Fiscal Research Working Paper

The Effect of LEED Certification Levels on Multi-family Residential Buildings in the District of Columbia

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Abstract

This research uses cross-sectional administrative data to investigate the effect of LEED certification on multi-family residential building rent and expenses in the District of Columbia. To our knowledge, this is the first analysis that uses government administrative data to empirically test the impact of LEED certification on multi-family residential buildings in a jurisdiction. For this study, we use a unique dataset comprises District of Columbia Government Office of Tax Revenue's 2018 Property Income Expense and Real Property Assessment data along with CoStar data. This study finds that for 2018, LEED-certified buildings had, on average, 10.1 percent lower operating expenses, and 19.7 percent higher rent than their conventional counterparts. The results also indicate that the level of certification matters with respect to operating and utilities expenses. Specifically, only Silver- and Gold-level buildings saved on operating (24.7 percent and 29.1 percent) and utilities (68.3 percent and 53.0 percent) expenses, respectively.

Office of Revenue Analysis
Office of the Chief Financial Officer
District of Columbia Government

1 Introduction

Approximately 55 percent of the world's population live in urban areas and, by 2050, this figure is projected to be over 66 percent (United Nations, 2018). These areas are significant contributors to greenhouse gas emissions but at the same time cities and their populations are also quite vulnerable to climate change impacts. Thus, tackling climate change and environment sustainability is a challenge that is emerging as a key urban policy issue. Consequently, mechanisms have been designed to mitigate and adapt to climate change and its impacts. One such response on the national level is the introduction of the United States Green Building Council (USGBC)'s Leadership in Energy and Environment Design (LEED) green building rating system in 1998. LEED has become a leading design standard for green buildings in the United States. While there is growing literature on the impact of this certification on rental premia, occupancy rates and sales prices, most research focus on commercial office space. Thus, there is a knowledge gap regarding the impact of LEED certification on the financial performance of multi-family residential buildings (hereafter referred to as residential buildings). The present analysis adds to past research in this area by using government administrative data to examine the impact of certification on rent, and operating and utilities expenses.

First, this study tests for effects of voluntary LEED certification on the operating and utilities expenses of residential buildings in the District of Columbia. Second, I use a modified hedonic pricing model, to determine the impact of the certification on residential building average monthly effective rent. Third, I extend the analysis to test the significance of the

various levels of LEED certification on residential building rents and expenses. I create a unique dataset consisting of government administrative data that provides a breakdown of building operating expenses in combination with data on building characteristics sourced from CoStar. The latter is the largest commercial real estate database and is typically used in commercial real estate literature. Government administrative data were sourced from the District of Columbia Government's Office of Tax Revenue (OTR)'s 2018 Property Income Expense and Real Property Assessment databases. To my knowledge, this analysis is the first to use government administrative data to test the economic value of LEED certification in a particular jurisdiction.

I find that, on average, LEED-certified residential buildings charge rent 19.7 percent higher and have 10.1 percent lower operating expenses than their conventional counterparts. However, there is no significant impact on utilities expenses. After extending the analysis to estimate the differences in rents and expenses between the different certification levels, I find that middle tiers have lower operating and utilities expenses than the base level certification. Specifically, Silver- and Gold-certified buildings spend 24.7 percent and 29.1 percent less on operating expenses, and 68.3 percent and 53.0 percent less on utilities expenses, respectively. However, the estimates show that there is no distinction between certification levels with respect to the impact on rent. These results have important implications for the construction and real estate development industries with regards to the benefits of green-label certification.

Section II presents a background on the buildings sector's role in sustainable development and the District of Columbia Government's strategy to become more energy efficient. Section III provides a review of the literature in this area. Section IV discusses the theory that guides part of this research while Section V outlines the data sources and empirical strategy. The results are discussed in Section VI and the paper concludes in Section VII.

2 Background

In 2016, cities consumed 75 percent of global energy produced and were responsible for 60 to 70 percent of greenhouse gas emissions (Kammen & Sunter, 2016). In the same year, the global buildings sector, an important factor in environmental sustainability, consumed approximately 30 percent of total final energy use and represented 28 percent of global energy-related CO^2 emissions (IEA, 2017). Experts suggest that emissions from buildings could double or triple by mid-century due to in-migration to cities, population growth and lifestyles changes that contribute to building energy use (Broadwater, 2016). This is further aggravated by projections that show the global building construction industry recording a compound annual growth rate of 5.8 percent reaching $7,761.6 billion by 2024 (Research and Markets, 2020). Thus, the buildings sector has been identified as a key sector that needs major adjustments if any of the climate change mitigation goals are to be achieved.

Consequently, there has been a global call for minimum building efficiency standards to be implemented on a broad scale.

With respect to the United States, in 2002 buildings accounted for 39 percent of total CO^2 emissions and were responsible for more such emissions than any other country in the world, with the exception of China (Kinzey & Kim, 2002). More recently, the U.S. Energy Information Administration estimated that in 2019 the residential and commercial sectors[1]represented almost 40 percent of total U.S. energy consumption (U.S. EIA, 2020). Thus, enhancing sustainability in the U.S. buildings sector is vital.

2.1 LEED Certification

In the U.S., the LEED green building rating system, established in 1998 by the USGBC, has emerged as a leading green building rating system. The program rates buildings on how their design and systems affect energy and water efficiency, carbon dioxide emissions and other green performance measures. The rating system consists of eight categories: building design and construction, interior design and construction, building operations and maintenance, neighborhood and development, homes, cities and communities, LEED recertification, and LEED zero. There are four certification levels: "Certified", "Silver", "Gold", and "Platinum", which are awarded to buildings based on the number of points achieved in various green performance categories such as design, operations, and maintenance. The points required

[1] The commercial sector also includes street and other outdoor lighting energy consumption, and for water and sewage treatment; however, their contribution to commercial sector's total energy consumption is minuscule.

for each level of certification are 40 to 49 for Certified, 50 to 59 for Silver, 60 to 79 for Gold, and 80 and above for Platinum[2]. A LEED rating can be assigned either to a certain portion of the structure or the entire building. In some cases, part of a building is eligible to have a higher rating than the entire structure.

Critics of the system posit that the program focuses heavily on points achieved through a checklist of items without giving proper recognition to actual energy performance. Thus, recognizing the need for actual performance data, beginning in 2009 the USGBC required all certified buildings to measure and report annual energy consumption data (to the US-GBC) for five years following certification. Further complaints of the LEED program include the high certification costs, and that it is not climate-specific (Bond & Devine, 2014). Despite the skepticism, the number of LEED-certified projects in the U.S. increased from 296 certifications in 2006 to over 67,200 in 2018 (Tiseo, 2020).

2.2 The District's Call to Action and Private Sector Response

In 2006, the District of Columbia Government enacted The Green Building Act, which required all new privately-owned non-residential buildings with 50,000 or more square feet of gross floor area meet the USGBC's LEED certification standards. Therefore, it is presumed that nearly all large private non-residential buildings built in recent years are "green" at least in certain respects. Surprisingly, a growing number of new residential buildings have also been adhering to LEED certification standards. This suggests that residential developers

[2] USGBC. http://www.usgbc.org (Retrieved on 3/19/2019).

have recognized the economic value and opportunities of going green and have decided to emulate this practice. As shown in Figure 1, the number of LEED residential building units has been steadily increasing since 2015 with a huge spike in 2017. LEED certification allows these buildings to claim environmental sustainability, increased efficiency and reduced costs, while charging higher lease rates (Younis, 2016).

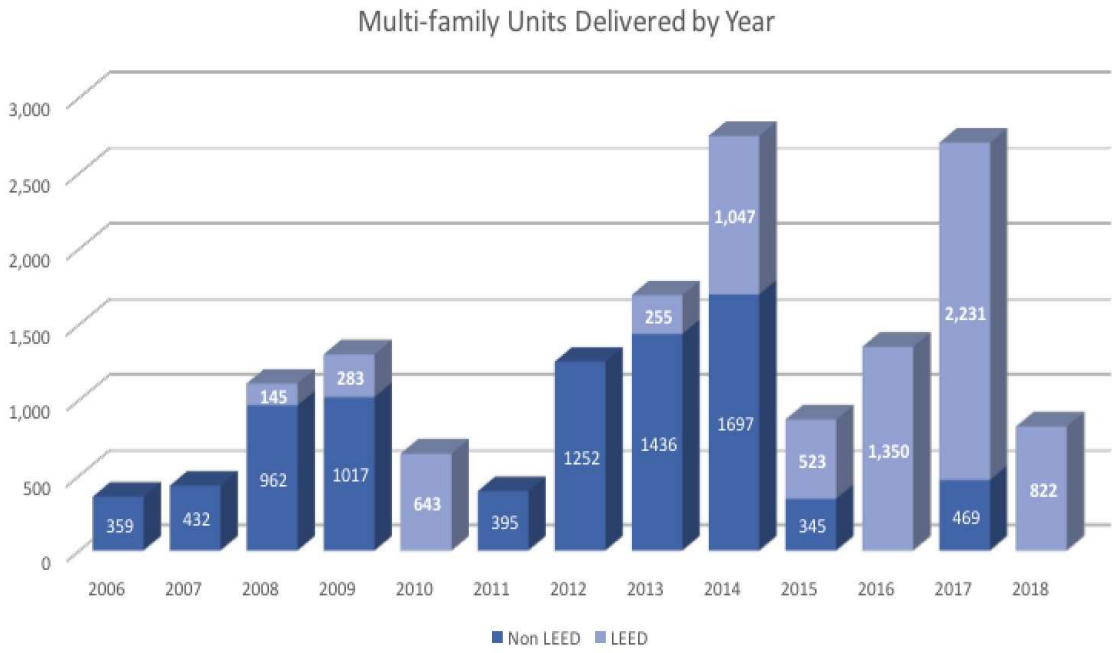

Figure 1: Multi-family Units in the District of Columbia Delivered by Year

3 Literature Review

Sustainable real estate literature has typically focused on commercial office space. These studies often use the same database – CoStar – to provide empirical evidence of rental and

sale price premiums as well as superior occupancy rates associated with green commercial building labeling systems (Bond & Devine, 2014).

Eichholtz, Kok, and Quigley (2010) and Fuerst and McAllister (2011a, 2011b) use hedonic frameworks to test the price effects of sustainable certification on commercial property. Eichholtz et al. (2010) use Geographic Information System Mapping techniques to find comparable buildings within a 0.25-mile radius around certified buildings. Studying 10,000 U.S. office buildings – 694 of which are certified (Energy Star and LEED) – they find no significant contract rent premium for LEED-certified buildings; however, they find a 9 percent[3]premium on effective rents. Using a 0.25-mile radius as a location control may not have been the best strategy to proxy actual sub-markets as the size of sub-markets between locations and the density of development may vary significantly. Fuerst and McAllister (2011a) address this shortcoming by using actual sub-markets to control for location effects when testing the effect of certification on rent. They estimate a rent premium of 5 percent for LEED-buildings and also find that "Certified" and "Platinum" LEED-buildings command significant rent premiums at 9 percent and 16 percent, respectively. In their follow-up study using a larger dataset, Fuerst and McAllister (2011b) find a significant rental premium of 4 to 5 percent for office buildings with LEED certification.

Reichardt, Fuerst, Rottke, and Zietz (2012) use a panel data approach to investigate whether obtaining sustainable building certification causes a rental premium for commercial office space. Examining ENERGY STAR and LEED labels' effect on rental and occupancy rates,

[3] Significant at the 10 percent level.

the authors track the development of the premium from 2000 to 2010 for 1,768 certified and 5,372 non-certified buildings located across U.S. metropolitan markets. Using difference in-difference and fixed-effects models, the authors find that LEED certification command a 2.9 percent rent premium over the time period. Similarly, Wang and Stanley (2017) compare LEED office building to non-LEED office buildings in 20 U.S. cities from 2008 to 2012. Using propensity-score matching and a difference-in-difference approach they find that LEED buildings, on average, command rent approximately 5 to 8 percent higher than comparable non-LEED buildings.

Reichardt (2014) is one of the few to study the effect of lower operating expenses on [4] rent premium commanded by environmentally sustainable buildings. Propensity-weighted regressions and log-linear hedonic models are used to study 4,217 buildings, 737 of which are certified[4], across eight large metropolitan markets[5]. He finds that LEED-certified buildings have operating expenses that are 5.4 percent lower than conventional buildings. His results also show that net lease[6] buildings command a rent premium of 8.6 percent but gross lease buildings do not command significant rent premium compared to comparable non-certified buildings. The author then controls for lower operating expenses to determine the premium on net rents that are attributed to savings in operating expenses. He finds that lower operating expenses significantly reduce the rent premium of LEED-certified buildings

[4] Energy Star labeled, 142 LEED-certified, and 110 have both certifications.

[5] New York, Chicago, Dallas, Miami, Tampa, Atlanta, Houston and Minnesota.

[6] There are two types of lease contracts available for office tenants in the U.S.: (i) triple-net lease – the lessee pays a base rent and all expenses associated with their share of building occupancy; and ii) gross lease – the lessee pays a flat rent and the lessor pays all operating expenses.

from 8.6 percent to 4.8 percent. Reichardt (2014) concludes that savings on operating expenses are a major source of the rent premium.

One of the few studies that look at multi-family residential buildings, Bond and Devine (2014) examine the rental rates achieved by green multi-family properties. Similar to the findings on commercial office space, they find an approximate 8.9 percent rental rate premium associated with LEED-certified apartments. The authors' research also showed that LEED certification earns an additional premium over non-certified spaces that identify as green.

There is active and growing research examining the impact of energy efficiency certification on building financial performance. However, majority of the focus has been placed on commercial office properties using CoStar data and even fewer research test the effect of green-labeling on building expenses. Although attempted by Reichardt (2014), CoStar data alone does not allow for extraction of energy costs from total operating expenses. Using official administrative data, my research appears to be the first that separates energy costs from total operating expenses. Given that utilities expenses account for approximately 22 percent of total operating costs for buildings (Energy Management, 2017) this disaggregated data allow me to identify how LEED certification specifically affects energy costs as well as how those costs impact rent.

4 Theoretical Framework

The empirical objective is to estimate the effect of LEED certification on rental prices and expenses. To estimate the impact on rent, I use a modified hedonic pricing model. The hedonic methodology is used to estimate how attributes that are not explicitly tradable can affect the price of a unit of commodity, namely housing. Popularized by Zvi Griliches in the 1960s, hedonic pricing analysis dates back to 1939. "Hedonic" was used to "describe the weighting of the relative importance of various components...in constructing an index of 'usefulness and desirability'"(Goodman, 1998). Rosen (1974) defined hedonic prices as "equalizing differences" determined by market clearing conditions and "revealed to economic agents form observed prices of differentiated products and the...characteristics associated with them".

The hedonic price function can be written as,

$$P(Z) = f(Z_1, Z_2, Z_3, \ldots, Z_n) \quad (1)$$

where P(Z) represents the price of a given property and $Z_1 \ldots Z_n$ represent a vector of characteristics that contribute to the price by guiding consumer and producer locational choices about bundles of characteristics bought and sold. Intrinsic and extrinsic characteristics can be estimated by regression to determine the hedonic price of a property. The hedonic rental pricing functional form is,

$$R_i = \beta_0 + \beta_1 X_i + \beta_2 Z_i + \epsilon_i, \quad (2)$$

where R_i is the average rent per square foot, X_i is a vector of explanatory locational and physical characteristics such as age, size, vacancy, number of stories and Z_i is a vector of variables relating to time. For this study, hedonic regression modeling is used to estimate the contribution of building characteristics on residential buildings' effective rental price per square foot.

5 Data and Methodology

5.1 Data Description

This cross-sectional study measures the relationship between rental prices and operating expenses, and LEED-certification of residential buildings in the District of Columbia. This study draws on data from a number of sources. Costar is used to collect data on residential building characteristics. This national database is extensive, covering over 5 million commercial real estate properties in the market. Data were collected on average monthly effective rent per square foot by unit-type, year built, and number of stories. CoStar also indicates whether or not a building is LEED-certified as a means of providing information on a building's environmental performance. Buildings classified as LEED-certified were verified using the USGBC's information portal.

The CoStar dataset included 36 LEED-certified residential buildings in the District for

2018[7]. I matched 27 of these buildings to the District of Columbia Government's OTR 2018 Property Income and Expense Data, which provides a breakdown of operating expenses by type (for example janitorial, payroll, maintenance etc.). The comparison group consists of 26 non-certified residential buildings, which were selected based on being delivered during the same time period, of similar size, and in the same or nearby neighborhoods as the treatment buildings. The combined dataset was then merged with OTR's 2018 Real Property Assessment database to create a unique dataset that provides information on property assessment values, expenses, rent by type of unit, year built and number of stories. Table 1 provides summary statistics for select variables. On average, LEED-certified residential buildings charge 8.2 to 16.7 percent higher rents while enjoying operating and utilities expenses that are 3.4 and 1.6 percent per square foot lower than their conventional counterparts, respectively.

Table 1: Means of Selected Variables

	LEED	Non-LEED
Average monthly effective rent (per sq. ft.)		
Studio	3.96	3.66
One-Bedroom	3.49	3.17
Two-Bedroom	3.32	3.07
Three-Bedroom	3.56	3.05

[7] These buildings were crosschecked via the USGBC's website

Operating expenses (per sq. ft.)	6.87	7.11
Utilities expenses (per sq. ft.)	1.24	1.26
Number of Units	278	303
Vacancy percent	5.97	4.81
Assessment value (per sq. ft.)	282.41	310.42
Rentable building area (sq. ft.)	291,215.5	279,950.8
Tenant income ($)	88,987.3	83,008.7
Tenant age	27	26

Source: 2016 Individual Income Tax Data, 2018 Real Property Assessment Data and 2019 CoStar Data

5.2 Methodology

The empirical strategy has three phases. First, I test whether LEED-certification has a significant effect on operating and utilities expenses. The following functional form is estimated using a simple OLS regression to determine the relationship between expenses and building characteristics:

$$E_i = \beta_0 + \beta_1 LEED_i + \beta_2' X_i + \epsilon_i \quad (3)$$

where the dependent variable, E_i, represents operating expenses per square foot in the first specification and utilities expenses per square foot in the second; the main independent variable, $LEED_i$, is an indicator variable with value 1 if the building is LEED-certified and 0 otherwise; X_i is a vector of explanatory variables; and $_i$ is the error term. The vector of control variables, X_i, includes assessment value per square foot, building age measured as 2019 minus the year the building was constructed, and number of stories.

Second, I estimate whether or not LEED buildings charge higher rents as well as the role of expenses on rental prices. To do this, I estimate a modified hedonic pricing model, which takes the following functional form:

$$R_i = \beta_0 + \beta_1 LEED_i + \beta_2 E_i + \beta_3' X_i + \pi_{i,z} + \epsilon_i \quad (4)$$

where the dependent variable, R_i, represents average monthly effective rent per square foot; $\pi_{i,z}$ controls for unobserved heterogeneity within the zipcodes in which a building is located; and the vector of control variables, X_i, are as previously described.

A drawback of using this methodology is that LEED certification for residential buildings in the District is not mandatory or inherently random. Rather, residential building owners make decisions on whether to obtain LEED certification. This self-selection leads to possible endogeneity bias within the model as treatment is not randomly assigned to the buildings in the dataset. This potentially leads to biased estimates; however, the present study is preliminary and does not address this issue; such matters will be addressed in future iterations. Additionally, cross-sectional studies often fail to account for dynamic and unobservable differences between treatment and comparison groups. Thus, I incorporate zip code fixed effects to control for unobserved heterogeneity within geographic locations.

6 Results

Column 1 of Table 2 presents the effect of LEED certification on residential building operating expenses per square foot. The results show that LEED-certified buildings'

operating expenses are $0.57 (10.1 percent) lower per square foot than their conventional counterparts. This is statistically significant at the 10 percent level. Additionally, for each additional year a building exists, operating expenses increase by $0.27 per square foot. While this result is statistically insignificant, after a building has existed for approximately 4 years its operating expenses are reduced by $0.04 per square foot. Lastly, a 1 unit increase in assessment value increases operating expenses by $0.01 per square foot. This result is significant at the 1 percent level.

As shown in column 2, LEED certification has no significant impact on a building's cost of utilities per square foot. However, there is a significant and negative relationship between the number of stories a building has and its utilities expenses, and a significant and positive relationship between its assessment value and utilities expenses per square foot. These results are significant at the 5 and 1 percent levels, respectively.

The results in column 3 show that LEED-certified buildings are able to charge rent $0.75 (19.7 percent) higher than non-LEED buildings. Additionally, assessment value has a negligible but statistically significant (at the 5 percent level) negative effect on average effective rent per square foot. Lastly, a 1 unit increase in operating expenses per square foot increases average rent by $0.10. This is significant at the 1 percent level. In general, the results presented in Table 2 support the hypothesis that environmentally sustainable buildings have lower operating costs and higher rents.

Table 2: Regression Results

Variables	Operating expenses	Utilities Expenses	Avg. Effective Rent

	(per sq. ft.) (1)	(per sq. ft.) (2)	(per sq. ft.) (3)
Constant	5.650***	1.248***	3.283***
	(0.747)	(0.326)	(0.352)
LEED	−0.572*	−0.022	0.752**
	(0.330)	(0.144)	(0.293)
Age	0.273	−0.037	−0.088
	(0.187)	(0.082)	(0.068)
Age^2	−0.035***	0.002	0.004
	(0.013)	(0.006)	(0.005)
Number of Stories	−0.060	−0.048**	0.020
	(0.044)	(0.019)	(0.020)
Assessment Value (per sq.ft.)	0.007***	0.002***	−0.001**
	(0.001)	(0.0003)	(0.0003)
Operating Expenses (per sq. ft.)			0.103***
			(0.031)
Zip code fixed effects	No	No	Yes
Observations	188	188	147
R^2	0.394	0.151	0.620
Adjusted R^2	0.377	0.128	0.570
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 3 presents the impact of the top three tiers of LEED certification compared to the basic level: "Certified". Columns 1 and 2 reveal that Silver- and Gold-certified buildings spend less on operating and utilities expenses per square foot compared to buildings that hold the Certified status. On average, Silver- and Gold-certified buildings spend $1.46 (24.7 percent) and $1.72 (29.1 percent) less on operating expenses and $1.43 (68.3 percent) and $1.11 (53.0 percent) less on utilities expenses, respectively, than Certified buildings. The results also show that buildings certified at the Platinum level do not save on operating and utilities expenses, compared to Certified buildings -their operating and utilities expenses are $4.11 (69.7 percent) and $1.59 (76.3 percent) higher per square foot, respectively. One possible

reason is that to achieve Platinum-level certification, buildings install machinery and equipment that are costlier to maintain. Lastly, higher assessment values correspond with negligible increases in operating and utilities expenses. According to the results shown in Column 3, compared to buildings with the Certified LEED label, higher-tiered certifications do not have any significant impact on rent. Additionally, operating and utilities expenses appear to have no significant impact on the rent charged by buildings in this specification.

Table 3: Regression Results

Variables	Operating expenses (per sq. ft.) (1)	Utilities Expenses (per sq. ft.) (2)	Avg. Effective Rent (per sq. ft.) (3)
Constant	5.894***	2.085***	4.518***
	(0.773)	(0.330)	(0.762)
Silver	−1.456**	−1.425***	−0.171
	(0.671)	(0.287)	(0.494)
Gold	−1.717**	−1.106***	−0.130
	(0.687)	(0.294)	(0.502)
Platinum	4.107***	1.591***	
	(0.947)	(0.405)	
Age	0.154	−0.137	−0.056
	(0.208)	(0.089)	(0.159)
Age^2	−0.023	0.013*	−0.003
	(0.018)	(0.008)	(0.015)
Number of Stories	0.008	0.009	0.025
	(0.044)	(0.019)	(0.041)
Assessment Value (per sq.ft.)	0.007***	0.002***	−0.001
	(0.001)	(0.0004)	(0.001)
Operating Expenses (per sq.ft.)			0.029
			(0.053)
Utilities Expenses (per sq.ft.)			−0.085
Zipcode fixed effects	No	No	Yes
Observations	88	88	69
R^2	0.796	0.733	0.473
Adjusted R^2	0.778	0.710	0.336
Note:			*p<0.1; **p<0.05; ***p<0.01

7 Conclusion

In the District of Columbia, residential building developers have been voluntarily LEED certifying their properties. This increased trend suggests that developers have recognized the economic value in "going green", for example lower operating costs and the ability to command premium rents. This study tests the effect of voluntary LEED certification on the operating and utilities expenses of residential buildings in the District using unique a dataset with data from the District of Columbia Government's OTR's 2018 Property Income Expense and Real Property Assessment databases along with CoStar data. I find that for 2018, LEED-

certified buildings had, on average, 10.1 percent lower operating expenses than their conventional counterpart. With regard to savings on utilities expenses, this analysis finds that LEED certification is not an important determining factor for cost reductions.

To answer the question of whether sustainability comes at the cost of affordability. I use a modified hedonic pricing model to estimate the effect of residential building green-labeling on rental prices in the District. My regression estimates show that LEED-certified residential buildings command rental premiums that are 19.7 percent higher than non-LEED residential buildings.

After testing the significance of the various levels of LEED certification on residential building rents and expenses the results indicate that the level of certification matters with respect to operating and utilities expenses. Specifically, only Silver- and Gold-level buildings save on operating expenses (24.7 percent and 29.1 percent, respectively). While the initial model showed no effect of LEED-certification on utilities expenses, when I examine the universe of LEED-certified residential buildings I find that middle tiers have lower expenses than the base level. Specifically, utilities expenses are 68.3 percent and 53.0 percent lower for Silver- and Gold-level certification, respectively. Contrarily, residential buildings certified at the Platinum level have higher expenses than those certified at the base level. This finding requires further investigation. Additionally, while the initial model estimates that LEED certified residential buildings charge higher rents than non-LEED, there is no significant distinction/difference between certification levels with respect to rents. Thus, it appears that

it may be more cost-effective and profitable for residential buildings to certify at the Silver or Gold levels because they appear to command premium rents and enjoy lower expenses.

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