Tenant Satisfaction and Commercial Building Performance

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The widespread adoption of working-from-home policies by companies has shifted the demand for the office space market. Corporate tenants are reconsidering the amount of office space required for their operations. However, there is a lack of studies exploring the determinants of office demand by corporate tenants. In this study, we use a unique dataset combining the largest tenant survey of US office tenants with rental contracts retrieved from CoStar to estimate how tenant satisfaction shapes the demand for office space. Our sample includes 2,906 U.S. office buildings and 39,534 corporate tenants. We document that 1 point higher tenant satisfaction (on a scale of 1 to 5) is positively related to 8.62% higher willingness to renew the lease, 11.52% higher likelihood to recommend the property to the prospect tenants, and 15.80% lower probability of moving out of the property. ***In addition, the analysis of the financial performance of properties shows that 10% higher building level average overall satisfaction is associated with a 0.17% higher growth of gross rents, 0.59% higher growth of effective gross rent, and a 2.43% drop in the vacancy rate change****. Heterogeneity analyses suggest that the role of satisfaction is strongest for short-term tenants, for the properties that are located in the submarkets with high vacancy rates. Finally, 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 novel evidence for the financial implication of good customer relationship management in the real estate sector.*

JEL: R30, R32, R33, M31
Keywords: Tenant satisfaction, Tenant decision, Commercial building performance, Property management

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I. Introduction

The economic shock triggered by the COVID-19 pandemic and the widespread availability of remote work policies is disrupting commercial real estate markets across the US, Europe, and Asia (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(Van Nieuwerburgh, 2023). However, despite its relevance, little is known about how corporates 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 20 trillion in the U.S. alone (NAREIT, 2022)).

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. Extensive evidence from the marketing and psychology literature shows the relevance of customer satisfaction in determining the demand for goods and services(Fornell, Rust and Dekimpe, 2010; Bolton and Drew, 1991). Higher customer satisfaction is associated with a higher propensity to recommend products and services, and a higher willingness to pay (Homburg, Hoyer and Koschate, 2005). In addition, higher customer satisfaction has been linked to a variety of financial performance indicators of firms, 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 flows (Gruca and Rego, 2005), and the better stock market–based value (Aksoy et al., 2008). While it is therefore reasonable to expect that satisfaction will also shape rental contracts of firms, there is a shortage of data and evidence investigating this link. This is surprising, given the widespread use of customer relationship management (CRM) and tenant satisfaction surveys among real estate practitioners in the design of their operating strategy(JLL, 2022).

In this study, we compiled a unique longitudinal survey dataset, including 39,534 tenants surveyed from 2009 to 2022. In total, the dataset includes 104,586 survey responses and covers over 2,906 office buildings located in major metropolitan areas across the US. For each building in our sample, we collected a detailed list of hedonic attributes, and financial indicators (i.e., rent and vacancy rates). In an econometric analysis, we link annual tenant satisfaction measures for each building to multiple financial performance metrics of the building, controlling for an extensive list of property characteristics. Our results show that 1 point higher tenant overall satisfaction (on a scale of 1 to 5) is associated with an 8.36% higher willingness to renew the lease, 11.52% higher likelihood to recommend the property to prospect tenants, and 15.80% lower probability of moving out of the property. In addition, the analysis of the financial performance found that 10% higher building level average overall satisfaction is related to 0.17% higher growth of gross rents, 0.59% higher growth of effective gross rent, and 2.43%

lower growth of vacancy rate. The results are robust to controlling for a rich set of building characteristics, flexible trends in local real estate markets, and building fixed effects. Finally, results from a heterogeneity analysis show that the association between tenant satisfaction and financial performance is stronger for those properties located in submarkets with higher vacancy rates.

Our research contributes to the current literature from two aspects: Firstly, we complement the nascent literature that tries to quantify the impact of tenants on the financial performance of real estate assets (See Sanderson and Read (2020) for a review). By using the occupier satisfaction survey data from 240 UK commercial properties between 2002 to 2013, Sanderson and Devaney (2017) finds a positive correlation between occupier overall satisfaction and investment performance of commercial real estate in the UK. Our study includes a richer set of financial performance indicators to obtain a more robust understanding of how the bottom line is affected by tenant satisfaction. Liu, Liu and Zhang (2019) indicates that a tenant's credit quality is an important factor in the valuation of the building. Zheng and Zhu (2021) found that tenant concentration structures of 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 financially. These studies fail to incorporate the role of tenant satisfaction and its impacts on retaining tenants, ignoring 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 complements the literature that tries to improve the operating efficiency of the 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 tenant satisfaction, and section VIII concludes.

II. Data and Descriptive Statistics

A. Tenant Survey Data

Our main dataset contains all the responses to the universe of office tenants participating in the *Kingsley* survey, designed and implemented by Grace Hill Group to inform building owners and property management companies about

the experience and needs of their corporate tenants[1]. This survey represents the largest tenant satisfaction survey in the United States over the past two decades.

In particular, our main analysis relies on the annual *Kingsley* monitoring survey of corporate tenants[2]. The survey is distributed as an online questionnaire every year to each tenant in buildings owned and operated by the client. In total, the survey contains data from 820 commercial real estate owners across the U.S. Respondents are typically facility managers or office managers involved in the decision to renew the lease. At the beginning of the survey, it is stated that the survey results are not anonymous and will be shared with the property management office to "resolve any immediate concerns and to improve service delivery". The survey is administered throughout the calendar year. After receiving the invitation to complete the survey, tenants have a survey window from 4 to 6 weeks to complete it. The response rate of the official survey is high, around 70%, reducing concerns of attrition and self-selection bias in our sample[3].

The standard questionnaire contains a total of 116 questions divided in five different blocks: (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. Respondents rate their experience inside the building across multiple dimensions on a Likert scale from 1 to 5, where "1" means "Poor", "2" means "Fair", "3" means "Average", "4" means "Good" and 5 means "Excellent"[4]. Each respondent is asked to state their intentions to renew their lease on the date they are filling out the survey. [5]

Our sample contains 2,906 office buildings across the U.S. located in 74 metropolitan areas (MSAs) and 392 cities part of 38 states. Approximately, 90% of the observations are located in the 50 largest MSAs of the country. The dataset includes iconic buildings in the U.S., such as the Empire State Building, or the 30 Rockefeller Plaza. The sample includes answers from 39,534 corporate tenants from 2009 to 2022. In total, the sample includes 104,586 unique survey responses, allowing us to track all office buildings in our sample over multiple years. On average, each tenant completes 3 surveys. The tenants in our sample cover a

[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. Clients are mainly real estate investment companies, real estate management companies, and other real estate sector participants.

[2]Kingsley could also customize survey questions and branding to fit the needs of the client(e.g. evaluation of tenant's satisfaction with sustainability and ESG compliance).

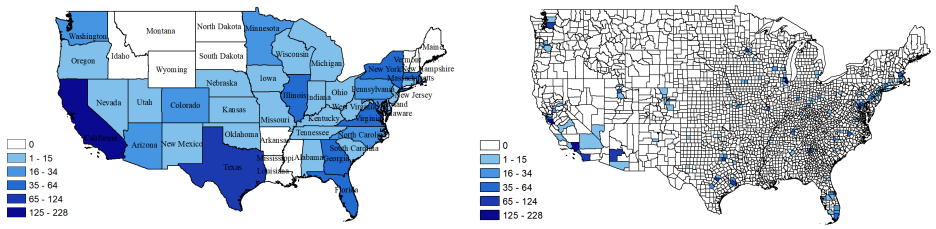
[3]Of course, selection bias is still present, given that not all commercial real estate assets are included in the Kingsley survey. That said, most of the institutional landlords in the U.S. are using the Kingsley survey, and as such, results reported in this paper can be generalized more broadly to the commercial real estate sector.

[4]For example, for the overall satisfaction questions, the survey will ask "Please rate your overall satisfaction as a tenant". In addition, the survey requires tenants to rate their satisfaction with a specific aspect of their experience as a tenant.

[5]The exact wording of the question is: "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". Finally, the likelihood to recommend the building is based on the following question "How likely would you be to recommend this building to others?", and the answers are from scores 1 to 5.

large range of large U.S. and international companies [6] In addition, it includes many middle and small-size companies. [7]

Figure 1 depicts the geographical distribution of the survey responses in our data. The figure shows that our sample covers almost all states in the U.S. (Our dataset covers 37 states and Washington D.C., there are only 13 states that are not covered by our sample (i.e., Alaska, Arkansas, Idaho, Wyoming, Montana). The figure shows that our observations are concentrated in California, and Texas, followed by New York, the District of Columbia, Illinois, and Florida. Panel B in Figure 1(b) indicates are mostly concentrated in large cities such as New York City, Los Angeles, San Francisco, and Washington D.C.



(a) State Level (b) County Level

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

Panel A and B in Table 1 show the distribution of the different variables retrieved from the tenant survey. On a scale of 1 to 5, the company-level average overall satisfaction score is 4.32, and the building-level average satisfaction is 4.31. The average scale of renewal intention in our sample is 3.83 out of a maximum scale of 5, with a relatively big standard deviation of 0.93. Finally, the average building recommendation is 4.27 also out of a scale of 1 to 5. Finally, 46.20% of tenants in our sample moved out of the property by the end of the sample.

B. Building Characteristics and Financial Performance

The financial indicators of the properties in our sample and building characteristics are retrieved from Costar, the largest data provider of building informa-

[6] For example, the dataset covers many of the subsidiaries and branches of Apple, Morgan Stanley, Bank of America, Goldman Sachs, Prudential Financial, Metlife, Wells Fargo, CVS Health, Amazon, Google, Microsoft, IBM, etc.

[7] For the same tenant company that has subsidiaries or branches located in different properties and in different cities, we consider different branches and subsidiaries of the same company as the same tenant. For example, for "JP Morgan Private Bank" we consider it the same as "JP Morgan Chase Bank". We have 53798 office tenants in total if we consider the branches of the same company but located in different buildings as different companies.

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)	46,161	0.462	0.50	0.00	1.00
Panel B: Tenant Perception					
$OverallSatisfaction_{i,b,t}$ (Score 1-5)(Company Level)	104,586	4.324	0.78	1.00	5.00
$AverageOverallSatisfaction_{b,t}$ (Score 1-5)(Building Level)	8,305	4.312	0.47	1.00	5.00
Panel C: Building Characteristics (Building Level)					
$Green_{b,t}$ (YES=1)	9,368	0.401	0.49	0.00	1.00
$GMgmt_{b,t}$ (YES=1)	9,368	0.645	0.48	0.00	1.00
Building Class(percent):					
$ClassA_b$ (YES=1)	2,906	0.667	0.47	0.00	1.00
$ClassB_b$ (YES=1)	2,906	0.309	0.46	0.00	1.00
$ClassC_b$ (YES=1)	2,906	0.024	0.15	0.00	1.00
Age_b (Years)	2,906	38.17	25.67	1.00	165.00
Built Year (percent):					
$Before1970_b$ (YES=1)	2,906	0.156	0.36	0.00	1.00
$1970-1979_b$ (YES=1)	2,906	0.096	0.30	0.00	1.00
$1980-1989_b$ (YES=1)	2,906	0.327	0.47	0.00	1.00
$1990-1999_b$ (YES=1)	2,906	0.150	0.36	0.00	1.00
$After2000_b$ (YES=1)	2,906	0.270	0.44	0.00	1.00
Stories (percent):					
Low_b (<10 floors) (YES=1)	2,906	0.612	0.49	0.00	1.00
$Medium_b$ (10<and<20 floors) (YES=1)	2,906	0.210	0.41	0.00	1.00
$High_b$ (>20 floors) (YES=1)	2,906	0.167	0.37	0.00	1.00
$Renovated_{b,t}$ (YES=1)	10,341	0.284	0.45	0.00	1.00
$Typicalfloorsize_b$(thousand SF)	2,906	28.187	19.154	2.70	356.75
$Amenities_b$ (YES=1)	2,906	0.596	0.491	0.00	1.00
Panel D: Financial Indicators (Building Level):					
Growth:					
$\Delta Rents_{b,t+1,t}$ (%)	5,964	1.72	6.07	-23.64	25.35
$\Delta EffectiveRents_{b,t+1,t}$ (%)	5,525	1.421	12.91	-44.53	47.34
$\Delta VacancyRate_{b,t+1,t}$(%)	7,874	2.523	64.89	-193.81	234.47
Level data:					
$Rents_{b,t}$ ($/SF yr)	6,490	36.49	14.66	8.00	121.69
$EffectiveRents_{b,t}$ ($/SF yr)	6,123	31.757	14.56	0.00	120.00
$VacancyRate$(%)	8,282	13.66	14.057	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. The performance data in panel D are winsorized at their respective 1st and 99th percentiles to reduce the influence of outliers.

tion in the U.S. for commercial properties, maintaining a database of more than 6 million properties[8]. For each building in our sample, we retrieve a comprehensive list of property characteristics, including location, building class, year of construction, the year when the last renovation took place on the building, number of stories, building size, and amenities in the property[9]. In addition, we collect information about the building owner and leasing company at the time point the data was downloaded [10], and also the historical data of the property management company of the building[11].

In addition, we use LEED and WELL to capture the sustainability attributes of office buildings. For each property in our sample, we collect the certification records from the two major sustainability grading systems in the U.S.: LEED certification program of the US Green Building Council (USGBC)[12], and the WELL certificate managed by the International WELL Building Institute (IWBI) [13]. LEED is primarily targeting environmental sustainability and resource efficiency, it also has some requirements for the health attribute of the building. The WELL certificate focuses on human health and well-being within the built environment, it is also applied to three different development statuses for the building: New and Existing Buildings, New and Existing Interiors, and Core and Shell Compliance. To achieve a WELL certificate the building must meet certain requirements in the following categories: Air, Water, Nourishment, Light, Movement, Thermal Comfort, Sound, Materials, Mind, and Community. Additionally, the WELL certification process involves on-site testing and verification by a third-party assessor to ensure that the building meets the standards set by the IWBI.[14]

For each green certification, we collect information on the building address, date of registration, date of certification, type of certification, and level of certification. Table 1 Panel C displays the descriptive characteristics of the green certificate in our sample, we have 1,177 green buildings in total(40.52% of our buildings sample), among which 1152 were only LEED certified, 7 were only WELL certified, and 18 are certified by both LEED and WELL. And 40.10% of buildings in our sample are surveyed after the building was certified as green buildings. [15]

In addition, we collected detailed financial performance data for each build-

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

[9]The amenities included in the sample are banking, convenience store, dry cleaner, fitness center, food court, food service, restaurant.

[10]CoStar maintains the record of the current property owner, and current leasing representative company of the building at the time the data was collected.

[11]CoStar maintain historical records of property management of the building, including the date that the property manager changes in the property

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

[13]https://delos.com/

[14]WELL Certification is valid for three years from the date of the certification award letter.

[15]The building characteristics of green buildings in our samples are similar to the figures of Holtermans and Kok (2019), green buildings with a higher proportion of class A buildings, larger in size, higher in height, a higher proportion of the buildings have on-site amenities, and higher in gross rents and lower in vacancy rate.

ing. First, we gathered quarterly weighted averages of the asking rent and vacancy rate of each property (e.g. From 1982Q1 to 2022Q4), and all details of the terms in leasing contracts attached to the property since 1986. CoStar reports the weighted average asking rent of each quarter 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 describes, therefore, the average of the asking rent of the available space weighted by the square feet of the corresponding listed space[16]. Costar also reports the vacancy rate of the building in every quarter, CoStar defines vacancy as space that is not physically occupied by a tenant[17]. For each leasing contract signed between 2009 and 2022 (i.e., overlapping period with the tenant satisfaction survey), we collect the contract terms of the lease including the agreed rent, sign date, start date, move-in date, expiration date, space leased, free rent period, lease type (i.e., direct or sublease), deal type(i.e., new or renewal), contract service type(full-Service gross, industrial gross, modified gross, negotiable net, plus all utilities, plus cleaning, plus electric, tenant electric, double net, and triple net.), tenant company, and tenant industry.

Table 1 displays the descriptive characteristics of buildings in our sample. Panel C in Table 1 describes that the office buildings in our sample are skewed towards prime 'Class A' and 'Class B' offices. Nearly 66.70% of the buildings are designated as "Class A", and 30.90% are "Class B". The average age of these office properties is 38.17 years, and 28.40% of have reported a renovation. The average size of the properties in our samples is 28,187 square feet. 59.60% of the office building in our sample have on-site amenities[18]. Table 1 Panel B shows the descriptive statistics associated with the average financial performance of properties in our sample. The average growth of rents is 1.72%, the average growth of effective rents is 1.42%, and the average vacancy growth is 2.52%. The average asking rent is 36.49$/SF, the average effective rent is 31.76$/SF, and the average vacancy rate is 13.66%. 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 rent-free period is 0.21 months. The distribution of rents and vacancies in our sample of buildings is similar to those presented in recent studies of the U.S. office market (See, for instance, An et al., 2016; Holtermans and Kok, 2019)

[16]For example, if building A has two spaces available for lease and listed on the market during 2022Q4 and the size is 90 and 100 and the asking rents are 100 and 120 correspondingly, then the average asking rent is 100*90/190+120*100/190 = 110.53.

[17]Data on commercial office buildings provided by Costar includes liquid commercial office space only, those owner-occupied headquarters buildings are underrepresented. "Demand" denotes the total occupied space in a market, and the vacancy rate is 1 - (demand or stock).

[18]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 takes the value of 1, 0 otherwise: banking, convenience store, dry cleaner, fitness center, food court, food service, restaurant.

C. *Data Construction*

For the econometric analysis, we match the tenant satisfaction survey data with building characteristics and financial data from the property, all based on the building address. We implement a number of data processing measures. First, we excluded observations where the building age is smaller than or equal to zero, and with missing information on specific building characteristics. Second, when multiple responses are available per tenant and year for a given building, we compute the average of responses. In total, there were 1,327 survey data observations from those companies with more than 1 respondent. In total, our final dataset contains 104,586 survey entries from 2,906 office properties.

Figure 2 shows the summary statistics of the overall satisfaction values by states, over 95% of the states with overall satisfaction values ranging between 4.00 to 5.00. However, we observe large variations at the individual building level. But given the building level average overall satisfaction is 4.30 (scale of 1 to 5), with a standard deviation of 0.47, we can observe some meaningful heterogeneity in overall satisfaction within geographic locations, for example, company tenants in Washington D.C. are happier than those company tenants in New York(0.25 points higher out of 1 to 5). [19]

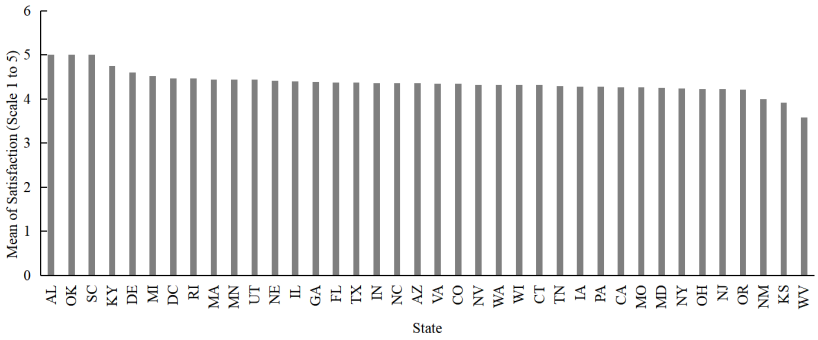


FIGURE 2. GEOGRAPHIC DISTRIBUTION OF SATISFACTION IN OUR SAMPLE

Note: The state-level average overall satisfaction is the arithmetic average of the overall satisfaction score of all the respondents in the corresponding state over the entire sample period, from 2009 to 2021.

In Figure 3, we document the time trend of the main dependent and independent variables by building class for the past 5 years (2017 to 2021)[20]. Figure 3(a) is the overall satisfaction level, which is relatively stable over the past 5

[19]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.

[20]Most of our surveys are filled after 2018, the past 5 years have taken up 70% of the observations, which might be more representative, while the first 8 years(2009 to 2016) only takes up 30%.

years, but shows heterogeneity in the time trend across different buildings' qualities. First, tenants tend to have higher satisfaction levels in "Class A" properties throughout the sample period, followed by the "Class B" properties and "Class C" properties. Second, the time trends in satisfaction. "Class A" properties show a stable and even upward trend throughout the sample period, "Class B" properties show a drop, and the "Class C" properties show a big drop in 2019 that rebounded after 2019.

Figure 3(b) displays the time series of stated renewal intentions for the different asset classes. The time series graph shows that renewal intention remained constant over the initial phase of the sample period, and all building types experienced a big drop in 2020, which rebounded partly in 2021. In addition, the figure shows meaningful heterogeneity across building classes. Firstly, the magnitude of the drop in "Class C" is more severe than" Class B" and "Class A". Second, renewal intention in those "Class C" properties shows a drop sign earlier than those "Class B" and "Class A" buildings.

Figure 3(c) shows the trend of direct gross rents[21]. Class A buildings show the best performance, which exhibits a stable upward trend even after the outbreak of covid-19. Followed by the Class B properties, which also show some stability 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), they observe a fall of 13.16% in the rents on newly-signed leases between 2020 to 2021 on average but with heterogeneity.

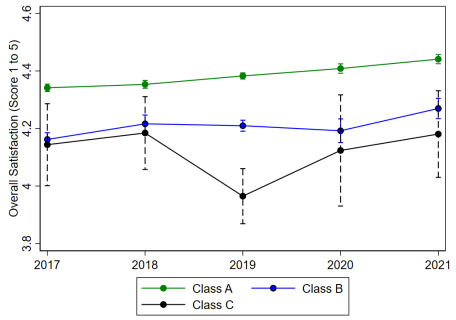
Figure 3(d) displays the trend of the vacancy rate, which shows an upward trend since covid across all building classes. But those "Class A" buildings tend to have lower vacancy rates throughout the period, and after the outbreak of Covid-19, the vacancy rate also raises slower than its peers, the "flight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

Finally, Figure 3(e) describes the trend of effective rents, 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 substantial drop in 2020 followed by a light rebound in 2021.

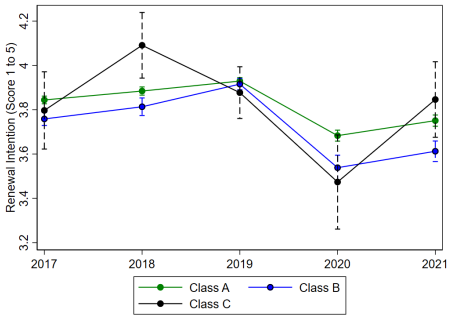
III. Methodology

Figure 4 presents the empirical research design for the study. The goal of the study is to test to what extent tenants' satisfaction with the building affects their willingness to remain in the building and recommend it to others, and ultimately their decision of whether to terminate their lease and move to another property.

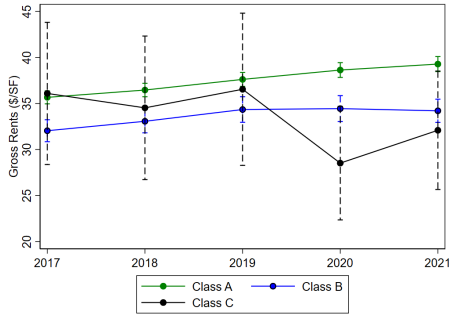
[21] We only use the "direct gross rents", which is the listing price directly from the landlord, instead of the subletting rents or overall rents combining both the direct rents and subletting rents.



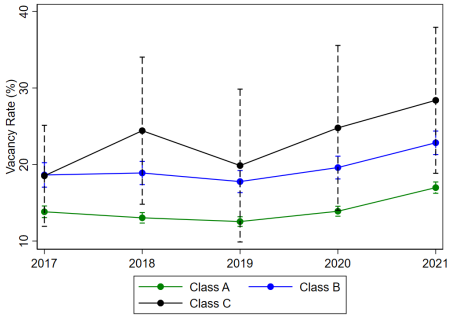
(a) Overall Satisfaction(Score 1 to 5)



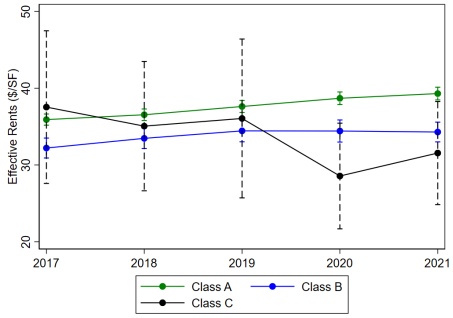
(b) Renewal Intention(Score 1 to 5)



(c) Gross Rents($/SF)



(d) Vacancy Rate(%)



(e) Effective Rents($/SF)

FIGURE 3. TIME SERIES OF SATISFACTION AND FINANCIAL PERFORMANCE

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 have preserved the rents and vacancy observations in years that didn't have survey responses to have a clearer picture of the actual dynamics of financial performance of the buildings in our sample.

Changes in the attractiveness of tenants may ultimately shape the reputation and space demand of the building, these changes in the demand could be reflected in the change of the rental rate and vacancy rate, and finally, interact with the cap rate to capitalize on the value of the building. Therefore, understanding the tenant experience and its influence is crucial for property owners and managers who want to improve building operating efficiency and maintain property value. In this study, we try to quantify the effect of tenant satisfaction on their decision to renew their leases, and the impact on the financial performance of the building.

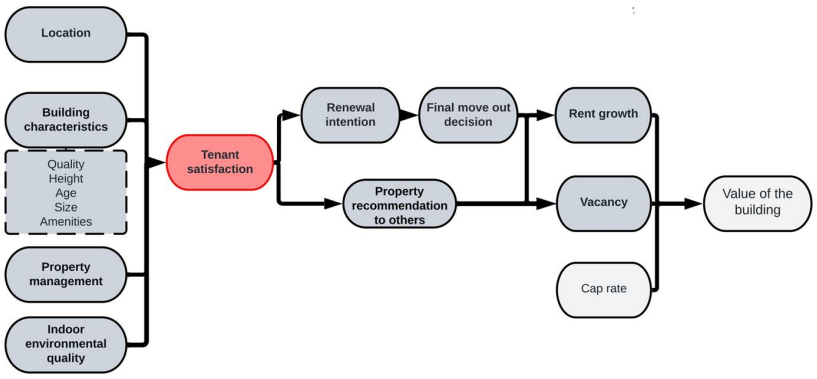


FIGURE 4. RESEARCH FRAMEWORK

A. *Leasing Contracts and Recommendations*

We test our hypothesis using a model relating tenant satisfaction to three key tenant decision indicators: (1) stated renewal intention, (2) propensity to do a building recommendation, and (3) likelihood to move out of the property using the following empirical model. Equation 1 describes the regression model linking the satisfaction to their intention to renew the lease and recommend the property to third companies:

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

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 on a scale from 1 (least satisfied) to 5 (most satisfied). In addition, tenants are requested to answer their willingness of

recommend the property to a third party from 1 (least likely) to 5 (most likely). Finally, we track whether the tenant exited the building (we construct a dummy variable taking the value of one if the tenant is no longer in the property and zero otherwise).

For the identification of the moved-out status, we compare the current tenant information of each building from the CoStar database with the tenant information in the survey data to identify whether the tenant is still in the building or not, if the tenant that fills out the survey appears on Costar's current tenant section, then we regarding it as "existing", otherwise it is "moved out", and we also cross-verify the tenant staying status using the Google Maps database and the official website of the tenant company (if exist): If the tenant is shown by Google Maps as "operating" in the building then we regard it as "existing", and as "move out" otherwise; if the contact address of the tenant company on their website is the same as the address in the survey, we regard the tenant as "existing", and as "move out" otherwise[22]

The variable $Satisfaction_{i,b,t}$, 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 key coefficient of interest is β, which captures the influence of tenant satisfaction intention on a tenant's decision to renew the different outcomes describing the lease renewal. 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 time (μ_t) and city-effects (λ_c), and tenant fixed-effects (τ_i)[23]. The city$\times$year fixed effect will absorb the variation in the dependent variable at the city level (e.g. due to variation in weather conditions). $\varepsilon_{i,b,t}$ is the error term, clustered at the building level to capture the correlation of responses within a property.

[22]For those tenants who have filled out the survey: (1)If the information of the tenant couldn't be found in any of the three data sources(CoStar/Google Map/Company's official website), we regard it as leaving; (2) If any of the 2 or all 3 data sources shows the tenant is "existing", then we consider the tenant as remaining in the building. (3) But if the current contact address information shown on the official website is not the same as the address during the survey period, no matter what is the existing or move-out status in Google Maps or CoStar database, we consider it as not existing in the building.

[23]Tenants with different characteristics might also have different preferences in their leasing decision(Crosby, Hughes and Murdoch, 2006; Halvitigala, Murphy and Levy, 2011; Eichholtz, Kok and Quigley, 2011), which will affect satisfaction levels and tenant decision at the same time, or affect their behavior preference without affecting the satisfaction level, which cannot be attributed to the building characteristics itself, thus we also include tenant fixed effect to control for the effect of permanent preference heterogeneity of corporate tenant. Similarly, the same tenant company might have subsidiaries or branches located in different properties and in different cities, we consider different branches and subsidiaries of the same company as the same tenant. For example, for "JP Morgan Private Bank" we consider it the same as "JP Morgan Chase Bank".

B. *Building Financial Performance: Rents and Vacancy Rates*

The next regression model estimates the relationship between tenant satisfaction and the financial performance of the building, reflected by the *change* in gross and effective rents, as well as the *change* in the vacancy rate. Note that the analysis focuses on *changes* and is not levels of financial performance to reduce concerns of omitted variable bias associated with the cross-sectional differences in levels (Eichholtz, Kok and Quigley, 2013). In addition, we follow the literature (e.g., Eichholtz, Kok and Quigley, 2013), and include a comprehensive list of hedonic characteristics of the building, to control for any unobserved characteristics that might be correlated with financial performance, or will affect tenant satisfaction and financial performance at the same time. Equation 2 describes the empirical model relating the average tenant satisfaction of tenants in the building to the average financial performance of the building, measured by the change in the average gross rents, change in effective rents, and change of the vacancy rates in the building:

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

$\Delta Log(Performance_{b,t+1,t})$ is the change in the financial performance of building b between year $t+1$. We include three separate financial indicators of the performance of building b between year $t+1$ and year t: (1) The change in the logarithm of the gross rent per square foot of building b between year $t+1$ and year t, (2) the change in the logarithm of listing effective gross rent per square foot of building b between year $t+1$ and year t, and (3) the change in the logarithm of vacancy rate of building b between year $t+1$ and year t[24]. It is important to note that the increment effect in rent growth we estimate is coming from the new listings, and will not affect the rent level of the existing leasing contracts, which is the "updating activity" of the landlord by changing the asking price of the listing space according to the market condition. Compared with contract rents, one significant advantage of using asking rents 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. Another advantage of using asking rents is that the asking rent usually has more observations compared with leasing contract rents, and there may not be a newly signed leasing contract

[24]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 gross 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 financial status and operating strategies of the companies that offer the listing.

every year.

The key variable of interest, $Log(Satisfaction_{b,t})$, describes the average overall satisfaction level of all tenants completing the tenant satisfaction survey for building b in year t. β describes the sensitivity of the financial performance indicators to tenant satisfaction. In particular, the coefficient allows testing for differences in vacancy rates or rents in buildings with comparable hedonic characteristics that have different tenant satisfaction. 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. (2) The logarithm of vacancy rate of building b in year t.[25]

Following the specification in Equation 1: The vector of control variables includes 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. Finally, we control for city-specific time trends with the interaction between city and time-fixed effects [26].

IV. Empirical Results

A. *Tenant Satisfaction and Tenant Decision*

Table 2 presents the estimates described in Equation 1, describing the decision to renew the lease and recommend the property to prospect tenants. The coefficients associated with control variables are not displayed in the main text due to space constraints (the full table is available in Appendix Table A1 and A2).

Columns (1) - (3) in Table 2 present the results on renewal intention, adding sequentially control variables, time and city-fixed effects, and tenant-fixed effects, respectively. Column (1) indicates that a 1-point higher overall satisfaction will lead to a 0.43 point higher renewal intention, the magnitude and sign of coefficient are similar when adding time and city fixed effects. Column (3) presents the most conservative specification, including tenant fixed effects. The results indicate that 1 point higher overall satisfaction will lead to a significant increase of 0.33 in the willingness to renew the leasing contract. The size of the increase in renewal intention represents an economically meaningful since it represents 8.62% of the average in the likelihood of renewal scale. ($8.62\% = 0.33/3.83$).

Columns (4) to (6) describe the results of the propensity to provide a building recommendation to other tenants, again adding controls sequentially to the

[25] We follow Verbrugge et al. (2017), which studies the dynamics of rents of individual properties, indicating that the relative rental level can predict the rent growth of the next period. Similarly, 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.

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

model to test the stability of our estimates. Column (6) shows that a 1 point improvement in satisfaction is related to a 0.49 point increase in the willingness to recommend a property to peers. This means a 1-point higher tenant satisfaction will lead to an 11.52%(0.49/4.27) improvement in willingness to recommend a property respectively compared with the average in the 5-point Likert scale that describes the propensity to recommend a property. In sum, the results in Columns (1) - (6) in Table 2 indicate a strong positive relationship between tenants' satisfaction and their self-reported intention to renew the lease and recommend the property to others.

Columns (7) - (8) show the results of conditional Logit estimation results for the impact of satisfaction on tenants' actual move-out status[27]. Column (8) indicates that, on average, a 1-point higher overall satisfaction will lead to a 15.80 percentage points lower probability of leaving. This means that 1 point higher tenant overall satisfaction will correspond to 34.20% of the average probability of leaving the building (34.20% $= 0.158/0.462$). These results indicate that satisfaction not only affects tenants' self-reported commitment, but is also a strong predictor of their *actual* leasing behavior[28].

B. Tenant Satisfaction and The Dynamics of Building Financial Performance

Table 3 presents the estimates of the model in Equation 2. Based on the weighted average asking rents per square foot of the building, Columns (1) - (3) in Table 3 show the impact of tenant satisfaction on the logarithm change of the gross rents. On average, a 10% higher average building level satisfaction is related to a 0.17% higher growth in gross rents. Column (4) - (6) in Table 3 describes the impact of satisfaction on the logarithm change of effective rents. The results mirror those in Columns (1) - (3) but the magnitudes of the coefficient are larger. Column (6) in Table 3 shows that a 10% improvement in satisfaction will lead to 0.59% higher growth in effective rent. Column (7) - (9) presents the analysis of the vacancy rate. A 10% improvement in tenant satisfaction is related to a 2.43% lower vacancy rate growth [29].

[27]The results of the equivalent linear OLS model display high consistency in terms of statistical significance and magnitude. Results are displayed in Appendix Table A3.

[28]For the analysis in Column (7) - (8), we preserved only the latest reply from each tenant. This approach helps to avoid the sample being over-represented by tenants who have filled out surveys more frequently. Additionally, the latest opinions of the tenant about the building are closer to their final leaving status in terms of the time point, which might be a better indicator of their actual decision. For instance, if a tenant had filled out a survey between 2015 and 2019, we would only preserve the survey from 2019 to explain their actual leaving status. The results are similar if we preserve all the survey responses from each tenant. We didn't control for the tenant fixed effect in Columns (7) - (8), because each tenant in each building only has one status of staying or leaving, controlling for tenant fixed effect will absorb the sample of tenants that do not have subsidies or branches, and preserve only those tenants who have subsidies in different buildings, which will cause the loss of almost all of our research observations.

[29]To avoid the impact of unobservable building characteristics which might be related to the rent level and vacancy level of the property, while the satisfaction level of the property might not be related to these characteristics(For example, gorgeous decoration, and more expensive amenities, will all be capitalized into the building's rent level. But tenants might be getting used to the environment they are in(Palacios, Eichholtz

TABLE 2—TENANT SATISFACTION, TENANT LEASING DECISION, AND PROPERTY RECOMMENDATION

	Renewal Intention$_{i,b,t}$ (Score 1-5)			Building Recommend$_{i,b,t}$ (Score 1-5)			Move Out Property$_{i,b,t+1}$ (YES=1)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overall Satisfaction$_{i,b,t}$	0.426***	0.427***	0.330***	0.598***	0.593***	0.492***	-0.208***	-0.158***
	(0.005)	(0.005)	(0.007)	(0.005)	(0.005)	(0.007)	(0.016)	(0.034)
Constant	2.082***	1.861***	2.106***	1.326***	1.238***	1.699***	0.445	2.236
	(0.117)	(0.128)	(0.227)	(0.087)	(0.094)	(0.166)	(0.641)	(2.212)
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	83,301	83,198	69,158	60,233	60,162	48,526	45,586	18,245
# Buildings	2,854	2,819	2,490	2,183	2,160	1,944	2,937	1,930
R-squared	0.123	0.157	0.554	0.374	0.394	0.670	0.014	0.194

Note: Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. 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 zero otherwise. Columns (1) - (6) are OLS regression, and (7) - (8) are Logit regression. The full table with the estimation of all control variables are in Appendix Table A1.

V. Robustness Check

This section presents a series of robustness checks to test the stability of the results.

A. *Tenant Satisfaction and Achieved Rents*

Using weighted average asking rents for analysis of the change in building financial performance has some advantages, such as the availability of 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. However, there are some issues with using asking rents. After all, the rent that the landlord asking for cannot guarantee to be realized in any future leasing activities. The data will also be over-represented by those buildings that have space available more frequently, which might be correlated with the functionality of the building(Jaffee, Stanton and Wallace, 2019), and under-represent well-performing properties that are fully occupied. Considering these issues with asking rent data, in this section we use leasing *contract* data to estimate Equation 2, to investigate the effect of satisfaction on achieved rents:

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 A1, at each rent level there might be a large variance in the distribution of satisfaction.), we add the building-level fixed effect and re-estimate (2), the results are shown in A7, the results are similar the findings of our main conclusion.

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$_{b,t}$)	0.006	0.006	0.017*	0.053**	0.043*	0.059**	-0.296***	-0.246***	-0.243***
	(0.007)	(0.007)	(0.009)	(0.021)	(0.023)	(0.026)	(0.066)	(0.068)	(0.081)
Constant	0.050***	0.057**	0.138***	-0.134***	-0.161**	-0.198*	0.989***	1.574***	1.892***
	(0.013)	(0.025)	(0.042)	(0.037)	(0.069)	(0.118)	(0.103)	(0.213)	(0.259)
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	4,717	4,717	4,100	4,378	4,378	3,802	6,361	6,361	5,703
# Buildings	1,672	1,672	1,500	1,573	1,573	1,409	2,134	2,134	1,963
R-squared	0.005	0.009	0.232	0.041	0.045	0.266	0.120	0.131	0.309

Note: Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. 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 (Table A2).

$$\text{Log(Contract Rent}_{g,b,t+1}) = \alpha + \beta \text{Log(Average Overall Satisfaction}_{b,t}) + \theta \text{Log(Lagged Level}_{b,t}) + \gamma X_b + \mu_t * \lambda_c + \varepsilon_{b,t} \quad (3)$$

where $Log(ContractRent_{g,b,t+1})$ is the logarithm of the rental level specified in a rental contract g in building b for the year $t+1$ (the year after tenants have completed 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 weighted by the size of realized leased space. For the analysis of the effective rents, the explanatory variable $Log(EffectiveContractRent_{g,b,t+1})$ is the logarithm of effective rents of leasing contract g in building b in year $t+1$, we also control for the $Log(AverageContractRent_{b,t})$, which is the logarithm of the current period average contract rent of building b in year t weighted by the size of realized leased space, and also the $Log(VacancyRate_{b,t})$, which is the direct vacancy rate of building b in year t. The explanatory variable $Log(AverageOverallSatisfaction_{b,t})$ is the same as the analysis in Table 2, which is the building level average of overall satisfaction of building b in year t. $Log(LaggedLevel_{b,t})$ is the lagged financial performance of building b in year t calculated using the contract rent data: (1) The logarithm of average gross rent per square foot of building b in year t. (2) The logarithm of vacancy rate 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 control variables for building charac-

teristics and fixed effects are the same as those in the analysis before. But we also incorporate fixed effects for the leasing contract services type[30] to account for the different rental levels that attribute to the leasing contract type.

Table 4 shows the estimated coefficients described in Equation 3 using leasing contract data[31]. To facilitate the comparison of results, Column (1) and Column (4) display the estimation results for asking rents displayed in Columns (3) and (6) in Table 3.

TABLE 4—TENANT SATISFACTION AND CONTRACT RENTS

	$\Delta Log(Rent_{b,t+1,t})$ ($/SF)	Log(Contract Rent$_{g,b,t+1}$)($/SF)		$\Delta Log(Effective$ Rent$_{b,t+1,t}$)($/SF)	Log(Effective Contract Rent$_{g,b,t+1}$)($/SF)	
	(1)	(2)	(3)	(4)	(5)	(6)
Log(Average Overall Satisfaction$_{b,t}$)	0.017*	0.060	0.071	0.059**	0.229**	0.401***
	(0.009)	(0.072)	(0.103)	(0.026)	(0.095)	(0.121)
Contract Characteristics:						
Time on Market$_{g,b,t+1}$($Years$)			0.004			0.003
			(0.003)			(0.002)
Contract Length$_{g,b,t+1}$($Years$)			0.027***			0.018***
			(0.009)			(0.003)
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)			-0.015***			-0.008
			(0.006)			(0.006)
Free Rent Period$_{g,b,t+1}$($Years$)			-0.147***			-0.148***
			(0.055)			(0.048)
Constant	0.138***	2.930***	2.827***	-0.198*	2.767***	2.118***
	(0.042)	(0.248)	(0.310)	(0.118)	(0.290)	(0.326)
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
Contract type FE	NO	YES	YES	NO	YES	YES
Observations	4,100	6,752	3,202	3,802	6,166	2,828
# Buildings	1,500	872	587	1,409	757	503
R-squared	0.238	0.755	0.769	0.266	0.773	0.786

Note: Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Explained variables are winsorized at their respective 1st and 99th percentiles to reduce the influence of outliers.

Columns (2) and (3) in Table 4 provide the results of the relationship between tenant satisfaction and the contract rent per square foot in the next period. Column (2) control for building characteristics, current period average contract rents

[30]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.

[31]In this section, only those properties have survey responses for the current period and have signed leasing contracts for the current period and the next period will enter into our regression. In addition, the regression only includes leasing contracts with observations of all the variables describing the leasing term, in order to mitigate the possibility that there are unobserved characteristics that affect the rents level or both the satisfaction level and the rent level at the same time.

level, and time-city fixed effects. The coefficient associated with tenant satisfaction shows that, on average, 1% higher overall satisfaction is related to a non-significant 0.06% higher contract rent, Column (3) is the result after we add in the contract characteristics based on Column (2). The results are similar in magnitude and (lack of) statistical significance when including controls for contract characteristics (Column (3) in Table 4).

Columns (5) and (6) show the estimates associated with tenant satisfaction on the effective contract rent per square foot. Column (5) is the result of controlling for building characteristics, current period performance, and time-city fixed effects. As displayed by the coefficient, on average, a 1% higher overall satisfaction is related to 0.23% higher effective contract rents. Column (6) indicates that after we control for the contract characteristics, the effective rents improvement effect is even higher, with a 1% higher overall satisfaction related to 0.40% higher effective rents. The results above support our main finding: tenant satisfaction has positive implications for the future financial performance of the building.

B. The Marginal Effect of Tenant Satisfaction Improvement

The categorical character of survey answers, with censored top or bottom response values, might introduce biases associated with respondents selecting the extreme values of the Likert scale. For example, for the samples with a response value of "5" to the overall satisfaction question, some respondents might be very happy, but some others are "super happy", and would have given a 6, or 7 if that answer is available. Similarly, score 1 might also include some "very unhappy" tenants. The existence of these respondent patterns might lead to the overestimation of the effect of satisfaction. Another concern is that the large proportion(90%) of the distribution of answers to the tenant satisfaction question is concentrated on scores 4 and 5 might be biased by the over-represented "high score" samples.

To address these issues, we decompose the satisfaction scale into each of the original categories in our original data. In particular, we include each value between 1 and 5 of the survey answer as a separate dummy variable in the regression. 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 to "2", and 0 otherwise. We specified the tenant samples with overall satisfaction scores equal to 1 as the baseline group. Therefore, the estimated coefficients will describe the differences in outcomes between the corresponding level of satisfaction and buildings being rated by tenants with a score of one (i.e., baseline category).Other control variables and fixed effects are the same as those in Table 2.

Table 5 shows the results of Equations 1 and 2 replacing the original, continuous variable describing tenant satisfaction with a set of dummies describing each of the categories in the tenant satisfaction question. Panel A in Table 5 presents the estimates describing the association between tenant satisfaction, renewal in-

tention, and their leasing decision. Columns (1), (3), and (5) are the results of the main regression. Column (1) presents our main results in Table 3. 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 tenant satisfaction score in the building is higher. However, for each point increase in the scale of tenant satisfaction, the marginal effect of improving tenant satisfaction is 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 0.43 points (on a scale of 1 - 5), and if the satisfaction score improves from 4 to 5, the renewal intention will improve by only 0.31 points. Results in Columns (4) and (6) present the results for the propensity to recommend the property to a third party and the likelihood of moving out of the property respectively. Consistent with the estimates showing the impact on renewal intention, the satisfaction score is positively related to higher property management recommendation, and a lower probability of final move-out. In addition, similar to our estimates on renewal intention, the marginal effect is smaller as the satisfaction score is higher.

Panel B in Table 5 describes the results on the impact of tenant satisfaction on the financial performance of the property. For this test, we decompose the distribution of average satisfaction to buildings in our sample into quartiles. For example, $Log(AverageOverallSatisfaction)20-40percentile_{b,t}$ is a binary value that equals 1 if the average overall satisfaction answer value of building b in year t is between the 20th to 40th percentile, and 0 otherwise. We specified the building samples with average satisfaction scores located at the lowest 20th percentile as the baseline group. The control variables and fixed effects are the same as those in Table 2.

Panel B in Table 5 presents the marginal effect of satisfaction on financial performance. Column (1) shows that, relative to the baseline group (i.e., those properties with overall satisfaction located at the lowest 20th percentile), the high-score group does not show a significantly higher asking rent level. Results in Columns (2) and (3) indicate that higher satisfaction is associated with higher effective rents, and lower vacancy rates. 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". In sum, the results above indicate that our main results are not driven by extreme values in tenant satisfaction, but there is a monotonic relationship between tenant satisfaction, the decision to renew the lease, and the financial performance of buildings.

VI. Heterogeneity Analysis

This section explores the heterogeneity in treatment effects across different market conditions and tenant types.

TABLE 5—THE MARGINAL EFFECT OF TENANT SATISFACTION IMPROVEMENT

	Renewal Intention$_{i,b,t}$ (Score 1-5)		Building Recommend$_{i,b,t}$ (Score 1-5)		Finally Move Out$_{i,b,t+1}$ (YES=1)	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Tenant Satisfaction and Tenant Decision						
Overall Satisfaction$_{b,t}$	0.330***		0.492***		-0.159***	
(Score 1 - 5)	(0.007)		(0.007)		(0.034)	
Overall Satisfaction Score 2$_{i,b,t}$		0.431***		0.709***		-0.623***
(YES=1)		(0.074)		(0.082)		(0.241)
Overall Satisfaction Score 3$_{i,b,t}$		0.778***		1.233***		-0.477**
(YES=1)		(0.072)		(0.079)		(0.228)
Overall Satisfaction Score 4$_{i,b,t}$		1.132***		1.788***		-0.697***
(YES=1)		(0.071)		(0.078)		(0.225)
Overall Satisfaction Score 5$_{i,b,t}$		1.440***		2.229***		-0.861***
(YES=1)		(0.071)		(0.079)		(0.230)
Constant	2.106***	2.310***	1.699***	1.916***	2.241	2.281
	(0.227)	(0.237)	(0.166)	(0.180)	(2.211)	(2.232)
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	69,158	69,158	48,526	48,526	18,245	18,245
# Buildings	2,490	2,490	1,944	1,944	1,930	1,930
R-squared	0.554	0.554	0.670	0.671	0.194	0.195
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*		0.059**		-0.245***	
	(0.009)		(0.027)		(0.082)	
Log(Average Overall Satisfaction) 20-40 percentile$_{b,t}$		0.003		0.017**		-0.088***
(YES=1)		(0.003)		(0.009)		(0.032)
Log(Average Overall Satisfaction) 40-60 percentile$_{b,t}$		0.000		0.016*		-0.088***
(YES=1)		(0.003)		(0.009)		(0.032)
Log(Average Overall Satisfaction) 60-80 percentile$_{b,t}$		0.005		0.021**		-0.129***
(YES=1)		(0.004)		(0.009)		(0.034)
Log(Average Overall Satisfaction) 80-100 percentile$_{b,t}$		0.003		0.025***		-0.124***
(YES=1)		(0.004)		(0.009)		(0.034)
Constant	0.140***	0.160***	-0.200*	-0.123	1.900***	1.612***
	(0.043)	(0.042)	(0.121)	(0.121)	(0.261)	(0.241)
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	4,100	4,100	3,802	3,802	5,703	5,703
# Buildings	1,500	1,500	1,409	1,409	1,963	1,963
R-squared	0.233	0.233	0.265	0.265	0.310	0.311

Note: Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. 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. Local Market Conditions

In this subsection, we explore whether the role of tenant satisfaction varies across submarkets. In particular, we test whether satisfaction is more impactful in markets with high availability of office space (i.e., high vacancy), compared to those markets with low availability of office space (i.e, low vacancy). If the (sub)market has a higher vacancy rate then the tenant would have more choices for moving out, and therefore the relationship between tenant satisfaction and the likelihood to terminate a lease might therefore weaken.

In this section, we explore the role of market conditions in shaping the implication of tenant satisfaction. We divide the submarkets in our sample into high and low-vacancy subsamples to examine the geographic variation of the satisfaction effect on the building performance. In particular, we take the average of the historical vacancy rates of each of the 484 submarkets in our sample during our research period and define the high vacancy market as those markets above the median and the low vacancy market as those markets below the median. Submarket vacancy is the average vacancy level of the office submarket that the building is located in, for example, if the tenant is in a building located in the 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.[32]. Table 6 shows the results of Equations (1) and (2) for the two separate samples according to the sub-market vacancy. [33]. The regression model for column (1) - (3) is the same as Equation 1, and the regression model for Column (4) - (6) is the same as Equation 2.

Panel A in Table 6 describes the results in the high vacancy submarket sample. Panel B in Table 6 displays the estimated result in the low vacancy submarket sample. Column (1) - (3) describes the estimation results in the regression model describing the intention to renew the lease, recommend the property to a third company, or move out of the property. The table shows a lack of significant differences in estimates across the two subsamples, indicating that tenant satisfaction is equally important for defining the renewal intention and recommending the property in markets with low and high vacancy rates. Columns (4) - (6) describes the analysis of how the submarket vacancy level affects the financial performance's sensitivity to the satisfaction level. As shown in Columns (4) in Panel A, the listing rents of buildings located in high vacancy markets are not sensitive to the satisfaction level of the tenant, while Columns (5) and (6) 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

[32]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.

[33]The number of observations is different for the top 50% vacancy submarket and the Bottom 50% submarket because the concentration of properties and survey observations are not evenly distributed across cities.

TABLE 6—MARKET VACANCY AND THE EFFECT OF TENANT SATISFACTION

	Tenant decision			Financial performance		
	(1) Renewal Intention$_{i,b,t}$ (Score 1-5)	(2) Building Recommend$_{i,b,t}$ (Score 1-5)	(3) Finally Move Out$_{i,b,t+1}$ (YES=1)	(4) $\Delta Log($ Rent$_{b,t+1})$ ($/SF)	(5) $\Delta Log(Effective$ Rent$_{b,t+1})$ ($/SF)	(6) $\Delta Log(Vacancy$ Rate$_{b,t+1}$ (%)
Panal A: High vacancy submarket(Top 50% percentile)						
Overall Satisfaction$_{i,b,t}$	0.322***	0.474***	-0.089*			
(Score 1-5)	(0.009)	(0.010)	(0.047)			
Log(Average Overall Satisfaction$_{b,t}$)				-0.002	0.076**	-0.390***
(Score 1-5)				(0.010)	(0.036)	(0.116)
Constant	1.896***	1.680***	-0.057	0.150***	-0.090	2.007***
	(0.337)	(0.263)	(2.914)	(0.047)	(0.147)	(0.376)
Lagged Level$_{b,t}$	NO	NO	NO	YES	YES	YES
Control	YES	YES	YES	YES	YES	YES
Time*City FE	YES	YES	YES	YES	YES	YES
Tenant FE	YES	YES	YES	NO	NO	NO
Observations	40,026	27,397	9,762	2,188	2,055	2,973
# Buildings	1,034	1,034	1,034	850	812	1,079
R-squared	0.582	0.691	0.182	0.294	0.326	0.347
Panal B: Low vacancy submarket(Bottom 50% percentile)						
Overall Satisfaction$_{i,b,t}$	0.333***	0.490***	-0.250***			
	(0.012)	(0.011)	(0.045)			
Log(Average Overall Satisfaction$_{b,t}$)				0.015	0.025	-0.076
(Score 1-5)				(0.013)	(0.037)	(0.114)
Constant	1.468***	1.699***	1.158	0.166**	-0.233	2.113***
	(0.358)	(0.249)	(2.660)	(0.064)	(0.157)	(0.354)
Lagged Level$_{b,t}$	NO	NO	NO	YES	YES	YES
Control	YES	YES	YES	YES	YES	YES
Time*City FE	YES	YES	YES	YES	YES	YES
Tenant FE	YES	YES	YES	NO	NO	NO
Observations	32,084	23,305	9,286	2,182	2,002	3,119
# Buildings	1,019	759	702	1,040	812	1,079
R-squared	0.578	0.682	0.251	0.237	0.276	0.314

Note: Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. For panel B the explained variables are winsorized at their respective 1st and 99th percent to reduce the influence of outliers. 2.

is sensitive to the tenant's opinion and reputation in markets with high vacancy rates. Column (4) - (6) shows that the building's financial performance is not influenced by tenant satisfaction in markets with low vacancy rates.

These findings above display the heterogeneity in our results. While in a high vacancy market, lower rents and higher vacancy rates are associated significantly with lower tenant satisfaction, this relationship is weaker and non-statistically significant in markets with low vacancy rates.

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 7 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 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. 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

TABLE 7—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$_{i,b,t+1}$ (YES=1)
Panal A: Stayed Long Tenants(Top 50th percentile)			
Overall Satisfaction$_{i,b,t}$	0.307***	0.485***	-0.171**
(Score 1-5)	(0.024)	(0.023)	(0.085)
Constant	3.008***	-0.407	2.313
	(1.045)	(1.048)	(3.693)
Control	YES	YES	YES
Time*City FE	YES	YES	YES
Tenant FE	YES	YES	NO
Observations	6,692	4,869	1,880
# Buildings	799	615	598
R-squared	0.584	0.693	0.196
Panal B: Stayed Short Tenants(Bottom 50th percentile)			
Overall Satisfaction$_{i,b,t}$	0.307***	0.502***	-0.234***
(Score 1-5)	(0.034)	(0.041)	(0.055)
Constant	0.907	0.955	3.517**
	(1.348)	(0.944)	(1.666)
Control	YES	YES	YES
Time*City FE	YES	YES	YES
Tenant FE	YES	YES	NO
Observations	4,010	2,631	3,757
# Buildings	760	542	651
R-squared	0.660	0.743	0.232

Note: Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. 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.

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 104,586 tenant surveys from 2,906 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 a more satisfied tenant is positively related to the decision to renew the lease. 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 contractual rents (vs. listed rents) shows a bigger positive effect from tenant satisfaction. Finally, the 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.

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 investment in their tenant 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.

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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$_{i,b,t+1}$ (YES=1)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overall Satisfaction$_{i,b,t}$	0.426***	0.427***	0.330***	0.598***	0.593***	0.492***	-0.208***	-0.158***
(Score 1-5)	(0.005)	(0.005)	(0.007)	(0.005)	(0.005)	(0.007)	(0.016)	(0.034)
Building Class:								
Class A$_b$	-0.147***	-0.093*	0.074	0.007	0.025	-0.013	0.288	0.411
(YES=1)	(0.047)	(0.050)	(0.091)	(0.035)	(0.039)	(0.057)	(0.303)	(0.682)
Class B$_b$	-0.125***	-0.088*	0.033	-0.044	-0.006	-0.056	0.369	0.696
(YES=1)	(0.046)	(0.049)	(0.090)	(0.035)	(0.038)	(0.056)	(0.300)	(0.655)
Construction Year:								
1970_1980$_b$	0.024	0.008	-0.012	-0.018	-0.032**	-0.043	-0.071	-0.037
(YES=1)	(0.020)	(0.020)	(0.032)	(0.014)	(0.016)	(0.028)	(0.112)	(0.304)
1980_1990$_b$	0.001	-0.003	0.025	0.009	0.003	-0.009	-0.259**	-0.568*
(YES=1)	(0.017)	(0.019)	(0.032)	(0.012)	(0.015)	(0.026)	(0.101)	(0.304)
1990_2000$_b$	-0.026	-0.032	0.025	0.052***	0.034**	-0.007	-0.429***	-0.525
(YES=1)	(0.020)	(0.021)	(0.035)	(0.014)	(0.016)	(0.028)	(0.121)	(0.364)
After 2000$_b$	-0.012	-0.011	0.034	0.050***	0.045***	0.028	-0.467***	-0.395
(YES=1)	(0.021)	(0.023)	(0.036)	(0.014)	(0.016)	(0.029)	(0.121)	(0.355)
Stories:								
High$_b$	-0.001	-0.018	-0.026	0.027***	0.030*	0.022	0.183***	0.016
(YES=1)	(0.013)	(0.018)	(0.030)	(0.010)	(0.015)	(0.028)	(0.071)	(0.280)
Medium$_b$	0.012	0.001	0.015	-0.004	-0.002	-0.006	0.126*	-0.158
(YES=1)	(0.013)	(0.015)	(0.021)	(0.010)	(0.012)	(0.019)	(0.067)	(0.221)
Renovated$_{b,t}$	0.005	0.011	0.035**	0.029***	0.012	-0.004	-0.348***	-0.342
(YES=1)	(0.012)	(0.012)	(0.018)	(0.010)	(0.010)	(0.015)	(0.076)	(0.219)
Log(Typical floor size$_b$)	0.001	0.019	0.017	0.032***	0.041***	0.047***	0.011	-0.031
(SF)	(0.011)	(0.012)	(0.020)	(0.008)	(0.009)	(0.016)	(0.060)	(0.180)
Amenities$_b$	0.024*	0.019	0.039*	0.014	0.016	-0.001	0.205***	0.723***
(YES=1)	(0.013)	(0.015)	(0.021)	(0.009)	(0.010)	(0.017)	(0.072)	(0.232)
Constant	2.082***	1.861***	2.106***	1.326***	1.238***	1.699***	0.445	2.236
	(0.117)	(0.128)	(0.227)	(0.087)	(0.094)	(0.166)	(0.641)	(2.212)
Time * City FE	NO	YES	YES	NO	YES	YES	NO	YES
Tenant FE	NO	NO	YES	NO	NO	YES	NO	NO
Observations	83,301	83,198	69,158	60,233	60,162	48,526	45,586	18,245
# Buildings	2,854	2,819	2,490	2,183	2,160	1,944	2,937	1,930
R-squared	0.123	0.157	0.554	0.374	0.394	0.670	0.014	0.194

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.

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$_{b,t}$)	0.006	0.006	0.017*	0.053**	0.043*	0.059**	-0.296***	-0.246***	-0.243***
(Score 1-5)	(0.007)	(0.007)	(0.009)	(0.021)	(0.023)	(0.026)	(0.066)	(0.068)	(0.081)
Lagged Level:									
Log(Rent$_{b,t}$)	-0.012***	-0.013***	-0.048***	-0.000	-0.006	-0.030*			
($/SF)	(0.003)	(0.003)	(0.008)	(0.006)	(0.007)	(0.016)			
Log(Vacancy Rate$_{b,t}$)				0.029***	0.030***	0.035***	-0.229***	-0.242***	-0.278***
(%)				(0.003)	(0.003)	(0.003)	(0.009)	(0.009)	(0.012)
Building Class:									
Building Class A$_b$				(0.003)	(0.003)	(0.003)	(0.009)	(0.009)	(0.012)
(YES=1)		(0.014)	(0.016)		(0.040)	(0.064)		(0.092)	(0.107)
Building Class B$_b$		0.009	0.009		0.023	0.038		-0.045	-0.046
(YES=1)		(0.014)	(0.016)		(0.040)	(0.065)		(0.091)	(0.106)
Construction Year:									
1970_1980$_b$		0.001	-0.001		0.004	0.007		0.040	-0.009
(YES=1)		(0.005)	(0.005)		(0.010)	(0.011)		(0.035)	(0.034)
1980_1990$_b$		-0.004	-0.006		-0.005	0.002		0.084***	-0.015
(YES=1)		(0.004)	(0.005)		(0.009)	(0.011)		(0.026)	(0.031)
1990_2000$_b$		-0.006	-0.006		-0.002	-0.002		0.089***	-0.004
(YES=1)		(0.005)	(0.006)		(0.010)	(0.012)		(0.033)	(0.038)
After 2000$_b$		-0.007	-0.004		-0.000	0.009		0.016	-0.136***
(YES=1)		(0.005)	(0.006)		(0.011)	(0.012)		(0.033)	(0.040)
Stories:									
High$_b$		0.002	0.007		0.010*	0.014*		-0.088***	-0.045
(YES=1)		(0.003)	(0.005)		(0.006)	(0.008)		(0.024)	(0.032)
Medium$_b$		0.002	0.003		0.009*	0.009		-0.032	-0.022
(YES=1)		(0.002)	(0.003)		(0.005)	(0.007)		(0.023)	(0.028)
Renovated$_{b,t}$		-0.003	0.002		0.007	0.016***		-0.026	-0.047**
(YES=1)		(0.002)	(0.003)		(0.005)	(0.006)		(0.018)	(0.020)
Log(Typical Floor Size)$_b$		-0.001	0.002		0.003	0.010		-0.060***	-0.077***
(SF)		(0.002)	(0.003)		(0.005)	(0.006)		(0.018)	(0.022)
Amenities$_b$		0.004	0.002		-0.003	-0.008		0.082***	0.071***
(YES=1)		(0.002)	(0.003)		(0.006)	(0.007)		(0.021)	(0.025)
Constant	0.050***	0.057**	0.138***	-0.134***	-0.161**	-0.198*	0.989***	1.574***	1.892***
	(0.013)	(0.025)	(0.042)	(0.037)	(0.069)	(0.118)	(0.103)	(0.213)	(0.259)
Time * City FE	NO	NO	YES	NO	NO	YES	NO	NO	YES
Observations	4,717	4,717	4,100	4,378	4,378	3,802	6,361	6,361	5,703
# Buildings	1,672	1,672	1,500	1,573	1,573	1,409	2,134	2,134	1,963
R-squared	0.005	0.009	0.232	0.041	0.045	0.266	0.120	0.131	0.309

Note: Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Explained variables are winsorized at their respective 1st and 99th percentiles to reduce the influence of outliers.

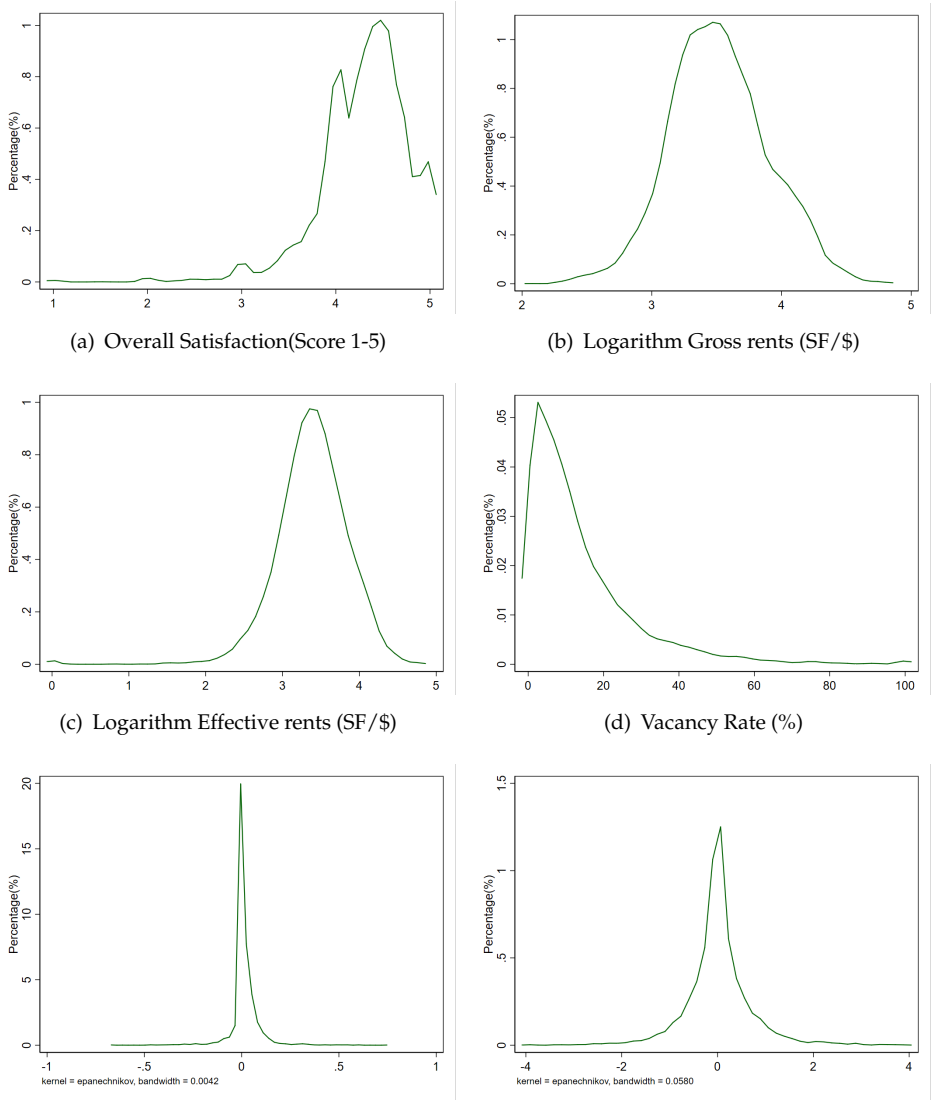
A2. OLS model results for move-out status

TABLE A3—TENANT SATISFACTION AND MOVE OUT DECISION

	Logit Regression		OLS model		
	(1)	(2)	(3)	(4)	(5)
Overall Satisfaction$_{i,b,t}$	-0.208***	-0.158***	-0.051***	-0.009***	-0.009**
(Score 1-5)	(0.016)	(0.034)	(0.004)	(0.002)	(0.004)
Constant	0.445	2.236	0.610***	0.475***	0.580***
	(0.641)	(2.212)	(0.156)	(0.151)	(0.136)
Control$_b$	YES	YES	YES	YES	YES
Time * City FE	NO	YES	NO	YES	YES
Tenant FE	NO	NO	NO	NO	YES
Observations	45,586	18,245	45,586	45,404	12,875
# Buildings	2,937	1,930	2,668	2,625	2,170
R-squared	0.014	0.194	0.019	0.761	0.842

Note: Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Columns (1) and (2) are the same as the results in Table 2. The dependent variable is a binary variable that takes one if the tenant is no longer in the building today and zeroes otherwise.

A3. Density distribution of Main Research Variables



(a) Overall Satisfaction(Score 1-5)

(b) Logarithm Gross rents (SF/$)

(c) Logarithm Effective rents (SF/$)

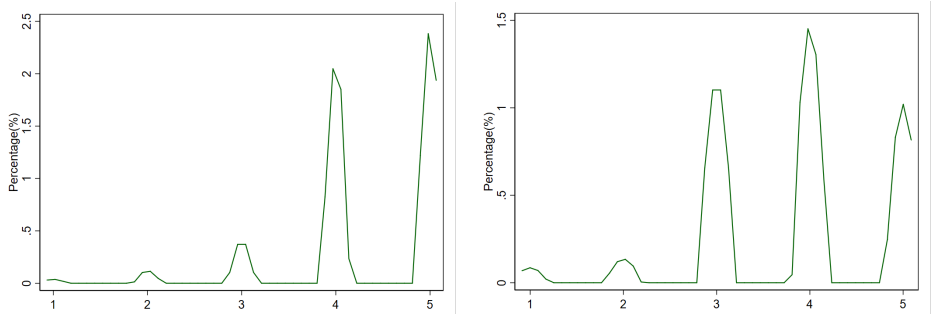
(d) Vacancy Rate (%)

(e) Logarithm Rents Growth (%)

(f) Logarithm Vacancy Growth (%)

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

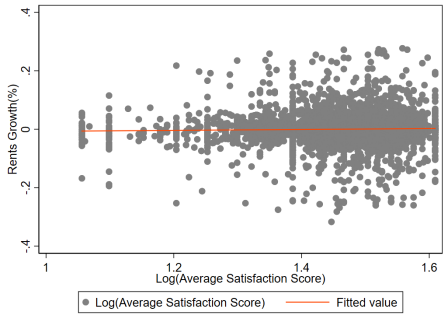
Note: Satisfaction, Renewal intention, Vacancy rate, Gross rent, and Effective rents are the arithmetic average. In this section, the statistics of the Vacancy rate, Gross rent, and Effective rents are only the observations of those properties in years that have survey responses.



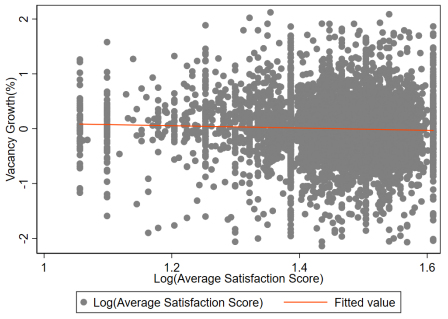
(a) Overall Satisfaction(Score 1-5) (b) Renewal Intention(Score 1-5)

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

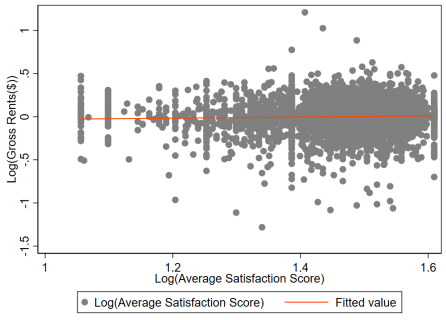
A4. Scatter Plot of Residual of main research variables and satisfaction



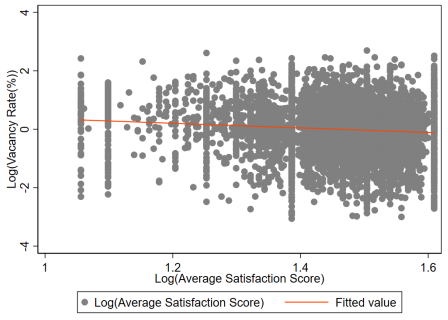
(a) Rents Growth Residual and Satisfaction



(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 city-by-year 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.

A5. Satisfaction's Rent Effects and Vacancy Effects

TABLE A4—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$_{b,t}$)	0.075*	0.329***	-0.849***
(Score 1-5)	(0.039)	(0.079)	(0.161)
Building Class:			
Class A$_b$	0.127	0.215	0.244
(YES=1)	(0.090)	(0.241)	(0.280)
Class B$_b$	0.016	0.077	0.304
(YES=1)	(0.090)	(0.243)	(0.280)
Construction Year:			
1970_1980$_b$	-0.039	-0.042	-0.014
(YES=1)	(0.027)	(0.036)	(0.078)
1980_1990$_b$	-0.033	-0.019	0.011
(YES=1)	(0.024)	(0.032)	(0.074)
1990_2000$_b$	0.030	0.037	-0.061
(YES=1)	(0.028)	(0.037)	(0.096)
After 2000$_b$	0.090***	0.124***	-0.350***
(YES=1)	(0.027)	(0.036)	(0.089)
Stories:			
High$_b$	0.140***	0.180***	-0.084
(YES=1)	(0.022)	(0.028)	(0.069)
Medium$_b$	0.066***	0.102***	-0.091
(YES=1)	(0.016)	(0.022)	(0.059)
Renovated$_{b,t}$	0.026*	0.036*	0.023
(YES=1)	(0.014)	(0.021)	(0.046)
Log(Typical Floor Size)$_b$	-0.021	0.010	-0.165***
(YES=1)	(0.013)	(0.019)	(0.046)
Amenities$_b$	0.029*	0.012	0.117**
(YES=1)	(0.016)	(0.023)	(0.050)
Constant	3.463***	2.552***	4.896***
	(0.166)	(0.324)	(0.536)
Time*City FE	YES	YES	YES
Observations	4,503	4,266	6,030
# Buildings	1,635	1,570	2,090
R-squared	0.802	0.678	0.306

Note: Robust standard errors are clustered by building in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Explained variables and main explanatory variables are winsorized at their respective 1st and 99th percentiles to reduce the influence of outliers.

A6. Satisfaction sub-component analysis and summary statistics

TABLE A5—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	-0.09	-0.02	0.37	0.88	0.14	-0.07	0.06	0.07	0.01	-0.02	0.01	0.03	0.00	0.01	-0.02	0.01	0.01		
Accessibility	0.24	-0.29	0.01	-0.03	-0.05	0.06	0.06	-0.05	-0.08	0.37	0.76	-0.28	-0.02	0.07	0.06	-0.07	-0.19	-0.01		
Special Needs	0.24	-0.30	-0.05	-0.05	-0.08	-0.02	-0.04	0.05	-0.01	-0.58	0.18	-0.08	0.56	0.06	-0.11	0.15	0.32	0.02		
Communication	0.25	-0.32	-0.03	-0.05	-0.04	0.02	-0.03	0.00	-0.02	-0.01	-0.05	0.11	-0.55	-0.17	-0.10	0.67	0.17	-0.03		
Problem Solving	0.25	-0.30	-0.08	-0.04	-0.07	-0.02	-0.06	0.03	0.08	-0.43	-0.17	0.02	-0.22	0.01	0.01	-0.27	-0.69	-0.05		
Professionalism	0.23	-0.33	0.06	-0.07	-0.07	-0.01	0.10	-0.03	0.00	0.52	-0.45	0.14	0.48	0.09	0.04	0.18	-0.20	-0.05		
Responsiveness	0.24	-0.34	-0.03	-0.07	-0.08	-0.01	0.03	0.01	-0.01	0.12	-0.17	0.10	-0.23	-0.07	0.08	-0.62	0.53	0.11		
Building Quality:																				
Amenities	0.23	0.17	0.24	0.10	-0.13	-0.03	-0.76	0.12	-0.14	0.08	0.14	0.42	0.07	-0.06	0.03	-0.04	-0.03	0.02		
Location	0.25	0.25	-0.09	-0.24	0.01	0.36	0.09	-0.04	-0.03	-0.03	-0.01	-0.07	0.15	-0.75	0.28	0.00	-0.05	-0.03		
Quality	0.22	0.22	-0.28	-0.08	-0.10	0.70	-0.02	-0.24	-0.02	0.00	-0.03	0.12	-0.05	0.46	-0.18	-0.01	0.04	0.01		
Elevator Appearance	0.26	0.20	0.23	-0.31	0.16	-0.23	0.12	-0.20	0.11	-0.04	0.06	0.10	-0.04	0.11	-0.06	-0.06	0.09	-0.75		
Elevator Performance	0.25	0.20	-0.34	0.25	-0.10	-0.26	0.07	-0.03	0.12	0.15	0.03	0.00	0.06	-0.28	-0.71	-0.10	-0.04	0.03		
Commom Area	0.23	0.18	-0.44	0.30	-0.16	-0.26	0.00	-0.08	0.42	0.00	0.05	0.07	0.00	0.15	0.56	0.11	0.06	-0.02		
Restroom	0.24	0.18	-0.12	0.16	0.02	-0.24	0.22	-0.07	-0.84	-0.08	-0.08	-0.01	-0.04	0.11	0.16	0.02	-0.03	0.03		
Lobby	0.18	0.08	0.58	0.55	-0.26	0.22	0.40	0.08	0.12	-0.10	0.03	0.10	-0.03	-0.03	0.01	-0.01	0.00	-0.01		
Indoor Environmental Quality:																				
IAQ	0.26	0.15	0.22	0.05	-0.07	-0.03	-0.33	-0.09	0.06	0.04	-0.30	-0.79	-0.07	0.09	-0.01	0.03	0.07	0.04		
Heating	0.23	0.22	-0.05	-0.27	0.03	0.00	0.15	0.87	0.05	0.06	0.01	-0.04	-0.05	0.19	-0.01	0.03	0.01	0.06		
Lighting	0.24	0.20	0.28	-0.35	0.17	-0.23	0.16	-0.31	0.18	-0.05	0.07	0.16	-0.02	0.09	-0.02	0.05	-0.07	0.65		
Cum explained(%)	52.74%	65.05%	69.98%	74.04%	77.44%	80.60%	83.35%	85.83%	87.96%	89.73%	91.45%	93.04%	94.45%	95.79%	97.00%	98.11%	99.11%	100.00%		

Panel B: Distribution of Satisfaction Measures																				
Percentile	f1	f2	Accu	Acce	Spe	Com	Prob	Prof	Resp	Ame	Loca	Qual	EleA	EleP	Comm	Rest	Lobby	IAQ	Heating	Light
1	-3.14	-2.55	1	2	1	2	1	2	2	1	3	2	1	1	2	1	2	1	1	2
5	-1.88	-1.63	3	3	3	3	3	3	3	2	4	3	2	2	3	2	3	2	2	3
10	-1.31	-1.22	3	4	4	4	3	4	4	3	4	3	3	2	3	3	4	3	2	3
25	-0.60	-0.57	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	3	4
50	0.16	0.14	4	5	5	5	5	5	5	4	5	4	4	4	5	4	5	4	4	4
75	0.88	0.37	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
90	1.08	0.93	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
95	1.08	1.59	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
99	1.08	3.07	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Panel C: Correlation of liquidity proxies																				
	f1	f2	Accu	Acce	Spe	Com	Prob	Prof	Resp	Ame	Loca	Qual	EleA	EleP	Comm	Rest	Lobby	IAQ	Heating	Light
f1	1.00																			
f2	0.00	1.00																		
Management:																				
Statement Accuracy	0.62	-0.13	1.00																	
Accessibility	0.74	-0.43	0.48	1.00																
Special Needs	0.75	-0.45	0.47	0.71	1.00															
Communication	0.76	-0.48	0.50	0.74	0.74	1.00														
Problem Solving	0.78	-0.45	0.50	0.70	0.78	0.79	1.00													
Professionalism	0.71	-0.50	0.46	0.70	0.70	0.74	0.72	1.00												
Responsiveness	0.75	-0.51	0.48	0.74	0.74	0.79	0.79	0.77	1.00											
Building Quality:																				
Amenities	0.71	0.25	0.39	0.41	0.42	0.42	0.43	0.38	0.40	1.00										
Location	0.55	0.12	0.33	0.36	0.33	0.33	0.33	0.34	0.33	0.46	1.00									
Quality	0.79	0.23	0.44	0.48	0.48	0.48	0.51	0.46	0.47	0.68	0.51	1.00								
Elevator Appearance	0.76	0.36	0.39	0.42	0.41	0.41	0.43	0.37	0.40	0.56	0.38	0.64	1.00							
Elevator Performance	0.67	0.32	0.36	0.37	0.36	0.37	0.39	0.32	0.35	0.48	0.32	0.54	0.71	1.00						
Appearance of Commom Area	0.79	0.30	0.42	0.46	0.45	0.45	0.47	0.43	0.45	0.60	0.44	0.69	0.68	0.52	1.00					
Appearance of Restroom	0.69	0.32	0.35	0.37	0.39	0.38	0.41	0.35	0.37	0.52	0.34	0.56	0.65	0.52	0.63	1.00				
Appearance of Lobby	0.75	0.29	0.39	0.43	0.42	0.43	0.44	0.41	0.41	0.56	0.42	0.65	0.65	0.49	0.83	0.58	1.00			
IEQ:																				
IAQ	0.76	0.29	0.43	0.43	0.44	0.44	0.46	0.39	0.43	0.54	0.38	0.60	0.62	0.57	0.58	0.57	0.54	1.00		
Heating	0.70	0.26	0.39	0.39	0.42	0.41	0.46	0.35	0.40	0.49	0.32	0.55	0.56	0.55	0.52	0.51	0.48	0.77	1.00	
Lighting	0.75	0.26	0.43	0.43	0.44	0.44	0.45	0.40	0.43	0.54	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 A.A8 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.

A7. Stability of Submarket Vacancy Ranking Liquidity

TABLE A6—SUBMARKET VACANCY RANKING LIQUIDITY OF 50TH PERCENTILE

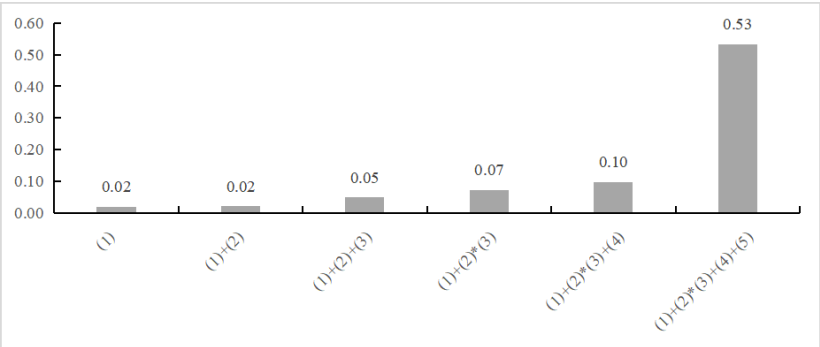
		NO	YES	Total
Top 50 percentile	NO	88.08	11.92	100
Bottom 50 percentile	YES	11.92	88.08	100
	Total	50	50	100

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.

A8. Question Library

Interpretation of question	Answer Scale
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
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 the statement accuracy.	Poor to excellent
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 problem resolution	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
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

A9. R-square explained for each stage



(e) R-square explained of overall satisfaction for each stage

Note: (1) is the building characteristics, (2) is the year fixed effect, (3) is the city fixed effect, (4) is the property management fixed effect, and (5) is the tenant fixed effect.

A10. Worries from the Distribution of Survey Answers

TABLE A7—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*	0.019*	0.059**	0.046	-0.245***	-0.178
(Score 1-5)	(0.009)	(0.011)	(0.027)	(0.039)	(0.082)	(0.114)
Constant	0.140***	1.158***	-0.200*	1.282***	1.900***	1.605***
	(0.043)	(0.096)	(0.121)	(0.168)	(0.261)	(0.171)
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	4,100	4,238	3,802	3,897	5,703	5,756
# Buildings	1,500	1,190	1,409	1,095	1,963	1,524
R-squared	0.233	0.470	0.265	0.427	0.310	0.470

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 2. Explained variables are winsorized at their respective 1st and 99th percentiles to reduce the influence of outliers.

Table A7 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 2.

A11. Mediation Model

(A1) $$Log(Satisfaction_{b,t}) = \alpha + \beta Green_{b,t}/GMgmt_{b,t} + \gamma X_b + \mu_t * \lambda_c + \varepsilon_{b,t}$$

(A2)
$$\Delta Log(Performance_{b,t+1,t}) = \alpha + \beta Green_{b,t}/GMgmt_{b,t} + \theta LaggedLevel_{b,t} + \gamma X_b + \mu_t * \lambda_c + \varepsilon_{b,t}$$

(A3)
$$\begin{aligned}\Delta Log(Performance_{b,t+1,t}) =& \alpha + \delta Log(Satisfaction_{b,t}) + \beta Green_{b,t}/GMgmt_{b,t} \\ &+ \theta LaggedLevel_{b,t} + \gamma X_b + \mu_t * \lambda_c + \varepsilon_{b,t}\end{aligned}$$

Equation A1 try to analyze whether the property management quality and the indoor environment have some influence on tenant satisfaction. Equation A2 investigates whether property management quality and the indoor environment affect the tenant's decision and building performance. Equation A3 try to study how overall satisfaction mitigates the effect of property management quality and the indoor environment.

$Green_{b,t}$ 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[34].

$GMgmt_{b,t}$ 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. $GMgmt_{b,t}$ equals 1 means it's a good quality property management company, and 0 otherwise[35]. 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[36][37]. The control

[34]In this section, we didn't distinguish between LEED or WELL, partially certified or the whole building, or the certified level.

[35]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

[36]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.

[37]There is no problem with certain companies managing just only a certain quality type of buildings, tenants

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.

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. 1110 buildings were always managed by the lower 50% percentile property management company