Do tenants pay energy efficiency rent premiums?

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ABSTRACT

Purpose: Using a unique dataset, this paper tests the hypothesis that tenants pay increased accommodation costs for space in energy efficient office property.

Design/Methodology/Approach: We obtain lease contracts for office space in central Sydney, Australia. Empirical data on annual gross face rent and contract terms from each lease are combined with building characteristics and measured energy performance at the time of lease. Hedonic regression isolates the effect of energy performance on gross face rent.

Findings: No significant price differentials emerged as a function of energy performance, leading to a conclusion that tenants are not willing to pay for energy efficiency. Six factors – tenancy floor level, submarket location, proximity to transit, market fixed effects, building quality specification, and, surprisingly, outgoings liability – consistently explain over 85% of gross face rent prices in Sydney.

Research limitations/implications: Rent premiums from an asset owner's perspective could emerge because of occupancy premiums, market timing or agent bias combined with statistically insignificant rental price differentials.

Practical Implications: Tenants are likely indifferent to energy costs because we demonstrate that energy efficiency lacks financial salience and legal obligation in Sydney. This means that split incentives between owner and tenant are not a substantial barrier to energy efficiency investment in this market.

Originality/Value: This study is the first to examine thoroughly energy efficiency rent price premiums at the tenancy scale in response to disclosure of measured performance. It also presents evidence against the common assumption that rent premiums at the asset scale reflect tenant willingness to pay for energy efficiency.

I. INTRODUCTION

Public policymakers and industry are interested in whether energy efficient buildings exhibit superior value characteristics relative to less efficient buildings. Warren-Myers (2012) provides a comprehensive survey of early literature associated with research into the market effects of green building certification. Natural resource-efficient buildings that reduce environmental damage are often known in the industry as "green" buildings. Improving data quality is critical to advance research on the market value of green property according to the Warren-Myers review; research has transitioned from cost-benefit case studies to advanced valuation methods that have found evidence of value premiums, but the lack of quality data has limited the effectiveness of research to inform practice. Having found initial evidence of energy efficiency premiums, these groups and academics are now interested in the cause and implications of observed premiums.

Tenant willingness to pay higher rent is a key potential cause of green building value creation and this paper will contribute to the literature by directly testing whether tenants are willing to pay rent premiums for energy efficient office accommodation. Rent premiums have important implications for the property industry because they act as a market incentive for private investment in energy efficiency, reducing the need for government intervention. Eichholtz et al. (2010) argue that rent premiums encourage investors to develop green buildings, even if there is a cost premium on green development. As for why tenants would pay energy efficiency rent premiums, Eichholtz et al. suggest tenants benefit from operating expense savings, insurance against operating cost inflation risk, and reputational benefits from locating in a property associated with social responsibility. They also discuss the relationship between indoor air quality and employee productivity, but the link between energy efficiency and indoor air quality is weak (Fisk, 2000, Roulet et al., 2006), so this argument applies to green building investments that are not considered in this paper. Reichardt et al. (2012) argue that a lack of energy efficient building supply means early-adopting owners can collect scarcity rents reflecting marginal tenant willingness to pay for energy efficiency.

Overcoming data limitations in existing studies, this paper directly examines tenant willingness to pay for space in energy efficient office buildings. Current hedonic pricing studies on energy efficiency rent premiums are restricted by their use of asset-scale data or – when leasing transactions are used – by omitted variables associated with subjective building quality characteristics. When rent is measured directly from lease contracts in a market where energy labelling and quality labelling are thorough, we find no evidence of a rent differential as a function of energy consumption or energy labelling. Further work demonstrates that this finding is in line with weak financial and legal incentives for energy efficiency facing tenants, even those in net lease contracts that pay all operating expenses.

II. RELEVANT LITERATURE

Hedonic regression studies examining the market value of energy efficiency in office property find a range of value premiums for certified energy efficient buildings relative to uncertified buildings.

Research in the United States finds evidence of rent premiums, occupancy rate premiums, cap rate reductions, and sales price premiums for Energy Star rated buildings (Miller et al., 2008, Eichholtz et al., 2010, Pivo and Fisher, 2010, Wiley et al., 2010, Fuerst and McAllister, 2011a, Fuerst and McAllister, 2011b, Reichardt et al., 2012). The rent and occupancy premiums from these models are summarised in Table 1. A diverse range of energy efficiency rent premiums from varied measures of asset-scale rent are found in the existing literature on the United States. Outside North America, studies on value premiums for energy efficient office space have been conducted in the United Kingdom (Chegut et al., 2012, Fuerst and McAllister, 2011c, Fuerst et al., 2013), the Netherlands (Kok and Jennen, 2012) and Australia (Newell et al., 2011). These studies reach similar conclusions in regard to green premiums as the American studies, with the lone exception of Fuerst and McAllister (2011c), who conjecture that their finding of no premium represents how difficult it is for prospective tenants to obtain an energy performance certificate in the UK.

[Insert Table 1]

This paper examines the findings associated with higher rents further. Most studies of energy efficiency premiums are conducted at the asset scale, which makes the causal factor unclear. Authors assume higher rent measured at the asset scale is sufficient to conclude tenants are willing to pay a price premium for energy efficiency (for example, Reichardt et al., 2012). However, higher rental rates are not necessarily the cause of a rent premium calculated at the asset scale. Converting a heterogeneous set of rental income streams from many individual contracts into one single rent value means asset-scale rent premiums can also arise from agent bias, occupancy rates, occupancy distribution, or market timing.

For example, one metric representing rent at the asset scale is asking rent, the price advertised to the market by leasing agents. Early studies in the United States using the CoStar database, such as Eichholtz et al. (2010) and Fuerst and McAllister (2011b), use asking rent to measure rent. One problem with asking rent is a valuation bias that measures expectations, not outcomes. Leasing agents may systematically overvalue energy efficient labelled offices relative to unlabelled offices as a result of numerous industry publications taking the normative position that energy efficiency premiums *should* exist (Sayce et al., 2010). Second, asking rents are not independent of other variables associated with asset value. Notably, Glascock et al. (1990) find a very strong relationship between occupancy and asking rents. In the energy efficiency premium literature, there is evidence that asking rent is influenced by occupancy in the results of Eichholtz et al. (2010); they calculate an “effective rent” premium from the owner perspective by multiplying asking rent by occupancy rate[i] and this premium is almost exactly equal to squaring their rent premium. Because their implied occupancy premium and measured asking rent premium are almost identical, we cannot reject the possibility that their asking rent premium already incorporates the occupancy premium. Third, rents are a function of micro-locational factors within a building such as floor level, so asking rents depend on the particular tenancy that is vacant. Overall, in a survey of econometric techniques of representing rent prices, asking rent is the least reliable (McDonald, 2002).

An alternative metric of asset rent is a calculation of average rent (R_{avg}) taking the form:

$$R_{avg} = \sum_{i=1}^{N} p_i R_i \tag{1}$$

where R_i represents rent paid per unit of floor area by tenant i at time T (when data is captured for each asset) and p_i represents the fraction of space leased by tenant i relative to the total space covered by rental contracts in the same building known to the data provider. Different measures of rent are used. For example, in the green building rent literature, Reichardt et al. (2012) use average gross rent to measure rent while Newell et al. (2011) use average net rent. Typically, gross rent equals net rent plus recoverable operating expenses.

Average rent is one step better than asking rent (McDonald, 2002). Since the data are agreed contract prices, the use of average rent removes valuation bias from agents. In addition, average rent can eliminate some influence from occupancy rates, though any significant difference in the microlocation of vacant space or rental rates not known to the data provider at the time of measurement could appear in an average rent differential. Reichardt et al. (2012) include lagged occupancy rates to further control for the influence of occupancy on average rent.

However, an inter-temporal aggregation problem arises because rent paid by each tenant was negotiated at a unique time, with year-to-year increases often representing pre-negotiated rent inflation, not open-market rents. Since energy efficient buildings tend to be newer buildings (Kok and Jennen, 2012), the possibility that most were leased-up with market rents at a peak just prior to the global financial crisis means energy efficient rent premiums may signal market timing as opposed to tenant demand for energy efficiency. Also, tenants may have signed leases before the building was formally identified as energy efficient, further weakening the assumed cause of tenant willingness to pay for energy efficiency. No study using average rent attempts to control for inter-temporal aggregation.

Finally, a third metric for average rent is net operating income (R_{NOI}), used by Pivo and Fisher (2010). Net operating income is a form of average rent that includes the cost of vacant space by replacing p_i with p_{i_A}, the percentage of total building leasable area occupied by tenant i, and subtracts unrecoverable operating expenses at time T (U_T) per unit of leasable area (A) to arrive at a measure of net income accruing to owners:

$$R_{NOI} = \sum_{i=1}^{N} p_{i_A} R_i - \frac{U_T}{A} \quad (2)$$

R_i must measure net rent paid by each tenant, not gross rent. Average net operating income is useful to measure a comprehensive outcome for owners, but not to determine the cause of the outcome. Average net operating income is influenced by market timing, occupancy, and expenses.

If one is to test tenant willingness to pay for energy efficiency, it is necessary to construct models of leasing transactions. Three European studies are conducted using individual lease transactions (Chegut et al., 2012, Kok and Jennen, 2012, Fuerst et al., 2013), but all are difficult to interpret as an energy efficiency premium. One key problem is the lack of a subjective measurement of building quality in Europe, leading to omitted variable bias. Sedlacek and Maier (2012) develop a theory that energy certifications in Europe are filling the niche of a metric for quality differentiation; they are used in practice to proxy a range of features unrelated to energy efficiency. The most recent study at the lease scale (Fuerst et al., 2013) finds that building age may be more important than energy ratings when the authors use variable interactions to explain why premiums appeared at both ends of the energy efficiency spectrum. Another problem is the strong regulatory environment in Europe, where policy compliance may be the cause of rental premiums, not market demand for energy efficiency. For example, the highest premium observed by Kok and Jennen (2012) is for tenancies in C-rated buildings, not the more energy efficient A- or B-rated buildings; this is notable because the C-rating is a policy requirement for government accommodation.

This paper continues the theme described by Warren-Myers (2012) that improved data quality is critical to the progress of research on the market value of energy efficiency. It seeks to improve on preliminary studies at the tenancy-scale and thoroughly test for tenant willingness to pay for energy efficiency in lease transactions. In particular, by self-constructing a dataset of lease transactions in a market with little government presence and where quality ratings and energy efficiency ratings are comprehensive, we can test directly for tenant willingness to pay for energy efficiency in a competitive open market. The Sydney central business district is an ideal choice for this study.

III. THE MARKET FOR ENERGY EFFICIENT OFFICE SPACE IN SYDNEY

The Sydney office market is the largest in Australasia, serving as a financial services hub and capital city for the state of New South Wales. In response to the enactment of a federal mandatory disclosure law in 2010, large office building owners participate in NABERS [National Australian Built Environment Rating Scheme], a certification programme designed to inform the market on measured energy performance. In addition, corporate social responsibility among office building owners is uniquely high: Australian property funds have been recognised as international leaders in environmental performance (Bauer et al., 2011). Readers interested in a detailed history of green building in Australia are encouraged to consult Warren (2009) and Mitchell (2010).

Newell et al. (2011) used central Sydney as one of three commercial office markets in the lone asset-scale investigation of energy efficiency price premiums in Australia. They found a similar trend in Sydney green property prices and rents as was found in the United States, arguing that net rental income was positively correlated with energy efficiency. As discussed above, this correlation could have been caused by tenants paying a price premium, lease-up market timing or occupancy profiles, so we seek to eliminate the influence of occupancy and market timing by testing directly whether tenants pay premiums for lease contracts in energy efficient buildings.

i. NABERS Certification

NABERS is a third-party scheme that certifies the performance of existing buildings in operation. This paper features NABERS Energy, a scheme that audits 12 months of building energy consumption and produces a rating from 0 to 6 stars based on the greenhouse gas emissions resulting from that measured energy consumption. In Sydney, there is near-perfect correlation between energy consumption and greenhouse gas emissions, so NABERS Energy ratings can be used to represent either metric. Ratings are valid for one year from the date of certification. Certificates are freely available via the programme website (www.nabers.gov.au). Besides the star rating, the certificate includes raw data from the audit on measured site energy consumption and its conversion into greenhouse gas emissions. Readers interested in a thorough description of the NABERS Energy methodology and auditing process are encouraged to consult the Department of Environment, Climate Change and Water NSW (2010).

The boundaries of certification are typically “Base Building” services, which exclude tenant power consumption (computers and plug-in appliances). Included in the Base Building rating are whole-building lighting, space conditioning, hot water production, and all common area power consumption. Tenant power consumption can also be included in a “Whole Building” rating, but these are rare in central Sydney. Base Building ratings conveniently mimic the boundaries of energy and greenhouse gas costs paid by the party liable for operating expenses in a rental contract – tenants in a net lease and owners in a gross lease. In Sydney, the energy used for tenant power consumption is always paid by tenants, even those in gross leases.

ii. Incentives for Energy Efficiency Investment

As early as 1999, Sydney office building owners obtained NABERS Energy certification voluntarily.[ii] Participation in the scheme increased in 2009, when consultation that led to the Australian Building Energy Efficiency Disclosure Act 2010 (BEED) began. This legislation mandates the disclosure of NABERS Energy ratings when advertising for sale or lease. Full disclosure obligations commenced in 2011. BEED is the first global test of mandatory measured environmental performance disclosure in the office property sector. An earlier regulation used in Europe mandates disclosure of simulated energy efficiency potential – not measured performance – updated every 10 years (Kok and Jennen, 2012). The enactment of BEED has spawned similar performance-based regulations, such as Assembly Bill 1103 in California.

Mandatory disclosure is not the sole legislative action to promote green building in Australia. As one of the largest tenants of office space, governments set energy efficiency minimum standards for office accommodation, such as the Energy Efficiency in Government Operations (EEGO) Policy that instructs federal government tenants to occupy space with NABERS Energy ratings of 4.5 stars or greater. Many state and local governments use similar standards as EEGO, although they often set a minimum of 4 stars. Unlike similar standards in Europe, EEGO policies in Australia are aspirational and not enforced; lease contracts gathered in this study reveal that government tenants in central Sydney often rent space in buildings rated below EEGO thresholds. The lack of government tenants in central Sydney further reduces the influence of EEGO policies in this paper; just over 5% of the lease transactions in this paper are for federal, state, or local government tenancies.

Government also seeks to influence capital markets and private investment. Between 2008 and 2011, the AusIndustry Green Building Fund distributed matching public funds to private commercial building owners that invest in capital improvement projects to reduce operational greenhouse gas emissions. Local governments have enabled building owners to obtain below-market loans for energy-efficiency investment as part of an Energy Upgrade Agreement, in which loan capital is repaid with energy savings and property tax assessments to provide added lender security. Lastly, the Australian federal government is one of the first countries to institute a direct tax on greenhouse gas emissions though the Clean Energy Bill 2011, which took effect at a fixed price of A$23 per tonne on 1 July 2012.

IV. DATA AND METHODOLOGY

Lease transaction data in Sydney is sourced from a sample of lease contracts with a permitted use of "commercial offices" registered between January 2009 and July 2011 on a land title with the New South Wales Department of Land and Property Information. Although it is not mandatory, most commercial lease transactions are registered in Sydney. 1,526 lease contracts for office accommodation in the Sydney central business district (as defined by the Property Council of Australia) were obtained. Leases in buildings that had not received a NABERS Energy certificate at the time of lease were excluded along with leases that did not represent transactions at market value. To ensure each observation is independent, 26 leases were condensed into 10 unique observations because of identical terms in lease contracts for multi-floor tenancies where separate contracts were procured for each floor leased. In total, 673 observations in NABERS-certified buildings with commencement dates between January 2007 and September 2011 make up the complete dataset.

From each lease, we obtain empirical data directly from the contract. The data extracted includes: lease type (net or gross), commencement date, term length (excluding options to renew), tenancy floor area, lowest floor of the tenancy, building address, first year operating expense estimations for net lease contracts, signing incentives and the annual face rent at commencement. As explained earlier, in a net lease, the tenant is responsible for a proportionate share of all common area operating expenses. A gross lease indicates common area operating expenses are included in the initial face rent, but a tenant in a Sydney gross lease pays the increase in expenses over the base year, which is the first year of the term. For comparability and to represent the total cost of accommodation facing the tenant, all net face rents from net lease contracts are converted to gross face rents by adding the estimate of first-year common area operating expenses.[iii]

Only 342 leases disclose full incentive payments in the text of the lease. It is common for Australian building owners to obfuscate incentives given to tenants, declaring them "confidential information" or simply omitting them from a registered lease contract. Thus, it is impossible to be confident that a lack of incentives in the registered lease contract indicates no incentives were paid. In order to preserve the full dataset, this paper makes the assumption that incentives are a fixed market effect. In other words, controlling for the time that each lease was signed is sufficient control for rent incentives. Future research will test this assumption using the truncated sample of 342 leases and a dependent variable of effective rent – an annual level payment representing the net present value of all cash flows in the lease. Preliminary results from the effective rent model are similar to those presented in this paper.

Information on the NABERS rating of the building at lease commencement is obtained from the website of the NABERS programme over the years from 2006 to 2011. Each certificate contains a star rating, data on site energy consumption, expressed as energy use intensity (MJ/m^2/year), and its conversion into greenhouse gas emissions (kgCO_2-e/m^2/year). We always select the star rating without "Green Power" because it is what must be disclosed at the time of lease in advertising under the mandatory disclosure scheme.[iv]

The 673 observations occur in 102 unique buildings. Data on each individual building was captured from a variety of sources. The RP Data Cityscope database is used to obtain building size and building age. The Property Council of Australia (2006) publishes guidelines for ratings of "Premium", "A-grade", "B-grade", "C-grade" and "D-grade" to differentiate subjective building quality in the market. The

Property Council conducts occasional audits of building quality in major markets – the most recent audit in Sydney was 2010 – but does not publish results. However, quality grades are widely known among real estate agents and published in agency reports. This study extracted quality grades for each of the 102 buildings from a wide variety of agency reports. There are no D-grade buildings in the sample. These ratings differentiate and standardise the quality of services provided to tenants, such as lift frequencies, emergency power availability, building management presence, communications technology, security, amenities, car parking, ventilation, and floor plate size.

Central Sydney is divided into six distinct submarkets.[v] All 102 buildings are located within four submarkets: City Core, Midtown, Western Corridor, and Southern. These submarket boundaries are used to control for locational factors. A further locational variable of pedestrian proximity to the nearest central city train station was calculated using the New South Wales Transport Info trip planner (http://www.131500.com.au).

i. Descriptive Statistics

Table 2 presents descriptive statistics of the 673 lease transactions used in this paper. Lease terms averaged just less than 5 years, which was the modal lease term so we define a "short" lease as less than 5 years and a "long" lease as greater than 5 years. Using data on the NABERS Energy certificate issued prior to the lease transaction, the mean star rating is 2.73 and median 3.0. Base building energy use intensity varied by more than a factor of 5, from a minimum of 274 MJ/m^2/year to a maximum of 1,712 MJ/m^2/year. With the compactness of the study area and concentration of urban transit, all the office buildings in the study can be considered accessible by public transit. The nearest train station was less than 450m walking distance away from every one of the buildings, much less than the 1,000m threshold considered as "accessible" in the Australian Green Star assessment system (Green Building Council Australia, 2008).

[Insert Table 2]

Tables 3a and 3b break down the sample by four NABERS Energy rating categories: poor (1.5 and lower), below average (2 or 2.5), above average (3 or 3.5) and best practice (4 and above). A rating of 2.5 is meant to represent the NABERS benchmark for “average”, but in practice it is closer to 3. Four stars and above is used to define the high-performing energy efficient buildings because of its use as an aspirational target for local and state government. The notable difference between groups is building energy use intensity, which is to be expected because it is highly correlated with the NABERS Energy rating. Sydney shows no bias towards large buildings being more energy efficient. Annual rents in buildings with best practice NABERS Energy ratings appear to be lower than those in lower rated buildings. But this is countered by the observation that lower rated buildings are more likely to be found in the prestigious City Core submarket and are more likely to be a Premium-grade building. To disentangle these competing effects on rent prices, we construct a hedonic price model for the central Sydney office market.

[Insert Tables 3a and 3b]

ii. Model

As with previous investigations of environmental premiums in commercial office property, we apply a semi-log ordinary least squares hedonic regression model to the data described above in five model specifications. The dependent variable is the natural logarithm of gross face rent per square metre in each transaction. The regression tests whether rental price can be explained as a function of a bundle of unique independent characteristics associated with each space:

$$\ln(rent\ per\ square\ metre) = f(\alpha_i, \beta, \gamma, \delta, \epsilon) \quad (2)$$

where α_i represents the fixed market effects in quarter i, β is a vector of building characteristics, γ is a vector of lease characteristics, δ is a representation of environmental performance, and ϵ is stochastic error. As explained earlier, this model assumes rent incentives are a fixed market effect controlled by α_i.

Each specification of the model varies the choice to represent δ, the vector of interest. As a control, specification 1 omits δ. Specification 2 groups NABERS Energy ratings as “poor”, “below average”, “above average” and “best practice” as was assessed in Table 3b. Specification 3 uses dummy variables for each unique NABERS Energy rating. Only 2 leases were for space in a 5-star NABERS Energy rating, so these are grouped with the 4.5-star cohort.

The final two specifications use measured energy consumption to represent δ. An examination of the distribution of energy consumption data revealed a long right tail, indicating a lognormal distribution is the most appropriate model. Hence, Specification 4 uses the natural log of building energy use intensity at the time of lease as obtained from the NABERS Energy certificate to test whether tenants react to the underlying performance characteristic of energy efficiency. To allow for additional functional flexibility, Specification 5 creates binary variables for each quintile of building energy use intensity. The first, or “highest”, energy consumption quintile contains buildings consuming in excess of 817 MJ/m^2/yr. The second quintile identifies buildings consuming between 706 and 817 MJ/m^2/yr, while the third quintile contains buildings consuming between 610 and 706 MJ/m^2/yr. The fourth quintile features buildings consuming between 502 and 610 MJ/m^2/yr, with the fifth, or “lowest”, quintile identifying the most energy efficient buildings consuming below 502 MJ/m^2/yr.

Two adjustments to the standard errors in each model are necessary because of the unique dataset. First is a finite population correction, which reduces standard errors because the number of observations is more than a trivial sample of the entire stock of office space in central Sydney. The Property Council of Australia (2011) reports that in the first half of 2011, the four office submarkets in central Sydney contained 4.8 million m^2 of office space. Our 673 observations cover just over 0.6 million m^2, so we observe approximately 12.6% of the market transacting. Cochran (1977) suggests multiplying the standard errors by a correction factor of $\sqrt{(1 - fraction\ observed)}$ when the sample exceeds 10% of the population. Thus, all standard errors in the regression output are multiplied by $\sqrt{(1 - 0.126)}$, or 0.935.

Second, Lagrange Multiplier tests on the residuals in each model indicate the presence of minor heteroscedasticity, likely caused by the presence of multiple leases in individual buildings. To correct for this, White's heteroscedasticity-consistent standard errors are used to determine significance thresholds. Typically, this correction has the effect of marginally increasing the standard errors. In combination, the finite population correction and heteroscedasticity correction work in opposite directions, so the net influence of these corrections is minimal.

V. RESULTS

The regression coefficients for the gross face rent model are presented in Tables 4 and 5. The variables of interest in Table 4 consistently reveal no significant presence of an energy efficiency premium. Neither is there strong evidence of discounts for energy inefficient buildings; leases in 1- and 1.5-star buildings demonstrate the expected negative coefficients, but the confidence in the former being significant is just over 85% after error adjustments. Specification 4 produces an expected negative coefficient for energy consumption – meaning tenants pay less gross face rent as buildings consume more energy – but model confidence in this value is extremely low, with a *t*-value of just -0.081. Specification 5 tells much the same story, with similarly low confidence, although only the most energy efficient quintile appears to show the expected negative coefficient when compared with leases in the least efficient quintile.

[Insert Table 4]

Six characteristics in Table 5 explain over 85% of variability in face rent prices in all four specifications. First, the vertical location of the tenancy within the building has a significant impact on face rent; higher floors attract higher gross face rent relative to lower floors. Second, tenancies in buildings graded "Premium" have the highest gross face rents while B- and C-grade buildings offer discounts of approximately 10% and 43% relative to A-Grade buildings. Third, the value of submarket location produces expected results; the highest rents are in the prime City Core precinct while a statistically equivalent building in the less desirable Southern precinct rents for approximately one-third less.

Fourth, being close to rail transit further increases gross face rents within each submarket. Fifth, market fixed effects variables had the expected pattern regarding the effect of the global financial crisis, with gross face rents rising during 2007 and 2008, falling in 2009 and slowly rising afterwards. Finally, the sixth major influence on the leasing market in Sydney is surprising. The variable for operating expense liability indicates tenants on net rental contracts pay approximately 8% more in gross rental costs than those on gross rental contracts, all else equal.

[Insert Table 5]

VI. DISCUSSION

Models at the tenancy scale did not find significant price signals in gross face rent as a function of NABERS Energy ratings or energy consumption in the central Sydney office market. Thus, the significance of rental premiums for energy-efficient buildings in prior studies may originate in the process employed to calculate a single rental value at the building scale. A common assumption that asset-scale premiums are caused by tenant willingness to pay higher rents for energy efficient space – or command discounts for inefficient space – is lacking evidence. Most likely, there is not just one cause of asset-scale rental premiums. In combination, income from tenants, occupancy rates and market timing may all play a role in previously observed premiums.

The models reveal six key variables – the height of the tenancy, building quality specifications, market conditions during negotiations, submarket location, proximity to transit, and the structure of operating expenses – can explain most of the variability in gross rent that tenants pay. These variables are what moves prices the Sydney leasing market. Could energy efficiency be accounted for in one of these variables? The quality specification variable appears to be the most likely, but there is some evidence to reject this possibility. A review of the methodology behind the quality ratings (Property Council of Australia, 2006) states that existing buildings rated B-Grade and above must have obtained a NABERS Energy certificate, but there is no specification on a minimum threshold. Table 3b confirms the lack of a threshold in practice, showing little correlation between quality grades and NABERS

Energy ratings. What seems more logical is a correlation between the levels of service offered to tenants and energy consumption; Premium-grade space uses more energy but also has greater accessibility (more lifts) and better control of thermal comfort, for example. While most Premium-grade buildings are energy inefficient relative to Sydney office stock as a whole, the A- and B-grade buildings are distributed across the entire spectrum of NABERS Energy ratings, revealing the possibility of meeting lower levels of service requirements using either energy-efficient or energy-inefficient technologies. But if the model is run with only A- and B-grade buildings, the results are similar to those in Tables 4 and 5.

A data limitation of this paper is the inability to calculate net rents from gross lease contracts, raising the possibility that tenant willingness to pay for energy efficiency is “hidden” when net rent and operating expenses are analysed together as gross rent. It is possible to measure net rents for the sub-sample of net lease contracts (N=300), which represents the cohort of tenants most likely to pay a premium for energy efficiency since they are exposed to all operating costs. But a semi-log specified model run on this group with net face rent as the dependent variable produces similar results as the gross face rent model specifications. Location, quality grade, tenancy floor level and market fixed effects explain 88% of net face rents. There is no signal that net lease tenants are willing to pay higher rent for energy efficiency, hence this data limitation is unlikely to hide energy efficiency premiums.

There is a surprising lack of theory taking the position that tenants will not pay for energy efficient office space, hence it is easy to understand why authors finding rent premiums at the asset scale assume these premiums reflect tenant willingness to pay. But we find it is not difficult to explain a lack of tenant willingness to pay for energy efficiency if energy consumption is viewed in the framework of factor costs and legal obligations typical in central Sydney. Notably, advocacy arguments making the financial case for energy efficiency are written from an owner’s perspective, not the tenant perspective that follows. [vi]

i. Explaining the Absence of Energy Efficiency Rent Premiums

Having found no significant rent premiums for energy efficiency, we examine three motivations from the tenant's viewpoint to pay a green rent premium – reducing factor costs, legal obligations, and social responsibility. We argue that, in Sydney, the first two motivations are trivial. This suggests that social responsibility and other qualitative benefits are not strong enough to elicit rent premiums in the Sydney market.

Businesses rent office space as one of many factor costs in the output of office work. When these factor costs are examined in the case of Sydney, energy costs and progressive efforts at carbon pricing are trivial. In mid-2010, Sydney energy costs for commercial offices averaged A$16.78 per m^2 of Net Leasable Area (NLA) and net rental costs averaged A$542.31 per m^2 of NLA (Property Council of Australia, 2010). In early 2011, the cost of office labour in Sydney was approximately A$4,700 per m^2 of NLA – nine times the cost of net rent and 280 times the cost of energy (Gabe and Gentry, 2013). Even a carbon tax at A$23 per tonne is trivial, adding an annual cost of approximately A$3 per m^2 of NLA for an average Sydney office building. If energy cost savings are a motivation for tenants to pay more rent, a 3% gross rent premium – the median from Table 1 for Energy Star buildings in the United States – would need to place the tenant in a zero-energy cost building in order for the tenant to be financially indifferent. While 4-star and above NABERS Energy rated buildings are energy efficient relative to market averages, they are far from zero energy consumption. Referencing Table 3a, if tenants in buildings with below average NABERS Energy ratings shift to buildings with high ratings, they will save approximately 37% in energy costs, which translates into a savings of A$7 per m^2 in gross rent. All else equal, such tenants paying an average gross face rent should only be willing to pay a marginal 1.1% premium if they benefit from all energy cost savings.

Second, Australia is a global leader in "green lease" clauses – behavioural and financial obligations to conserve natural resources and reduce environmental pollution written into lease agreements (Hinnells et al., 2008). Most large landlords in Sydney include a "Green Lease Schedule", which describes tasks to be performed by the landlord and tenant in regard to environmental performance.

In theory, tenants facing green lease obligations may be willing to pay a premium for a limited supply of highly-rated office space because these buildings already have systems in place for high performance, making the fulfilment of these obligations less costly. However, in the course of this research, nearly all Green Lease Schedules signed in Sydney between 2007 and 2011 were not enforceable with penalties in the event of a breach. Like EEGO policies, these documents are aspirational in purpose and do not represent a legal obligation, so tenants are not likely to pay a rent premium for green office buildings because of a Green Lease Schedule.

This leaves social responsibility and other qualitative motivations as the only logical driver for tenants to pay energy efficiency rent premiums. Most existing literature on social responsibility in the office property market is written from an owner's perspective, typically citing strategy as the driver for owners to avoid capital obsolescence because of green trends in the industry (Pivo and McNamara, 2005, de Francesco and Levy, 2008, Newell, 2008, Bauer et al., 2011). Our study falls into line with Miller and Buys (2008), who argue that tenants are awaiting clear signals on costs and benefits and see green building as a task for owners and developers. Hence our results show that tenants' willingness to pay for energy efficiency is noisy, with low confidence in the pricing effects of energy efficiency differentiation in the market. Although the overall explanatory power of these models is high relative to prior research, there is scope for future research to explore alternative variables associated with building energy efficiency, such as tenant willingness to pay for particular technical features of efficient office buildings.

ii. Research Implications

An implication of this research is that the split incentive problem – where owners invest in the necessary capital improvements for green performance but tenants reap the benefits of lower operating costs – is not as big a barrier to improving the environmental performance of the built environment as is often assumed. The financial benefit to arise from environmental performance investment is not significant when placed into the context of factor costs and legal obligations facing Sydney tenants. On the opposite side of the split incentive, the possibility that asset-scale variables such as occupancy rates contribute to asset-scale energy efficiency rent premiums means that owners are likely getting a return on their investment in the form of improved yields and lower vacancy costs.

Therefore, financial innovations designed to reduce the split incentive barrier may be an even better deal for owners than expected. One example is Australia’s Energy Upgrade Agreements, which are loans for energy upgrades that are partially repaid by tenants through a contribution to property taxes. In this case, tenants are paying for a capital improvement that enriches the owner’s asset value while providing them with a trivial benefit that this research shows they are not willing to pay for.

The surprising finding regarding contract structure in this study provides further support to tenant indifference on operating expenses. With the model showing tenants on net lease contracts paying approximately 8% higher gross rent than tenants on statistically equivalent gross lease contracts, tenants have an incentive to enter into gross rent contracts. One potential explanation for this apparent market imperfection is tenant indifference to operating expenses allows owners of net lease contracts to expend minimal effort to manage common area expenses and externalise the inefficiency on the tenant. On-going research will explore this curious finding in more depth.

This study also improves the understanding of market effects associated with the introduction of mandatory performance disclosure policies in regard to energy consumption and greenhouse gas emissions. There is no evidence that tenants change behaviours in response to the introduction of mandatory disclosure, despite evidence that the introduction of NABERS Energy in Australia led to significant investment and improvement in building operational efficiency (Gabe and Gentry, 2013). Future research can explore the relative importance of alternate incentives for owners to invest in the absence of tenant willingness to pay, such as competition for socially responsible portfolios, financial giveaways to owners, and increased occupancy rates.

VII. CONCLUSION

Our results present an alternate narrative to the assumption that tenants are willing to pay significant price premiums for energy efficient office space. A lack of significant gross rent premiums from leasing contracts in central Sydney can be explained from a tenant viewpoint by a lack of financial salience and the absence of enforceable legal obligations associated with energy and greenhouse gas efficiency. Some tenants may be willing to pay for a social responsibility signal or other qualitative benefits, but there appears to be adequate supply that these tenants do not pay a scarcity premium on annual rent for the choice. Previously observed asking and average rent premiums at the asset scale may arise because agent bias, occupancy rates and market timing combine with insignificant rental price differentials to produce an increase in income for owners.

In regard to the current literature on green building premiums, this study has made three important contributions. First, the dataset is unique and choosing Sydney as a case study enabled control for more factors, such as subjective building quality, than existing studies at the tenancy scale. Second, this paper developed an alternate narrative on why green rent premiums may not be attractive to tenants. Finally, it is an early case study on the market effects of mandatory environmental performance disclosure policy, which is gaining momentum as a tool to increase energy efficiency of existing buildings. These contributions call into question the assumption that split incentives between owners and tenants are a major barrier to energy efficient building investment.

Further research is needed to explore the wider applicability of these findings, test the assumption that signing incentives are a fixed market effect, and explore the effect of lease structure on energy efficiency investment. The dataset in this paper represents large buildings commanding high rents in a premier urban office market catering to financial services and other high-wage private-sector occupations. Markets with lower wages and rents will increase the relative importance of energy costs to prospective tenants, reducing the importance of the alternate narrative presented in this discussion. As for incentives, this paper assumed they are a fixed market effect indifferent to energy efficiency ratings. Forthcoming research will use a truncated version of this dataset and test whether energy efficiency price differentials emerge when rent is measured as effective gross rent. Finally, it appears net lease tenants in central Sydney pay 8% more gross face rent than equivalent gross lease tenants. This finding suggests a hypothesis to be explored further: gross leases are a preferred choice to eliminate split incentives for energy efficient office building operation because owners responsible for operating costs have greater incentives for managing them than high wage-paying tenants indifferent to the trivial factor costs of building operation.

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Table 1. Asset-scale energy efficiency rent and occupancy rate premiums in United States market models for buildings obtaining Energy Star certification. Occupancy rate premiums are not investigated in all studies.

			Energy Star Premiums		
Authors	Time Period & Source	Adj. R^2	Rent	Occupancy Rate	Rent times Occupancy
Eichholtz et al. 2010	CoStar at Sept. 2007	0.69 (rents) 0.42 (rent x occ.)	3.3%[A]		10%
Eichholtz et al. 2013	CoStar at Oct. 2009	0.82 (rents) 0.71 (rent x occ.)	2.1%[D]		6.5%
Fuerst and McAllister 2011b	CoStar at Q4 2008	0.63	4%[A]		
Fuerst and McAllister 2011a	CoStar at Q4 2009	0.60 (rents) 0.25 (occ. rate)	4%[A]	1 to 3%	
Wiley et al. 2010	CoStar at Jan. 2008	0.62 (rents) 0.46 (occ. rate)	7.6 to 8.6%[A,F]	10 to 11% [F]	
Pivo and Fisher 2010	NCREIF 1999-2008	0.48	2.7%[C]		
Reichardt et al. 2012	CoStar 2000-2009	0.86 (rents) 0.71 (occ. rate)	2.5%[B,E]	4.5% [E]	

[A] Asking rent used to define rent

[B] Average gross rent used to define rent.

[C] Net operating income used to define rent

[D] "Contract rent" used to define rent at the asset scale. No further clarification on methodology given.

[E] Authors present a premium for each year (2004-2009) using difference-in-differences regression as well as a time-demeaned fixed effects regression for their entire dataset. Results from the fixed effects model are presented here.

[F] Class A buildings only.

Table 2. Descriptive statistics (N=673)

	Mean	*Std. Dev.*	*Median*	*Minimum*	*Maximum*
Area Leased (m^2)	899	1,804	345	29	24,141
Building Size (m^2 NLA)	27,495	18,514	21,203	2,917	85,551
Base Building Energy Intensity (MJ/m^2/yr)	687	219	677	274	1,712
Gross Face Rent (A$/$m^2$/year)	687	193	650	320	1,446
Lease Term (months)	58.5	25.6	60	12	144
Lowest Floor of Leased Property	15.1	11.7	12	0	65
Number of Levels Leased	1.35	1.49	1	1	27
NABERS Energy Rating at Time of Lease	2.73	1.21	3.0	0	5.0
Walking Distance to Train Station (m)	216	108	232	3	443
Building Age at Commencement (years)	31.8	16.4	33	3	129

Table 3a. Descriptive statistics by NABERS Energy rating at the time of lease. See Table 2 for units. Statistics are: Mean (Standard Deviation).

NABERS Energy Rating Category	*Poor (0, 1, 1.5)*	*Below Avg. (2, 2.5)*	*Above Avg. (3, 3.5)*	*Best Practice (4, 4.5, 5)*	***All***
Area Leased	1,000 (1,645)	701 (1,418)	887 (1,545)	1,046 (2,507)	**899 (1,804)**
Building Size	29,791 (20,816)	27,252 (17,119)	27,644 (20,029)	25,717 (15,312)	**27495 (18,514)**
Energy Intensity	1,032 (204)	733 (52.4)	627 (95.3)	458 (70.3)	**687 (219)**
Gross Face Rent	702 (229)	728 (191)	673 (196)	652 (144)	**687 (193)**
Lease Term	62.8 (28.3)	60.8 (26.6)	56.9 (23.3)	55.3 (25.4)	**58.5 (25.6)**
Lowest Floor	13.3 (10.5)	18.0 (12.5)	14.9 (12.1)	14.0 (10.7)	**15.1 (11.7)**
Distance to Train	198 (106)	215 (103)	201 (108)	252 (106)	**216 (108)**
Building Age	30.1 (13.1)	33.1 (14.2)	30.7 (13.4)	33.5 (23.3)	**31.8 (16.4)**
N	122	162	234	155	**673**

Table 3b. Frequencies of categorical variables by NABERS Energy rating groups at the time of lease.

	Poor (0, 1, 1.5)	*Below Avg. (2, 2.5)*	*Above Avg. (3, 3.5)*	*Best Practice (4, 4.5, 5)*	***All***
Submarket Location					
City Core	80.3%	81.5%	45.3%	27.1%	**56.1%**
Midtown	17.2%	12.3%	23.5%	14.8%	**17.7%**
Western Corridor	2.5%	6.2%	30.8%	53.5%	**25.0%**
Southern	-	-	0.4%	4.5%	**1.2%**
	100%	100%	100%	100%	100%
Quality Grade					
Premium	26.2%	12.3%	7.7%	5.2%	**11.6%**
A-Grade	30.4%	50.0%	45.3%	50.3%	**44.9%**
B-Grade	35.2%	35.8%	37.6%	44.5%	**38.3%**
C-Grade	8.2%	1.9%	9.4%	-	**5.2%**
	100%	100%	100%	100%	100%
Operating Expenses					
Net	42.6%	38.3%	37.2%	63.9%	**44.6%**
Gross	57.4%	61.7%	62.8%	36.1%	**55.4%**
	100%	100%	100%	100%	100%
N	122	162	234	155	**673**

Table 4. Independent variables of interest from regression with dependent variable of natural log annual gross face rent per m^2. N=673. Statistics are coefficient (*t*-value).

Independent Variable	*Spec. 1*	*Spec. 2*	*Spec.3*	*Spec. 4*	*Spec. 5*
NABERS Energy Rating at Signing Date					
0			1.80×10^{-3} (0.087)		
1			-0.039 (-1.627)		
1.5			-0.014 (-0.650)		
2			-6.62×10^{-4} (-0.040)		
2.5			*Reference*		
3			0.022 (1.562)		
3.5			8.05×10^{-3} (0.588)		
4			-0.019 (-1.350)		
4.5 or 5			-4.11×10^{-3} (-0.208)		
Poor (0, 1, or 1.5)		-0.013 (-1.000)			
Below Average (2 or 2.5)		*Reference*			
Above Average (3 or 3.5)		0.018 (1.816)			
Best Practice (4 and up)		-0.016 (-1.348)			
Natural Log of Energy Intensity (ln MJ/m^2/yr)				-1.20×10^{-3} (-0.081)	
Highest Energy Consumption Quintile (most inefficient)					*Reference*
2nd Energy Consumption Quintile					0.056 (0.439)
3rd Energy Consumption Quintile					0.021 (1.611)
4th Energy Consumption Quintile					0.001 (0.078)
Lowest Energy Consumption Quintile (most efficient)					-0.005 (0.357)
R-Squared	**0.868**	**0.871**	**0.872**	**0.868**	**0.869**
Adjusted R-Squared	**0.863**	**0.865**	**0.865**	**0.863**	**0.863**

* Significant at the 95% confidence level, **Significant at the 99% confidence level

Table 5. Remaining independent variables from regression models with dependent variable of natural log annual gross face rent per m^2. N=673. Statistics are coefficient (*t*-value).

Independent Variable	*Spec. 1*	*Spec. 2*	*Spec.3*	*Spec. 4*	*Spec. 5*
Operating Expenses Liability					
Net Lease	0.085** (10.895)	0.089** (11.520)	0.083** (9.027)	0.085** (10.870)	0.086** (10.991)
Gross Lease	*Reference*	*Reference*	*Reference*	*Reference*	*Reference*
Lease Term Length					
Short (4 years or less)	-0.015 (-1.860)	-0.013 (-1.626)	-0.014 (-1.766)	-0.015 (-1.854)	-0.013 (-1.622)
Average (5 years)	*Reference*	*Reference*	*Reference*	*Reference*	*Reference*
Long (6 years or more)	-0.021* (-2.010)	-0.019 (-1.841)	-0.020 (-1.963)	-0.021* (-2.001)	-0.019 (-1.885)
Submarket					
City Core	*Reference*	*Reference*	*Reference*	*Reference*	*Reference*
Midtown	-0.114** (-10.940)	-0.117** (-11.410)	-0.116** (-10.994)	-0.114** (-10.915)	-0.110** (-10.216)
Western Corridor	-0.105** (-11.556)	-0.106** (-10.444)	-0.106** (-9.997)	-0.105** (-10.596)	-0.101** (-9.969)
Southern	-0.331** (-13.892)	-0.320** (-12.276)	-0.325** (-12.311)	-0.332** (-13.583)	-0.322** (-13.729)
Building Quality Rating (PCA)					
Premium	0.250** (14.866)	0.252** (14.694)	0.249** (13.938)	0.250** (14.423)	0.252** (14.301)
A-Grade	*Reference*	*Reference*	*Reference*	*Reference*	*Reference*
B-Grade	-0.094** (-10.598)	-0.093** (-10.274)	-0.097** (-10.074)	-0.094** (-10.558)	-0.097** (-10.260)
C-Grade	-0.411** (-17.582)	-0.419** (-17.501)	-0.424** (-17.894)	-0.411** (-17.607)	-0.414** (-16.859)
Lowest Floor Leased	0.012** (12.695)	0.011** (12.635)	0.011** (12.394)	0.012** (12.708)	0.012** (12.565)
Lowest Floor Leased Squared	-4.93×10^{-5} ** (-2.720)	-5.02×10^{-5} ** (-2.800)	-4.94×10^{-5} ** (-2.694)	-4.94×10^{-5} ** (-2.718)	-4.88×10^{-5} ** (-2.718)
Leased Area (natural log)	-0.006 (-1.404)	-0.006 (-1.450)	-0.005 (-1.329)	-0.006 (-1.400)	-0.006 (-1.464)
Walking Distance to Train (natural log)	-0.015** (-3.118)	-0.014** (-2.791)	-0.013* (-2.374)	-0.015** (-2.994)	-0.013* (-2.634)
Building Age at Lease Commencement	-3.18×10^{-4} (-0.408)	3.20×10^{-4} (-0.414)	-5.37×10^{-4} (-0.667)	-3.06×10^{-4} (-0.394)	-2.07×10^{-4} (-0.256)
Building Age Squared	7.16×10^{-6} (1.249)	8.00×10^{-6} (1.439)	9.40×10^{-6} (1.620)	7.07×10^{-6} (1.244)	6.64×10^{-6} (1.138)
Market Fixed Effects (Half-Year)	*Included*	*Included*	*Included*	*Included*	*Included*
Constant	6.37** (142.60)	6.37** (137.71)	6.37** (137.21)	6.38** (55.734)	6.35** (136.96)
R-Squared	**0.868**	**0.871**	**0.872**	**0.868**	**0.869**
Adjusted R-Squared	**0.863**	**0.865**	**0.865**	**0.863**	**0.863**

* Significant at the 95% confidence level, **Significant at the 99% confidence level

[i] This asset-scale definition of effective rent used by Eichholtz et al. (2010, 2013) – occupancy rate times rent – is from an owner's perspective and is *not* the same definition of effective rent typically used when discussing lease transactions. Effective rent from a leasing viewpoint is an annual level payment representing the net present value of all cash flows associated with a lease contract.

[ii] Prior to 2006, the NABERS Energy rating was called an Australian Building Greenhouse Rating (ABGR).

[iii] Gross lease contracts do not state the base year operating expense amount because it is not determined until the end of the first tenancy year. Hence, it is not possible to convert all gross lease rent amounts to net rent amounts without assumptions that could introduce bias.

[iv] NABERS Energy ratings can be improved over time by reducing energy consumption and by purchasing "Green Power" from the local utility company. Green Power is a national Australian scheme administered by the federal government that allows an electricity consumer to pay a premium for electricity that goes to renewable energy producers in exchange for certification that the consumer's electricity was generated by renewable energy. When an owner elects to purchase Green Power to improve his NABERS Energy rating, the certificate includes star ratings with and without the Green Power purchase. Because Green Power must be excluded from a disclosure, it is rarely used.

[v] See page 9 of http://www.propertyoz.com.au/library/OMR_Maps_Jan_2011.pdf for a precise map of central Sydney and its submarket boundaries.

[vi] A common justification for price premiums from green investment is the premise that US energy costs are around 30% of total building operating expenses facing an owner and that they are a manageable cost for increasing Net Operating Income (Ciochetti and McGowan, 2010, Eichholtz et al., 2013).