+1}$($Years$) | | 0.019*** | | 0.020*** |
| | | (0.003) | | (0.004) |
| Contract Length$^2_{g,b,t+1}$($Years^2$) | | -0.000*** | | -0.000*** |
| | | (0.000) | | (0.000) |
| Log(Size Leased)$_{g,b,t+1}$($SF$) | | -0.013*** | | -0.014*** |
| | | (0.005) | | (0.006) |
| Free Rent Period$_{g,b,t+1}$($Years$) | | -0.129** | | -0.178** |
| | | (0.042) | | (0.066) |
| Constant | 2.992*** | 2.723*** | 2.060*** | 1.750*** |
| | (0.244) | (0.297) | (0.365) | (0.400) |
| Lagged Level$_{b,t}$ | YES | YES | YES | YES |
| Control | YES | YES | YES | YES |
| Time*City FE | YES | YES | YES | YES |
| Contract type FE | YES | YES | YES | YES |
| Observations | 6,720 | 3,016 | 6,528 | 2,962 |
| R-squared | 0.750 | 0.776 | 0.754 | 0.796 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Column (1) has 872 buildings, Column (2) has 587 buildings, Column (3) has 757 buildings, and Column (4) has 503 buildings. Contract type FE is the fixed effect of different leasing contract types, in our sample, we have 12 contract types in total, including Double Net, Full-Service Gross, Industrial Gross, Modified Gross, Negotiable Net, Plus All Utilities, Plus Cleaning, Plus Electric, Tenant Electric, and Triple Net. In this equation, we only have a small size of leasing contract for analysis: The first reason is that different properties might be tracked by the survey starting in different years and ending tracking in different years, which means only those properties have survey responses for the current period, have sign leasing contract for the current period and the next period will enter into our regression. Another reason is that we only preserve those leasing contract samples with observations of all leasing term variables, in order to mitigate the possibility that there are unobserved characteristics that determine both the satisfaction level and the rent level. 3704 leasing contract data were deleted because of missing contract rents, missing on-market time, or missing contract length. In this equation, the explained variables that achieve rents and achieve effective rents are contracted level data, and the explanatory variable tenant satisfaction is building level average data. The contract characteristics control variables are contracted-level data. The current performance control variable in $LaggedLevel_{b,t}$: For column (1) - (2) is $AverageContractRent_{b,t}$, which is the weighted average of the contract rents for building $b$ in year $t$; and for column (3) - (4) is $AverageContractRent_{b,t}$, which is the weighted average of the contract rents for building $b$ in year $t$ and is calculated based on the contract level data, and $AverageVacancyRate_{b,t}$ is the weighted average of the Vacancy rate for building $b$ in year $t$.

shows that, on average, 10% higher overall satisfaction is related to 0.46% higher contract rents, Column (2) is the results after we add in the contract characteristics based on Column (1). The coefficient of satisfaction is even bigger, for 1 point higher satisfaction the rental level is around 0.97% higher. Compare with the analysis of using listing gross rents in Table 3, the magnitude of the coefficients of satisfaction are larger while using the achieved rents.

Column (3) and (4) shows the results of satisfaction's effect on the effective contract rent per square foot. Similar to Column (1), Column (3) is the result of controlling building characteristics, current period performance, and time-city fixed effects. As displayed by the coefficient of overall satisfaction, on average, 10% higher overall satisfaction is related to 4.50% higher effective contract rents. Column (4) indicates that after we control for the contract characteristics, the effective rents improvement effect is even higher, 10% higher overall satisfaction is related to around 6.19% higher effective rents. The results above also support our main findings, higher satisfaction has positive implications for the future financial performance of the building.

### *B. Marginal Effect of Satisfaction Improvement*

Because of the limitation of the scale of the survey answer, the survey answer with top or bottom response value might include the observations from some abnormal respondents. For example, for the samples with a response value of "5" to the overall satisfaction question, some respondents might be very happy, but some are "super happy", and would have given a 6, or 7 if that answer is available. Similarly, score 1 might also include some "super unhappy" tenants. The existence of these abnormal respondents might lead to the over-estimate of the effect of satisfaction.

Another concern is that given the answer values of the tenant survey are not normally distributed[26], and a large proportion(90%) of the overall satisfaction answer is concentrated on scores 4 and 5, for the building level average overall satisfaction around 95% of the observations are higher than 3.5 points[27], it is possible that the average treatment effect of the improvement of satisfaction we estimated is will be biased by the over-represented "high score" samples, which makes our conclusions may be applied to the building at different satisfaction levels.

In this section, we try to solve the problems above by investigating the marginal effect of tenants' satisfaction improvement and average building satisfaction improvement when they are at different original levels. For the analysis of satisfaction on tenant decision, we take each value between 1 to 5 of the survey answer as a group, for example, $OverallSatisfactionScore2_{i,b,t}$ is a binary value equal to 1 if the overall satisfaction answer value of tenant $i$ in building $b$ in year $t$ is equal

[26]See Appendix Figure 6 (a) the density distribution of the tenant level answer of overall satisfaction.
[27]See Appendix Figure 5 (a) the density distribution of the building level answer of overall satisfaction.

to "2", and 0 otherwise. We specified the tenant samples with overall satisfaction scores equal to 1 as the baseline group. And other control variables and fixed effects are the same as those in Table 2.

For the analysis of satisfaction and financial performance, the grouping rule of panel B is different from panel A. We take the value of the building level within certain percentile intervals as a group, for example, $Log(AverageOverallSatisfaction)20-40percentile_{b,t}$ is a binary value equals 1 if the average overall satisfaction answer value of building $b$ in year $t$ is between 20th to 40th percentile, and 0 otherwise. For other groups the grouping rules are similar. We specified the building samples with average satisfaction scores located at the lowest 20th percentile as the baseline group. So we have the groups with satisfaction scores between the 20th to 40th percentile, between the 40th to 60th percentile, between the 60 to 80 percentile, and between the 80th to 100th percentile. And other control variables and fixed effects are the same as those in Table 3.

Table 5 shows the results of Equations (1) and (2) after we replaced the explanatory variables–the consecutive value of overall satisfaction, with a series of dummy variables–which the score range the overall satisfaction belongs, to research the marginal effect of improving tenant satisfaction and renewal intention.

Panel A analysis the relationship between tenant satisfaction, renewal intention, and their leasing decision. Columns (1), (3), and (5) are the results of the main regression. Column (2) indicates that compared with the baseline group with tenants' satisfaction score equal to 1, the magnitude of the improvement effect is bigger as the satisfaction score is higher, but for each 1-score improvement, the marginal effect of improving tenant satisfaction is becoming smaller, for example, on average if the satisfaction score improves from 1 to 2(On a scale of 1 - 5), the renewal intention will improve by 0.47 points(On a scale of 1 - 5), but if the satisfaction score improves from 4 to 5, the renewal intention will improve by only 0.30 point. Results in Column (4) and (6) shows a similar pattern, satisfaction score is positively related to higher property management recommendation, and a lower probability of final move-out, but the marginal effect is smaller as the satisfaction score is higher.

Panel B analyzed the marginal effect of satisfaction on financial performance. Column (1) shows that compare with the baseline group of those properties with overall satisfaction located at the lowest 20th percentile, the high-score group shows a higher asking rent level. Results in columns (2) and (3) have similar conclusions, higher satisfaction, higher effective rents, and lower vacancy rate. But the improvement effect of satisfaction becomes smaller as the satisfaction score becomes higher, which means the financial performance improvement effect may be mainly driven by those properties that improve from "no satisfied" to "satisfied" instead of from "satisfied" to "very satisfied".

The results above indicate that the marginal effect of improvement of satisfaction is not equally distributed, for those with lower satisfaction could have

TABLE 5—MARGINAL EFFECT OF SATISFACTION IMPROVEMENT

| | Renewal Intention$_{i,b,t}$ (score 1-5) | | Building Recommend$_{i,b,t}$ (score 1-5) | | Finally Move Out$_{i,b,t+1}$ (1=YES) | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Panel A: Tenant Satisfaction and Tenant Decision | | | | | | |
| Overall Satisfaction$_{b,t}$ | 0.332*** | | 0.471*** | | -0.180*** | |
| (Score 1 - 5) | (0.008) | | (0.008) | | (0.031) | |
| Overall Satisfaction Score 2$_{i,b,t}$ | | 0.470*** | | 0.722*** | | -0.679*** |
| (YES=1) | | (0.075) | | (0.080) | | (0.217) |
| Overall Satisfaction Score 3$_{i,b,t}$ | | 0.808*** | | 1.243*** | | -0.621*** |
| (YES=1) | | (0.073) | | (0.077) | | (0.204) |
| Overall Satisfaction Score 4$_{i,b,t}$ | | 1.170*** | | 1.796*** | | -0.805*** |
| (YES=1) | | (0.073) | | (0.076) | | (0.201) |
| Overall Satisfaction Score 5$_{i,b,t}$ | | 1.478*** | | 2.236*** | | -1.001*** |
| (YES=1) | | (0.073) | | (0.077) | | (0.207) |
| Constant | 2.287*** | 2.343*** | 2.102*** | 2.133*** | 2.245 | 2.983*** |
| | (0.225) | (0.244) | (0.169) | (0.213) | (2.224) | (0.716) |
| Control | YES | YES | YES | YES | YES | YES |
| Time*City FE | YES | YES | YES | YES | YES | YES |
| Tenant FE | YES | YES | YES | YES | NO | NO |
| Observations | 70,921 | 70,921 | 49,968 | 49,968 | 21,851 | 21,851 |
| R-squared | 0.553 | 0.554 | 0.670 | 0.671 | 0.227 | 0.228 |
| Panel B:Tenant Satisfaction and building Financial Performance | | | | | | |
| | $\Delta Log(Rent_{b,t+1,t})$ (\$/SF) | | $\Delta Log(EffectiveRent_{b,t+1,t})$ (\$/SF) | | $\Delta Log(VacancyRate_{b,t+1,t})$ (%) | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Log(Average Overall Satisfaction$_{b,t}$) | 0.017* | | 0.069*** | | -0.234*** | |
| (Score 1 - 5) | (0.009) | | (0.029) | | (0.081) | |
| Log(Average Overall Satisfaction) 20-40 percentile$_{b,t}$ | | 0.001 | | 0.021*** | | -0.091*** |
| (YES=1) | | (0.004) | | (0.009) | | (0.031) |
| Log(Average Overall Satisfaction) 40-60 percentile$_{b,t}$ | | -0.002 | | 0.013 | | -0.092*** |
| (YES=1) | | (0.004) | | (0.009) | | (0.030) |
| Log(Average Overall Satisfaction) 60-80 percentile$_{b,t}$ | | 0.004 | | 0.023** | | -0.126*** |
| (YES=1) | | (0.004) | | (0.010) | | (0.032) |
| Log(Average Overall Satisfaction) 80-100 percentile$_{b,t}$ | | 0.001 | | 0.027*** | | -0.119*** |
| (YES=1) | | (0.004) | | (0.010) | | (0.034) |
| Constant | 0.164*** | 0.184*** | -0.059 | 0.026 | 1.562*** | 1.287*** |
| | (0.042) | (0.042) | (0.108) | (0.106) | (0.254) | (0.234) |
| Lagged Level$_{b,t}$ | YES | YES | YES | YES | YES | YES |
| Control | YES | YES | YES | YES | YES | YES |
| Time*City FE | YES | YES | YES | YES | YES | YES |
| Observations | 3,962 | 3,962 | 3,659 | 3,659 | 5,467 | 5,467 |
| R-squared | 0.239 | 0.240 | 0.271 | 0.271 | 0.288 | 0.289 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Panel A: Column (1) - (2) has 2,490 buildings, Column (3) - (4) has 1,944 buildings, and Column (5) - (6) has 1,930 buildings. Panel B: Column (1) - (2) has 1,500 buildings, Column (3) - (4) has 1,409 buildings, and Column (5) - (6) has 1,963 buildings. For panel B the explained variables are winsorized at their respective 1st and 99th percentiles to reduce the influence of outliers. Columns (1), (3), and (5) of Panel A and B are the results of the main regression same as those in Tables 2 and 3.

a bigger positive effect on their decision and the financial performance of the building.

### C. *Worries from the Distribution of Survey Answers*

It is possible that some characteristics of the building are not measurable, but might be related to the rent level of the property and vacancy level of the property, such as gorgeous decoration, and more expensive amenities, which will all be capitalized into the building's rent level, while the satisfaction level of the property might not be related to these characteristics. For example, tenants might be getting used to the environment they are in(Palacios, Eichholtz and Kok, 2020; Loewenstein and Ubel, 2008; Galiani, Gertler and Undurraga, 2018), even if it's a bad-quality building, or they might still feel satisfied with the building as long as they feel what they pay is equal to what they get. As we can show by the scatter plot of the distribution of satisfaction across different rents level in Appendix I, at each rent level there might be a large variance in the distribution of satisfaction. E.g. Property quality affects the performance of the property without showing some implication on the tenant's satisfaction.

In this section, we add the building-level fixed effect, to mitigate the influence of tenant adaptation, and re-estimate (2).

TABLE 6—WORRIES FROM THE DISTRIBUTION OF SURVEY ANSWERS

| | $\Delta Log(Rent_{b,t+1,t})$ ($/SF) | | $\Delta Log(EffectiveRent_{b,t+1,t})$ ($/SF) | | $\Delta Log(VacancyRate_{b,t+1,t})$ (%) | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Log(Average Overall Satisfaction$_{b,t}$) | 0.017* | 0.020* | 0.069** | 0.035 | -0.232*** | -0.175 |
| (score 1-5) | (0.009) | (0.012) | (0.028) | (0.031) | (0.080) | (0.115) |
| Constant | 0.161*** | 1.196*** | 1.352*** | 1.338*** | 1.552*** | 1.586*** |
| | (0.042) | (0.095) | (0.106) | (0.160) | (0.251) | (0.173) |
| Control$_b$ | YES | YES | YES | YES | YES | YES |
| Lagged Level$_{b,t}$ | YES | YES | YES | YES | YES | YES |
| City*Time FE | YES | NO | YES | NO | YES | NO |
| Building FE | NO | YES | NO | YES | NO | YES |
| Time FE | NO | YES | NO | YES | NO | YES |
| Observations | 3,962 | 4,088 | 3,659 | 3,747 | 5,467 | 5,524 |
| R-squared | 0.238 | 0.477 | 0.270 | 0.478 | 0.288 | 0.464 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Columns (1), (3), and (5) are the results of the main regression same as those in Table 3. Column (2) has 1,190 buildings, Column (4) has 1,095 buildings, and Column (6) has 1,524 buildings. Explained variables are winsorized at their respective 1st and 99th percentiles to reduce the influence of outliers.

Table 6 shows the results of Equations (2) after we control the building's fixed effects. The magnitude and sign of the coefficients are similar to the findings in our main regression in Table 3.

### D. *Effect of Satisfaction Sub-component Improvement*

In our analysis, after controlling for all the observational building characteristics and different types of fixed effects, the variance of tenant satisfaction could be coming from several sources: The quality of different property management companies (Combination of accounting, leasing process, maintenance, cleaning, security.), the different indoor environmental quality(Appearance, indoor air quality, temperature, lighting.), the time-varying relationship of the tenant with the property management company. These variances in the office characteristics could affect the tenant's experience.

In this section, we try to discompose the effect of the change of different aspects of satisfaction, to investigate the contribution of the improvement satisfaction sub-component on the tenant's decision and building's performance. But one common problem with the survey data is, the tenant satisfaction of different sub-components is highly correlated with the overall satisfaction, which might lead to biased estimation of the effects of sub-component improvement[28]. We try to solve this problem by using principal component analysis (PCA)[29] and examine whether satisfaction index constructing based on PCA will affect our previous inferences.

Principal component analysis (PCA) assigns weights to each dimension of satisfaction to maximize the common variation captured by the principal components. But the disadvantage is that the component is not transparent and the interpretation of identified common factors is subjective. We incorporate 21 sub-component of satisfaction questions, which consist of three parts: Sub-component of satisfaction with property management(9 questions), sub-component of satisfaction with building quality(9 questions), and sub-component of satisfaction with indoor environmental quality(3 questions). Sub-component of satisfaction with property management will ask the tenants "Please rate your property management staff in the following areas from score 1 to 5: (1)Statement accuracy of the property management, (2) Accessibility, (3)Addressing the special needs, (4)Communication (5) Problem-solving ability, (6)Professionalism, (7)Responsiveness, (8)Response time, (9) Connection." Sub-component of satisfaction with property management will ask the tenants "Please rate the following features of your property: (1)Building Amenities, (2) Location, (3)Quality of Building, (4)Elevator Appearance, (5)Elevator Performance, (6)Appearance of Common Area, (7)Appearance of Restroom, (8)Appearance of Lobby. " Sub-component of satisfaction with indoor environmental quality will ask the tenants "Please rate the following features of your property: (1)Indoor Air Quality, (2)Heating and Air Conditioning, (3)Light."

[28]The VIF(Variance Inflation Factor) of sub-component of satisfaction measures is 4.89(smaller than 10), means there is some sort of multi-collinearity problem, but not severe multi-collinearity.

[29]The p-value of Bartlett is approximately 0 and KMO(Kaiser-Meyer-Olkin Measure of Sampling Adequacy) is 0.859( 0.5), these estimates indicate that the survey questions we choose are suitable for using PCA analysis.

Appendix A5 shows the satisfaction sub-component analysis and the summary statistics of the principal components. According to the Eigenvalue, only the first and second principal components with a value higher than 1, thus we only take the first and the second principle components to construct the new satisfaction measure. The first component explains 48.97% of the variation in tenant satisfaction, and the second component explains 10.50% of the variation in tenant satisfaction. The range of the first components is from -5.66 to 1.08, and the range of the second components is from -5.42 to 6.55. For the first principle component, the loading is relatively evenly distributed across different sub-components, the loading of the property management question satisfaction sub-component, the building quality satisfaction sub-component, and the indoor environmental quality satisfaction sub-components are all between 0.20-0.24 on average, which means for the overall measurement of tenant satisfaction, the contribution of different sub-component is similar. For the second principle component, the loading of the property management satisfaction sub-component is positive, while the loading on the "physical attribute" such as building characteristics and indoor environmental quality are all negative, which emphasizes the substituting role of management satisfaction and environmental satisfaction.

$FirstComponent_{i,b,t}$ and $SecondComponent_{i,b,t}$ are the new measurement of tenant satisfaction we constructed, it denotes the satisfaction of tenant $i$ in building $b$ in year $t$(The year tenant answer the survey). Then we re-estimate Equation (1), and we have the following results:

Table 7 presents the results of the satisfaction principle component on the tenant's decision. Although the magnitude of the coefficients is a little bit smaller than the main results, the sign of the coefficients is consistent with our main conclusion.

Because the principle component takes into consideration the influence of all the sub-component, these results indicate that the improvement of any sub-component of satisfaction will more or less contribute to the tenant's leasing decision-making.

## VI. Heterogeneity

### *A. Different Vacancy Level of the Submarket*

Whether the unsatisfied tenant could successfully move out of the current location at a low cost and find a new suitable place also depends on the office market situation(Wheaton, 1990). If the sub-market has a higher vacancy rate then the tenant would have more choices for moving out[30], their move-out decision

[30]Cushman & Wakefield indicates that for companies in London that relocate, 57% of them will choose a different submarket, and on average the distance between the new office location and old office location is 1.23 miles. This means although companies tend to move within the same submarket while some move outside the submarket but within the same office market of the certain MSA. https://www.cushmanwakefield.com/en/united-kingdom/news/2019/07/london-occupiers-

TABLE 7—PRINCIPLE COMPONENTS OF SATISFACTION

| | (1) Renewal Intention$_{i,b,t}$ (score 1-5) | (2) Renewal Intention$_{i,b,t}$ (score 1-5) | (3) Building Recommend$_{i,b,t}$ (score 1-5) | (4) Building Recommend$_{i,b,t}$ (score 1-5) | (5) Finally Move Out$_{i,b,t+1}$ (1=YES) | (6) Finally Move Out$_{i,b,t+1}$ (1=YES) |
|---|---|---|---|---|---|---|
| Overall Satisfaction$_{i,b,t}$ | 0.321*** | | 0.471*** | | -0.194*** | |
| (score 1-5) | (0.008) | | (0.008) | | (0.014) | |
| First Component$_{i,b,t}$ | | 0.264*** | | 0.405*** | | -0.121*** |
| | | (0.018) | | (0.016) | | (0.021) |
| Second Component$_{i,b,t}$ | | -0.032** | | -0.029** | | 0.014 |
| | | (0.014) | | (0.012) | | (0.019) |
| Constant | | 3.863*** | | 4.154*** | | 0.410 |
| | | (0.464) | | (0.357) | | (1.025) |
| Control | YES | YES | YES | YES | YES | YES |
| Time*City FE | YES | YES | YES | YES | YES | YES |
| Tenant FE | YES | YES | YES | YES | NO | NO |
| Observations | 13,525 | 11,489 | 21,344 | 13,525 | 11,489 | 21,344 |
| R-squared | 0.689 | 0.776 | 0.111 | 0.689 | 0.776 | 0.111 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Column (1) has 879 buildings, Column (2) has 771 buildings, and Column (3) has 1207 buildings. The model in table A5 is the same as Equation (1). The dependent variable in column (3) is a binary variable that takes one if the tenant is no longer in the building today and zeroes otherwise. Column (3) is the fixed effects logit regression model, we didn't control for the tenant fixed effect because of too many dummy variables, and each tenant in the building only has the status of staying or had left.

might be less sensitive to their experience, but more affected by the cost-benefit trade-off considerations. It might be also difficult for the landlord to raise the rent level if the building is located in a submarket with a high vacancy rate even if their tenants are very satisfied with the buildings because the tenants have more potential choices for a new location[31].

In this section, we explore the role of market conditions on the implication of tenant satisfaction. We separate the submarket into high/low vacancy samples to examine the geographic variation of the satisfaction effect on the building performance. We take the average of the historical vacancy level of the submarkets in our sample during our research period and define the high vacancy market or low vacancy market by using the ranking of the average vacancy level[32]. For those submarkets with average vacancy rate higher than 50% percentile as high vacancy submarkets, and those submarkets with average vacancy rate lower than 50% percentile as low vacancy submarket[33].

moving-further-to-secure-the-best-office-space

[31]Office buildings in our sample are located across 506 submarkets, 374 cities, and 99 markets.

[32]Submarket vacancy is the average vacancy level of the office submarket that building is located in, for example, if the tenant in a building located in Brookfield/New Berlin submarket in county Brookfield in State Wisconsin, then we take the average of the vacancy level of this submarket for each quarter from 2009 to 2022, then we have the average vacancy level for this submarket.

[33]The ranking of submarket are relatively stable over time, see the submarket vacancy ranking table in the Appendix A6, on average, 88% those submarkets with average vacancy rate located within the top 50th percentile remain the in the high vacancy over time, similar for those low vacancy submarkets.

TABLE 8—DIFFERENT MARKET CONDITION AND THE EFFECT OF TENANT SATISFACTION

| | Tenant decision | Financial performance | | |
|---|---|---|---|---|
| | (1) Finally Move Out$_{i,b,t+1}$ (1=YES) | (2) $\Delta Log($ Rent$_{b,t+1})$ (\$/SF) | (3) $\Delta Log(Effective$ Rent$_{b,t+1})$ (\$/SF) | (4) $\Delta Log(Vacancy$ Rate$_{b,t+1}$ (%) |
| Panal A: High vacancy submarket(Top 50% percentile) | | | | |
| Overall Satisfaction$_{i,b,t}$ | -0.126*** | | | |
| (score 1-5) | (0.042) | | | |
| Log(Overall Satisfaction$_{b,t}$) | | -0.002 | 0.066* | -0.313*** |
| (score 1-5) | | (0.010) | (0.036) | (0.109) |
| Constant | -0.813 | 0.173*** | 0.406** | 1.682*** |
| | (2.784) | (0.058) | (0.168) | (0.370) |
| Lagged Level$_{b,t}$ | NO | YES | YES | YES |
| Control | YES | YES | YES | YES |
| Time*City FE | YES | YES | YES | YES |
| Observations | 12,711 | 2,278 | 2,143 | 3,034 |
| R-squared | 0.224 | 0.314 | 0.310 | 0.317 |
| Panal B: Low vacancy submarket(Bottom 50% percentile) | | | | |
| Overall Satisfaction$_{i,b,t}$ | -0.291*** | | | |
| (score 1-5) | (0.043) | | | |
| Log(Overall Satisfaction$_{b,t}$) | | 0.020 | 0.062 | -0.110 |
| (score 1-5) | | (0.015) | (0.039) | (0.117) |
| Constant | 1.040 | 0.174*** | -0.178 | 1.566*** |
| | (2.587) | (0.059) | (0.128) | (0.337) |
| Lagged Level$_{b,t}$ | NO | YES | YES | YES |
| Control | YES | YES | YES | YES |
| Time*City FE | YES | YES | YES | YES |
| Observations | 9,956 | 1,933 | 1,752 | 2,795 |
| R-squared | 0.188 | 0.223 | 0.303 | 0.306 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Panel A: Column (1) has 1,034 buildings, Column (2) has 850 buildings, Column (3) has 812 buildings, and Column (4) has 1,079 buildings. Panel B: Column (1) has 1,019 buildings, Column (2) has 759 buildings, Column (3) has 702 buildings, and Column (4) has 1,040 buildings. For panel B the explained variables are winsorized at their respective 1st and 99th percent to reduce the influence of outliers. The number of observations is different for the top 50% vacancy submarket and the Bottom 25% submarket because the concentration of properties and survey observations are not evenly distributed across cities. The regression model for column (1) is the same as Equation (1), and the regression model for Column (2) - (4) is the same as Equation (2).

Table 9 shows the results of Equations (1) and (2) after we separate our samples according to the sub-market vacancy condition that building $b$ belongs to.

Panel A is the result of the high vacancy submarket sample, Panel B is the result of the low vacancy submarket sample. Column (1) is the sensitivity of tenants' move-out status to their satisfaction level. And the coefficient of satisfaction is smaller than the main regression, which means that in those sub-market has higher vacancy rates, tenants' staying decisions will be less sensitive to their satisfaction level. This result indicates that the effect of satisfaction is playing a smaller role in their leasing decision, it could be because, in these high vacancy submarkets, the tenant has some financial constraint, so they tend to have less motivation to move out not because of their satisfaction level with the building.

Columns (2), (3), and (4) are the analysis of how the submarket vacancy level affects the financial performance's sensitivity to the satisfaction level. As shown in Columns (2), the listing rents of buildings located in high vacancy markets are not sensitive to the satisfaction level of the tenant, while Columns (3) and (4) show that the effective rents and vacancy rate are more sensitive to satisfaction in low vacancy submarkets, which indicates that the building level vacancy rate is sensitive to the tenant's opinion and reputation and it's not driven by the current tenants but the new move-in tenants.

Panel B shows a different conclusion. Column (1) shows that the coefficient of satisfaction is even bigger than the main regression, this indicates that tenants' move-out status is more sensitive to their satisfaction level in the low vacancy market. While Column (2) shows that the rent growth is more sensitive to satisfaction compared with the high vacancy market sub-sample, Column (3) - (4) shows that the building vacancy level is less sensitive compared with panel A.

These findings above indicate not only the identical effects of satisfaction on tenants and buildings across markets with different geographic heterogeneity: higher satisfaction will lead to lower move-out probability and better financial performance in different markets. But also heterogeneous reactions between individual tenant decisions and building-level averages: In a high vacancy market tenant's move-out status are less sensitive while building vacancy is more sensitive, and in a low vacancy market it's on the contrary, tenants' decision and building rents level are more sensitive while building level vacancy is not.

### *B. How Long Tenant Have Already Stayed*

Tenants have different characteristics and moving costs, so it is possible that tenants might have different sensitivity of moving out decisions to their satisfaction level and renewal intention. In general, because of giving up the satisfied leasing conditions negotiated with the landlord, or because of the high cost of changing the location of operation activities, those who have already stayed in the building for a long time might have a higher burden of moving out.

In this section, we study the interaction between tenant satisfaction and how long they already stayed when they answer the survey, which shows the variation in the satisfaction effect across different tenants. We matched the tenant survey data to the leasing contract data from the costar based on the tenant's company name and building address, which allowed us to get the move-in date for the tenant. Our matching finally has 23,784 survey data from 9,633 tenants that could identify tenants' leasing activities. For every natural year, we generate the median of years tenants have already stayed in that certain year, if the length of tenants has already stayed is higher than the median, then it was assigned to the "Stayed Long Group", otherwise it was assigned to the "Stayed Short Group". Table 9 provides a set of results:

Panel A is the result of the tenant sub-sample that has stayed for a long time. The coefficient of Column (1) in panel A is the sensitivity of renewal intention to

TABLE 9—MOVE OUT BURDEN AND MOVE OUT DECISION

| | (1) Renewal Intention$_{i,b,t}$ (score 1-5) | (2) Building Recommend$_{i,b,t}$ (score 1-5) | (3) Finally Move Out$_{i,b,t+1}$ (1=YES) |
|---|---|---|---|
| Panal A: Stayed Long Tenants(Top 50th percentile) | | | |
| $OverallSatisfaction_{i,b,t}$ | 0.307*** | 0.480*** | -0.166* |
| | (0.024) | (0.023) | (0.087) |
| Constant | 3.032** | 0.082 | 2.126 |
| | (1.475) | (1.219) | (3.781) |
| Control | YES | YES | YES |
| Time*City FE | YES | YES | YES |
| Tenant FE | YES | YES | NO |
| Observations | 6,466 | 4,713 | 1,907 |
| R-squared | 0.582 | 0.692 | 0.197 |
| Panal B: Stayed Short Tenants(Bottom 50th percentile) | | | |
| $OverallSatisfaction_{i,b,t}$ | 0.307*** | 0.504*** | -0.207** |
| | (0.033) | (0.039) | (0.093) |
| Constant | 1.332 | 0.825 | 2.094 |
| | (1.233) | (0.860) | (3.239) |
| Control | YES | YES | YES |
| Time*City FE | YES | YES | YES |
| Tenant FE | YES | YES | NO |
| Observations | 4,098 | 2,696 | 1,762 |
| R-squared | 0.660 | 0.741 | 0.197 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Panel A: Column (1) has 799 buildings, Column (2) has 615 buildings, and Column (3) has 598 buildings. Panel B: Column (1) has 760 buildings, Column (2) has 542 buildings, and Column (3) has 651 buildings. The regression model for columns (1) - (3) is all from Equation (1). The difference in observations between panel A and panel B is because of the tenant's asymmetry missing valid data for the survey response, which will lead to the observations dropping in the regression, and also the time-city fixed effects will drop those samples with only one tenant observations in a specific city in a certain year. For the analysis of Column (3) in both panel A and panel B we only preserve the last response from the tenant.

the satisfaction level of the stayed long tenant group, 1 point higher overall satisfaction is correlated to 0.307 points higher renewal intention, which is similar to the results in panel B.

The specifications in column (2) examine the impact on building recommendations. The coefficient of satisfaction in panel A is 0.48, while the coefficient of panel B is 0.50, which means how long the tenant has already stayed in the building will affect their decision's sensitivity to their satisfaction level, and the satisfaction effect for those "Stayed long group" are lower than those who stayed short.

Columns (3) analyzed the impact of tenant satisfaction on the final move-out status while considering how long the tenant has already stayed. Consistent with the findings of column (1), the magnitude of the coefficient of panel B is much bigger. These results indicate that improving the satisfaction level of those "new" tenants would be more economically beneficial, tenant has stayed a long time in the office building they are in will improve their "stickiness" to their

office, which will make whether they are moving out less sensitive to their experience.

## VII. What Can We Do to Improve Tenant Satisfaction?

Previous analyses have provided evidence of the importance of tenant satisfaction, and the heterogeneity effect of satisfaction. In this section, we try to investigate the implication of our findings: how can we improve tenant satisfaction and the financial performance of the building?

The "fixed" attributes of the building cannot be changed, physical characteristics such as the location, number of floors, or the main structural framework. But there are certain things of the building we could change with some capital input, such as the interior decoration, the facilities, and the amenities, all of which could affect the indoor environmental quality. Or some attributes are even easier to change without having a big influence on the operation routine of the building, such as replacing the property management company and other building operating services groups. Thus although the building owner has nothing much to do if tenants are not satisfied with the structural and location problem of the building, they could make some improvements if the tenants are not satisfied with characteristics that could be modified.

Better property management companies could give tenants a better experience. The research by Sirmans and Sirmans (1992) already proves that buildings that are managed by property management companies have at least one designation that would be capitalized into a 19$ higher each month for each apartment unit. Thus we can reasonably assume that better property management companies will improve tenants' overall satisfaction level with their experience with the building.

Because indoor environmental quality is difficult to measure and compare with each other. The green certificate provides us with the specification to distinguish the building from a good or bad indoor environment. As a prevailing trend in the U.S. commercial building market, the cost of getting a sustainability certificate is relatively small compared with the rental rate of the building, but the green certificate brought a significant premium for the building in terms of rent and sales price(Eichholtz, Kok and Quigley, 2010). Thus if the building is qualified to get a green certificate the landlord will have the incentive to apply for it. It is reasonable to assume that those existing properties with green certificates always have a better interior environment than those without, green certificates are good labels to distinguish properties with different indoor environmental qualities. In this section, we take the LEED[34] and WELL[35] certificates as the measure of the green attribute, which all have criteria for the building's indoor environmental conditions that will benefit the occupant inside the build-

[34]https://www.usgbc.org/leed-tools/scorecard
[35]https://v2.wellcertified.com/en/wellv2/overview

ing, and investigate whether by changing the interior facilities and amenities of the building.

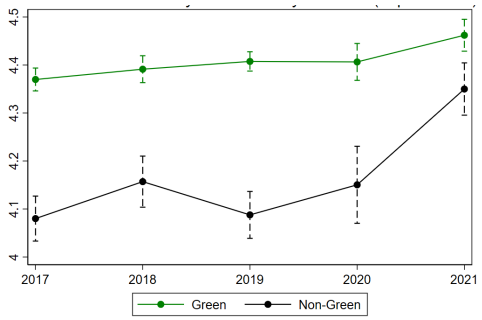



FIGURE 5. TIME TREND OF SATISFACTION BY SUSTAINABILITY

*Note:* Satisfaction is the arithmetic average of overall satisfaction for all observations. Dash lines are the 95% confidence interval.

Evidence has shown that better indoor environmental quality is related to better tenant experience and a higher probability of lease renewal(Zhang and Tu, 2021). Our data also support this conclusion, as shown in Figure 5, tenants' overall satisfaction with green buildings is always higher than those of non-green buildings, even after the outbreak covid-19 green building also shows resilience and an upward trend. This indicates that a green certificate could be a reasonable measurement of a better indoor environment.

In this section, we try to investigate the implication of improving these flexible attributes of the building on tenant satisfaction: The property management company and the indoor environmental quality of the building. The models for this section are specified as follows:

$$(3) \quad Log(Satisfaction_{b,t}) = \alpha + \beta Green_{b,t}/GMgmt_{b,t} + \gamma X_b + \mu_t * \lambda_c + \varepsilon_{b,t}$$

$$(4) \quad \Delta Log(Performance_{b,t+1,t}) = \alpha + \beta Green_{b,t}/GMgmt_{b,t} + \theta LaggedLevel_{b,t} + \gamma X_b + \mu_t * \lambda_c + \varepsilon_{b,t}$$

$$(5) \quad \begin{aligned} \Delta Log(Performance_{b,t+1,t}) =& \alpha + \delta Log(Satisfaction_{b,t}) + \beta Green_{b,t}/GMgmt_{b,t} + \\ & \theta LaggedLevel_{b,t} + \gamma X_b + \mu_t * \lambda_c + \varepsilon_{b,t} \end{aligned}$$

Equation (3) try to analyze whether the property management quality and the indoor environment have some influence on tenant satisfaction. Equation (4) investigates whether property management quality and the indoor environment affect the tenant's decision and building performance. Equation (5) try to study

how overall satisfaction mitigates the effect of property management quality and the indoor environment.

$GoodMgmt_{b,t}$ is a dummy variable specified whether the property management group of building $b$ in year $t$(The year tenant answers the survey) is a good one. $GoodMgmt_{b,t}$ equals 1 means it's a good quality property management company, and 0 otherwise[36]. We define a good property management group as those property management companies that have a score of "satisfaction with the property management quality" higher than the medium of our sample[37][38].

$Green_{b,t}$ is a dummy variable specified whether building $b$ is certified as green in year $t$(The year tenant answers the survey). $Green_{b,t}$ equals 1 means it's a green building, and 0 otherwise.

The control variables are the same in Equation (2), including all the observable building characteristics, cross term of time and city fixed effects, and tenant fixed effects.

Table 11 shows the regression results. Panel A is the result of better property management, and panel B is the effect of the green certificate. Column (1) investigates whether a good property management company and the green certificate affect the satisfaction level of the building. Columns (2), (5), and (8) are the same as the results of Table 3. Columns (2) - (4) investigate the effect on gross rents, Columns (5) - (7) investigate the influence on effective rents, and Column (8) - (10) investigate vacancy rates.

In panel A, Column (1) indicates that after controlling the building characteristics, and the interaction term of time and city fixed effects, the overall satisfaction level of a good property management company will be 4.10% higher,

[36]We assume the allocation of good and bad management are random across buildings. If this assumption was violated we might attribute the satisfaction improvement effect to better property management wrongly, which should be systematically different between buildings

[37]We calculate the average score of the satisfaction of the individual answer about the property management company, that is the arithmetic average of the satisfaction score with property management from all the tenant in all the building this specific property management company is managing during our research sample, for example, the average score of tenant's satisfaction level with property management company CBRE is the arithmetic of the answer "Please rate your satisfaction level with the property management company" from all the tenant of all the building that CBRE managed during 2009 to 2022 in our sample, and if the building change property management company, then only the period a certain property management company that is managing the building would the answer be part of the component of the average score. We can track the date when there is a change in the property management firm associated with a building using the Costar database, the Costar database records the historical changes of the property management company of the building, including the change date, previous property management firm, and new property management firm. If the change is happen during the first half of the year, then we take the new property management firm as the property management of that year, if the change happens in the second half of the year, then we take the previous property management firm as the property management company of that year. Then we take the property management company samples that are located at the upper 50% as a good property management firm, and the lower 50% as a bad property management firm.

[38]There is no problem with certain companies managing just only a certain quality type of buildings, tenants live in different quality buildings with different property management companies because they will accommodate the environment they are in they still give a high score to the building, then the property management only affect performance but not satisfaction, then the measurement of good/bad property management groups based on the survey data might be biased. For each property management company, the buildings they manage are across different rents level and building classes, and for different rent levels, there are high satisfaction level property management companies and low satisfaction ones. Thus the allocation of satisfaction should be more likely to base on the service quality itself, not just the building quality.

and for buildings with the green certificate the satisfaction level would be 1.80% higher. Column (2) is the same as the results in table 3. Column (3) shows that the rent growth of buildings will be 0.1% higher for buildings with good property management companies. The results of Column (4) show that after we add the satisfaction variable into the regression, the coefficient of the satisfaction is positive, but the magnitude is a little bit smaller than the coefficient of column (2), which means that satisfaction partially mediates the effect of better property management on rents.

This conclusion also holds for the effective rents as shown in Columns (5) to (7), and vacancy rate shown in Columns (8) and (10). The direction of the coefficient of satisfaction is consistent with the findings of table 3, but the magnitude of the coefficient is smaller. Our findings are consistent with those from Zhang et al. (2020), which also find the mediation effect of customer satisfaction on the rents premium of green-certified buildings in the hotel industry, and similar to that of Luo and Bhattacharya (2006), which proves that customer satisfaction is a mediator between a company's policy and the company's performance.

The findings of the effect of sustainability are similar in panel B. Column (1) indicates that the satisfaction level in green-certified buildings is 1.9% higher than those of non-green buildings. And the results of satisfaction on rents, effective rents, and vacancy rate are similar to those in panel A: both the coefficient of satisfaction and the coefficient of the green certificate are smaller, which means that satisfaction partially mediates the effect of the green certificate on the financial performance of the building.

## VIII. Conclusion

The outbreak of Covid-19 has aroused people's attention to the impact of what the tenants are thinking because companies are adapting to the work-from-home trend and shrinking their demand for office space. But there is still a lack of evidence of what and how severe the impact will be. Although customer satisfaction has gained much attention from practitioners and scholars and has proven to be a leading indicator of client demand and purchasing decisions, how important the role of satisfaction is playing in the real estate sector is not clear.

Using a large data set of 108,627 tenant surveys from 2,965 office properties in the U.S., matched with the building characteristics, rents, and vacancy data from the costar group, we quantified the financial implication of tenant satisfaction on the performance of the commercial real estate sector. The findings of the hedonic models show that more satisfied tenant is positively related to both their self-reported leasing decision and actual staying status. Further analysis found that those properties with higher tenant satisfaction levels indeed enjoyed stronger growth of rental rate and occupancy rate. The analysis of using leasing contracts to measure achieve rents shows a bigger positive effect from tenant satisfaction, and analysis of the marginal effect found that for those properties or tenants who have lower original satisfaction levels, the beneficial effect of their satisfaction

level improvement is even larger. And this conclusion is robust when we use PCA to construct different satisfaction measurements, and when we control for the building fixed effects. In the heterogeneity analysis, we document that tenant satisfaction level is more valuable for properties that are located in areas with higher vacancy rates when tenants already stay in the building for a long time.

We found that the variation in tenant satisfaction is coming from the different property management quality, and different indoor environmental quality, we could improve the tenant satisfaction level by improving the services and facilities of the building, and eventually the better performance of the building.

But our study has several limitations. Firstly, our research samples are mainly prime office buildings in the U.S., which means that our conclusion might only apply to high-end office buildings. Secondly, our survey data is unbalanced panel data, with only a small proportion of our data with consecutive observations across time, which lead to the dropping of a large number of observations after adding more fixed effects and having limited observations in our financial performance analysis using the dynamic panel model.

The findings uncovered through this analysis carry significant income implications for the client-centered property management strategy, which means that real estate investors should see the return on any investment in their customer experience. Our findings also provide evidence of the economic benefits of encouraging institutional investors to participate in ESG programs, such as green investment, which will not only benefit the building performance itself and also have an externality of promoting sustainable processes in the real estate sector.

TABLE 10—WHAT CAN WE DO TO IMPROVE TENANT SATISFACTION

| | Log(Average Overall Satisfaction$_{b,t}$) | $\Delta Log(Rent_{b,t+1,t})$ (\$/SF) | | | $\Delta Log(Effective$ Rent$_{b,t+1,t})(\$/SF)$ | | | $\Delta Log(Vacancy$ Rate$_{b,t+1,t})(\%)$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Panel A: Better Property Management Team | | | | | | | | | | |
| $Log(AverageOverall$ | | 0.017* | | 0.017* | 0.070** | | 0.068** | -0.321*** | | -0.307*** |
| $Satisfaction_{b,t})$ | | (0.009) | | (0.009) | (0.028) | | (0.029) | (0.095) | | (0.097) |
| $GoodMgmt_{b,t}$ | 0.041*** | | 0.001 | 0.001 | | 0.006 | 0.003 | | -0.033 | -0.019 |
| (YES=1) | (0.004) | | (0.002) | (0.002) | | (0.006) | (0.006) | | (0.023) | (0.024) |
| Constant | 1.165*** | 0.163*** | 0.183*** | 0.164*** | -0.062 | 0.018 | -0.059 | 1.798*** | 1.409*** | 1.785*** |
| | (0.049) | (0.042) | (0.042) | (0.042) | (0.107) | (0.104) | (0.108) | (0.302) | (0.276) | (0.304) |
| Lagged Level$_{b,t}$ | NO | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Control | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Time*City FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Observations | 8,374 | 3,962 | 3,962 | 3,962 | 3,659 | 3,659 | 3,659 | 3,944 | 3,944 | 3,944 |
| R-squared | 0.255 | 0.239 | 0.238 | 0.239 | 0.271 | 0.269 | 0.271 | 0.322 | 0.320 | 0.322 |
| Panel B: Incorporate Sustainability Attribute | | | | | | | | | | |
| $Log(AverageOverall$ | | 0.017* | | 0.015* | 0.070** | | 0.066** | -0.321*** | | -0.316*** |
| $Satisfaction_{b,t})$ | | (0.009) | | (0.009) | (0.028) | | (0.029) | (0.095) | | (0.095) |
| $Green_{b,t}$ | 0.019*** | | 0.008*** | 0.008*** | | 0.014** | 0.013** | | -0.025 | -0.019 |
| (YES=1) | (0.004) | | (0.003) | (0.003) | | (0.006) | (0.006) | | (0.024) | (0.024) |
| Constant | 1.190*** | 0.163*** | 0.195*** | 0.178*** | -0.062 | 0.039 | -0.038 | 1.798*** | 1.378*** | 1.774*** |
| | (0.049) | (0.042) | (0.041) | (0.042) | (0.107) | (0.104) | (0.108) | (0.302) | (0.274) | (0.305) |
| Lagged Level$_{b,t}$ | NO | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Control | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Time*City FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Observations | 8,374 | 3,962 | 3,962 | 3,962 | 3,659 | 3,659 | 3,659 | 3,944 | 3,944 | 3,944 |
| R-squared | 0.240 | 0.239 | 0.240 | 0.241 | 0.271 | 0.270 | 0.272 | 0.322 | 0.320 | 0.322 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Panel A: Column (1) has 2,771 buildings, Column (2)-(4) has 1,500 buildings, Column (5)-(7) has 1,409 buildings, and Column (8)-(10) has 1,508 buildings. Panel B: Column (1) has 2,771 buildings, Column (2)-(4) has 1,500 buildings, Column (5)-(7) has 1,409 buildings, and Column (8)-(10) has 1,508 buildings. The explained variables of rent growth, effective rent growth, and vacancy growth are winsorized at their respective 1st and 99th percent to reduce the influence of outliers. The model of columns (2) (5) and (8) are Equation (3). The model of columns (3) (6) and (9) are Equation (4). The model of columns (4) (7) and (10) are in Equation (5). The control variables included building class, building size, building age, building height, and whether experienced a renovation. The coefficient and number of observations of columns (2) (5) and (8) are slightly different from table 3, that is because we only preserve those observations with valid values for all the variables in the three-step mediation model.

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# APPENDIX

## *A1. Full Table of Main Regression*

TABLE A1—TENANT SATISFACTION AND TENANT DECISION

| | Renewal Intention$_{i,b,t}$ (score 1-5) | | | Building Recommend$_{i,b,t}$ (score 1-5) | | | Finally Move Out$_{i,b,t+1}$ (1=YES) | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Overall Satisfaction$_{i,b,t}$ | 0.427*** | 0.428*** | 0.333*** | 0.598*** | 0.593*** | 0.492*** | -0.230*** | -0.180*** |
| (Score 1-5) | (0.005) | (0.005) | (0.007) | (0.005) | (0.005) | (0.007) | (0.015) | (0.031) |
| Building Class: | | | | | | | | |
| Class A$_b$ | -0.135*** | -0.095** | 0.068 | 0.013 | 0.019 | -0.002 | 0.320 | 0.456 |
| (YES=1) | (0.046) | (0.047) | (0.081) | (0.034) | (0.037) | (0.055) | (0.293) | (0.628) |
| Class B$_b$ | -0.115** | -0.090* | 0.022 | -0.039 | -0.014 | -0.045 | 0.319 | 0.674 |
| (YES=1) | (0.046) | (0.046) | (0.080) | (0.033) | (0.036) | (0.053) | (0.290) | (0.603) |
| Construction Year: | | | | | | | | |
| 1970_1980$_b$ | 0.021 | 0.008 | -0.015 | -0.019 | -0.032** | -0.045 | -0.077 | -0.054 |
| (YES=1) | (0.019) | (0.020) | (0.031) | (0.014) | (0.016) | (0.027) | (0.109) | (0.296) |
| 1980_1990$_b$ | 0.001 | -0.003 | 0.025 | 0.008 | 0.003 | -0.004 | -0.278*** | -0.742** |
| (YES=1) | (0.017) | (0.019) | (0.031) | (0.012) | (0.015) | (0.026) | (0.097) | (0.301) |
| 1990_2000$_b$ | -0.024 | -0.029 | 0.025 | 0.050*** | 0.037** | -0.000 | -0.407*** | -0.292 |
| (YES=1) | (0.020) | (0.021) | (0.035) | (0.014) | (0.016) | (0.028) | (0.115) | (0.343) |
| After 2000$_b$ | -0.011 | -0.008 | 0.037 | 0.050*** | 0.047*** | 0.029 | -0.418*** | -0.305 |
| (YES=1) | (0.021) | (0.023) | (0.035) | (0.014) | (0.017) | (0.028) | (0.116) | (0.344) |
| Stories: | | | | | | | | |
| High$_b$ | 0.000 | -0.016 | -0.021 | 0.028*** | 0.030** | 0.026 | 0.181*** | -0.055 |
| (YES=1) | (0.013) | (0.017) | (0.035) | (0.010) | (0.015) | (0.030) | (0.067) | (0.260) |
| Medium$_b$ | 0.011 | 0.003 | 0.006 | -0.008 | -0.005 | 0.004 | 0.146** | -0.026 |
| (YES=1) | (0.013) | (0.015) | (0.021) | (0.010) | (0.012) | (0.018) | (0.065) | (0.203) |
| Renovated$_{b,t}$ | 0.006 | 0.011 | 0.033** | 0.031*** | 0.015 | 0.002 | -0.355*** | -0.438** |
| (YES=1) | (0.012) | (0.012) | (0.017) | (0.010) | (0.010) | (0.014) | (0.072) | (0.206) |
| Log(Typical floor size$_b$) | 0.000 | 0.019 | 0.021 | 0.032*** | 0.040*** | 0.049*** | 0.047 | -0.014 |
| (SF) | (0.011) | (0.012) | (0.020) | (0.008) | (0.009) | (0.016) | (0.057) | (0.180) |
| Amenities$_b$ | 0.024* | 0.020 | 0.035* | 0.013 | 0.015 | -0.005 | 0.186*** | 0.634*** |
| (YES=1) | (0.013) | (0.014) | (0.020) | (0.009) | (0.010) | (0.017) | (0.065) | (0.216) |
| Constant | 2.075*** | 1.858*** | 2.067*** | 1.321*** | 1.253*** | 1.666*** | 0.177 | 2.245 |
| | (0.116) | (0.125) | (0.220) | (0.086) | (0.094) | (0.163) | (0.608) | (2.224) |
| Time * City FE | NO | YES | YES | NO | YES | YES | NO | YES |
| Tenant FE | NO | NO | YES | NO | NO | YES | NO | NO |
| Observations | 85,198 | 85,094 | 70,921 | 61,781 | 61,709 | 49,968 | 54,321 | 21,851 |
| R-squared | 0.124 | 0.157 | 0.553 | 0.373 | 0.393 | 0.670 | 0.013 | 0.227 |

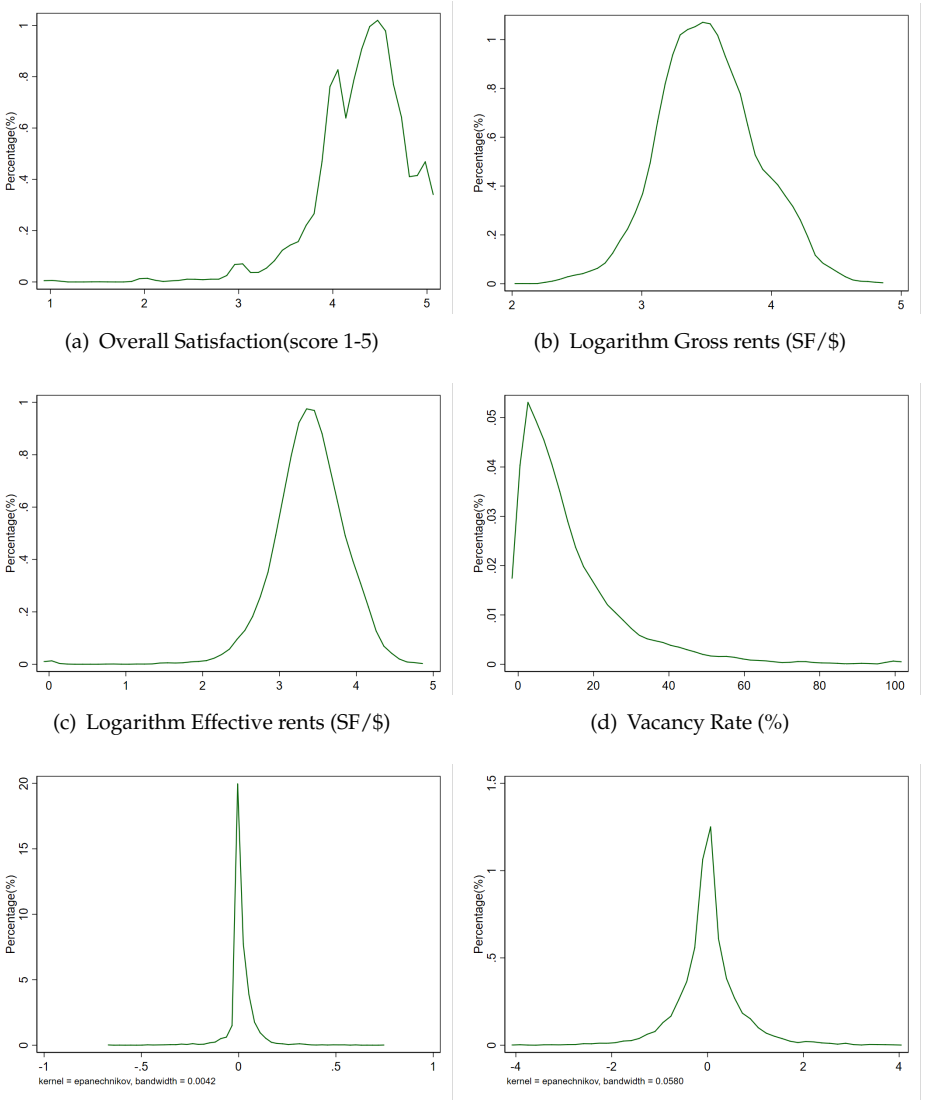
*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Column (1) has 2,854 buildings, Column (2) has 2,819 buildings, Column (3) has 2,490 buildings, Column (4) has 2,183 buildings, Column (5) has 2,160 buildings, Column (6) has 1,944 buildings, Column (7) has 2,937 buildings, Column (8) has 1,930 buildings. The dependent variable in columns (8)-(9) is a binary variable that takes one if the tenant is no longer in the building today and zeroes otherwise. Column (8)-(9) is the fixed effects logit regression model, we didn't control for the tenant fixed effect because most of the tenants who have no subsidies only have either status of staying($MoveOut_{i,b}$=0) or had left($MoveOut_{i,b}$=1). For the logit regression, we only preserve the last survey the tenant filled out to avoid over-represent by those tenants who have filled out more surveys, and the opinion of the tenant about the building is closer to their final staying status in terms of the time point. We didn't control for the tenant fixed effects because tenants who have no subsidies, one tenant only has either status of staying or had left, control for tenant fixed effects will delete all the tenants that have no subsidies. The results of keeping all the tenant's responses are similar in terms of coefficient significance level and magnitude. For the tenant fixed effect, if the tenant has subsidies in different buildings, we regard it as the same tenant in the grouping.

TABLE A2—TENANT SATISFACTION AND BUILDING FINANCIAL PERFORMANCE

| | $\Delta Log(Rent_{b,t+1,t})$ ($/SF) | | | $\Delta Log(EffectiveRent_{b,t+1,t})$ ($/SF) | | | $\Delta Log(VacancyRate_{b,t+1,t})$ (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Log(Average Overall Satisfaction$_{b,t}$) | 0.005 | 0.006 | 0.017* | 0.065*** | 0.056** | 0.069** | -0.290*** | -0.243*** | -0.232*** |
| (Score 1-5) | (0.007) | (0.007) | (0.009) | (0.024) | (0.025) | (0.028) | (0.065) | (0.067) | (0.080) |
| Lagged Level: | | | | | | | | | |
| Log(Rent$_{b,t}$) | -0.014*** | -0.016*** | -0.054*** | -0.007 | -0.014* | -0.051*** | | | |
| ($/SF) | (0.003) | (0.003) | (0.008) | (0.007) | (0.007) | (0.015) | | | |
| Log(Vacancy Rate$_{b,t}$) | | | | 0.030*** | 0.031*** | 0.037*** | -0.225*** | -0.237*** | -0.268*** |
| (%) | | | | (0.003) | (0.003) | (0.003) | (0.009) | (0.009) | (0.012) |
| Building Class: | | | | | | | | | |
| Building Class A$_b$ | | -0.003 | 0.015 | | -0.005 | 0.006 | | -0.098 | -0.046 |
| (YES=1) | | (0.011) | (0.017) | | (0.038) | (0.054) | | (0.082) | (0.108) |
| Building Class B$_b$ | | -0.002 | 0.012 | | -0.018 | -0.003 | | -0.036 | -0.019 |
| (YES=1) | | (0.011) | (0.018) | | (0.038) | (0.056) | | (0.082) | (0.107) |
| Construction Year: | | | | | | | | | |
| 1970_1980$_b$ | | 0.000 | -0.000 | | 0.004 | 0.013 | | 0.052* | -0.028 |
| (YES=1) | | (0.005) | (0.005) | | (0.011) | (0.012) | | (0.030) | (0.033) |
| 1980_1990$_b$ | | -0.006 | -0.007 | | -0.005 | 0.005 | | 0.065** | -0.031 |
| (YES=1) | | (0.004) | (0.005) | | (0.009) | (0.011) | | (0.025) | (0.030) |
| 1990_2000$_b$ | | -0.008 | -0.005 | | -0.005 | 0.004 | | 0.057* | -0.048 |
| (YES=1) | | (0.005) | (0.006) | | (0.010) | (0.013) | | (0.032) | (0.038) |
| After 2000$_b$ | | -0.008* | -0.003 | | 0.003 | 0.020* | | -0.010 | -0.158*** |
| (YES=1) | | (0.005) | (0.006) | | (0.011) | (0.012) | | (0.032) | (0.039) |
| Stories: | | | | | | | | | |
| High$_b$ | | 0.003 | 0.008* | | 0.008 | 0.013 | | -0.080*** | -0.009 |
| (YES=1) | | (0.003) | (0.005) | | (0.006) | (0.009) | | (0.022) | (0.031) |
| Medium$_b$ | | 0.002 | 0.004 | | 0.007 | 0.008 | | -0.028 | -0.006 |
| (YES=1) | | (0.002) | (0.003) | | (0.006) | (0.008) | | (0.021) | (0.027) |
| Renovated$_{b,t}$ | | -0.003 | 0.003 | | 0.008 | 0.022*** | | -0.030* | -0.060*** |
| (YES=1) | | (0.002) | (0.003) | | (0.005) | (0.006) | | (0.018) | (0.020) |
| Log(Typical Floor Size)$_b$ | | -0.000 | 0.001 | | -0.003 | 0.004 | | -0.029* | -0.048** |
| (SF) | | (0.002) | (0.003) | | (0.005) | (0.007) | | (0.017) | (0.021) |
| Amenities$_b$ | | 0.004* | 0.003 | | 0.003 | 0.006 | | 0.076*** | 0.048* |
| (YES=1) | | (0.002) | (0.003) | | (0.006) | (0.008) | | (0.021) | (0.025) |
| Constant | 0.060*** | 0.070*** | 0.161*** | -0.131*** | -0.061 | -0.066 | 0.970*** | 1.255*** | 1.552*** |
| | (0.014) | (0.026) | (0.042) | (0.042) | (0.071) | (0.106) | (0.101) | (0.202) | (0.251) |
| Time * City FE | NO | NO | YES | NO | NO | YES | NO | NO | YES |
| Observations | 4,570 | 4,570 | 3,962 | 4,225 | 4,225 | 3,659 | 6,134 | 6,134 | 5,467 |
| R-squared | 0.007 | 0.011 | 0.238 | 0.040 | 0.045 | 0.270 | 0.119 | 0.127 | 0.288 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Column (1) has 1,672 buildings, Column (2) have 1,672 buildings, Column (3) has 1,500 buildings, Column (4) has 1,573 buildings, Column (5) has 1,573 buildings, Column (6) has 1,409 buildings, and Column (7) has 2,134 buildings, and Column (8) has 2,134 buildings, and Column (9) has 1,963 buildings. Explained variables are winsorized at their respective 1st and 99th percentiles to reduce the influence of outliers.

## *A2. Density distribution of Main Research Variables*




(a) Overall Satisfaction(score 1-5)

(b) Logarithm Gross rents (SF/$)

(c) Logarithm Effective rents (SF/$)

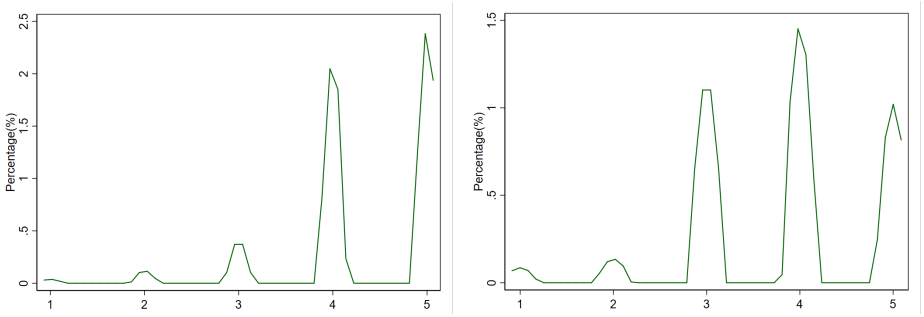
(d) Vacancy Rate (%)

(e) Logarithm Rents Growth (%)

(f) Logarithm Vacancy Growth (%)

FIGURE A1. DENSITY DISTRIBUTION OF MAIN RESEARCH VARIABLES(BUILDING LEVEL)

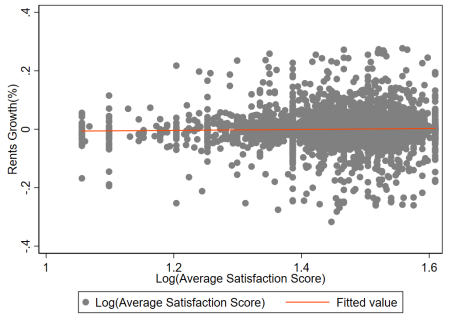
*Note:* Satisfaction, Renewal intention, Vacancy rate, Gross rent, and Effective rents are the arithmetic average. In this section, the statistics of the Vacancy rate, Gross rent, and Effective rents are only the observations of those properties in years that have survey responses.



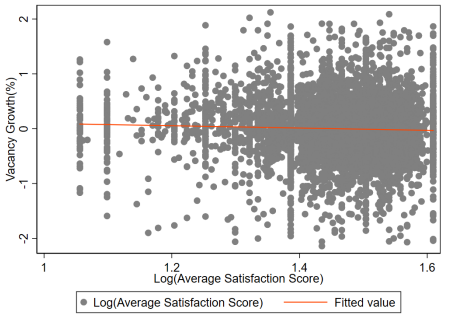

(a) Overall Satisfaction(score 1-5) (b) Renewal Intention(score 1-5)

FIGURE A2. DENSITY DISTRIBUTION MAIN RESEARCH VARIABLES(TENANT LEVEL)

## *A3. Scatter Plot of Residual of main research variables and satisfaction*

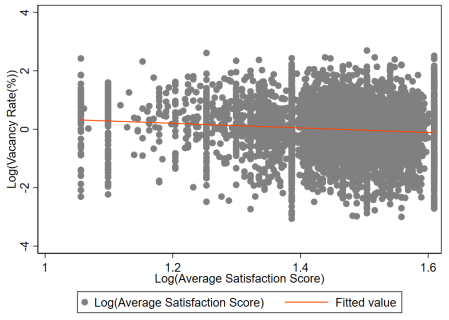



(a) Rents Growth Residual and Satisfaction




(b) Vacancy Growth Residual and Satisfaction


(c) Rents Residual of and Satisfaction




(d) Vacancy Rate Residual and Satisfaction

*Note:* For Figures (a) and (b), the residual of the Y axis is from regressing the explained variables with a vector of building characteristics control variables, current financial performance, and interaction of time and city fixed effects, the X axis is the logarithm of building level average overall satisfaction. For Figures (c) and (d), the residual is from regressing the explained variables with a vector of building characteristics control variables, and interaction of time and city fixed effects, the X axis is the logarithm of building level average overall satisfaction.

## *A4. Satisfaction's Rent Effects and Vacancy Effects*

TABLE A3—TENANT SATISFACTION AND BUILDING FINANCIAL PERFORMANCE

| | (1) | (2) | (3) |
|---|---|---|---|
| | Log(Rent$_{b,t}$) | Log(Effective Rent$_{b,t}$) | Log(Vacancy Rate$_{b,t}$) |
| | ($/SF) | ($/SF) | (%) |
| Log(Average Overall Satisfaction$_{b,t}$) | 0.096** | 0.327*** | -1.061*** |
| (Score 1-5) | (0.047) | (0.080) | (0.192) |
| Building Class: | | | |
| Class A$_b$ | 0.095 | 0.188 | 0.326 |
| (YES=1) | (0.090) | (0.248) | (0.290) |
| Class B$_b$ | -0.012 | 0.051 | 0.414 |
| (YES=1) | (0.090) | (0.250) | (0.289) |
| Construction Year: | | | |
| 1970_1980$_b$ | -0.014 | -0.016 | -0.048 |
| (YES=1) | (0.029) | (0.038) | (0.080) |
| 1980_1990$_b$ | -0.026 | -0.012 | -0.026 |
| (YES=1) | (0.027) | (0.035) | (0.075) |
| 1990_2000$_b$ | 0.046 | 0.063 | -0.112 |
| (YES=1) | (0.031) | (0.040) | (0.097) |
| After 2000$_b$ | 0.099*** | 0.130*** | -0.428*** |
| (YES=1) | (0.030) | (0.041) | (0.092) |
| Stories: | | | |
| High$_b$ | 0.142*** | 0.182*** | -0.070 |
| (YES=1) | (0.022) | (0.030) | (0.072) |
| Medium$_b$ | 0.071*** | 0.112*** | -0.093 |
| (YES=1) | (0.017) | (0.024) | (0.060) |
| Renovated$_{b,t}$ | 0.024 | 0.032 | -0.030 |
| (YES=1) | (0.015) | (0.022) | (0.049) |
| Log(Typical Floor Size)$_b$ | -0.015 | 0.018 | -0.151*** |
| (YES=1) | (0.015) | (0.020) | (0.049) |
| Amenities$_b$ | 0.018 | 0.013 | 0.099* |
| (YES=1) | (0.016) | (0.024) | (0.051) |
| Constant | 3.399*** | 2.471*** | 5.058*** |
| | (0.180) | (0.329) | (0.567) |
| Time*City FE | YES | YES | YES |
| Observations | 4,367 | 4,128 | 5,801 |
| R-squared | 0.775 | 0.636 | 0.291 |

*Note:* Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Column (1) has 1,635 buildings, Column (2) has 1,570 buildings, and Column (3) has 2,059 buildings. Explained variables and main explanatory variables are winsorized at their respective 1st and 99th percentiles to reduce the influence of outliers.

## *A5. Satisfaction sub-component analysis and summary statistics*

TABLE A4—SATISFACTION SUB-COMPONENT ANALYSIS AND SUMMARY STATISTICS

| Panal A: Principal component (PC) loadings | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | Comp1 | Comp2 | Comp3 | Comp4 | Comp5 | Comp6 | Comp7 | Comp8 | Comp9 | Comp10 | Comp11 | Comp12 | Comp13 | Comp14 | Comp15 | Comp16 | Comp17 | Comp18 | Comp19 | Comp20 | |
| Management: | | | | | | | | | | | | | | | | | | | | | |
| Statement Accuracy | 0.20 | -0.07 | 0.06 | 0.20 | 0.32 | 0.10 | -0.88 | -0.13 | -0.07 | 0.05 | 0.06 | 0.00 | -0.02 | 0.01 | 0.03 | 0.00 | 0.01 | -0.02 | -0.02 | 0.01 | |
| Accessibility | 0.24 | -0.27 | 0.09 | 0.06 | -0.06 | -0.05 | 0.05 | -0.06 | 0.06 | -0.06 | -0.08 | 0.69 | 0.50 | -0.24 | 0.00 | 0.06 | 0.06 | -0.10 | 0.19 | -0.01 | |
| Special Needs | 0.24 | -0.28 | 0.05 | 0.10 | -0.07 | -0.06 | 0.08 | 0.03 | -0.04 | 0.06 | -0.01 | -0.44 | 0.45 | -0.02 | 0.55 | 0.07 | -0.10 | 0.17 | -0.29 | 0.04 | |
| Communication | 0.25 | -0.30 | 0.04 | 0.07 | -0.07 | -0.05 | 0.04 | -0.02 | -0.04 | 0.00 | -0.02 | -0.02 | -0.03 | 0.09 | -0.56 | -0.18 | -0.07 | 0.67 | -0.14 | -0.05 | |
| Problem Solving | 0.25 | -0.28 | 0.02 | 0.12 | -0.07 | -0.03 | 0.07 | 0.03 | -0.07 | 0.05 | 0.10 | -0.46 | 0.05 | 0.02 | -0.27 | -0.01 | 0.00 | -0.36 | 0.63 | -0.07 | |
| Professionalism | 0.23 | -0.31 | 0.15 | 0.07 | -0.10 | -0.11 | 0.07 | 0.01 | 0.08 | -0.02 | -0.02 | 0.21 | -0.64 | 0.15 | 0.47 | 0.09 | 0.04 | 0.16 | 0.24 | -0.07 | |
| Responsiveness | 0.24 | -0.33 | 0.04 | 0.04 | -0.08 | 0.04 | 0.09 | 0.01 | 0.03 | 0.01 | -0.01 | 0.05 | -0.23 | 0.06 | -0.20 | -0.07 | 0.07 | -0.56 | -0.60 | 0.15 | |
| Building Quality: | | | | | | | | | | | | | | | | | | | | | |
| Amenities | 0.22 | 0.17 | 0.15 | -0.21 | 0.14 | -0.03 | 0.10 | 0.06 | -0.75 | 0.12 | -0.16 | 0.14 | 0.08 | 0.43 | 0.05 | -0.07 | 0.03 | -0.05 | 0.02 | 0.02 | |
| Location | 0.17 | 0.10 | 0.47 | -0.24 | 0.62 | -0.05 | 0.24 | -0.23 | 0.39 | 0.06 | 0.13 | -0.07 | 0.05 | 0.09 | -0.03 | -0.03 | 0.01 | 0.00 | 0.00 | -0.01 | |
| Quality | 0.25 | 0.17 | 0.18 | -0.11 | 0.06 | -0.01 | 0.07 | 0.05 | -0.34 | -0.07 | 0.04 | -0.10 | -0.24 | -0.80 | -0.03 | 0.11 | -0.02 | 0.06 | -0.05 | 0.04 | |
| Elevator Appearance | 0.24 | 0.25 | -0.07 | 0.03 | -0.24 | 0.07 | 0.01 | -0.37 | 0.07 | -0.04 | -0.04 | -0.05 | 0.00 | -0.07 | 0.16 | -0.73 | 0.32 | -0.01 | 0.04 | -0.04 | |
| Elevator Performance | 0.21 | 0.22 | -0.18 | 0.22 | -0.10 | 0.11 | 0.13 | -0.68 | -0.06 | -0.24 | 0.00 | -0.02 | -0.03 | 0.14 | -0.06 | 0.45 | -0.20 | 0.00 | -0.04 | 0.02 | |
| Commom Area | 0.25 | 0.21 | 0.15 | -0.22 | -0.29 | 0.02 | -0.15 | 0.21 | 0.13 | -0.20 | 0.11 | -0.01 | 0.06 | 0.10 | -0.04 | 0.11 | -0.07 | -0.08 | -0.13 | -0.74 | |
| Restroom | 0.22 | 0.22 | -0.07 | -0.07 | -0.24 | 0.00 | -0.04 | -0.03 | 0.17 | 0.87 | 0.05 | 0.06 | -0.02 | -0.03 | -0.05 | 0.19 | -0.02 | 0.03 | 0.00 | 0.06 | |
| Lobby | 0.24 | 0.21 | 0.19 | -0.25 | -0.33 | 0.00 | -0.17 | 0.22 | 0.17 | -0.31 | 0.19 | -0.01 | 0.06 | 0.16 | -0.04 | 0.08 | -0.02 | 0.06 | 0.09 | 0.64 | |
| Indoor Environmental Quality: | | | | | | | | | | | | | | | | | | | | | |
| IAQ | 0.24 | 0.20 | -0.25 | 0.28 | 0.20 | -0.01 | 0.11 | 0.27 | 0.08 | -0.02 | 0.10 | 0.14 | -0.05 | 0.00 | 0.07 | -0.31 | -0.70 | -0.07 | 0.03 | 0.03 | |
| Heating | 0.22 | 0.17 | -0.31 | 0.34 | 0.23 | 0.00 | 0.17 | 0.29 | -0.01 | -0.06 | 0.42 | 0.05 | 0.03 | 0.07 | 0.00 | 0.16 | 0.56 | 0.09 | -0.06 | -0.02 | |
| Lighting | 0.24 | 0.19 | -0.09 | 0.12 | 0.13 | 0.02 | -0.01 | 0.24 | 0.24 | -0.08 | -0.83 | -0.12 | -0.02 | 0.00 | -0.06 | 0.13 | 0.15 | 0.00 | 0.03 | 0.03 | |
| Cum explained(%) | 48.97% | 60.47% | 65.39% | 69.42% | 73.06% | 76.55% | 79.61% | 82.45% | 84.95% | 87.15% | 89.06% | 90.68% | 92.26% | 93.71% | 94.98% | 96.19% | 97.29% | 98.29% | 99.19% | 100.00% | |

| Panel B: Distribution of Satisfaction Measures | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Percentile | Satis Complex | Accu | Acce | Spe | Com | Prob | Prof | Resp | Resp | Conn | Ame | Loca | Qual | EleA | EleP | Comm | Rest | Lobby | IAQ | Heating | Light |
| 1 | -2.44 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 2 |
| 5 | -1.57 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 4 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |
| 10 | -1.10 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 1 | 3 | 4 | 3 | 3 | 2 | 3 | 3 | 4 | 3 | 2 | 3 |
| 25 | -0.49 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 2 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 3 | 4 |
| 50 | 0.09 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 3 | 4 | 5 | 4 | 4 | 4 | 5 | 4 | 5 | 4 | 4 | 4 |
| 75 | 0.76 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 90 | 0.94 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 95 | 0.96 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 99 | 0.97 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |

| Panel C: Correlation of liquidity proxies | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Satis Complex | Accu | Acce | Spe | Com | Prob | Prof | Resp | Resp | Conn | Ame | Loca | Qual | EleA | EleP | Comm | Rest | Lobby | IAQ | Heating | Light |
| Satis Complex | 1.00 | | | | | | | | | | | | | | | | | | | | |
| Management: | | | | | | | | | | | | | | | | | | | | | |
| Statement Accuracy | 0.58 | 1.00 | | | | | | | | | | | | | | | | | | | |
| Accessibility | 0.63 | 0.47 | 1.00 | | | | | | | | | | | | | | | | | | |
| Special Needs | 0.64 | 0.47 | 0.71 | 1.00 | | | | | | | | | | | | | | | | | |
| Communication | 0.64 | 0.49 | 0.73 | 0.74 | 1.00 | | | | | | | | | | | | | | | | |
| Problem Solving | 0.67 | 0.50 | 0.69 | 0.78 | 0.79 | 1.00 | | | | | | | | | | | | | | | |
| Professionalism | 0.59 | 0.45 | 0.69 | 0.70 | 0.74 | 0.71 | 1.00 | | | | | | | | | | | | | | |
| Responsiveness | 0.63 | 0.47 | 0.74 | 0.74 | 0.79 | 0.79 | 0.77 | 1.00 | | | | | | | | | | | | | |
| Response Time | 0.34 | 0.26 | 0.38 | 0.38 | 0.41 | 0.40 | 0.34 | 0.46 | 1.00 | | | | | | | | | | | | |
| Current Connection | -0.39 | -0.24 | -0.34 | -0.35 | -0.37 | -0.36 | -0.32 | -0.35 | -0.29 | 1.00 | | | | | | | | | | | |
| Building Quality: | | | | | | | | | | | | | | | | | | | | | |
| Amenities | 0.74 | 0.38 | 0.41 | 0.42 | 0.42 | 0.43 | 0.37 | 0.40 | 0.23 | -0.26 | 1.00 | | | | | | | | | | |
| Location | 0.55 | 0.32 | 0.35 | 0.32 | 0.32 | 0.32 | 0.33 | 0.32 | 0.14 | -0.14 | 0.45 | 1.00 | | | | | | | | | |
| Quality | 0.82 | 0.44 | 0.48 | 0.48 | 0.48 | 0.51 | 0.46 | 0.47 | 0.24 | -0.26 | 0.68 | 0.50 | 1.00 | | | | | | | | |
| Elevator Appearance | 0.82 | 0.40 | 0.42 | 0.41 | 0.41 | 0.43 | 0.37 | 0.40 | 0.22 | -0.27 | 0.55 | 0.37 | 0.63 | 1.00 | | | | | | | |
| Elevator Performance | 0.72 | 0.36 | 0.37 | 0.36 | 0.37 | 0.40 | 0.32 | 0.35 | 0.20 | -0.24 | 0.48 | 0.32 | 0.54 | 0.71 | 1.00 | | | | | | |
| Appearance of Commom Area | 0.83 | 0.42 | 0.45 | 0.45 | 0.45 | 0.46 | 0.43 | 0.44 | 0.24 | -0.26 | 0.60 | 0.43 | 0.68 | 0.67 | 0.52 | 1.00 | | | | | |
| Appearance of Restroom | 0.75 | 0.36 | 0.37 | 0.39 | 0.38 | 0.41 | 0.34 | 0.37 | 0.21 | -0.27 | 0.52 | 0.34 | 0.56 | 0.65 | 0.52 | 0.63 | 1.00 | | | | |
| Appearance of Lobby | 0.79 | 0.39 | 0.43 | 0.42 | 0.42 | 0.44 | 0.41 | 0.41 | 0.21 | -0.25 | 0.56 | 0.41 | 0.65 | 0.65 | 0.49 | 0.83 | 0.58 | 1.00 | | | |
| IEQ: | | | | | | | | | | | | | | | | | | | | | |
| IAQ | 0.80 | 0.43 | 0.42 | 0.44 | 0.43 | 0.47 | 0.38 | 0.42 | 0.24 | -0.30 | 0.53 | 0.36 | 0.60 | 0.62 | 0.57 | 0.58 | 0.57 | 0.54 | 1.00 | | |
| Heating | 0.74 | 0.39 | 0.39 | 0.42 | 0.41 | 0.46 | 0.35 | 0.40 | 0.23 | -0.29 | 0.49 | 0.31 | 0.55 | 0.56 | 0.55 | 0.51 | 0.51 | 0.47 | 0.76 | 1.00 | |
| Lighting | 0.78 | 0.43 | 0.43 | 0.44 | 0.43 | 0.45 | 0.39 | 0.42 | 0.24 | -0.28 | 0.53 | 0.41 | 0.60 | 0.61 | 0.53 | 0.62 | 0.55 | 0.57 | 0.68 | 0.60 | 1.00 |

*Note:* The survey question asked respondents "Please rate your satisfaction with the property in the following areas on a scale from 1 to 5", and is the B, C and D part of the Appendix A7 question library. For the first component, the Eigenvalue is 9.79, and for the second component, the Eigenvalue is 2.30. We have 22,684 survey observations with valid answer values for all the survey questions. The principle component is calculated as the linear combination of the sub-component of tenant satisfaction. Panel A shows the principle components loading for each satisfaction sub-component, and Panel B shows the distribution of satisfaction sub-components. Panel C shows the correlation matrix of the original satisfaction sub-components and the converted measure of satisfaction.

## *A6. Stability of Submarket Vacancy Ranking Liquidity*

TABLE A5—SUBMARKET VACANCY RANKING LIQUIDITY OF 50TH PERCENTILE

| | | NO | YES | Total |
|---|---|---|---|---|
| Top 50 percentile | NO | 88.08 | 11.92 | 100 |
| Bottom 50 percentile | YES | 11.92 | 88.08 | 100 |
| | Total | 50 | 50 | 100 |

*Note:* The quarterly submarket vacancy rate data are from the CoStar database, we take the average of four quarters to measure the average vacancy rate of a certain submarket in a certain year. In each year, the submarkets will be separated into two groups: "Top 50 percentile" or "Bottom 50 percentile". The ranking of submarkets is "in-sample", which is based on the submarkets that have survey data in our dataset. For those submarkets ranking as the first 50 percentile for a certain year, the "Top 50 percentile" is "YES", otherwise the "Top 50 percentile" is "NO". As shown in A6, 88% of the submarket will remain in the same group as the last year.

## *A7. Question Library*

| Interpretation of question | AnswerScale |
|---|---|
| A.Overall Questions | |
| Please rate your overall satisfaction as a tenant. | Poor to excellent |
| How likely would you be to recommend this property to others? | Definitely would not to definitely would |
| If the renewal decision had to be made today, how likely would your company be to renew the lease? | Definitely would not to definitely would |
| B.Property Management | |
| Please rate your property management staff in accessibility. | Poor to excellent |
| Please rate your property management staff in the accommodation of special requests. | Poor to excellent |
| Please rate your property management staff in the communication. | Poor to excellent |
| Please rate your property management staff in the following areas. | Poor to excellent |
| Please rate your property management staff in professionalism/courtesy | Poor to excellent |
| Please rate your property management staff in responsiveness. | Poor to excellent |
| How long does it typically take management to respond in non-emergency situations? | Within 2 hours to 48+ hours |
| Other than for general announcements, how often does property management proactively check in with your company? | Never to Once a week |
| C.General Property Features | |
| Please rate the building amenities of your property | Poor to excellent |
| Please rate the location of your property | Poor to excellent |
| Please rate the quality of your property | Poor to excellent |
| D.Interior Property Features | |
| Please rate the appearance of common areas of your property | Poor to excellent |
| Please rate the appearance of the lobby of your property | Poor to excellent |
| Please rate the appearance of restrooms of your property | Poor to excellent |
| Please rate the elevator appearance of your property | Poor to excellent |
| Please rate the elevator performance of your property | Poor to excellent |
| Please rate the heating and A/C of your property | Poor to excellent |
| Please rate the indoor air quality of your property | Poor to excellent |
| Please rate the workspace lighting of your property | Poor to excellent |