Handle With Care?

An Evaluation of Empirical Research on the Financial Returns from Investing in Real Estate Assets with Superior Environmental Performance

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This paper evaluates the contribution that empirical research on the financial effects of superior environmental performance in real estate assets can make to providing reliable and useable information to market participants. The first part of the paper assesses the key financial metrics of real estate assets that may be affected by superior environmental performance. The main *a priori* expectations will be outlined. This is followed by a discussion of some limitations of the existing body of research. The systematic review finds that nearly all studies examining the effects of voluntary and compulsory environmental certification on the prices of real estate assets find a positive effect of superior environmental performance. However, it is pointed out that much of the research is preliminary and contingent upon sample size and sampling period.

1 Introduction

Over the last decade, there has been a growing interest among market participants in the relative financial costs and benefits associated with developing or investing in buildings with superior environmental performance. This has also been reflected a growing body of work from the academic community. There is little doubt that sustainability and real estate performance is a hot topic amongst the real estate research community. Just one example is the launch of the *Journal of Sustainable Real Estate* in 2009. Within the real estate field, the scope of research in this area is broad both in scope and geographically. Research has been on different aspects of environmental performance focusing on range of real estate sectors, in a relatively narrow selection of markets, over various (often short) timescales and for a variety of performance metrics.

This paper sets out to provide a critical evaluation of the body of work on the effects of the environmental performance of real estate assets on financial variables such as rental and sales prices, appraised values, occupancy rates *inter alia*. Although it is possible to distinguish between energy and environmental performance, no distinction is made here. Whilst financial variables such as development and operating costs (taxes, utilities) and occupancy rates may also be directly influenced by environmental performance and can also, in turn, influence prices, the paper mainly focuses on evidence of direct price effects.

2 *A priori* expectations

To date, the vast majority of the empirical evidence on the economic effects of environmental performance on real estate assets has focused on environmental certification. One of the direct aims of environmental certification has been to provide information to consumers or users about the environmental performance of a product. The indirect objective is to then change consumption and investment choices, suppliers' production outputs and, as a result, the level of environmentally harmful emissions. It is expected that, by providing independently verified information to investors and occupiers about the environmental performance of buildings, there will be increased willingness-to-pay or demand for buildings with superior environmental performance. Consequently, this shift in demand from investors and occupiers will produce rental and sale price premiums and reduce operating costs and regulatory obsolescence. The 'invisible hand' of the pricing mechanism should ensure that suppliers of buildings (investors and developers) have the financial incentives to improve their environmental performance. Whilst robust and rigorous studies of these economic effects should be central to evaluating the effectiveness of environmental certification in real estate markets, currently, for most markets we can be sure of very little about the effectiveness of this policy approach. This is essentially due to the interaction of a lack of data and a limited timescale – it is still fairly early days.

There is a growing body of evidence (relative to proclamation) that occupiers of, and investors in, buildings with better environmental performance can obtain a range of benefits. Owners, developers and occupiers can benefit from subsidies, tax reliefs and reduced regulatory barriers that have been offered in many jurisdictions. In addition to the above, the other significant tangible benefit to occupiers is lower

utility costs regarding energy and water use. Difficult to measure benefits tend to be associated with productivity improvements (lower staff turnover, absenteeism, higher outputs *inter alia*), reduced obsolescence, lower regulatory risks and reputational rewards. Advantages for investors and developers tend to fall into similar categories. There is a growing, albeit, as we see below, far from definitive body of research to suggest that investors may gain from higher occupancy rates, lower operating costs, rental and sale price premiums. Other cited, but as yet largely unsubstantiated, potential benefits to investors are similar to occupiers and include decreased depreciation, reduced regulatory risk and reputational rewards.

There is also interest in the transmission of the growing eco-consciousness of investors to real estate asset pricing. This is based on an implicit assumption that investor demand affects prices. As has been restated many times, under the efficient markets hypothesis, investor demand should not matter since prices encapsulate the present value of the cash flow generated by the asset. Given this horizontal demand curve assumption, investors can buy or sell any amount of a security without affecting its price. However, while in an efficient market clientele effects should not exist, there are numerous studies demonstrating that they do. The downward sloping demand curve for securities is typically explained by deviations from a perfect market. In market segmentation literature, there is a longstanding body of work suggesting that the size and nature of the investor base affects security prices. This has also been found in the SRI literature; a decrease in the size of the investor base produces a neglect effect associated with exclusionary screening, lower demand for 'sin' securities, a negative effect on prices and a positive effect on returns. The body of work on the performance of securitized SRI funds broadly consistent with underperformance in terms of returns (see Bauer *et al*, 2005,Geczy *et al*, 2003 and Renneboog *et al*, 2008). It is worth stating that the expectation is that price premiums for eco-certified assets are expected to be associated with underperformance in terms of returns.

As stated above, in securities markets, when perfect market assumptions are relaxed, there are strong *a priori* grounds to predict that the size of a security's investor base will affect its prices and returns. In commercial real estate markets, it is almost axiomatic that deviations from perfect market assumptions are substantially larger. Thin trading, high search costs, information asymmetries, heterogeneous assets and expectations all increase potential clientele effects. Indeed, segmentation is also often highlighted between investor types. Short-hand clientele investor categories such as institution/non-institutional and core/value/opportunistic reflect variations in risk preferences amongst investor groups. Indeed, assets are also classified in the same way. There tends to be cross-sectional and time-varying variations in marginal investors for real estate assets with different investment qualities.

As we discuss further below, the output from the academic and professional research communities is also dynamic as existing studies are refined and new studies emerge. Before going onto to discuss potential bias problems in this type of research, we critically review the body of work to date on the effects of both voluntary and compulsory environmental performance on real estate prices.

3 Evaluating the Research: 10 Reasons to be Careful

Given the growing societal concern about climate change in the last two decades, it has been argued above that there is a compelling case to expect higher relative demand for commercial real estate assets with superior environmental performance from both investors and occupiers. Whilst there are also compelling reasons to expect a supply response, the tangible and intangible benefits of assets with superior environmental may be transmitted to high occupancy, reduced time-on-market, lower operating costs, higher rents, higher net incomes, higher prices etc. in a virtuous circle. However, in commercial real estate markets, rental and sale prices are formed in highly imperfect markets and an 'efficient' transmission of costs and benefits to prices and performance may not occur. Further, there are a number of other reasons to stamp "handle with care' on the studies that have been carried out to date.

Table 1: A Summary of the Evidence

Author(s)	Refereed	Sample	Findings on price differentials
Miller. Spivey and Florance (2008)	No	'Filtered' sample of Class A buildings (larger than 200,000 sq ft, multi-tenanted, over five stories, built after 1970) to compare to 643 ES buildings. 927 sale transactions between 2003 and 2007. Breakdown between LEED and ES sale price observations is unclear.	Finds no statistically significant sales price premium.
Wiley, Benefield and Johnson (2010)	Yes	Class A office buildings only. 46 metropolitan markets (25 markets for sales). Breakdown between LEED and ES is unclear. We estimate 30 LEED and 440 ES rental observations and 12 LEED and 70 ES sales observations.	Hedonic OLS and 2SLS find rental differentials of 15-17% for LEED and 7-9% for ES. Hedonic OLS model of sales prices in absolute form. Estimate sale price premiums of $130 psf and $30 psf for LEED and ES.

Eichholtz, Kok and Quigley (2010)	Yes	Weighted average rents for 694 certified buildings. Sale prices for 199 certified buildings 2004-2007. Breakdown between LEED and ES is unclear.	No statistically significant rental premium for LEED. 3% rental premium for Energy Star. No statistically significant sale price premium for LEED. 19% sale price premium for Energy Star.
Fuerst and McAllister (2011)	Yes	Asking rents for 990 ES and 210 LEED certified buildings. Sale prices for 662 ES and 139 LEED certified buildings 99-2009.	6% rental premium for ES and LEED certified buildings. 35% and 31% price premium for LEED and ES.
Chegut, Eichholtz, Kok and Quigley (2010)	No	Sale prices for 78 office BREEAM offices in UK. Sales data obtained from Real Capital Analytics. 'Achieved' rents for 1011 offices obtained from CoStar	Estimate rental premium of 16-20% to eco-certification. Excellent – 22%-27%, Very Good – 18%-19%, Good – 8%-11%, Pass – 17%-18%. In two out of three specifications – no statistically significant sale price premium.
Dermissi (2009)	Yes	Appraisal estimates of Market Values for 351 LEED-rated US office buildings. Study period is first half of 2009.	Provides detailed results for NC, EB and CS sub-samples. Results are inconsistent between specifications. For LEED NC, estimates a 36% discount for LEED Silver. LEED EB has a 118% premium.
Fisher and Pivo (2009)	Yes	Investment performance of RPI properties – 209 Energy Star, 158 in regeneration areas, 669 near transit stations.	Estimate 12.5% premium on appraised capital value for Energy Star compared to buildings in same CBSA. Estimates 1% higher occupancy rates in Energy Star buildings.
Deng, Li and Quigley (2011)	Yes	Residential sales prices of 74,278 dwelling units in 1439 projects in Singapore between 2000-2010. 4% of sample had Green Mark by 2009. Had 18269 transactions in 62 residential projects with Green Mark were matched against 55982 transactions. 51% Gold, 21% Gold-plus, 19% Green Mark and 3% Platinum	Significantly different results for different models. PSM Regression estimates average price premium for Green Mark of about 4-6%., Platinum – 14%, Gold Plus – 2.3%, old – 5.5%, Certified – 0.1%. Project Fixed Effects Regression estimate average price premium for Green Mark of about 14-21%., Platinum – 21%, Gold Plus – 15%, Gold – 15%, Certified – 10%.
Shimizu (2010)	No	A blend of residential asking prices (80207) and actual (2063) sale prices for Tokyo 2005-2009. Appears that approx 14%-15% of the sample had eco-labels.	Estimate a 5% asking price premium for Green Label.
Brounen and Kok (2011)	Yes	31993 residential sale prices in the Netherlands in 2008-9 for buildings with EPC rating	Compared to buildings rated D, they estimate premiums of 10%, 5.5% and 2.5% for A, B and C respectively. For dwellings rated E, F and G, the estimate discounts of 0.5%, 2.5% and 5% respectively. All coefficients are statistically significant. No statistically significant effect estimated for time on market.
Fuerst and McAllister (2010)	Yes	Weighted average rents for 1846 Energy Star, 268 LEED and 254 dual certified office buildings. Sale prices for 876 ES, 87 LEED and 123 dual certified office buildings 1999-2009. Occupancy rates for 2111 ES, 313 LEED and 254 dual certified office buildings.	Estimate rental premium of 3%-4% for ES. 4%-5% for LEED and 9%-10% for dual certified. Estimate sale price premium of 18% for ES, 25% for LEED and 28%-29% for dual certified buildings
Eichholtz, Kok and Quigley (2010)	Yes	Two samples – 2009 and 2007. For 2007 sample, 694 green office buildings in a total sample of 8182. 2009 – 2687 observations in a sample of 26794. Sales 744 rated 5249 control. Rents 1943 rated 18858 control. Breakdown between LEED and ES is unclear. Mentions 209 LEED rental buildings later in paper.	When comparing performance of 2007 sample, they find that estimated rental premium goes down to 1.2%. For 2009 sample, estimate rent premium of 2% for ES and 6% for LEED. Estimate sale price premium of 13% for ES and 11% for LEED
Yoshida and Sugiura (2011)	No	1154 buildings evaluated under Tokyo Green Building Program which is mandatory for buildings exceeding 5000 square meters. They obtain a total sample of 34862 sales of condominiums. It is not clear how many condominiums are TGBP rated.	Find a statistically significant discount of 5.5% for labeled buildings. Discount is robust in a number of tests. When they estimate the price effects of the different components of the rating, they find mixed results. The individual drivers of the negative premium tend to be increased energy efficiency, water efficiency and planting. They suggest that perceived additional maintenance costs associated with these features may produce the discount. Find evidence of lower depreciation for eco-labeled condominiums.
Jaffee, Stanton and Wallace (2010)	No	15230 transactions (2001-10) for office buildings located in 43 US metropolitan areas. 545 Energy Star properties (3.6% of total). Only 142 rated at the time of sale (0.93% of total). Have data of total expenses (1473), NOI (1532) and cap rates (2323) for a subset of the sample. (Presumably) Due to missing variables, this sample decreases substantially in the hedonic models.	Estimate an Energy Star premium of 13.5% when total expenses and operating costs are excluded as confounding factors. When they are included in the model of a subset of the data, the ES premium becomes statistically insignificant. Although sample size for Energy Star is not stated, it is likely to be quite small. In a subset of 816 observations, they find no significant ES effect on NOI, cap rate or operating expenses. However,

			again sample size of ES is not indicated and may be small.
Zheng, Wu, Kahn and Deng (2011)	Yes	In the absence of an eco-label in China, an index of building greenness is estimated from marketing claims. Apply this index to 1992 residential building complexes constructed 2003-2008.	Estimates a green premium of 9.1%.
Fuerst and McAllister (2011)	Yes	Examines effect of EPC rating on yield, Market Value and Market Rent for 708 commercial property assets in IPD UK. Includes 23 BREEAM rated buildings. Date of data is Q3 2010. Given the large geographical scope of the sample and the number of EPC and geographical 'segments', it is likely that there were small sample effects.	Finds no significant effect of EPC rating on Market Rent and Market Value. Very similar results for yield estimation. For one EPC rating (E compared to G for retail) was the coefficient significantly negative at the 10% level. The BREEAM results were similar. The coefficient on the BREEAM dummy was statistically significantly negative at the 10% level.
Kok and Jennen (2012)	Yes	Examines the effect of EPC rating and Energy Index on 1057 rental transactions in Netherlands for the period 2005-2010.	Finds a rental premium of approximately 4.7% for buildings rated C or lower compared to buildings rated D and above. Compared to D rated buildings, find significant premiums of about 10% for C rated and 5% for B rated. Significant discount for E (0.8%), F (0.5) but G rated offices had a 2.3% premium.
Newell, McFarlane and Kok (2011)	No	Compares 206 NABERS rated office buildings with 160 non-NABERS rated buildings in Sydney and Canberra in March 2011. 23 (4-6) Green Star rated buildings were also included. Covers 51% of the total office market.	Providing no indication of statistical significance, the study finds a small rental and value premium for high NABERS-rated buildings 0.3% and 1.9% specifically. Finds a discount in value for offices with NABERS rating of 2.5 stars or less.
Das, Tidwell and Ziobrowski (2011)	Yes	Looks at rental performance of 53 LEED buildings in San Francisco and Washington DC between 2007 and 2010. Control sample is 70 conventional buildings.	Find positive effect of 'green' label in falling market but no significant effect in rising market.
Fuerst, van de Wetering and Wyatt (2012)	No	Looks at the relationship between a sample of asking and achieved rent and EPC rating for a sample of 400-800 offices in the UK. Draws upon a database provided by CoStar for transactions in 2008-2010. Includes potential price determining variables such as lease incentives and lease lengths.	Finds that, compared to D rated buildings, in a pooled (of asking and contract rents) sample with 817 buildings there is a statistically significant premiums for properties rated A-C **and** E-G. When only asking rents are modelled a similar pattern is found with very similar premiums for A-C and E-G in relation to D. For actual contract rents, no significant effects on rents are identified for EPC rating.
Reichardt, Fuerst, Rottke and Zietz (2011)		Drawing upon the CoStar database, examines a time series of rents for a sample of 1584 Energy Star and 337 LEED certified buildings in 10 largest metropolitan areas of US over the period 2000-2010.	DID approach indicates variations in the effect of certification between years. For Energy Star, for buildings certified between 2004 and 2007, there is an approximate increase in rent of 3-5%. For LEED rated buildings certified in 2008 and 2009, no significant effect on rent is identified. For the panel regression fixed effects model, average rental premiums of 2.5% and 2.9% are estimated over the sample period. However, the premiums tend to vary. They emerge in 2005, increase in the period 2006-2008 and decrease after this point.
Chegut, Eichholtz and Kok (2012)	No	Draw upon CoStar, EGi and RCA databases to create a database of office leasing and sales transactions. 1149 lease transactions including 64 BREEAM-certified buildings. 2019 sale transactions including 69 BREEAM-certified buildings	Estimate rental premiums of 25-30%. Different model specifications estimate quite different sales price premiums – 17%, 26% and 38%.
Aroul and Hansz (2012)	Yes	Draws upon NTREIS transaction database of two centres in Texas, USA (Frisco and McKinney). From a sample of 14055 residential transactions, 6781 were tagged as green transactions.	Estimates price premium of 2% for green transactions. When disaggregated into mandatory and voluntary green transactions, the respective premiums are 5% and 1%.
Australian Bureau of Statistics (2007)	No	Draws upon a database of residential sales in the Australian Capital Territory for the period 2005 (2385 transactions) and 2006 (2719 transactions). Since a four star rating was a mandatory requirement, houses less than 10 years old are excluded.	For 2005 sample, estimate an (approximately) 1% premium for every 0.5 increase in rating (EER ranges from 0-5). For 2006 sample, estimate an approximately 2% premium for every 0.5 increase in EER. For pooled sample, relative to zero rating house estimates premiums of 1.6% (EER 1), 3% (EER 2), 5.9% (EER 3), 6.3% ((EER 4) and 6.1% (EER 5). Explanatory power of model is high and there is a large range of quality controls.
Fuerst, Gabrieli and	No	Sale prices for 4,591 transactions involving Class A offices sold in US 2007-2011. 931	Estimate sale price premium of 4-5% for Energy Star, no premium for LEED and 11% for dual

McAllister (2012)		Energy Star certified, 108 LEED certified, 355 LEED **and** Energy Star certified.	certified buildings.
Kok and Kahn (2012)	No	Sale prices for 4231 eco-certified dwellings and 1,600,558 control dwellings in California sold between 2007-2012. 68% ES label, 47% Green Point, 3% LEED for Homes, 17% had multiple certifications.	Estimate sale price premium of 14.5% for Energy Star, no significant premium for Green Point and no premium for LEED for Homes. For recently constructed homes, Energy Star premium reduced to 11%. No change for other ratings
Hyland, Lyons and Lyons (2012)	No	Where information is provided on energy efficiency score, the sample has asking sale prices for approximately 20,000 dwellings in Republic of Ireland. Asking rental rates for approximately 40,000 dwellings over the period Jan 2008-Mar 2012.	Find substantial asking price premiums related to D-rated properties for A (11%), B (6%) and E!! (2%). Find a discount of 6% for F/G. For rental rates, find rental rate premiums related to D-rated properties for A (2%), B (4%). Find discounts for E (2%) and 3% for F/G.

Reason 1 Quality control is highly variable

Largely due to the pioneering nature of early studies, lack of peer review in other cases and difficulties assembling appropriate data sets, the studies that have been conducted are of varying quality. Over time, better data has become available and the research community has become more knowledgeable about the pitfalls and problems of some of the data itself and the appropriate techniques for analysing it. Some papers have been published in peer-reviewed journals (in which there is also a clear hierarchy); others are part of the 'grey' literature in that they are in the public domain but have not been subject to peer review. Some are moving through the various stages of production to final publication along which they may change dramatically. Others are published by professional bodies or interest groups without any formal review process. Inevitably, the most up-to-date research will be part of the 'grey' literature studies.

Reason 2 Data quality is variable

The feasibility and quality of empirical research into the price effects of environmental certification is dependent upon the availability of data on three main areas market prices (rents and sales), environmental performance of real estate assets and the attributes of buildings – leases, specification, size, location, quality etc. Outside of US office markets, adequate data in terms of scale (sample size) and scope (number of variables) has rarely been available and it is unlikely that any researcher has had all the information that they would have liked. The main problem tends to be obtaining data on all the potential price determinants. The related issue of omitted variable problems is discussed in more depth below.

Reason 3 Sample size is often small

It can be surprisingly difficult to even find basic information in some papers about how many 'green' assets are being compared to a (usually) much larger sample of conventional assets. In studies involving commercial real estate assets, sample sizes have been small with typically hundreds (but sometimes less) of environmentally certified assets being compared to thousands of conventional assets. For studies involving residential properties, typically the sample size is much larger. However, where 'green' buildings are an extremely small proportion of the stock, they may constitute a highly atypical subset of the population.

Reason 4 Results may be sensitive to econometric model specification

Due to differences between 'green' and conventional buildings (e.g. in the US office sector 'green' buildings tend to be newer, larger and located in better locations), it is usually not possible to use simple descriptive statistics such as simple averages to identify whether there are significant differences between 'green' buildings and non-'green' buildings in terms of rents, prices etc. It can be difficult to measure the contribution of an individual attribute (such as eco-certification, energy performance, location, design etc) to identified single price paid for a bundle of attributes. Most studies use some variation of widely accepted econometric procedure (a hedonic regression) to estimate the contribution of each asset attribute (size, age, location, certification etc) on its price. However, hedonic model outputs can be sensitive to choice of model specification and scope of explanatory variables. Indeed, many studies apply a number of different techniques (e.g. Ordinary Least Squares, Generalised Least Squares, Propensity Score Matching) and include different independent variables. This can be extremely useful since it provides some indication of the robustness of results. Clearly, concerns are raised when results vary significantly between different models i.e. when using the same data, the findings are not consistent between different models.

Reason 5 Data errors can bias findings

When dealing with thousands of observations, we have found that the can be a significant number of errors in the data. For instance, in pricing studies, the price of a portfolio sale may be allocated to a single building or the price of a single building may be allocated to a portfolio. The results can be sensitive to such outliers.

Reason 6 There are usually omitted variable problems

Essentially, the research question in most price studies boils down to "All else equal, how does being 'green' affect the price of a building". The problem for researchers lies in the three words - all else equal. Due to data constraints, researchers may omit a variable that is having an effect on the prices of 'green' buildings. Perhaps, being 'green' is only one element of a bundle of 'extras' that a developer uses to create

a superior product. For instance, homes with better energy performance may tend to be of a higher quality of construction. By omitting this variable (superior construction) from a model, all else will not be equal and a construction quality effect will be attributed as an energy efficiency effect. However, it is also possible that these unobserved variables may also be affected by environmental certification. For instance, higher quality tenants may be attracted to eco-certified buildings. Tenants may also take longer leases or accept fewer lease incentives in eco-certified buildings. Atkin et al (2011) looked again at the evidence of apparent large price premium that REITs seemed to pay (not necessarily for eco-certified asset) in the US. They referred to a potential bias in the studies – that REITs may have tended to buy the best properties within a quality category with the result that an unobserved explanatory variable (the premium property explanation) resulted in hedonic models producing "unrealistic" price premiums. They supplemented their hedonic estimation with an analysis of repeat sales transactions (a sample of properties that had sold twice). Using this type of approach, they estimate REIT premiums of 6% compared to the 20%-50% premiums estimated in their hedonic regression models. It is possible that eco-labelled buildings may be best-in-class assets with superior attributes that are not included in a data set (better construction, specification, tenants, leases?)

Usually the most important control in this type of price study is controlling for locational differences. In terms of location, what other buildings are the 'green' buildings being compared against? Other buildings in the same city? Other buildings in the same sub-market? Other buildings within a certain distance? This issue can be crucial because 'green' buildings may be concentrated in the specific (e.g. high value) locations. If this factor is not controlled for adequately, a location effect may be mis-attributed to a 'green' effect.

Reason 7 Results of studies are not always consistent

In some papers, there are some results that seem illogical. For instance, it seems reasonable to expect that higher environmental ratings will have larger price effects than lower environmental ratings.

Reason 8 Findings are likely to be highly contingent

It is also important to bear in mind that supply and demand conditions determine prices and that they are inherently dynamic and variable over space. The balance between supply and demand for 'green' and conventional buildings is not uniform and is evolving. Empirical studies, while useful in a context where evidence is scarce, are inherently backward-looking. Essentially, at an aggregate level they estimate the outcomes of previous supply and demand conditions. Further, the contribution of studies that focus on specific sectors, in specific countries and over specific timeframes means that results may not be capable of being generalised to other sectors, places and time periods. Studies can be quite broad e.g. US offices and 'disguise' substantial variation in price effects between assets. The benefits from adopting green buildings will vary according to climate, economic structure, prevailing attitudes towards climate change and a range of factors. Cross-sectional and temporal variations in this these and other factors will lead to cross-sectional variations in supply and demand.

Reason 9 There may be a decline effect

Popularized by Lehrer (2010), the decline effect refers to a phenomenon identified in some areas of scientific, particularly medical, research to describe a pattern whereby initial strong findings disappear over time. This effect has broadly been explained as a consequence of the interaction of perverse incentives for researchers and the increased likelihood of false positives in small samples. It is associated with a tendency for a bandwagon effect with confirmatory papers being produced early in the hype cycle. However, as more rigorous studies with larger samples are carried out, there is then a regression to the mean. As a result, later studies fail to replicate the effects seen in previous studies. Another possible cause for an apparent strong initial effect is that the sample is not representative of the population. In terms of eco-labeled buildings, this is unlikely. However, more relevant is the possibility that the time period is unrepresentative. For instance, most studies of green building price effects have been carried out in 2007-2010. This may be the period when interest in eco-labeled buildings peaked. According to Google Trends, searches for LEED and Energy Star peaked in 2008-2009. Other causes of the decline effect are well-known publication biases in academic research.

Reason 10 There may be publication bias

Publication bias is a longstanding phenomenon that refers to a tendency for research with positive results to be published. Sterling (1959) first noted that 97% of all published papers in psychology confirmed their hypothesis. As a result of publication bias, findings that are not significant or inconclusive are hard to publish. This, in turn, produces a 'file drawer' effect whereby studies that are non-confirmatory tend to be shelved. Publication bias may reinforce other biases. Researchers are not objective and may select or selectively report results that confirm pre-existing theories and views. Publication bias can also cause researchers to 'shoe horn' findings to fit expectations or engage in data and/or model manipulation in a 'significance chasing' exercise. However, as a finding becomes a stylized fact, leading journals become less likely to publish studies replicating existing findings and contrary results become more interesting and publishable. Publication bias becomes a particular problem for papers (such as this paper) carrying out a systematic review of research on specific issue.

4 Concluding Remarks

Probably the most important finding of this literature review is that nearly all studies examining the effects of voluntary and compulsory environmental certification on the prices of real estate assets find a positive effect of superior environmental performance. However, it is worth bearing a number of points in mind. Many of the studies have not yet been through a rigorous peer review process. Even for publications in high quality journals, it may be the case that the 'worthiness' and topicality of the subject area have created a publication bias. The vast majority of studies use hedonic analysis to attempt to isolate the effect on price of the environmental certificate. However, the omitted variable problem is pervasive in such studies. No studies have a complete coverage of all the price determining variables.

Despite rapid growth, a fairly small pool of researchers is common to many of the studies. Perhaps controversially, it is also possible that the perceived 'worthiness' of the topic has produced a tendency for researchers to accentuate positive findings and to play down negative findings. This may be enhanced by publication bias – the tendency of some journal editors to prefer papers with strong rather than inconclusive findings which can also further incentivise authors to play down the limitations of their research. Finally, the findings of the studies are becoming obsolete. Broadly, they provide us with a 'noisy' signal of positive or, in some cases, negligible price effects associated with environmental certification. However, given dynamic markets, up-to-date studies with better (in terms of scale and scope) data are still needed. Whilst it is rarely advisable to finish a paper with a quotation – especially one from a blog, it is perhaps justified breaking this rule in order to benefit from the wisdom of leading scientific thinker P. Z. Myers who argues that

> "**you don't get to choose what you want to believe, but instead only accept provisionally a result; and when you've got a positive result, the proper response is not to claim that you've proved something, but instead to focus more tightly, scrutinize more strictly, and test, test, test ever more deeply".**

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