Lease Structures & Occupancy Costs in Eco-Labeled Buildings

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Structured Abstract

Purpose: This research investigates whether energy-efficient green buildings tend to provide net lease structures over gross lease ones. It then considers whether owners benefit by trading away operational savings in a net lease structure.

Design: Empirical models of office leasing transactions in Sydney, Australia, with wider transferability supported by analysis of office rent data in the United States.

Findings: Labelled green buildings are approximately four to five times more likely than non-labelled buildings to use a net lease structure. However, despite receiving operational savings, tenants in net leases pay higher total occupancy costs, benefiting owners. On average, the increase in total occupancy costs paid by tenants in a net lease is equal to or greater than savings attributed to an eco-labelled building.

Implications: A full accounting of total occupancy costs in eco-labelled buildings suggests that net lease structures provide numerous benefits to owners that offset the loss of trading away operational savings.

Originality/Value: The principal-agent market inefficiency, or "split incentive", is a widely cited barrier to private investment in energy-efficient building technology. Here, a uniquely broad look at rental cash flows suggests its role as a barrier is exaggerated.

Keywords: Commercial Real Estate, Energy Efficiency, Green Buildings, Real Estate Investment, Split Incentive, Sustainable Real Estate

I. Introduction

Private benefits associated with energy efficiency – utility cost savings – create a theoretical market incentive for greenhouse gas mitigation, a public good. Yet, there is a literature that observes contradiction between uptake and expected profitability of energy efficiency investments (Kok et al. 2011). Exploration of the observed investment gap often arrives at a convincing principal-agent market failure narrative called the "split incentive" or "landlord-tenant dilemma": while building owners must fund capital asset upgrades, their occupants benefit from the operational efficiencies created by those investments (Heinzle et al. 2013; Janda et al. 2016; Schleich and Gruber 2008).

In response, complex schemes have been implemented to influence managerial decisions and "fix" the split incentive problem. Environmental upgrade financing[1], whereby repayments of capital improvement loans are added to property tax collections (Van der Heijden, 2017), is an attempt to directly alter financial incentives. Environmental upgrade financing offers a potential solution because property taxes are paid by whichever party – landlord or tenant – takes on liability for paying operational expenses, thereby matching costs and benefits. Other solutions seek to influence corporate governance. For example, Janda et al. (2016) find increased use of "green" lease clauses – negotiated environmental or social performance obligations – in an Australian and United Kingdom context, though very few of their model clauses involved legal liability or dispute resolution in the event of a breach.

But are these interventions necessary? In theory, total occupancy costs should be at equilibrium as tenants trade increased rent for their own operational savings (Mooradian and Yang, 2002). Importantly, we observe that current discourse above on the split incentive theory is limited to analysis of direct cash flows. However, little broader property market perspectives exist in the literature beyond an initial estimate by Eichholtz et al. (2010) that operational cost savings may be fully capitalized in rent. Two recent studies suggest building owners are not concerned with trading away savings to tenants. Christensen et al. (2018) found that institutional owners strategically focus on energy savings, implying meaningful incentives to eco-label investments beyond operational savings. Brotman (2016) implies that collective tenant demand for energy efficiency motivates medical office owners, who always use triple net leasing, to invest in energy upgrades in competitive markets.

We pose two questions to establish the salience of the split-incentive-as-barrier theory. First, since a gross lease structure is the simplest means to eliminate a split incentive, do owners disproportionally agree to gross lease structures to capture the savings from targeted investment in operational efficiencies? Second, when net lease structures are used in energy-efficient buildings, can it be quantified how energy savings affect the gross income received by the owner?[2] To answer these questions, we study lease transactions in markets with substantial identification of eco-certified, energy efficient, buildings and choice in lease structure.

The findings present compelling evidence that the split incentive is not a significant barrier to private investment in environmental building upgrades. Where markets offer diversity in lease structures, energy-efficient building owners are significantly more likely to enter into net lease arrangements, granting tenants subsequent operational benefits. However, landlords are indirectly compensated without the need for environmental upgrade financing. Besides the traditional role of a net lease in removing cost risk for the owner, we find that tenants offset the small operational savings from energy efficiency with higher total costs of occupancy. For a well-managed building, the overall outcome of trading away operational energy savings can be higher net income.

II. Background & Hypotheses

At a fundamental level, there are two primary financial incentives that attract private investors into the market for eco-labelled property investment: capital value security (i.e. lower obsolescence risk) and operational expense savings. Capital value benefits accrue exclusively to owners. However, lease negotiations determine which party benefits from operational expense savings.

i. Commercial Lease Structures

Lease contracts create windows for insight into commercial real estate markets, cycles and participant behavior (Clapham and Gunnelin 2003; Ibanez and Pennington-Cross 2013; Wheaton 1987). Worldwide, leases can be classified along a spectrum from “gross” to “net”, based on the liability for operational charges over the term. The gross lease classification assigns the risk and responsibility of operational costs to the landlord; tenants only pay a fixed base rent as written in the contract. Net leases assign the tenant a lower base rent and liability to pay its share of future operational expenses. Economic theory suggests that landlords should extract the same value from a property regardless of lease structure (Ambrose et al. 2002; Booth and Walsh 2001; Grenadier 1996). However, despite these expectations, there is limited qualitative or empirical support to this theory (Bond et al. 2008).

Considering only risk shedding in an efficient market, tenants prefer gross leases as they reduce operational cost inflation risk while landlords prefer net leases for the same reason (Wiley et al. 2014). Theory on lease market equilibriums (Grenadier 2005; Mooradian and Yang, 2002) supported with recent empirical work by Wiley (2014) suggests that heterogeneity in operating expenses provides a scenario where gross leases can be more profitable for a building owner. Notably, owners with relatively low operating expenses can benefit when offering the gross lease contract. One of the key conditions for this argument to hold is that the “gross lease markup” – the additional base rent that a tenant pays for the landlord to assume liability for operating expenses (Wiley et al. 2014) – is determined by the market. The result, Mooradian and Yang (2002) argue, is that landlords with lower-than-average costs should offer gross leases so as to capture surplus from a market equilibrium gross rent.

One potential reason why a landlord may choose not to use a gross lease when theoretically advantageous is an adverse selection problem (Benjamin et al. 1992). Tenants that heavily consume operational services and use office space intensively are more likely to select gross leases as they privately know their use expectations (Chinloy and Maribojoc 1998). Accordingly, the literature confirms that landlords will not willingly offer a gross lease without symmetric information on expected consumption (Mooradian and Yang 2002).

ii. Sustainable Commercial Real Estate

While the societal purpose of eco-labels in real estate is to signal natural resource conservation or reduced environmental pollution, both public goods, there is a literature arguing owners can be privately rewarded for capital invested (Ciochetti and McGowan 2010; Eichholtz et al. 2010; Fuerst and McAllister 2011; Pivo and Fisher 2010). Research identifies a range of attributes associated with capital value preservation associated with eco-labels: less risk of regulatory obsolescence, lower expense volatility and lower cost of capital – all of which manifest in increased appraisal and sale values (Christensen, 2018; Orlitzky and Benjamin 2001; Wiley et al. 2010). Some of this valuation increase may be due to the unique locational and physical attributes of these buildings (Ott and Hahn, 2018).

Theoretical expense savings are generated from expected operational efficiencies (Eichholtz et al. 2010; Pivo and Fisher 2010). Lease structure determines who benefits from these savings by allocating responsibility for operational charges, modifying private incentives for green building investment. Under the net lease, the landlord would appear to have little direct incentive to invest in technology that facilitates more efficient operation if the primary returns are operational savings accruing to the tenant. Likewise, tenants in a gross lease may not earn benefits from operating in their space more efficiently (Pivo 2010). As introduced earlier, researchers speculate that use of a net lease could serve as a deterrent to future sustainability technology-related investment by other building owners (Bordass 2000; Heinzle et al. 2013; Vernon and Meier 2012).

Eco-labelled building owners and occupants also receive reputational benefits associated with social responsibility (Orlitzky and Benjamin 2001). Owner and tenant commitment to Corporate Social Responsibility (CSR) also has the potential to influence lease transactions (Hebb et al. 2010). Notably, CSR can moderate the effect of adverse selection. Public commitment to ecological consciousness and social responsibility can act as a signal of low resource consumption intentions by tenants. Therefore, CSR committed landlords and tenants would seek lease structures that reward them for their CSR behavior. In this case, CSR-seeking tenants may prefer net leases while CSR-seeking investors prefer gross leases (Robinson et al. 2016; Simons et al. 2014).

Empirical studies complicate these theoretical expectations. For example, not all CSR oriented tenants behave the same way and not all businesses operationalize CSR values the same way (Ho et al. 2012). Also, heterogeneity among eco-labelled buildings creates mixed expectations about building performance; not all eco-labels reliably indicate operational resource efficiency at the building level (Oates and Sullivan 2012; Scofield 2009), though aggregated research has found eco-labels to be associated with reduced operational costs relative to non-labelled competitors on average (Newsham et al. 2009). Finally, tenants do not appear to deviate from market rents when leasing space in a green-labelled building (Gabe and Rehm, 2014), suggesting that the occupancy benefits of green labelled space – CSR & operational expense savings – are not of significant private value.

iii. Research Questions & Hypotheses

We suggest study into the relationship between eco-labels and lease structure can resolve the apparent contradictions between theory and empirical evidence on tenant demand for labelled space, leading to a test of the split-incentive theory. One hypothesis following from the split-incentive theory is that a gross lease eliminates this problem, thus there is investor sorting based on lease structure:

H1. Eco-labelled properties are more likely to offer gross leases.

However, an equally tenable alternative hypothesis grounded in leasing theory recognizes that operational savings potential could be offset by adverse tenant selection. Thus, an owner may see an eco-label as an opportunity to shed adverse selection risk. This narrative produces a directly conflicting hypothesis:

H1a. Eco-labelled properties are more likely to offer net leases.

Simply deciding on which competing hypothesis is supported empirically will be insufficient to resolve who benefits from the particular lease structure. Notably, tenants could be paying lower expenses in a net lease, but if their savings are capitalized into a higher rental rate the occupant may not be better off. Some early evidence that this may be the case comes from Eichholtz et al. (2010), who argue empirically that eco-labeled building rent premiums are of similar magnitude to reduced energy costs.

To go deeper, we next evaluate the total costs of occupancy for each lease and test for a relationship between total occupancy costs and lease structure. Again, two tenable and conflicting hypotheses exist:

H2: Tenants pay lower total costs of occupancy in eco-labelled buildings.
H2a: Tenants pay the same (or higher) total costs of occupancy in eco-labelled buildings.

According to Grenadier (1995), lease structure should have nil effect as the total costs of occupancy are what is traded in a competitive market equilibrium between the supply of space and demand for its use. If so, then all else equal – including risk profiles – landlords should be able to capitalize any operational savings (**H2a**) as argued by Eichholtz et al. (2010). However, the literature on split incentives associated with investment in eco-labeled building renovations makes an implicit assumption that **H2** is true because the landlord is assumed not to benefit from her capital investment.

III. Data & Method

To test these competing hypotheses, we begin with data on urban office leasing transactions in Australia where there is a near binary mix of gross and net lease structures. Logistic regression models are used to describe the association between lease structure (net or gross) and lease transaction attributes. Mixed effects regression techniques are then employed to investigate the effect of lease structure on the total costs of occupancy. Further robustness tests are conducted, including a test for transferability using lease transactions in the United States.

i. Leasing Data - Australia

Information on Australian office leasing markets is obtained for the central Sydney market, Australia's largest and most competitive market for office space. In Sydney, a net lease is identical to the "triple net" (NNN) lease, where tenants are required to pay for property taxes, common-area utilities/maintenance (CAM) and property insurance. An Australian gross lease is identical to a "full service gross" (FSG) lease in the first year of the contract, but, important for this study, tenants are subsequently liable for property tax, CAM and insurance increases relative to that base year. This arrangement, often referred to as a "base stop", is a useful structure for real estate research because there is nil expense risk traded in the contract negotiation as tenants will always take on this risk in both net and gross structures. Another benefit of the Sydney market is that there are no other lease structures observed in regard to operating expense sharing.

The Sydney sample contains 880 office lease contracts registered between January 2009 and July 2011 on a land title with the New South Wales (NSW) Department of Land and Property Information. Initial face rent (A\$/m^2/year), tenancy floor area (m^2), lease structure (NNN or Gross), first year operating expense estimations (available for NNN contracts only), commencement date, term length (excluding options to renew),[3] lowest floor of the tenancy and building address were extracted from each contract. For later robustness tests, security deposit amounts, commencement incentives, leasing broker, and tenant industry classification were established from the contract when available. After excluding non-market transactions, records with missing data, and repeat observations, 673 lease transactions remain. All lease dealings were conducted between January 2007 and July 2011 in 102 unique commercial office buildings.

The RP Data Cityscope database for central Sydney is used to obtain leasable floor area (m^2), number of unique tenants in the entire building and asset age at time of lease. Quality audits are conducted by the Property Council of Australia (2006) and this study includes Premium, A- and B-grade buildings as defined in the 2010 audit of Sydney buildings. The Property Council of Australia has also defined key submarkets within Sydney's central business district; all buildings fall into four of these submarkets (City Core, Western Corridor, Midtown, and Southern). Finally, access to public transport is calculated for this study as the walking distance to the nearest train station.

Operational energy efficiency is measured by the presence of an eco-label. In Australia, an analogous eco-label to Energy Star, a US eco-label common in green building research, is the presence of a four-star or greater National Australian Built Environment Rating System (NABERS) Energy rating. The method behind a NABERS Energy rating is an annual site energy consumption audit, mandatory in the event of a lease or sale of large office buildings. Ratings range from zero to six stars, in half-star increments, with 2.5 stars representing the market average at the commencement of the scheme in 1999. It is generally accepted that a rating of four stars or above is "best practice", as this threshold is specified in federal and state guidelines that encourage, but do not mandate, government tenants to seek accommodation in four star or higher properties. Around 25% of all buildings obtain a 4-star or greater rating, so this threshold is also reasonably analogous to the top-quartile requirement for Energy Star certification in the US.

Australia also has a more holistic eco-labelling system called Green Star designed primarily for new construction, but there are no leasing observations in Green Star-rated buildings in this study.

IV. Methodology

To achieve comparability between NNN and gross contract rents,[4] all observed NNN contract rents are converted to total costs of occupancy by adding all first-year operating charges, included in a gross contract.[5] The formula for total occupancy costs (TOC) on a NNN lease is as follows (NLA refers to the net leasable area):

$$\frac{TOC}{Tenancy\ NLA} = \frac{NNN\ Contract\ Rent}{Tenancy\ NLA} + \frac{Operating\ Charges}{Whole\ Building\ NLA} \quad (1)$$

The contract rent on a gross lease is taken as the grossed-up rent, with no addition of operating charges since the tenant does not pay any additional occupancy costs. Estimated building expenses as reported by the lessor in the lease contract are used to gross up NNN leases.

As the lease transactions observed in Sydney span a five-year period, a rental market index is used to inflate each observation as an equivalent rent for the 2nd half of 2011 to ensure that rents observed across a number of years are directly comparable. The market index used is the coefficients for fixed time effects as reported in Gabe and Rehm (2014).

Table 1 describes the dataset by lease type. Of interest is an observation that NNN leases tend to have higher total costs of occupancy and be offered in newer assets, while the incidence of an energy efficiency eco-label appears to bias towards NNN leases. Further investigation seeks to isolate the probabilities of lease structure given these exogenous effects

[Insert Table 1 Here]

i. Probability of Lease Structure

To explore the probability of a particular lease type while controlling for other exogenous effects, a fixed effects logistic regression model is estimated: [6]

$$NET = \beta_0 + \beta_1\, EcoLabel + \boldsymbol{\beta_2}\, \boldsymbol{Building} + \boldsymbol{\beta_3}\, \boldsymbol{Lease} + \boldsymbol{\beta_4}\, \boldsymbol{Geo} + \varepsilon \quad (2)$$

Where:

- *NET* equals one if an observed lease transaction is a net lease contract.
- *EcoLabel* is a binary variable indicating the presence of an eco-label.

- ***Building*** is a vector describing the building in which a lease transaction occurs.
- ***Lease*** is a vector describing the terms of a lease contract.
- ***Geo*** is a classification vector that groups each observation by submarket.
- ε is residual stochastic error.

Exploration of the Sydney data reveals that lease structure is not related to the year a contract was signed, so there is no need to complicate the model with time controls.

The variable of interest in Equation 2 is the binary attribute that identifies eco-labelled buildings, which equals one if the building has obtained a four-star or higher NABERS Energy rating. As specified, if **H1** is true, the eco-label coefficient will be negative, meaning that owners of operationally efficient buildings are more likely to offer a gross lease. If **H1a** is true, then the eco-label coefficient will be positive, indicating a higher probability of a net lease contract associated with eco-labels. If there is no relationship between lease structure and eco-labels, the eco-label coefficients will be statistically indifferent to zero.

It is possible to further explore the Sydney data as a robustness check to test whether other factors that could influence lease structure decisions are instrumented by the eco-label variable. For example, some owners (occupiers) may strategically position themselves as owners (occupiers) of eco-labeled real estate and prefer a particular lease structure; excluding identification of the owner (occupier) would result in the lease structure preference appearing in the eco-label parameter. Further model estimations control for the owner's leasing broker (often the institutional owner itself), the tenant's business sector, and the security deposit required.

ii. Total Costs of Occupancy

To test for the effect of lease structure on overall rental market outcomes, three models are tested using a linear mixed-effects specification. We examine associations between building characteristics, lease characteristics, market characteristics and total occupancy costs as follows:

$$Ln(TOC) = \gamma_m + \boldsymbol{\delta_1}(\boldsymbol{Lease}) + \boldsymbol{\delta_2}(\boldsymbol{Bldg}) + \varepsilon_{w,b} \qquad (3)$$

TOC is the total cost of occupancy for each lease transaction in the database as calculated in Equation 1. Parameters δ are estimated from observed lease transactions, γ_m is a floating intercept representing random effects for each submarket (***Geo***) and $\varepsilon_{w,b}$ is stochastic error containing both within- and between-market effect errors. Rent distributions have a long right tail, so in accordance with other hedonic models of office lease transactions (Fuerst et al. 2013; Gabe and Rehm 2014), the natural log of the dependent variable is used. The variable of interest here is the lease characteristic associated with lease structure – NNN or gross.

However, as seen in Exhibit 2, NNN leases are not randomly distributed in the data, opening up the parameter of interest to possible selection bias. To mitigate selection bias, Specification 3 introduces propensity weighting based on the likelihood a lease uses a net structure. The logistic regression model (Equation 2) estimates the probability that a lease is structured as a net lease, ρ(NNN = 1|*EcoLabel*, ***Lease, Building, Geo***). In Specification 3, each rental observation is weighted by the inverse of the probability of having the lease structure observed; all NNN leases are weighted by $\rho(NNN=1)^{-1}$ while all FSG leases are weighted by $1- \rho(NNN=1)^{-1}$.

For a subsample where data on leasing incentives is complete (n=340 of 673), we run robustness checks to establish whether accounting for tenancy improvement allowances or rent-free periods alter the findings. Specifications 4 and 5 are identical to Specifications 2 and 3, but the dependent variable is changed to the natural log of the annuitized lease value, which takes into consideration both incentives and future rent escalation clauses.

iii. Transferability

Lease structure decisions can vary by market. To investigate whether our results apply to other markets, we run the models specified in Equations 2 and 3 on lease transactions from selected markets in the United States. Leasing data used here comes from Robinson et al. (2017), which contains rent rolls of CBRE-managed buildings across the US.

Market selection is based on the context most relevant to our study: a market where occupants have a binary choice between NNN and gross lease structures. Many markets in the US disqualify because one structure (typically FSG or NNN) dominates, leaving investors with no strategic decision in the matter. Other US markets like Dallas disqualify with many "modified gross" leases featuring bespoke arrangements for expense sharing, details of which are not available in our US dataset. Based on the data in Robinson et al. (2017), only San Francisco Bay Area, Seattle and Minneapolis/St. Paul feature leasing markets similar to Sydney, so leasing transactions in these three markets are used to test whether the Sydney findings based on the models above replicate in similar markets overseas.

V. Results

We find that energy efficiency eco-labels are significantly associated with net lease structures. While tenants usually benefit from the operational savings offered by energy efficient space, we further find that their overall total costs of occupancy stay the same or increase.

i. *Lease Structure*

Table 2 contains four estimations of Equation 2 with data obtained from lease transactions in Sydney. Control variable parameters suggest an association between high value buildings and the use of a net lease instrument. Based on the fourth, and most complete, specification, a one dollar (per m^2) increase in total occupancy costs is significantly associated with a 1.7% increase in the odds of using a net lease, assuming all else remains constant. However, this high-rent-net-lease pairing is mitigated by other controls: higher-floor tenancies and premium buildings (both of which would be associated with higher rents) are more likely to offer gross leases.

Another control is the unsurprising negative relationship between number of tenants in a building and probability of a net lease. There is a significant association between having five or fewer tenants and the likelihood of agreeing to a net lease; the probability a net lease is used increases by a factor of 2000 in a building with five or fewer tenants.[7] As the number of tenants in a building increase, the transaction costs of managing expense accounts for each tenant increase, so it is unsurprising that the probability of using a gross lease is positively associated with number of tenancies.

[Insert Table 2 here]

In regards to the variable of interest, there is a consistent signal indicating a higher probability that an eco-labelled building owner will agree to a net lease contract with tenants. In terms of the hypotheses presented earlier, there is strong support for **H1a**, which states that eco-labelled buildings are more likely to offer net leases. Eco-labelled building owners in Sydney are approximately five times as likely to enter into a net lease agreement if all control variables in the model are held constant. Specifications 3 and 4 demonstrate that the probability of using a net lease in an eco-labeled building increases when owner and tenant preferences for lease structure are included in the model.

ii. *Total Occupancy Costs*

With increased probability of agreeing to a net lease, tenants in energy efficient buildings are more likely to benefit from reduced operating costs, confirming that split incentives may be a concern for efficient investment. But this is only the direct effect. How does a net lease arrangement affect their total costs of occupancy? Table 3 presents the estimations of rent models exploring the effect of a net lease structure and eco-labels on total occupancy costs.

[Insert Table 3 here]

Control variables in these models conform to traditional expectations. Higher floors in an office building cost more to occupy, with an approximately 1% increase in total occupancy costs per story. Total occupancy costs increase the closer an occupant is to a train station. A-Class buildings experience a premium relative to B-Class or lower buildings and buildings graded

"Premium" by the Property Council of Australia cost 23-27% more to occupy relative to the benchmark A-Grade properties. In the propensity weighted specification (Model 3), control for the tendency of new buildings to offer net rents shows that buildings cost less to occupy as they age.

When a building is leased using a net lease structure, Sydney tenants pay approximately 7% more in total occupancy costs after controlling for the propensity of net leased buildings to be of higher quality than gross leased buildings. The magnitude of this cost increase far outweighs the weak and generally not significant 1 to 2% discount in total occupancy costs associated with leasing space in an eco-labeled property.

The subsample of leases where annuitized lease values can be calculated confirms these findings hold after controlling for tenant incentives. For this subsample, overall consideration paid during a lease is approximately 12% higher in a net lease[8] while overall operational savings gained via choosing an eco-labeled building is only 5%. Overall, the Australian models suggest an approximate 5 to 7% increase in total occupancy costs (which is potential gross revenue for the owner) on average in an eco-labeled building. Since operating cost inflation risk is always borne by the tenant in Australia, no matter the lease structure, this outcome represents a risk-neutral trade.

iii. *Transferability*

In the selected US markets, Table 4 suggests tenants in Energy Star-labelled properties are approximately four times more likely to agree on a net lease arrangement than tenants in a non-labelled building. This finding is remarkably similar to that observed in Sydney. The type of eco-label does not appear to matter in the US dataset; US tenants in LEED-labelled assets (a design specification that includes more than just energy efficiency) are also four times more likely than tenants in non-LEED assets to agree on a net lease structure.

Similarity with Sydney also emerges in the US model of total occupancy costs. Propensity weighted results in Table 5 show net lease premiums of approximately 20%. While the coefficient magnitude appears to be capturing effects above and beyond purely net lease structure, the directional support of the Sydney findings is strong. Interestingly, in the US, the eco-label discount on total occupancy costs (20-22%) almost exactly offsets the increase associated with a net lease structure, meaning that the average net lease tenant in an Energy Star or LEED building is paying roughly the same total costs of occupancy as they would in a non-eco labelled, gross-leased building.

[Insert Tables 4 and 5 here]

VI. **Discussion**

There is significant association between net lease structures and operationally efficient eco-labelled buildings in open markets where lease structures vary. However, buildings with net lease structures are also associated with higher total occupancy costs on average, thus eco-labels may be a useful strategy to extract higher gross income out of tenants. Despite the appearance of a split incentive limiting investment in building energy efficiency, landlords indirectly benefit from investing in operational efficiencies that are passed on to tenants.

This research strengthens the recent work of Brotman (2016) and the early observation of Eichholtz et al. (2010) that landlords are able to capitalize energy savings into higher net rental income; we find this holds no matter who receives the direct savings. Logistic models in both the Australia and US can be interpreted that the offer of operational savings may make a tenant more amenable to enter into a net lease agreement, suggesting Brotman's case study of medical offices is transferrable across markets and sectors. Far from being a disincentive to investment in upgrades needed for an eco-label, the sharing of operational expense savings with tenants in a risk-neutral trade comes with either increased (Australia) or unaffected (US) gross income benefits for landlords.

Although this study is not able to measure investor return directly as we do not have data on the cost of energy upgrades, landlords investing in eco-labels are likely to be receiving an even higher risk-adjusted return, all else equal (including lease structure), by reducing risk. While Sydney lease structures do not trade future expense risk, past studies of eco-labelled buildings agree that sustainable real estate investment is associated with lower obsolescence risk (Eicholtz et al. 2010; Pivo and Fisher 2010), which reduces capitalisation rates (the amount the capital markets are willing to pay for a building's future cash flow). The split incentive literature solely considers operational cash flows and does not factor in decreased capitalization rates from reduced obsolescence risk. Furthermore, net lease structures reduce adverse selection risk, so an investment that increases the probability of tenants agreeing to a net lease would theoretically reduce capitalisation rates.

Reverse causation is also a possibility for our finding: net-leased buildings could be more likely to be eco-labelled. In particular, owners seeking to maintain performance-based labels such as Energy Star or NABERS Energy must be re-audited regularly as these are not awarded on static design potential, but measured outcomes that can vary as a result of occupant & management decisions. Heavy energy consumption by tenants lacking the incentive to pay in full could result in failure to qualify for an eco-label. The net lease provides a natural incentive for a tenant to operate efficiently, eliminating the need for additional "green lease" clauses (Bright and Dixie 2014) that seek to regulate tenant behavior in order to maintain eco-label certifications.

A perplexing question remains, why might tenants be willing to pay more for in total occupancy costs than they receive in financial benefits? CSR benefits are one possible explanation because a net lease allows tenants to benefit directly from CSR behavior. As such, CSR tenants are able to communicate their corporate values and measure the value of their strategy through operational savings.

Another possible explanation is that owners may be using an eco-label to exploit information asymmetry. Just as tenants have private information on expectations of their use intensity – creating the adverse selection problem – the reverse could occur with net leases. Owners have private knowledge of their operational costs, so owners with higher relative costs have an incentive to seek a net lease. Eco-labels only audit a small fraction of total operating expenses so the label theoretically could be used to mask inefficiencies in non-evaluated aspects of building operation – such as insurance, management fees or taxes – and entice tenants to sign a net lease. Some suggestive evidence of this theory appears in Reichardt (2014), who found surprising overall operating expense premiums in Energy Star-labelled buildings. Further research into the causality of why net leases are associated with higher total costs of occupancy on average should explore the role of information asymmetry.

VII. Caveats and Limitations

While this study offers important new insights into the relationship between eco-labels and lease structures for office markets with lease structure heterogeneity, there are some limitations that open additional avenues for further research. Notably, these data represent market outcomes at the lease transaction scale and do not allow comment on the owner's investment decision-making process or the owner's total investment return, which would need to be measured at the building scale.

Most importantly, our findings are derived from markets with relatively binary net/gross lease structure offerings and thus are not applicable in markets where culture or an exogenous factor not studied has a significant role in determining lease structure. Likewise, further investigation of markets with high incidence of bespoke modified gross structures will be necessary to establish relationships between specific operational expenses and lease structure. In addition, most properties studied are investment-grade commercial real estate, so the conclusions here are likely suggestive of patterns that exist in other top tier markets.

VIII. Conclusions

Using lease transaction data, this paper examines the complexity of who benefits from operational efficiency in commercial office buildings. There is a consistent association between the presence of an eco-label and the probability of a net lease structure observed in selected Australian and US markets. Further exploration associates net lease structures with higher total costs of occupancy relative to a statistically equivalent property using a gross lease. The magnitude of this cost premium for tenants offsets any savings traded to tenants. With tenants more likely to agree to net lease arrangements, landlords also benefit from reduced risk of adversely selecting resource-intensive tenants if CSR motivates efficient tenants to seek eco-labeled space.

Despite the attractive logic of the split incentive as a barrier to private investment in eco-label upgrades, deeper exploration reveals that landlords benefit indirectly when trading away operational savings to tenants. While further qualitative research is needed to explain exactly why tenants may choose to pay higher overall costs to lease on net terms, this study is promising to real estate managers, investors, and urban policymakers concerned about the split incentive problem as a barrier to investment in energy saving building upgrades. Expanding beyond simple direct incidence, our research provides evidence that an owner's total income or risk exposure can be positively influenced by trading away operational savings.

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Table 1. Descriptive statistics for Sydney Lease Transaction Data. Energy Eco-Label indicates presence of four-star or higher NABERS Energy certification. †Indicates a dummy variable with 1 representing presence of variable.

	Gross		**NNN**	
	Mean	**S.D.**	**Mean**	**S.D.**
TOC per sqm	$629	$135	$810	$221
Lease Area (sqm)	699	1,625	1,149	1,979
Lease Term (yr.)	4.57	1.96	5.25	2.29
Floor Level of Tenancy	12.38	10.68	18.57	12.04
Bldg. Area (sqm)	21,352	17,915	35,133	16,292
Bldg. Age (yr.)	36.69	17.85	25.78	11.79
Bldg. Height (floors)	25.76	13.89	35.58	12.59
Energy Eco-Label†	0.15	0.36	0.33	0.47
CBD†	1.00	0.00	1.00	0.00
Dist. to Transit (km)	0.20	0.12	0.21	0.08
Number of Obs.	373		300	

Table 2. Sydney Logistic Models. Results of logistic regressions on the likelihood of the lease being NNN. ***, **, and * represent statistical significance at the 99%, 95% and 90% levels respectively. Standard error in brackets.

Effect	*1*	*2*	*3*	*4*
Eco-label (1=NABERS ≥4)	1.077*** (0.268)	1.089*** (0.270)	1.483*** (0.334)	1.660*** (0.352)
TOC (2011 dollars)	0.015*** (0.002)	0.015*** (0.002)	0.016*** (0.002)	0.017*** (0.002)
Tenancy area (log.)	0.008 (0.128)	0.059 (0.177)	-0.042 (0.196)	0.106 (0.207)
Building area (log.)	0.109 (0.477)	0.068 (0.488)	-0.525 (0.614)	-0.475 (0.638)
Lease term (months)	0.006 (0.006)	0.006 (0.006)	0.007 (0.006)	0.005 (0.007)
Building age (log.)	-2.732 (2.359)	-2.765 (2.363)	-4.801 (3.288)	-4.499 (3.440)
[Building age (log.)]^2	0.277 (0.356)	0.282 (0.356)	0.581 (0.487)	0.534 (0.512)
Number of building floors	0.054** (0.021)	0.055** (0.022)	0.102*** (0.027)	0.096*** (0.027)
5 or less tenants (1=yes)	5.151*** (1.768)	5.278*** (1.821)	7.365*** (2.068)	7.735*** (2.124)
Tenancy floor level	-0.108*** (0.020)	-0.110*** (0.020)	-0.113*** (0.022)	-0.121*** (0.023)
Distance to train (log.)	0.790*** (0.157)	0.787*** (0.157)	1.097*** (0.203)	1.030*** (0.200)
Premium grade building (1=yes)	-1.847** (0.742)	-1.880** (0.746)	-3.001*** (0.897)	-3.509*** (0.954)
A-grade building (1=yes)	-0.451 (0.329)	-0.466 (0.331)	-0.596 (0.403)	-0.510 (0.409)
B-grade building (1=yes)	Reference	Reference	Reference	Reference
Intercept	-11.300** (5.212)	-11.125** (5.245)	-4.680 (6.405)	-6.628 (6.698)
Submarket Fixed Effects (3)	Included	Included	Included	Included
Security Deposit %		-1.361 (3.282)	-3.486 (3.781)	-5.328 (3.670)
Leasing Broker Dummies (15)			Included	Included
Tenant Sector Dummies (12)				Included
Tjur's D	0.493	0.493	0.562	0.586
AIC	569.3	571.2	525.8	526.8
Num. Obs.	673	673	673	673

Table 3. Australia Total Costs of Occupancy Regressions. The dependent variable is the natural log of total occupancy costs for each lease. All regressions are mixed effect regressions with submarkets controlled by random effects. Model 1 reports results excluding lease structure. Model 2 incorporates Net lease structure. Model 3 uses propensity weights on the likelihood of a net structure. Models 4 and 5 are identical to Models 3 and 4 but use Annuitized Lease Value as the dependent variable to account for incentives and rent escalation structures. ***, **, and * represent statistical significance at the 99%, 95% and 90% levels respectively.

	1	**2**	**3**	**4**	**5**
Dependent Variable	Ln(TOC)	Ln(TOC)	Ln(TOC)	Ln(ALV)	Ln(ALV)
NNN Lease		0.088^{***}	0.072^{***}	0.142^{***}	0.124^{***}
		(0.009)	(0.007)	(0.017)	(0.012)
Eco-Label	-0.013	-0.026^{**}	-0.005	-0.042^{**}	-0.051^{***}
	(0.011)	(0.010)	(0.009)	(0.020)	(0.017)
Short-Term Lease (<5 yr.)	-0.005	-0.012	-0.009	-0.060^{***}	-0.063^{***}
	(0.010)	(0.009)	(0.009)	(0.016)	(0.015)
Long-Term Lease (>5 yr.)	-0.009	-0.020^{*}	-0.004	0.035^{*}	0.054^{***}
	(0.012)	(0.011)	(0.010)	(0.021)	(0.018)
Tenancy Floor (story)	0.012^{***}	0.012^{***}	0.012^{***}	0.008^{***}	0.011^{***}
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Tenancy Floor squared	-0.000^{***}	-0.000^{**}	-0.000^{***}	-0.00001	-0.00001
	(0.000)	(0.000)	(0.000)	(0.00003)	(0.00003)
Tenancy Area (sqm)	-0.008^{*}	-0.006	-0.002	-0.012	-0.017^{**}
	(0.004)	(0.004)	(0.003)	(0.008)	(0.007)
Distance to Train (log)	-0.007	-0.014^{***}	-0.003	-0.009	0.005
	(0.005)	(0.005)	(0.005)	(0.010)	(0.010)
Premium Grade	0.274^{***}	0.246^{***}	0.227^{***}	0.304^{***}	0.289^{***}
	(0.016)	(0.015)	(0.013)	(0.035)	(0.038)
B Grade	-0.113^{***}	-0.093^{***}	-0.092^{***}	-0.141^{***}	-0.125^{***}
	(0.011)	(0.010)	(0.009)	(0.018)	(0.015)
C Grade	-0.466^{***}	-0.420^{***}	-0.411^{***}	-0.432^{***}	-0.425^{***}
	(0.021)	(0.021)	(0.023)	(0.034)	(0.036)
Building Age (years)	-0.001	-0.001	-0.002^{***}	-0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Building Age squared	0.000	0.000	0.000^{***}	0.00004^{*}	0.0001^{**}
	(0.000)	(0.000)	(0.000)	(0.00002)	(0.00002)
Constant	6.257^{***}	6.235^{***}	6.152^{***}	6.214^{***}	6.194^{***}
	(0.076)	(0.080)	(0.095)	(0.101)	(0.094)
Random Submarket Effects	Included	Included	Included	Included	Included
Propensity Weighted	No	No	Yes	No	Yes
AIC	-928	-1001	-998	-291	-281
BIC	-820	-889	-885	-195	-186
Num. Obs.	673	673	673	340	340

Table 4. US Logistic Model of Lease Structure. Dependent variable = 1 if lease is net lease. Selected U.S. markets include Minneapolis, San Francisco and Seattle; intra-market differences are are controlled by fixed effects. ***, **, and * represent statistical significance at the 99%, 95% and 90% levels respectively.

Effect	*Estimate*	*Std. Err.*
Intercept	-7.086	7.893
Energy Star eco-label (1=yes)	1.359***	0.339
LEED eco-label (1=yes)	1.386***	0.370
Total occupancy costs (log.)	4.292***	0.380
Tenancy area (log.)	0.257***	0.088
Building area (log.)	-0.952***	0.353
Lease term	-0.023	0.020
Building age (log.)	4.437***	1.651
[Building age (log.)]^2	-0.659**	0.258
Number of building floors	-0.513***	0.044
5 or less tenants (1=yes)	3.375***	0.422
Renovated lobby (1=yes)	7.169***	0.574
Retail tenant (1=yes)	0.305	0.520
Tenancy floor level	-0.011	0.018
Annual occupancy rate	-0.015	0.010
Located in CBD (1=yes)	9.803***	0.783
Distance to transit	0.159***	0.017
Class A (1=yes)	-1.091	5.793
Class B (1=yes)	-2.672	5.774
Class C (1=yes)	Reference	Reference
Market Fixed Effects	Included	
Generalised Chi-Square	253.47	
Number of Obs.	676	

Table 5. US Total Costs of Occupancy Regressions: This table reports results of regressions on the natural log of total occupancy costs for selected US markets. Model 1 reports results excluding lease structure. Model 2 incorporates net (NNN) lease structure variable. Model 3 uses propensity weights on the likelihood of a NNN structure. ***, **, and * represent statistical significance at the 99%, 95% and 90% levels respectively.

Variable	**1**	**2**	**3**
NNN Lease		0.320*** (11.691)	0.190*** (6.357)
Eco-Label	-0.180*** (-4.791)	-0.190*** (-5.573)	-0.222*** (-7.311)
Tenancy Area (log. SF)	0.012 (1.158)	0.012 (1.296)	0.013 (1.531)
Building Size (log. SF)	-0.230*** (-7.035)	-0.159*** (-5.258)	-0.144*** (-5.094)
Lease Term (months)	0.001 (0.279)	0.002 (0.972)	0.001 (0.221)
Building age (log.)	-0.403** (-2.440)	-0.647*** (-4.272)	-0.520*** (-3.447)
[Building age (log.)]²	0.068*** (2.700)	0.103*** (4.500)	0.084*** (3.762)
Number of building floors (log.)	0.100*** (3.619)	0.149*** (5.859)	0.110*** (3.986)
Renovated Lobby	0.013 (0.381)	-0.085*** (-2.586)	-0.035 (-1.137)
CBD	0.323*** (8.298)	0.105*** (2.624)	0.196*** (4.841)
B-Class or lower grade	-0.229*** (-5.377)	-0.123*** (-3.087)	-0.122*** (-3.288)
Access to Transit	0.215*** (3.523)	0.194*** (3.496)	0.111** (2.039)
Annual Occupancy Rate	0.006*** (5.809)	0.004*** (4.334)	0.005*** (5.697)
Retail	0.254*** (4.041)	0.272*** (4.764)	0.288*** (5.372)
Tenancy Floor (story)	0.010*** (4.131)	0.011*** (5.278)	0.010*** (4.988)
Intercept	5.752*** (11.204)	5.199*** (10.651)	4.859*** (10.483)
Random MSA Effects	Included	Included	Included
Propensity Weighted	No	No	Yes
AIC	399	281	235
BIC	395	277	231
Num. Obs.	664	664	664

[1] Examples include the Property Assessed Clean Energy (PACE) programme in the United States and Environmental Upgrade Agreements (EUA) in major Australian cities.

[2] Total gross potential income is considered to be the same as total costs of occupancy in this study. Indirect ancillary incomes (parking, on-site vending, etc.) are ignored, so our findings may not be applicable in rare cases where energy efficiency initiatives significantly affect ancillary incomes.

[3] Every contract with a tenant's right for a further term includes a clause adjusting the contract rent to an appraised market rent at the commencement of any further term. This means that the value of a further term as a call option has nil value since it could never be exercised at below-market rates. Nevertheless, specifications including option terms were tested, with no impact on any outcomes.

[4] The "contract rent" is the payment made by the tenant as specified in the lease contract. Without the adjustment performed here, gross leases will always have higher contract rents relative to net leases because a gross lease includes a markup to compensate the landlord for accepting payment liability for operating expenses (Wiley et al., 2014).

[5] An alternative approach would be to compute net operating income (NOI) for each lease. We have chosen to use total costs of occupancy to describe benefits to both occupant and owner. There is also an asymmetry in the Sydney lease data; net leases have operating expense data but gross leases do not. Separate modelling specifications using estimated NOI as the dependent were run for both markets, with no change in the results reported here.

[6] The authors have also run mixed linear effects models (where submarkets are specified as random intercepts and the error term contains between- and within-market errors) with practically identical results. The decision was taken to present the fixed effects model here owing to its relative ease of interpretation.

[7] Caution is advised when interpreting the magnitude of this odds ratio ($e^{7.775} = 2287$). By convention, there will always be a dearth of lease transactions in buildings with few tenants, so it is a difficult relationship to model. In Sydney, there are only 12 (out of 673) lease transactions in buildings with five or fewer tenants, so the statistical power of this estimate is low. Raising the cutoff for a "low tenant" building gradually erodes the high odds ratio (of a net lease).

[8] Besides it being a subsample, one quirky reason for the increase from 7 to 12% in total costs to the tenant with the switch to ALV is specific to Sydney (and Australian markets in general). Incentives are typically calculated as a % of the base rent due over the term and can be spent as improvement allowances or rent discounts. Since gross leases include base year opex in the base rent, gross lease tenants receive higher nominal value incentives at the same incentive percentage.