ESG and Occupant Retention in Multifamily Apartments

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Abstract: Advocates of Environmental, Social, and Governance (ESG) practice argue that proactive investment in ESG performance delivers benefits to real estate investors in the form of reduced tenant turnover and competitive advantage in tenant recruitment. Survey methodologies have been used to associate environmental certification with occupant satisfaction, implying that observed satisfaction results in reduced turnover and vacancy. But long lease term structures in office markets, where ESG research is popular, limit direct examination of turnover and vacancy outcomes associated with ESG investment. Multifamily, with its annual lease renewal cycle, is a better product to observe tenant decisions between certified and non-certified assets. Using a database of United States multifamily lease contracts signed between January 2019 and the March 2020, a logistic regression model finds that tenants are approximately 4% more likely to renew leases in labeled assets, verifying the hypothesis of reduced turnover associated with ESG investment. Furthermore, there is a clear distinction that eco-labels associated with audited cost savings, such as Energy Star, and management quality in existing buildings are responsible for increased renewal probability. However, when a Poisson regression investigates the number of months vacancy persists until filled, there is no clear relationship between ESG and the duration of vacancy. In conclusion, ESG investments marginally increase retention rates for existing tenants, but do not appear to provide a notable competitive advantage when recruiting new tenants in the US multifamily market.

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Introduction

In the past decade, the business case for private capital investment in Environmental, Social, and Governance (ESG) outcomes has shifted from a value-add return strategy to a proactive market transition risk management strategy. Current discourse on ESG in both Europe and the United States is related to regulatory risks of inaction and strategies to maintain leadership in dynamic regulatory regimes (Vrensen et al. 2020; Cloutier et al. 2021; Robinson & McIntosh 2022). While these risks theoretically span a range of ESG outcomes, regulatory actions in response to demand for greenhouse gas mitigation and climate change adaptation best represent this global market transition risk. Additional ESG transition risks include global demand for enhanced occupant health and wellness triggered by the recent COVID-19 pandemic and local demand for cultural and gender equality triggered by historical discrimination.

The most common strategy to manage future ESG market transition risks is certification or labeling, which identify properties that exceed standards in pursuit of ESG objectives (Gabe and Christensen, 2019). By outperforming existing regulatory minimums, the risk of regulatory obsolescence, vacancy, and costly capital spend needed to cure any defect is expected to reduce. Eco-labels, which specifically identify assets that conserve natural capital and reduce environmental damage relative to minimum standards, are the most popular ESG labelling strategy given the salience of climate change as a market transition risk. In the United States, popular eco-labels include the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED), Energy Star, Institute for Real Estate Management (IREM) Certified Sustainable Property, and Green Globes.

Besides reducing future market obsolescence risks, advocates of eco-labels make further claims of immediate competitive advantage benefits resulting from the labels themselves as well as the capital investments required to obtain labelling standards. For example, according to the US Green Building Council (USGBC, 2023), the "Top 10" reasons to pursue a LEED eco-label are: (1) energy efficiency and reduced carbon emissions, (2) third-party accountability, (3) higher resale value, (4) lower operational costs, (5) less waste, (6) increase employee/occupant retention, (7) alignment with corporate ESG goals, (8) tax benefits, (9) management efficiency, and (10) LEED's dominant market share of eco-labeled buildings in the United States. Of these, only claim #3 addresses future market transition risks while the other nine provide an immediate advantage in the real estate space and asset markets.

Research on these benefits is widespread. Most popular are studies examining price effects. Many find evidence of claim #3, that eco-labeled properties sell for higher prices on resale (e.g. Eichholtz et al. 2010 for office markets). Since prices are a function of income return and risk, subsequent research investigated income return and found mixed evidence that eco-labels may increase rental rates (e.g. Bond & Devine 2016) but have no effect on total cost of occupancy (e.g. Gabe & Rehm 2014). More recent research on aggregated portfolio returns reveals that ESG premiums associate with capital returns, but not income returns (Devine et al. 2022). In general, the research canon suggests that eco-label price premiums benefit asset owners because eco-labels improve investors' forward-looking net income risk perceptions.

But there has been very little empirical research that *perceptions* of reduced risk associated with eco-labels match *outcomes*. Most real estate research measures risk via the capitalization (cap) rate (e.g. Pivo and Fisher, 2010; McGrath, 2013; Gabe et al. 2021a), but cap rates measure perceptions of risk, either at the time of purchase (transaction cap rates) or as a benchmark of current capital market sentiment (market cap rates). The major contribution this project seeks is to observe a risk-related ***outcome*** at the asset scale of commercial real estate investment – tenant attraction and retention – and associate this outcome with proactive eco-labelling strategy.

The USGBC describes retention in their marketing as the #6 benefit of pursuing LEED certification. To date, evidence of this benefit has been investigated indirectly, through the lens of occupant satisfaction as a proxy measure for retention. These occupant satisfaction studies rely on surveys to conclude that occupants, usually office tenants, prefer to work in eco-labeled or wellness-labeled buildings (e.g. Kok et al. 2023; Robinson et al. 2016). Thus, logic suggests satisfied office tenants are more likely to renew their leases.

Using lease transaction and unit rent roll data from a major US multifamily portfolio in 2019 and 2020, this paper observes tenant retention and attraction outcomes. Two specific research questions guide the work. First, on tenant retention, are tenants in eco-labeled multifamily apartment buildings more likely to renew their leases compared with tenants in unlabeled properties? Second, on tenant attraction, does the presence of an eco-label reduce time-to-lease vacant space? Combined, these two empirical outcomes lead to conclusions about the contribution of eco-labels to reduce vacancy losses. To answer these questions, logistic and Poisson regressions attribute retention and attraction outcomes respectively to ESG activity alongside exogenous control variables such as size, age, apartment complex amenities, location, seasonality, and neighbourhood effects expected to influence tenant decisions. Results show a marginal improvement in retention as a result of ESG investment in existing buildings, but no clear effect on attraction.

Literature

This study contributes to the literature on market transformation effects associated with ESG information becoming more accessible to the market. Existing studies have considered the market effects of ESG investment on real estate asset prices, real estate capitalization rates, rents, net income, operating costs, portfolio returns, and occupant satisfaction. Below is a sample of these narratives and how this study finds its niche in evaluating a gap in the literature on empirical evidence of tenant attraction and retention. For a more thorough review of this literature, consult Robinson & McIntosh (2022).

Rental and Asset Premiums

Seminal works regarding the impact of eco-certification typically involve the commercial office sector, given its early adoption of LEED and Energy Star certified properties. The majority of these studies investigate asset and rental pricing at the building scale. For example, Wiley et al. (2010) examined Class A office properties and found sales premiums to range from $29.71 per square foot for Energy Star properties and $129 per square foot for LEED certified properties. They also found rental premiums ranging from a low of 7.3% for Energy Star properties to a high of 17.3% for LEED properties. Eichholtz et al. (2010) and Fuerst and McAllister (2011) examined a broader range of commercial office properties with the former attaining a 16% sales premium and a 3.3% rental premium for the Energy Star certification, and the latter identifying sales premiums of approximately 25% and rental premiums of approximately 5% for both LEED and Energy Star. It should be noted that the number of eco-certified properties in the marketplace at this time was relatively low, so there is likely a first-mover advantage included in these results. In addition, LEED at this time was a design-only certification, with no disclosure or liability for post-occupancy performance. Later, Kok et al. (2012) examined the early impact of the only operational-stage LEED certification – LEED for Existing Buildings Operations and Management (EBOM) – and found a $2 per square foot rental premium.

Eco-labelling in multifamily properties is less popular relative to office properties, so the asset and rental price literature here is thin. Couch, Carswell & Zahirovic-Herbert (2015) examined the relationship between LEED and sales prices for multi-family properties in the Chicago, New York, Portland, and Seattle markets. Their resultant sample of 136 properties consisted of 25 LEED certified, and 111 non-certified control properties, with results indicating that LEED certification was not a significant predictor of variation in asset pricing. The next year, Bond & Devine (2016) investigated the impact of green multi-family housing on rental rates. They hand-collected a sample comprising 97 LEED-certified properties and 193 comparable properties, totaling 26,774 and 57,115 units, respectively, and found a 9% rent premium for LEED-certified units. The sample also included a substantial volume of building attributes beyond basic characteristics and introduced a Walk Score to the model—building on work by Pivo & Fisher (2010) to account for urban form.

More recently, Gabe et al. (2023) replicated Bond & Devine (2016) with a much larger sample of 82,094 unique market-rate multifamily apartment complexes across 36 CBSAs, with 736 of those buildings being LEED certified. They used monthly configuration-weighted asking rent observations obtained through Apartments.com to calculate the average rent per square foot for each individual multi-family building relative to the weighted average per configuration type. Price premiums were nearly identical in magnitude to Bond & Devine, between 7% and 10% depending on specification, demonstrating validity and persistence of market pricing incentives across time.

Challenges of Attribution

One major challenge faced in the literature using eco-labels to quantify market transformation for ESG is attribution of observed premiums to ESG investment and ESG performance. Notably, ESG investment also correlates with age, premium amenities, external governance, and occupant satisfaction (Robinson & Sanderford, 2016). Studies have shown how eco-certifications that only require energy efficiency modelling associate with occupant satisfaction (Parkinson et al. 2013) and confidence via third-party governance during the auditing process (Costa et al., 2018; Sedlacek & Meier, 2012). Furthermore, the correlation between ESG certification and ESG performance is poor, particularly for the design- and construction-stage assessments of new developments that are typically used in asset and pricing studies (Gabe & Christensen, 2019).

Better empirical evidence of these ESG pricing effects can be seen when improved statistical controls for these endogenous correlates are used. ESG pricing effects tend to remain material, but reduce in economic importance. For example, Gabe et al. (2021a) found that multifamily apartment eco-label rent premiums decrease, from 7% to 4%, when enhanced intra-urban spatial controls from the EPA Smart Location Database were introduced, because eco-labeled buildings tend to be newer and built in emerging “hot” submarkets. Likewise, the early office eco-labelling literature briefly discussed above provides unrealistic double-digit price and rental premiums associated with design- and construction-stage certifications like LEED for New Development (Eichholtz et al. 2010; Fuerst and McAllister 2011; Wiley et al. 2010). These eco-labeling premiums reduce in magnitude to the low single digits for Energy Star, an operational certification, or when existing building certifications are used (Kok et al. 2012), demonstrating a “hype effect” associated with initial performance expectations.

Occupancy and Satisfaction

As explained in the introduction, producers of eco-labels market improved occupancy rates as a benefit of certification. Empirical work has investigated overall building occupancy rates in the office sector. Fuerst & McAllister (2009), in examining commercial office properties, found occupancy rates to be 8% higher in LEED buildings, and 3% higher for Energy Star buildings (again, evidence of the hype effect). Not dissimilarly, Kok et al. (2012) found that properties with initial lower relative occupancy rates closed that occupancy gap after undergoing renovation and achieving the LEED Existing Buildings certification, though the authors note that these occupancy benefits depended on the timing of renovations and that some of the observed properties continued to exhibit lower occupancy rates. Wiley, et al. (2010), focused only on Class A office buildings, found much higher occupancy rate premiums ranging from a low of 10.2% for Energy Star Certified Properties to a high of 17.9% for some LEED properties.

These early studies on office building occupancy rates are criticized for the endogeneity of novelty with eco-labelling, providing need to isolate what causes occupancy effects in eco-labeled buildings: novelty, hype (marketing), or ESG investment. This question rose to salience following the COVID-19 pandemic, when office occupancy began falling and research sought to quantify the relationship between occupant satisfaction and lease renewal or word-of-mouth recommendations to prospective tenants. For example, Kok et al. (2023) found that tenant satisfaction scores associated with about an 8% increase in stated renewal probability and 11% increase in word-of-mouth recommendations to other tenants. In robustness testing, the authors investigated the mediating factor of eco-labeling (and wellness-labeling) on satisfaction, finding no marginal effect on stated intention to renew directly related to eco-labeling. Instead, the authors find a positive correlation between the presence of an eco-label and overall building satisfaction, which then contributes to the 8% and 11% headline retention and recruitment effects as a result of enhanced satisfaction.

But most research into employee and tenant retention stops at this positive correlation between occupant satisfaction and eco-labeling (for another example, see Guo et al. 2021), leaving an opportunity for our research to contribute by directly measuring retention rates independent of satisfaction. Long term structures associated with office lease renewal decisions present limitations in using the office sector to observe retention since actual decisions are rare. For example, Kok et al. (2023) could only investigate ***stated*** intent to renew, not actual decisions.

This paper is among the first to investigate occupant retention and attraction in the multifamily sector, which typically has annual lease renewals and hundreds of units in a single institutionally-owned complex. The closest existing study is exploratory work in the office market by Devine and Kok (2015). They obtained information on 148 buildings in Canada, modelled the probability of lease renewal over 10 years using a probit model, and found that LEED had no effect on lease renewal probability, but BOMABest certification may have a marginal 3.4% increased likelihood of renewal. However, their results are statistically weak, with only a handful of certified buildings in a geographically diverse portfolio, and inconsistency during robustness testing, including a decrease in the probability of renewal if an asset was dual-certified (BOMABest and LEED).

To improve on Devine and Kok (2015), the multifamily market is a much better laboratory to investigate these intangible risk-based outcomes empirically. Apartments generate more leasing activity and thus much higher turnover to observe empirical differentiation of actual retention decisions between eco-labeled and non-labeled product. This study will also introduce a novel model to test the hypothesis that eco-labels reduce vacancy risk through enhanced tenant attraction.

Data

Observation of multifamily apartment lease transactions and monthly rent roll information comes from one of the top U.S. multifamily owner/operators with a significant management portfolio. Their data contain approximately 2,000 apartment complexes spanning 41 states and 124 unique Core-based Statistical Areas (CBSAs) for the time period January 2019 through March 2020. After March 2020, the COVID-19 pandemic is expected to influence both rent collection and lease renewal incentives, thus data after March 2020 is considered unrepresentative of an open market. As a result, this study can serve as a pre-COVID benchmark and a future follow-up study can investigate any pandemic effects.

Four separate datasets obtained from the owner are used in this research. Two are observed at the individual unit scale, including a record of every leasing transaction (hereafter the “lease transaction” dataset) and monthly observations of rent paid for each unit (hereafter the “rent roll” dataset). The other two are observed at the apartment complex scale: descriptive characteristics of each complex (hereafter the “property information” dataset) and results from an internal company survey into ESG characteristics and technology (hereafter the “sustainability” dataset). In general, later model identifications combine one of the unit datasets with both apartment complex datasets.

Multifamily Apartment Data

The lease transaction dataset is 406,035 transactions over the entire 15-month observation period. Each transaction record identifies the apartment complex, unit number, whether the rent is above or below the submarket average (binary variable only), lease term duration, and, important for this research, whether the lease is a renewal of an existing tenant or a new contract with a new tenant. These transactions take place in 2,048 unique apartment complexes. About 2.6% of the lease transactions (10,674) contract for an effective rent below the submarket average. Importantly, these discounted rent transactions are not concentrated in any single complex; discounts are observed in 1,559 of the 2,048 complexes (76%). Just under half of observed lease transactions (48%) are renewals to an existing tenant.

The rent roll dataset is 14,471,914 monthly effective rent observations across 1,112,251 unique units from January 2019 through March 2020. Each observation includes descriptive information about the unit (number of bedrooms, number of bathrooms, and rentable square feet), an estimate of submarket average rent, a flag indicating whether the unit is currently occupied or vacant, monthly rental concessions, and the overall effective rent due that month. Effective rent is the contracted monthly rent minus any concessions.

The property information dataset is descriptive information about each apartment complex. This includes a street address; use type (seniors housing, student housing, or general residential housing); a quality grade (A+,A,A-,B+,etc.) that accounts for amenities and condition; complex size (number of units and total square feet); and complex-level occupancy rates for every month. With the exception of the monthly occupancy rates, it's assumed that descriptive information about the complex is fixed throughout the two-year observation period.

Finally, the sustainability dataset is the results of an internal survey sent to property managers in 2022. There are 1,333 apartment complexes that completed this survey. It asks each property manager about the presence or absence of hundreds of corporate sustainability activities and policies. Some examples include asking if the complex has a sustainability plan, whether the site uses Forest Stewardship Council (FSC) certified paper, if LED lighting is installed, what category the site's Walk Score aligns with (e.g. car-dependent, walker's paradise), and so on. Mangers that answer "yes" to any of these activities and policies are then asked to input details, such as the % of all lighting in common areas that are LED technology. Of relevance to this research are questions related to the self-reported presence or absence of the following eco-labels: LEED, Energy Star, IREM Certified Sustainable Property, Green Globes, and the National Green Building Standard (NGBS). In addition, the owner aggregates answers to the survey into an internal "form score" from 0 to 328; while the exact methodology behind form score is unknown, it appears to be a weighted sum of all "yes" answers to the survey, thus it can be interpreted that higher form scores are correlated with higher levels of investment in ESG.

Additional Data

To supplement the four datasets from the property owner, additional apartment complex-level information is obtained from external sources. First, each property was geocoded with latitude and longitude obtained from Google Maps API. Geocoding was valid if the location match was described as "rooftop", "range interpolated", or "approximate". Less precise location matches were manually geocoded by locating the property on satellite view using Google Maps. Geolocation coordinates are then used to identify U.S. Census geographies, notably the CBSA, or metropolitan market.

Next, the sustainability dataset was audited and enhanced. Eco-labels were independently verified with the certifying agencies. Many discrepancies were found, as will be discussed later, resulting in two identifications of eco-labelled properties: self-reported (from the sustainability dataset) and independently verified. In addition, Walk Score, a percentile ranking of nearby urban amenities within a 20-minute walking distance, was obtained from Walkscore.com based on the longitude and latitude captured during geocoding. The sustainability dataset contains self-reported Walk Score values, but property managers report Walk Score into one of five categories, not with the precise 1-100 number available on Walkscore.com. The more precise independently obtained Walk Score is used in all modelling specifications.

Research shows tenants are willing to pay higher rents for better schools (Gabe et al. 2021b), so school quality is likely to have an independent effect on tenant retention and attraction. Data from Greatschools.com provides every complex with assigned public schools and associated school quality metrics. The geocoded location of each apartment complex is associated to multiple school catchment zones where there is an enrolment priority specific to the location of the apartment complex.[1] Each matched school is rated on multiple factors, including test scores, equity of outcomes, and student-teacher ratios. Greatschools aggregates these school quality metrics into an overall rating for each school. Since each apartment complex is usually associated with more than one school, a school quality rating is

[1] School choice policies vary by school district. However, in most cases, school districts implementing school choice policies set a spatial catchment zone for each school to enable location as a selection criteria somewhere in the school allocation process. Past research has shown that school choice diminishes the location value associated with school quality (Gabe et al. 2021b), but does not eliminate it, so priority catchment areas still matter even when school choice is available.

associated with each complex by weighting the individual rating associated with each of n matched schools (s) by the inverse of the size of the matched school's catchment area:

$$Apartment\ Complex\ School\ Rating = \frac{\sum_{s=1}^{n} \frac{(School\ Rating)_s}{(Size\ of\ Catchment\ Area)_s}}{\sum_{s=1}^{n} (Size\ of\ Catchment\ Area)_s}$$

The theory is that smaller school catchments are more exclusive to a specific location. This method has a further advantage in this study because past research has shown that renters are most sensitive to primary (elementary) school quality (Gabe et al. 2021b), and primary schools tend to have the smallest catchment size. As a result, primary school quality tends to have a higher weight in the apartment complex school rating.

Finally, while Walk Score captures some aspects of urban spatial structure and thus can serve as an exogenous control for micro-location value within an MSA, further control for urban form is obtained through the first two principal components of the EPA Smart Location Database (Ramsey and Bell, 2014). Gabe et al. (2021a) find that these first two principal components provide continuous variables for urban economic activity (Factor 1) and for exurban low-density urban form (Factor 2), providing spatial control for micro-location in urban areas and aligning well to observed market risk (capitalization rates) associated with location. Latitude and longitude of each complex is used to identify its Census Block Group, which is the geography of the EPA Smart Location Database, and supplementary data from Gabe et al. (2021a) is used to match each Census Block Group with its national-scale Factor 1 (urban) and Factor 2 (exurban) spatial structure scores.[2]

Data Preparation & Descriptive Statistics

In preparation for estimating the models described in the next section, complex-level information (from the property dataset, sustainability dataset, and the additional data described above) is merged into the rent roll and lease transaction datasets. Rent or lease transaction observations missing complex-level information used in any modelling specification are omitted from this study. Lease transactions are limited to lease terms of 11 months (330 days) or greater to eliminate short-term rental units in the

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[2] Gabe et al. (2021) also published Factor 1 and Factor 2 EPA Smart Location Database scores for each individual Metropolitan Statistical Area. However, in this study, not all selected Core-based Statistical Areas fall within a "Metropolitan" Statistical Area – some are "Micropolitan" Statistical Areas – so the national-scale factors are used here. For robustness, all models and analyses in this paper were tested on a reduced sample with the Metropolitan Statistical Area-scale urban form scores, which do not improve nor alter the results reported here.

portfolio. Rent and lease observations in apartment complexes classified as “student housing” were also removed. Finally, to improve confidence in the identification of ESG effects, only units in CBSAs containing at least seven apartment complexes, two or more of which are eco-labeled (either self-identified or independently verified), are included. These four data preparation steps narrowed down the sample to 1,101 apartment complexes across 34 CBSAs. The spatial breakdown of eligible CBSAs can be found in the Appendix.

Exhibit 1 describes unit configuration and size comparisons between the entire rent roll dataset and the selected units after the data preparation described above. One advantage with data from a single owner is the consistency of the owner’s products within its portfolio. The distribution of unit configurations is very similar in both the overall sample and subsample used for model identification. One- and two-bedroom apartments dominate the portfolio, accounting for approximately 85% of units; the remaining 15% is roughly equal between studios and larger 3-bedroom (or more) units. The only notable distributional difference between the entire rent roll dataset and the selected units is the relatively low share of selected units that have 0 or 0.5 bathrooms (i.e. communal bathrooms or showers), likely caused by the exclusion of student housing complexes.

For the selected unit data, Exhibit 2 breaks down the key dependent and independent variables used in later modelling of rental rates and vacancy duration using the rent roll dataset. Of note is the gap in self-reported and verified eco-labels, particularly for LEED and Energy Star. It may be the case that self-identified but not verified LEED properties are “Registered” for LEED certification, leading the property manager to self-report LEED certification, but the complex may have failed the audit for formal certification, chose not to pursue formal certification, or is still in the process of obtaining formal certification after December 2023. Energy Star certification must be renewed annually, so it could be that some properties had obtained formal Energy Star certification in the past but did not renew or did not qualify during the years of this study. Verified Energy Star ratings must have carried formal certification in 2019 or 2020. As expected, other eco-labels (IREM, Green Globes, and NGBS) are less popular, but there is less of a gap between self-reported and verified. Interestingly, IREM certification was underreported by property managers.

As data is sourced from an institutional real estate owner, it is unsurprising that the modal quality grade is high, with approximately 57% of the apartment complexes in the sample rated as “A” or “A+”. Likewise, only 7% of the apartment complexes are rated “B-“ or lower.

For the dependent variables, there is an expected log-normal distribution in rent, with the median ($1485/month effective rent) less than the mean ($1707/month). When a property experiences vacancy, there is an average turnover period of 1.56 months. Exhibit 3 reports the incidence of vacancy duration when vacancy is observed for one month or greater, demonstrating a declining Poisson distribution typical of count data. More than half of all vacancies only last for one month.

Exhibit 4 takes a deeper look at the cross-tabular relationship between quality grades and certification, or the presence of eco-labels. In line with the literature (Robinson and Sanderford, 2016), there is a strong correlation between eco-labelling and premium-grade buildings. In this dataset, for any definition of an eco-label, the presence of an eco-label is a minority of all observations, providing sufficient differentiation within each quality grade for statistical differentiation of quality from the presence of a label. Interestingly, discrepancies between self-identified and verified eco-labels happen at both ends of the quality spectrum. There is less of a correlation between quality and eco-labels at the top of the quality spectrum when verified data is used because "A+" and "A" building managers appear to overreport certification while "A-" building managers underreport the presence of eco-labels.

Model Identification Strategies

Observations in the lease and rent roll datasets are combined with apartment complex-level information to test two hypotheses:

H1: Investment in ESG leads to a higher probability of occupants choosing to renew a lease.
H2: Investment in ESG leads to a shorter vacancy period between occupants.

The theory informing these two hypotheses is that a higher probability of renewal is associated with competitive advantage in tenant retention. Likewise, a shorter vacancy period is associated with competitive advantage in tenant attraction. In a competitive commercial real estate market, advantages in tenant attraction and retention are expected to reduce collection losses and thus increase net income. Lower probability of future collection losses may also lead to a lower capitalization rate of that net income relative to properties with a market average collection loss.

However, before describing the models that test for these two hypotheses, we first validate the apartment datasets by replicating existing findings in the literature, specifically the 7% - 9% institutional multifamily apartment monthly rental rate premiums associated with ESG investment observed by Bond and Devine (2016) and Gabe et al. (2023). Data sourced from a single owner can exhibit sample bias, so this validation through replication helps understand the direction and magnitude of any bias, if present.

All model estimations described below are estimated for the selected subset of unit observations described in the section above that maximise the statistical power to differentiate attraction and retention outcomes as a result of eco-labeling.

Rent Premium Model (Data Validation)

The rent roll dataset serves as the basis for validating past findings that occupants pay higher monthly rental rates to live in eco-labeled multifamily apartment complexes relative to unlabeled properties. The model specification and independent variables explaining monthly rent are chosen to be as similar to Bond and Devine (2016) and Gabe et al. (2023) as possible:

$$LN(Avg\_Month\_Rent)_i = \beta_0 + \beta_1 \overrightarrow{Complex_i} + \beta_2 \overrightarrow{Location_i} + \beta_3 \overrightarrow{Unit_i} + \beta_4 \overrightarrow{ESG_i} + \epsilon_i$$

To avoid overfitting and artificially high statistical confidence that would occur if each monthly rental observation is treated as an independent observation, each unit is assigned an average monthly rent across the entire 15-month period. In the equation above, the logarithm of the average monthly rent for each unit (i) is a linear combination of exogenous variables associated with the apartment building (e.g. quality classification, vacancy rate, and age), the location of the building (e.g. school quality, Census-Based Statistical Area, Walk Score, and EPA Smart Location Database urban form factors), the specific unit (e.g. size, bedroom/bathroom configuration, and timing of observed vacancies), and the ESG variable of interest. Multiple specifications of the ESG vector are tested for robustness, resulting in six modelling specifications:

1. Baseline (ESG vector omitted).
2. Self-identification of an eco-label
3. Independent verification of an eco-label
4. Self-identification of a specific eco-label (e.g. LEED, Energy Star, etc.)
5. Independent verification of a specific eco-label
6. Internal "form score" from the sustainability survey

As described earlier, existing literature suggests an eco-labelling rent premium of between 4% and 9% (Bond and Devine, 2016; Gabe et al., 2023). Data availability means our model specifications are not identical to past work. Notably, we do not observe the presence of specific amenities; instead, the owner's aggregated building quality measure includes information on amenities offered in each apartment complex. In addition, the presence of the two EPA Smart Location Database principal components adds additional control of spatial location value absent from prior studies. As discussed earlier, better identification of location and other endogenous correlates with eco-labeling are expected to reduce statistical attribution of pricing effects to the eco-label. For example, Gabe et al. (2023) observe that the inclusion of Walk Score into its apartment rent model reduced the observed rent premium associated with eco-labeling, so with enhanced spatial controls, we are likely to observe rent premiums on the lower end of what is expected.

Tenant Retention Model

To evaluate H1, the relationship between the probability that a lease is a renewal and the presence of an eco-label, a logistic identification model is proposed using the lease transaction database:

$$Renewal_i = \beta_0 + \beta_1 \overrightarrow{Complex_i} + \beta_2 \overrightarrow{Location_i} + \beta_3 \overrightarrow{Unit_i} + \beta_4 Discount_i + \beta_5 \overrightarrow{ESG_i} + \epsilon_i$$

The dependent variable *Renewal* equals 1 if the lease is identified as a renewal, zero otherwise. About half of the lease observations are renewals, so there is almost a 50/50 split in the dependent variable. As in the rental pricing model above, $\overrightarrow{Complex_i}$. $\overrightarrow{Location_i}$, $\overrightarrow{Unit_i}$, and $\overrightarrow{ESG_i}$ are similarly specified as independent estimators. The same five definitions of ESG described above are used to evaluate the probability any lease transaction is a renewal to the way ESG is measured.

The big difference here is an independent variable unique to the lease transaction dataset that is likely to influence the decision to renew. *Discount* is a binary variable equal to 1 when the rent in the new lease is below the owner's estimate of the submarket average rent (regardless of whether it is a renewal or a new tenant). We expect this discount to be strongly related to the probability of renewal as such a pricing advantage makes it much more likely that a tenant remains, similar to the incentive faced by tenants in rent-controlled apartments, whose pricing advantage leads to a much longer tenure in uncontrolled apartments (Ault et al. 1994).

As lease renewal is a binary variable, this model will be estimated using Maximum Likelihood Estimation. β_4 is the parameter of interest. In line with the theory described above, if β_4 is positive, observed retention (renewal) is more likely in eco-labeled properties. We will express the degree of retention effect as an "odds ratio" ($=e^{\beta_4}$), which can be interpreted as the probability of a tenant renewing a lease in an eco-certified building relative to the same tenant renewing in an unlabeled complex.

Vacancy Duration (Turnover) Model

To test the second hypothesis, H2, related to an expected advantage in attracting tenants to lease in buildings with eco-labels, we return to the rent roll database and model the duration of vacancy when one occurs:

$$Duration\ of\ Vacancy_i = \beta_0 + \beta_1 \overrightarrow{Complex_i} + \beta_2 \overrightarrow{Location_i} + \beta_3 \overrightarrow{Unit_i} + \beta_4 \overrightarrow{ESG_i} + \epsilon_i$$

Using the data from Exhibit 3, a Poisson regression specification is used to estimate a model explaining the duration of vacancy (in months) for each unit *i* when any vacancy lasting one month or longer occurs. Independent variables are nearly identical to the rent premium model described above, which uses the same dataset. Notably, including the timing of observed vacancy is likely to have an impact on vacancy duration; vacancies in the winter (December, January, February) are likely to last longer than summer vacancies (June, July, August) due to seasonality in market demand.

Recall that the rent roll dataset observes vacancy on a monthly scale as an integer, so the duration of vacancy can be 1 month, 2 months, 3 months, and so on. We also observe the lack of vacancy (0 months), but choose to exclude these observations from the vacancy duration model because a zero month vacancy will include lease renewals and thus bias interpretation of the estimators with information on the probability of renewal (which is isolated in the earlier model). Looking only at units with 1 month or more vacancy naturally excludes renewals and thus isolates duration of vacancy in the estimated parameters. Furthermore, with one month or longer of vacancy observed in 114,987 units, this equates to 47% of all selected units. Just under half of all lease transactions (48%) are renewals, so even allowing for multiple renewals in the same unit over the 15-month rent roll observation period it is likely that most 0-month vacancy periods are renewals.

Poisson regression is a common technique to model the frequency of repeat events. Our estimation of the model uses Maximum Likelihood estimation for the duration of vacancy, similar to how Cheung et al. (2004), investigated the number of times a home transacts an observation period to test a hypothesis related to drivers of transaction frequency.

Results and Discussion

Empirical estimation of the three models explained above find slightly smaller rent premiums associated with eco-labeling as compared with those reported in the literature on multifamily rents. In regards to the first hypothesis, that eco-labeling increases the probability of tenant renewal, the logistic regression finds a 4.7% probability of renewal in buildings with independently verified eco-labels. Finally, in regards to the second hypothesis, that eco-labeling decreases vacancy periods between tenants, the models of vacancy duration cannot reject the null hypothesis.

Rent Premium Model Results

Exhibit 5 describes the parameter estimates for all six identifications of eco-labels and ESG. Control parameters are consistent across all six specifications and directionally rational. For example, higher building occupancy, and larger unit size results in higher monthly rents. Older units and those in more suburban locations associated with lower monthly rents. Units with a lot of nearby urban amenities, as measured by Walk Score, and located in areas of densely populated urban forms, as measured by the EPA Smart Location Database, attract higher monthly rents. As expected, units with higher quality schools see higher rents too. The owner's quality grading is also highly predictive of monthly rents, with A+ units renting for 7% higher than A-grade units and C-grade units renting for over 20% less than A-grade units.

In regards to eco-labeling price effects, we observe the expected positive correlation between monthly rents and an eco-label. Notably, this pricing effect is stronger for independently verified eco-labels, which enhances the argument that pricing effects are associated with the eco-label and not an exogenous correlate. As explained earlier, the self-certified identification of eco-labeling includes a larger number of properties than could be independently verified. As results show, these "poseur" properties add noise into the certification signal, resulting in reduced pricing effect. Further enhancing confidence in attribution of the rental effect to the eco-label, Exhibit 3 demonstrates less correlation with asset quality grades for the verified sample as compared with the self-identified sample.

The internal "form score" measurement of ESG characteristics, which is essentially the sum of "yes" answers by property managers to the owner's sustainability survey asking about the presence or absence of ESG technologies or processes, has essentially no economically relevant relationship to rental prices in Specification 6.

The magnitude of observed eco-labeling premiums is lower than what was observed in Bond & Devine (2016) and Gabe et al. (2023), who both estimated rent premiums for LEED-certified assets around 7% to

9% over non-LEED assets. Here, the equivalent pricing premium on LEED-certified assets is just under 4%. This could result from a better control for urban spatial structure here via the EPA Smart Location Database, reducing the endogeneity between location, asking rent, and eco-labeling observed in Gabe et al. (2021a). The lower LEED rent premium observed here could also reflect temporal decay; over time, market penetration of eco-labeled assets increases, diluting the competitive advantage of eco-labeling. However, the data in Gabe et al. (2023) was observed in 2017 and 2018, two years prior to this study, so it is unlikely, but possible, that rent premiums halved in that time. Finally, this lower premium could be a signal of sampling bias associated with using data from a single owner and manager, and this replication serves to measure that bias. If this is the case, there may be less differentiation in the market between this owner's eco-labeled and non-labeled products relative to the market average owner observed in prior studies.

Tenant Retention Results

Coefficients from the logistic regression models are reported in Exhibit 6 as odds ratios for ease of interpretation. An odds ratio of 1.0 means there is no effect on the probability of the outcome (lease renewal); values lower than 1.0 reflect lower probability of the outcome while values greater than 1.0 reflect higher probability.

The headline result here is the sensitivity of lease renewal probability to pricing. Offering a rent lower than the submarket average (Rent discount variable), results in a massive 53% increase in the probability of renewal. While it is challenging to merge the lease transaction dataset with the rent roll dataset, exploratory investigations into the sensitivity of discounting to the probability of renewal suggest there is little difference in renewal probability between a small rental discount and a larger one, though more research is needed to confirm this follow-up research question. Tenants appear to be well aware of market rents and given that relocation incurs high transaction costs, discounted rent results in a very large decrease in mobility.

Other control parameters have more marginal effects on renewal probability. For example tenants in larger units and older apartment complexes are more inclined to renew leases, but the effect is only 0.07% increase in probability for every 1 square foot of increase in apartment area. For every one unit increase in school quality measured by Greatschools.com on a scale of 1 to 10, tenants are 1% more likely to renew.

The relationship between apartment complex quality and lease renewal is nuanced. Tenants are 7% *less* likely to renew in an A+ building (relative to an A-grade building), about the same probability of renewal as tenants in B- or C+ buildings, while the highest probability of renewal as a function of building quality is in the moderate A-/B+ category, where tenants are 6% to 7% more likely to renew than tenants in an A-grade building. This likely reflects an optimization effect, where tenants balance desire for highly amenitized space with the costs of those amenities, preferring a complex that provides some luxuries, but at a more affordable price.

Location control variables reveal spatial sorting preferences. Tenants both high density urban and low density suburban tenants are likely to renew leases based on the strength of a building's urban and suburban form characteristics respectively. Tenants who prefer suburban living are more likely to renew leases that score high in suburban form as measured by the second principal component in the EPA Smart Location database while tenants that prefer high density urban living are more likely to renew leases that score high in urban form as measured by the first principal component in the EPA Smart Location database.

In regards to the eco-labeling variables of interest, the prior rent-renewal model suggests Specifications 3 and 5 – the independently verified eco-labels – are the best expressions of ESG investment. For the simple presence of a verified eco-label, Specification 3 reveals that tenants are 4% more likely to renew their lease, all else equal. While that's a small increase relative to the effect of pricing on the probability of renewal, it's a potential competitive advantage for a portfolio containing hundreds of thousands of units. Even more interesting is that Specification 5 reveals that this renewal signal is strongly driven by Energy Star buildings. This makes a lot of sense because Energy Star certification is a performance-based label that one can only obtained by using less energy, i.e. reducing tenants' expenditures on utility bills. IREM-certified buildings also increase tenant retention, though this certification is more reflective of the presence and training of professional property managers than it is reflective of ESG performance.

Again, the internal "form score" for ESG achievement is essentially noise when it comes to tenant renewal probability with an odds ratio of almost exactly 1.0.

Vacancy Duration (Turnover) Results

Exhibit 7 reveals the results of the novel Poisson regression seeking to explain the duration of vacancy for any unit experiencing at least one month of vacancy during the 15-month observation period. Again, the parameter estimation results are displayed as odds ratios for interpretation.

The strongest effect on vacancy duration appears to be seasonality. When a property is vacant in January or February, the vacancy is expected to last about 24% longer than if the same property was vacant in the summer months of June, July or August (24% = 40% - 16%). Age and quality also affect tenant recruitment as expected. C-quality building vacancies last 4% to 6% longer than a vacancy in an A-grade building. For every year a building ages, its vacancies last 5.5% longer, reflecting the effect of depreciation.

Location has very marginal effects on vacancy duration. High demand urban areas see a marginal reduction in vacancy duration while suburban locations take slightly longer to fill. Interestingly, locations with higher rated schools are also seen to have marginally longer vacancy periods, though the effect is only a vacancy duration increase of 0.32% per Greatschools.com rating (which only goes to 10 points) so this finding is economically immaterial. This seemingly irrational result makes sense if asking prices overestimate residents' willingness to pay for school quality; Gabe et al. (2021b) observed that asking rents respond to school quality, but this pricing premium may come at the expense of a longer time-on-market to find a renter willing to pay the premium.

For eco-labeled properties, Specification 3 fails to reject the null hypothesis that presence of a verified eco-label is unrelated to vacancy duration, so there is no empirical support for the claim that an eco-label makes it easier to attract new tenants and reduce vacancy. In regards to specific certifications, only the National Green Building Standard (NGBS) has a significant relationship with vacancy duration, and it is in the opposite direction, suggesting that NGBS certification increases vacancy duration by about 6%. This fits an overall pattern of NGBS as an outlier in the eco-labeling industry; while minor effective rent premiums were observed for NGBS in Exhibit 5, labeled buildings appear to have poor retention (22% less likely to renew according to Exhibit 6) and poor tenant attraction. One potential explanation is that NGBS is purely a new building construction standard, with its objective to ensure green building features are installed correctly, so it's of less importance to tenants.

Conclusions

The results above demonstrate nuanced findings for the tenant retention hypothesis (H1). While aggregated eco-label identification reveals a 4% increase in lease renewal probability in institutional multifamily apartments, the relationship with specific eco-labels suggest that this increase is largely due to tenants receiving financial benefits from energy savings. Energy Star certification, which can only be obtained by demonstrating energy efficient performance through measured consumption, is associated with a nearly 7% increase in renewal probability while there is no significant relationship between renewal probability and LEED. This finding of price sensitivity driving eco-label renewal decisions aligns well with the strong over 50% likelihood of renewal if the tenants renew at a rent below the submarket average.

On the other hand, the data for this research rejects hypothesis H2, finding that there is no relationship between the duration of vacancy and eco-labeling. Thus, there is no empirical support for the claimed advantage in tenant recruitment associated with the presence of an eco-label. Instead, vacancy duration responds to traditional signals of depreciation and seasonality. Older buildings with few amenities are more difficult to lease and vacancies take longer to fill in the winter months than in the summer months.

In combination, the lease renewal and vacancy duration models also reveal interesting tenant behaviors unrelated to demand for ESG features. High-amenity and high quality A+ space is easier to fill (2% faster than A grade space according to Exhibit 7), but more difficult to retain tenants (7% less likely than A grade space according to Exhibit 6). This supports a narrative that tenants may not find value in these luxury amenities given their higher price (7% higher rent according to Exhibit 5). Instead, there seems to be a sweet spot in the A- quality classification. Here, prices are 7% cheaper than A grade space, but tenants are 7% more likely to renew with the same ease of filling vacancies as observed in A grade space. For multifamily investors, this tenant preference would suggest that A+ high-amenity spaces are likely to have slower net income growth after the "honeymoon period" when the amenities attract tenants, who then are more likely to leave and seek better value.

From an ESG perspective, this study advises multifamily investors that cost-saving ESG investments, such as energy efficiency, are most likely to retain tenants. While tenants realize these cost savings, leading to complaints of a "split-incentive problem" (tenants obtain the financial benefits from the owner's capital investment), the increased likelihood of lease renewal results in less vacancy and more net income for the owner. On the other hand, the ESG benefits promised by LEED and other largely design-based certifications, where there is less correlation between design intentions and operational performance benefits (Gabe and Christensen, 2019), do not appear to influence lease renewal or tenant attraction.

As an academic contribution, this study adds considerable value and scope to the pioneering exploratory work of Devine & Kok (2015). With $1/10^{th}$ the data of this study and thus a lot of statistical noise, Devine & Kok concluded that there was no evidence that office tenants were more likely to renew leases in LEED-certified assets. But they found that BOMABest, a certification rewarding good management of existing buildings (similar to IREM certification in this study) resulted in a slight increase in renewal probability. With this much larger study in the multifamily market, eco-label certifications that directly add value to tenants, either through cost savings or better management, are rewarded with increased lease renewal probabilities while eco-label certifications concentrated in building design and construction do not appear to influence tenant renewal or attraction. Interestingly, cost saving and management quality benefits do not appear to *attract* tenants to certified spaces, so there is an aspect of experience that is needed for occupants to be aware of the benefits that these certifications promise.

Exhibits

Exhibit 1. Configuration and size comparison between the raw data in the rent roll dataset and the selected units following data preparation.

	Entire Dataset	**Selected Units**
Studio	67,941	15,934
1 bedroom	498,089	116,367
2 bedroom	454,322	97,221
3 bedroom	75,781	140,26
4+ bedroom	16,118	311
0/0.5 bath	131,878	5,772
1/1.5 bath	562,715	142,399
2/2.5 bath	397,406	94,127
3+ bath	19,745	1,078
Median size (sq. ft.)	870	868
Mean size (sq. ft.)	907	911
Total number of units	**1,112,251**	**243,859**

Exhibit 2. Descriptive statistics of dependent and independent variables used in the rental rate and vacancy duration models. N = 243,859 selected units from the rent roll dataset.

	Median	Mean	Low	High	SD
Effective rent ($/month)	$1485	$1,707	$402	$23,550	818
Vacancy duration (months)	0	1.56	0	14	2.58
Self-reported eco-certification (1=yes)	0	26.3%	0	1	-
Verified eco-certification (1=yes)	0	21.3%	0	1	-
Self-reported LEED (1=yes)	0	11.6%	0	1	-
Verified LEED (1=yes)	0	8.3%	0	1	-
Self-reported Energy Star (1=yes)	0	13.7%	0	1	-
Verified Energy Star (1=yes)	0	7.1%	0	1	-
Self-reported Green Globes (1=yes)	0	1.4%	0	1	-
Verified Green Globes (1=yes)	0	1.2%	0	1	-
Self-reported IREM (1=yes)	0	4.4%	0	1	-
Verified IREM (1=yes)	0	6.0%	0	1	-
Self-reported NGBS (1=yes)	0	1.9%	0	1	-
Verified NGBS (1=yes)	0	1.7%	0	1	-
Internal ESG "form score"	136.5	140.6	0	328.2	64.7
Quality grade A+ (1=yes)	0	18.2%	0	1	-
Quality grade A (1=yes)	0	38.8%	0	1	-
Quality grade A- (1=yes)	0	7.8%	0	1	-
Quality grade B+ (1=yes)	0	10.2%	0	1	-
Quality grade B (1=yes)	0	17.4%	0	1	-
Quality grade B- (1=yes)	0	3.5%	0	1	-
Quality grade C+ (1=yes)	0	1.8%	0	1	-
Quality grade C or lower (1=yes)	0	2.4%	0	1	-
Building age (years)	11	16.5	1	143	15.6
Urban spatial structure factor	2.66	5.39	-3.14	85.98	10.2
Exurban spatial structure factor	1.71	1.89	-15.83	40.21	4.7
Building vacancy rate	6.69%	10.48%	0%	83.10%	11.23%
School quality rating (1-10)	5.156	5.247	1	9.84	1.68
Walk score (0-100)	58	58.15	0	100	26.44

Exhibit 3. Distribgution of vacancy duration for all selected units where vacancy is observed. (N = 114,987 selected units)

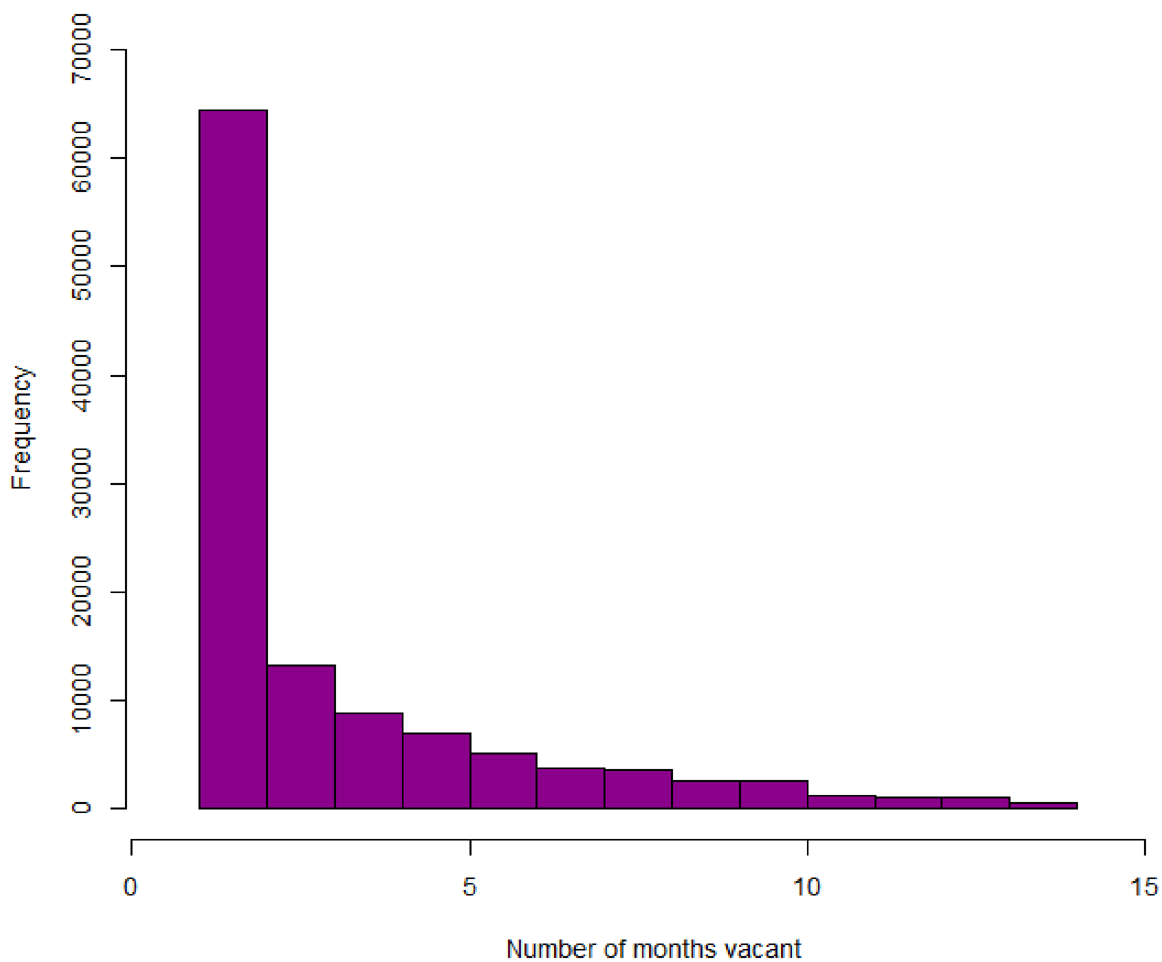
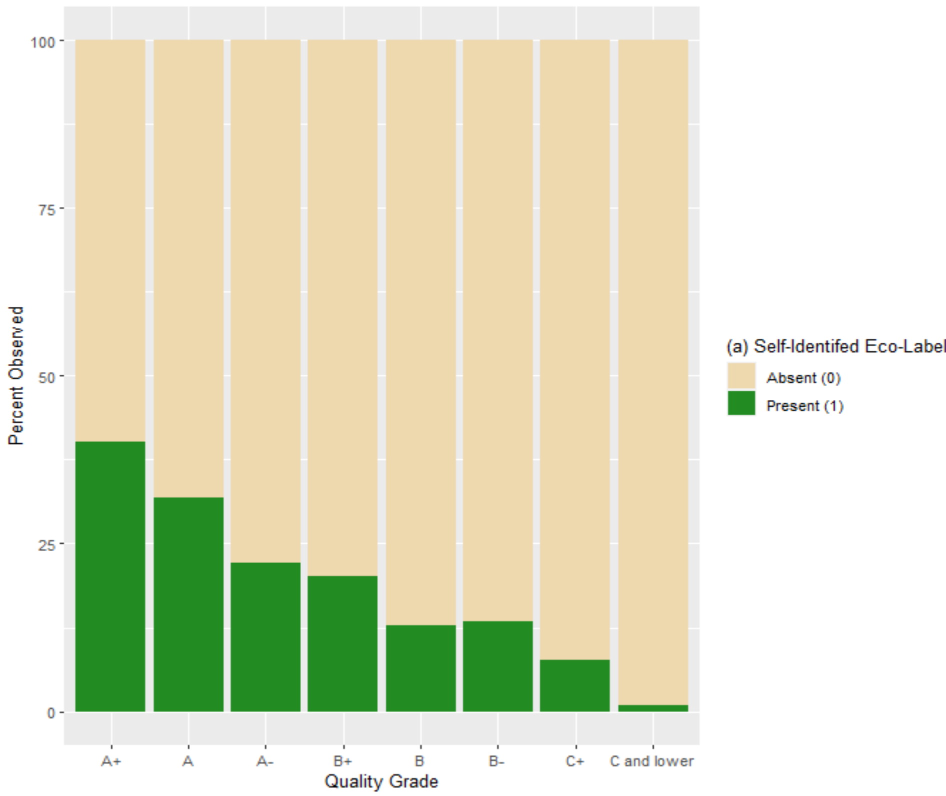


Exhibit 4. Cross-tabular selected unit incidence of eco-labels by quality grade for (a) self-identified eco-labels from the sustainability dataset, and (b) independently verified eco-labels.



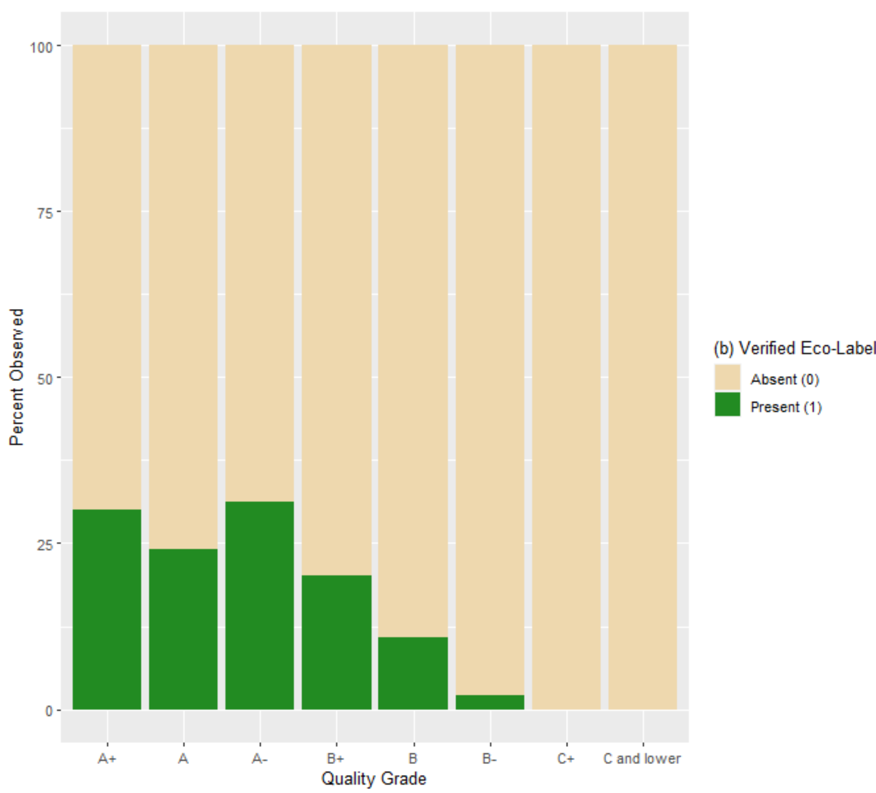


Exhibit 5. Results of the rent premium model used to replicate existing research with the rent roll dataset. The dependent variable is the natural log of monthly average rent for each unit. Specification 1 is a baseline omitting ESG factors. Specifications 2 and 4 define eco-labels as self-reported. Specifications 3 and 5 define eco-labels as independently verified by the certifying agencies. Specification 6 defines ESG as the "form score" on the internal sustainability survey. *, **, and *** identify significant differences from an odds ratio of 1.00 at the 10%, 5%, and 1% level.

	1	**2**	**3**	**4**	**5**	**6**
Esg identification	None	Self	Verified	Self	Verified	Survey
Any eco-label		0.0289***	0.0471***			
LEED				0.0228***	0.0388***	
Energy Star				0.0069***	0.0212***	
NGBS				0.0164***	0.0228***	
Green Globes				0.0104***	0.0618***	
IREM				0.0200***	0.0476***	
Internal ESG score						0.0004***
Bldg. Occupancy	0.1013***	0.1059***	0.1145***	0.1061***	0.1153***	0.1236***
Unit size (sq. Ft.)	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***	0.0007***
Size squared	-0.0000***	-0.0000***	-0.0000***	-0.0000***	-0.0000***	-0.0000***
Age (in 2019)	-0.0049***	-0.0047***	-0.0046***	-0.0048***	-0.0047***	-0.0038***
Age squared	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Walk Score	0.0031***	0.0030***	0.0029***	0.0030***	0.0029***	0.0029***
EPA: urban form	0.0051***	0.0051***	0.0051***	0.0050***	0.0051***	0.0051***
EPA: exurban form	-0.0104***	-0.0104***	-0.0103***	-0.0105***	-0.0104***	-0.0106***
School rating	0.0085***	0.0086***	0.0081***	0.0086***	0.0081***	0.0080***
Bedroom count	0.0319***	0.0307***	0.0313***	0.0309***	0.0317***	0.0305***
Bathroom count	-0.0196***	-0.0188***	-0.0181***	-0.0187***	-0.0185***	-0.0155***
A+ quality	0.0737***	0.0731***	0.0708***	0.0725***	0.0709***	0.0687***
A quality	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
A- quality	-0.0682***	-0.0634***	-0.0703***	-0.0654***	-0.0685***	-0.0588***
B+ quality	-0.0586***	-0.0563***	-0.0598***	-0.0565***	-0.0583***	-0.0551***
B quality	-0.1462***	-0.1431***	-0.1414***	-0.1443***	-0.1403***	-0.1388***
B- quality	-0.1813***	-0.1812***	-0.1778***	-0.1820***	-0.1766***	-0.1781***
C+ quality	-0.2299***	-0.2242***	-0.2214***	-0.2259***	-0.2224***	-0.2152***
C quality or lower	-0.2004***	-0.1960***	-0.1939***	-0.1972***	-0.1939***	-0.1990***
Residential use	-0.1383***	-0.1408***	-0.1414***	-0.1401***	-0.1403***	-0.1308***
Active adult use	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Mixed use	-0.1172***	-0.1173***	-0.1145***	-0.1168***	-0.1115***	-0.1092***
Constant	6.5454***	6.5373***	6.5451***	6.5434***	6.5485***	6.4766***
CBSA fixed effects	Included	Included	Included	Included	Included	Included
Month of Vacancy	Included	Included	Included	Included	Included	Included
Observations	179,364	179,364	179,364	179,364	179,364	179,364
R-squared	0.8028	0.8037	0.8047	0.8034	0.8045	0.8061
Adjusted R-squared	0.8027	0.8036	0.8046	0.8033	0.8044	0.8061

Exhibit 6. Results of the lease renewal probability model expressed as an odds ratio. The dependent variable is equal to 1 if the lease transaction is a renewal to the existing tenant, zero otherwise. Specification 1 is a baseline omitting ESG factors. Specifications 2 and 4 define eco-labels as self-reported. Specifications 3 and 5 define eco-labels as independently verified by the certifying agencies. Specification 6 defines ESG as the "form score" on the internal sustainability survey. *, **, and *** identify significant differences from an odds ratio of 1.00 at the 10%, 5%, and 1% level.

	1	**2**	**3**	**4**	**5**	**6**
ESG identification	None	Self	Verified	Self	Verified	Survey
Any eco-label		1.0688***	1.0399***			
LEED				1.0797***	1.0298	
Energy star				0.9934	1.0675***	
NGBS				0.7898***	0.7462***	
Green globes				0.8796***	1.001	
IREM				1.1537***	1.1058***	
Internal ESG score						0.9997***
Rent discount	1.5257***	1.5274***	1.5235***	1.5304***	1.5293***	1.5244***
Unit size (sq. Ft.)	1.0010***	1.0010***	1.0010***	1.0010***	1.0010***	1.0010***
Size squared	1.0000***	1.0000***	1.0000***	1.0000***	1.0000***	1.0000***
Age (in 2019)	1.0379***	1.0384***	1.0381***	1.0374***	1.0374***	1.0372***
Age squared	0.9996***	0.9996***	0.9996***	0.9996***	0.9996***	0.9996***
Walk score	1.0008***	1.0008***	1.0008***	1.0006**	1.0006***	1.0010***
EPA: urban form	1.0030***	1.0030***	1.0029***	1.0030***	1.0029***	1.0030***
EPA: exurban form	1.0073***	1.0073***	1.0073***	1.0070***	1.0071***	1.0073***
School rating	1.0097***	1.0101***	1.0096***	1.0096***	1.0090***	1.0099***
Bedroom count	1.0412***	1.0398***	1.0415***	1.0432***	1.0440***	1.0420***
Bathroom count	0.8515***	0.8526***	0.8515***	0.8517***	0.8507***	0.8497***
A+ quality	0.9373***	0.9331***	0.9352***	0.9433***	0.9435***	0.9402***
A quality	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
A- quality	1.0680***	1.0735***	1.0647***	1.0677***	1.0599***	1.0636***
B+ quality	1.0553***	1.0589***	1.0539**	1.0529**	1.0484**	1.0533**
B quality	0.9022***	0.9084***	0.9058***	0.9071***	0.9122***	0.8976***
B- quality	0.9619	0.9643	0.9659	0.9617	0.9718	0.9566
C+ quality	0.9111**	0.9183**	0.9175**	0.9209**	0.9297*	0.9062**
C quality or lower	0.8335***	0.8422***	0.8402***	0.8425***	0.8499***	0.8313***
Residential use	0.8018***	0.7958***	0.7968***	0.8022***	0.7979***	0.7987***
Active adult use	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Mixed use	0.4672***	0.4654***	0.4671***	0.4625***	0.4724***	0.4656***
Constant	0.5255***	0.5140***	0.5255***	0.5268***	0.5377***	0.5489***
CBSA fixed effects	Included	Included	Included	Included	Included	Included
Observations	186,055	186,055	186,055	186,055	186,055	186,055
Log likelihood	-126,075.9	-126,059.1	-126,071.2	-126,022.4	-126,028.8	-126,071.4
Akaike inf. Crit.	252,257.80	252,226.10	252,250.30	252,160.80	252,173.60	252,250.80

Exhibit 7. Results of the duration of vacancy Poisson regression. Coefficients are expressed as an odds ratio. The dependent variable is the number of months a vacancy lasts. *, **, and *** identify significant differences from an odds ratio of 1.00 at the 10%, 5%, and 1% level.

	1	**2**	**3**	**4**	**5**	**6**
ESG identification	None	Self	Verified	Self	Verified	Survey
Any eco-label		1.0062	1.0042			
LEED				1.005	1.0054	
Energy star				0.9906	0.9866	
NGBS				1.0418***	1.0593***	
Green globes				1.0458**	1.0145	
IREM				0.9868	0.9869	
Internal ESG score						1.0001*
Unit size (sq. Ft.)	1.0001	1.0001	1.0001	1.0001	1.0001*	1.0001
Size squared	1	1	1	1	1	1
Age (in 2019)	1.0555***	1.0541***	1.0544***	1.0571***	1.0581***	1.0548***
Age squared	0.9990***	0.9990**	0.9990**	0.9991**	0.9991**	0.9991**
Walk score	1.0000***	1.0000***	1.0000***	1.0000***	1.0000***	1.0000***
EPA: urban form	0.9990***	0.9990***	0.9990***	0.9989***	0.9990***	0.9990***
EPA: exurban form	1.0019***	1.0019***	1.0019***	1.0020***	1.0021***	1.0019***
School rating	1.0032***	1.0031**	1.0031**	1.0033***	1.0032***	1.0032***
Bedroom count	0.9924	0.9923	0.9925	0.9924	0.992	0.9924
Bathroom count	1.0112***	1.0114***	1.0114***	1.0117***	1.0117***	1.0118***
A+ quality	0.9883**	0.9882**	0.9880**	0.9880**	0.9878**	0.9879**
A quality	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
A- quality	0.9987	0.9991	0.9982	0.9981	0.9997	1.0004
B+ quality	1.0326***	1.0329***	1.0324***	1.0338***	1.0333***	1.0334***
B quality	1.0264***	1.0263***	1.0265***	1.0260***	1.0245***	1.0272***
B- quality	1.0037	1.0033	1.0038	1.0019	1.0023	1.0046
C+ quality	1.0641***	1.0639***	1.0643***	1.0635***	1.0594***	1.0656***
C quality or lower	1.0339**	1.0344**	1.0342**	1.0324**	1.0316**	1.0340**
Vacant in January	1.3960***	1.3960***	1.3961***	1.3956***	1.3947***	1.3963***
Vacant in February	1.4180***	1.4179***	1.4180***	1.4181***	1.4172***	1.4180***
Vacant in March	1.3536***	1.3538***	1.3537***	1.3532***	1.3535***	1.3539***
Vacant in April	1.3096***	1.3095***	1.3096***	1.3082***	1.3077***	1.3096***
Vacant in May	1.2363***	1.2359***	1.2363***	1.2361***	1.2352***	1.2360***
Vacant in June	1.1607***	1.1606***	1.1609***	1.1617***	1.1616***	1.1610***
Vacant in July	1.1625***	1.1630***	1.1626***	1.1623***	1.1624***	1.1629***
Vacant in August	1.1604***	1.1602***	1.1601***	1.1612***	1.1599***	1.1603***
Vacant in Sept.	1.1859***	1.1861***	1.1861***	1.1853***	1.1864***	1.1861***
Vacant in October	1.1960***	1.1962***	1.1962***	1.1957***	1.1955***	1.1959***
Vacant in Nov.	1.2392***	1.2389***	1.2390***	1.2398***	1.2400***	1.2395***
Vacant in Dec.	1.2588***	1.2589***	1.2588***	1.2590***	1.2594***	1.2592***
Constant	0.8965***	0.8978***	0.8985***	0.8957***	0.8969***	0.8880***
Property use	Included	Included	Included	Included	Included	Included
CBSA fixed effects	Included	Included	Included	Included	Included	Included
Observations	89,782	89,782	89,782	89,782	89,782	89,782
Log likelihood	-133,455.2	-133,454.3	-133,454.9	-133,445.5	-133,444.8	-133,453.4
Akaike inf. Crit.	267,040.40	267,040.60	267,041.80	267,031.10	267,029.50	267,038.90

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