JULY 2012

THE VALUE *of* GREEN LABELS *in the* California Housing Market

An Economic Analysis of the Impact of Green Labeling on the Sales Price of a Home

NILS KOK Maastricht University, Netherlands / University of California, Berkeley, CA
MATTHEW E. KAHN University of California, Los Angeles, CA

NILS KOK

Nils Kok currently holds positions as a visiting scholar at the Goldman School of Public Policy at the University of California at Berkeley, and as associate professor in Finance and Real Estate at Maastricht University, the Netherlands. His research on the intersection of sustainability and finance in the real estate sector has been rewarded with several international grants and prizes, and has appeared in leading academic journals. He communicates his ideas and findings in the global arena as a frequent speaker at academic and industry conferences and actively shares his expertise through workshops with investment practitioners and policy-makers. Nils is also the co-founder of the Global Real Estate Sustainability Benchmark (GRESB), a premier investor-led initiative to assess the environmental and social performance of the global real estate investment industry. More information and blog at www.nilskok.com.

kok@haas.berkeley.edu

MATTHEW E. KAHN

Matthew E. Kahn is a professor at the UCLA Institute of the Environment, the Department of Economics, the Department of Public Policy, the UCLA Anderson School of Management and the UCLA School of Law. He is a research associate at the National Bureau of Economic Research. He holds a Ph.D. in economics from the University of Chicago. Before joining the UCLA faculty in January 2007, he taught at Columbia University and the Fletcher School at Tufts University. He has served as a visiting professor at Harvard and Stanford Universities. He is the author of Green Cities: Urban Growth and the Environment (Brookings Institution Press 2006) and the co-author of Heroes and Cowards: The Social Face of War (Princeton University Press 2008). He is the author of Climatopolis: How Our Cities Will Thrive in the Hotter World (Basic Books 2010). His research areas include environmental, urban, energy and real estate economics.

mkahn@ioe.ucla.edu

Financial support for this research has been provided by the San Francisco Department of the Environment and StopWaste.Org. Nils Kok is grateful for the financial support of the Netherlands Organization for Scientific Research (NWO). We thank the US Green Building Council and Build It Green for their generous supply of data. We are grateful to Kim Goodrich, Barry Hooper and Reuben Schwartz for their helpful comments. Owen Heary provided excellent research assistance. All errors pertain to the authors.

JULY 2012

THE VALUE *of* GREEN LABELS
in the California Housing Market

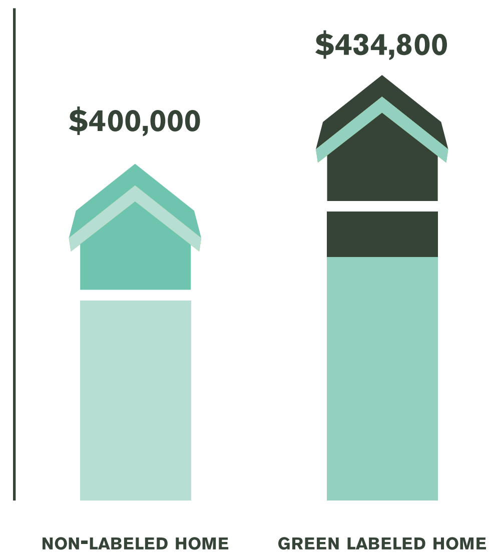
"The Value of Green Labels in the California Housing Market" is the first study to provide statistical evidence that, holding other factors constant, a green label on a single-family home in California provides a market premium compared to a comparable home without the label. The research also indicates that the price premium is influenced by local climate and environmental ideology. To reach these conclusions, researchers conducted an economic analysis of 1.6 million homes sold in California between 2007 and 2012, controlling for other variables known to influence home prices in order to isolate the added value of green home labels.

KEY FINDING: *Green Home Labels Add 9 Percent Price Premium*

This study, conducted by economists at the University of California, Berkeley and University of California, Los Angeles, finds that California homes labeled by Energy Star, LEED for Homes and GreenPoint Rated sell for 9 percent more (±4%) than comparable, non-labeled homes. Because real estate prices depend on a variety of factors, the study controlled for key variables that influence home prices including location, size, vintage, and the presence of major amenities such as swimming pools, views and air conditioning. Considering that the average sales price of a non-labeled home in California is $400,000, the price premium for a certified green home translates into some $34,800 more than the value of a comparable home nearby.

GREEN LABELED HOMES SELL AT HIGHER PRICES

A green label adds an average **9%** price premium to sale price versus other comparable homes.



GREEN LABELS FOR HOMES

Green home labels such as Energy Star, LEED for Homes, and GreenPoint Rated have been established to verify and communicate to consumers that a home is designed and built to use energy efficiently. Green homes also provide benefits beyond energy savings, such as more comfortable and stable indoor temperatures and more healthful indoor air quality. LEED and GreenPoint Rated homes also feature efficient water use; sustainable, non-toxic building materials; and other features that reduce their impact on the environment, such as proximity to parks, shops and transit.

EXPLAINING THE GREEN PREMIUM

This study yields two key insights into the effect of green labels on property values, and why these effects can be so significant. This is especially important in light of the fact that the added value of a green-labeled home far exceeds both the estimated cost of adding energy efficiency features to a home and the utility-bill savings generated by those improvements. Clearly, other factors are in play in producing this premium:

- The results show that the resale premium associated with a green label varies considerably from region to region in California, and is highest in the areas with hotter climates. It is plausible that residents in these areas value green labels more due to the increased cost of keeping a home cool.
- The premium is also positively correlated to the environmental ideology of the area, as measured by the rate of registration of hybrid vehicles. In line with previous evidence on the private value of green product attributes, this correlation suggests that some homeowners may attribute value to intangible qualities associated with owning a green home, such as pride or perceived status.

RESEARCH METHODOLOGY

The study, conducted by Matthew E. Kahn of UCLA and Nils Kok, visiting scholar at UC Berkeley and affiliated with Maastricht University in the Netherlands, examined all of the 1.6 million single-family homes sold between 2007 and 2012 in California. Of those homes, 4,321 were certified under Energy Star Version 2, GreenPoint Rated, or LEED for Homes. Seventy percent of the homes with a green label that were sold during this time period were new construction. The economic approach used, called "hedonic pricing analysis," controlled for a large number of variables that affect real estate pricing, such as vintage, size, location (by zip code) and the presence of major amenities (e.g., pools, views, and air conditioning). The findings of this study echo the results of previous research in the commercial real estate sector, which has found that green labels positively affect rents, vacancy rates and transaction prices for commercial space in office buildings.

RESEARCH QUESTIONS:

- *Commercial real estate investors and tenants value "green" building features. Do homeowners?*
- *How much more value do green homes have?*
- *What factors influence the value homeowners place on green or energy efficient homes? Hotter climate? Higher electricity prices? Environmental ideology?*

1 INTRODUCTION

Increased awareness of energy efficiency and its importance in the built environment have turned public attention to more efficient, green building. Indeed, previous research has documented that the inventory of certified green commercial space in the U.S. has increased dramatically since the introduction of rating schemes that attest to the energy efficiency or sustainability of commercial buildings (based on criteria published by the public and private institutions administering the rating schemes). Importantly, tenants and investors value the green features in such buildings. There is empirical evidence that green labels affect the financial performance of commercial office space: Piet Eichholtz et al. (2010) study commercial office buildings certified under the LEED program of the US Green Building Council (USGBC) and the Energy Star program of the EPA, documenting that these labels positively affect rents, vacancy rates and transaction prices.

Of course, private homeowners may be different from tenants and investors in commercial buildings, especially in the absence of standardized, publicly available information on the energy efficiency of homes. But in recent years, there has been an increase in the number of homes certified as energy efficient or sustainable based on national standards such as Energy Star and LEED and local standards such as GreenPoint Rated in

California. By obtaining verification from a third party that these homes are designed and built to use energy and other resources more efficiently than prescribed by building codes, homes with green labels are claimed to offer lower operational costs than conventional homes. In addition, it is claimed that owners of such homes enjoy ancillary benefits beyond energy savings, such as greater comfort levels and better indoor environmental quality. If consumers observe and capitalize these amenities, hedonic methods can be used to measure the price premium for such attributes, representing the valuation of the marginal buyer (Patrick L. Bajari and Lanier C. Benkard, 2005, Sherwin Rosen, 1974).

In the European Union, the introduction of energy labels, following the 2003 European Performance of Buildings Directive (EPBD), has provided single-family homebuyers with information about how observationally identical homes differ with respect to thermal efficiency. Presumably, heterogeneity in thermal efficiency affects electricity and gas consumption. The EU energy label seems to be quite effective in resolving the information asymmetry in understanding the energy efficiency of dwellings: Dirk Brounen and Nils Kok (2011) estimate hedonic pricing gradients for recently sold homes in the Netherlands and document that homes receiving an "A" grade in terms of energy efficiency sell for a 10 percent price premium. Conversely, dwellings that are labeled as inefficient transact for substantial discounts relative to otherwise comparable, standard homes.

We are not aware of any large sample studies the United States that have investigated the financial performance of green homes. There is some information on the capitalization of solar panels in home prices; one study based in California documents that homes with solar panels sell for roughly 3.5 percent more than comparable homes without solar panels (Samuel R. Dastrup et al., 2012). But unlike findings in previous research on the commercial real estate sector, there is a dearth of systematic evidence on the capitalization of energy efficiency and other sustainability-related amenities in asset prices of the residential building stock, leading to uncertainty among private investors and developers about whether and how much to invest in the construction and redevelopment of more efficient homes.[1]

This paper is the first to systematically address the impact of labels attesting to energy efficiency and other green features of single-family dwellings on the value of these homes as observed in the marketplace, providing evidence on the private returns to the investments in energy-efficient single-family dwellings, an increasingly important topic for the residential market in the U.S.

Using a sample of transactions in California, consisting of some 4,231 buildings certified by the USGBC, EPA, and a statewide rating agency, Build It Green, and a control sample of some 1.6 million non-certified homes, we relate transaction prices of these dwellings to their hedonic characteristics, controlling for geographic location and the time of the sale.

[1] There are some industry-initiated case studies on the financial performance of green homes. An example is a study by the Earth Advantage Institute, which documents for a sample of existing homes in Oregon that those with a sustainable certification sell for 30 percent more than homes without such a designation, based on sales data provided by the Portland Regional Multiple Listing Service. However, the sources of the economic premiums are diverse, not quantified, and not based on rigorous econometric estimations.

The results indicate the importance of a label attesting to the sustainability of a property in affecting the transaction price of recently constructed homes as observed in the marketplace, suggesting that an otherwise comparable dwelling with a green certification will transact for about 9 percent more.

The results are robust to the inclusion of a large set of control variables, such as dwelling vintage, size and the presence of amenities, although we cannot control for "unobservables," such as the prestige of the developer and the relative quality of durables installed in the home.

In addition to estimating the average effect, we test whether the price premium is higher for homes located in hotter climates and in electric utility districts featuring higher average residential electricity prices. Presumably, more efficient homes are more valuable in regions where climatic conditions demand more cooling, and where energy prices are higher. In line with evidence on the capitalization of energy efficiency in commercial buildings (Piet Eichholtz et al., in press), our results suggest that a label appears to add more value in hotter climates, where cooling expenses are likely to be a larger part of total housing expenses. This provides some evidence on the rationality of consumers in appropriately capitalizing the benefits of more efficient homes.

We also test whether the price of certified homes is affected by consumer ideology, as measured by the percentage of hybrid registrations in the neighborhood. A desire to be environmentally conscious may increase the value of green homes because it is a tangible signal of environmental virtue (Steven E. Sexton and Alison L. Sexton, 2011), and an action a person can take in support of their environmental commitment. The results show that the green premium is positively related to the environmental ideology of the neighborhood; green homes located in areas with a higher fraction of hybrid registrations sell for higher prices. Some homeowners seem to attribute non-financial utility to a green label (and its underlying features), which is in line with previous evidence on the private value of green product attributes (Matthew E. Kahn, 2007).

The remainder of this paper is organized as follows: Section 2 describes the empirical framework and the econometric models. Section 3 discusses the data, which represent a unique combination of dwelling-level transaction data with detailed information on green labels that have been assigned to a subsample of the data. In Section 4, we provide the main results of the analysis. Section 5 provides a discussion and policy implications of the findings.

1.6 MILLION HOMES SOLD IN CALIFORNIA DURING THE STUDY PERIOD *(control group)*

4,231 CALIFORNIA HOMES SOLD
with a green label from Energy Star, GreenPoint Rated or LEED for Homes

An otherwise comparable home with a green certification transacts for ***8.7% more*** *(+/-4%).*

The green homes in our sample are mostly "production homes" and not high-end custom homes. Many large residential developers, such as KB Homes, are now constructing Energy Star and GreenPoint Rated homes.

2 METHOD AND EMPIRICAL FRAMEWORK

Consider the determinants of the value of a single-family dwelling at a point in time as a bundle of residential services consumed by the household (John F. Kain and John M. Quigley, 1970). It is well-documented in the urban economics literature that the services available in the neighborhood, such as schools, public transport and other amenities, will explain a large fraction of the variation in price (see, for example, Joseph Gyourko et al., 1999). But of course, the dwelling's square footage, architecture and other structural attributes will also influence its value.

In addition to attributes included in standard asset pricing models explaining home prices, the thermal characteristics and other "sustainability" features of the dwelling may have an impact on the transaction price. These characteristics provide input, which combined with energy inputs, provide comfort (John M. Quigley and Daniel L. Rubinfield, 1989). However, the energy efficiency of homes (and their equipment) is often hard to observe, leading to information asymmetry between the seller and the buyer. In fact, homeowners typically have limited information on the efficiency of their own home; it has been documented that the "energy literacy" of resident households is quite low (Dirk Brounen et al., 2011). Indeed, recent evidence shows that providing feedback to private consumers with respect to their energy consumption is a simple, but effective ''nudge'' to improve their energy efficiency (Hunt Allcott, 2011).

To resolve the information asymmetry in energy efficiency, and also in related green attributes, energy labels and green certificates have been introduced in commercial and residential real estate markets. The labels can be viewed as an additional step to enhance the transparency of resource consumption in the real estate sector. Such information provision may enable private investors to take sustainability into account when making housing decisions, reducing costly economic research (Robert W. Gilmer, 1989). From an economic perspective, the labels should have financial utility for prospective homeowners, as the savings resulting from purchasing a more efficient home may result in lower operating costs during the economic life, or less exposure to utility cost escalation over time.[2] In addition, similar to a high quality "view," various attributes of homes, such as durability or thermal comfort, may not provide a direct cash flow benefit, but may still be monetized in sales transactions.

To empirically test this hypothesis, we relate the logarithm of the transaction price to the hedonic characteristics of single-family homes, controlling precisely for the variations in the measured and unmeasured characteristics of rated buildings and the nearby control dwellings, by estimating:

$$(1)\ \log(R_{ijt}) = \alpha green_{it} + \beta X_i + \gamma_{jt} + \varepsilon_{ijt}$$

In this formulation, R_{ijt} is the home's sales price commanded by dwelling i in cluster j in quarter t; X_i is the set of hedonic characteristics of building i, and ε_{ijt} is an error term. To control more precisely for locational effects, we include a set of dummy variables, one for each of the j zip codes. These zip-code-fixed effects account for cross-area differences in local public goods such as weather, crime, neighborhood demographics and school quality. To capture the time-variance in local price dynamics, we interact zip-code-fixed effects with year/month indicators; the transaction prices of homes are thus allowed to vary by each month during the time period, in each specific location. This rich set of fixed effects allows for local housing market trends and captures the value of time-varying local public goods, such as crime dynamics or the growth or decline of a nearby employment district. $green_i$ is a dummy variable with a value of one if dwelling i is rated by the EPA, USGBC or Build It Green, and zero otherwise. $\alpha, \beta, \gamma_{jt}$ are estimated coefficients. α is thus the average premium, in percent, estimated for a labeled building relative to those observationally similar buildings in its geographic cluster—the zip code. Standard errors are clustered at the zip code level to control for spatial autocorrelation in prices within zip codes.

[2] For the commercial real estate market, a series of papers that study investor and tenant demand for green office space in the U.S. show that buildings with an Energy Star label—indicating that a building belongs to the top 25 percent of the most energy-efficient buildings—or a LEED label have rents that are two to three percent higher as compared to regular office buildings. Transaction prices for energy-efficient office buildings are higher by 13 to 16 percent. Further analyses show that the cross-sectional variation in these premiums has a strong relation to real energy consumption, indicating that tenants and investors in the commercial property sector capitalize energy savings in their investment decisions (Piet Eichholtz *et al.*, 2010; in press).

In a second set of estimates, we include in equation (1) additional interaction terms where we interact "green" with a vector of locational attributes:

$$(2)\ \log(R_{ijt}) = \alpha_0 green_{it} + \alpha_1 N green_{it} + \beta X_i + \gamma_{jt} + \varepsilon_{ijt}$$

We estimate equation (2) to study whether the "green label" premium varies with key observables such as climatic conditions and local electricity prices.[3] We posit that green homes will be more valuable in areas that experience more hot days and areas where electricity prices are high. Presumably, the present value of future energy savings is highest in those regions, which should be reflected in the valve attributed to the "green" indicator.

A second interaction effect addressed in this study is whether the capitalization effect of green labels is larger in communities that reveal a preference for "green products." A desire to appear environmentally conscious or to act on one's environmental values may increase the financial value of "green" homes because it is a signal of environmental virtue.[4] Our proxy for environmental idealism is the Toyota Prius share of registered vehicles in the zip code (these data are from the year 2007).[5] Last, we test for whether the green home premium differs over the business cycle. The recent sharp recession offers significant variation in demand for real assets, which may affect the willingness to pay for energy efficiency and other green attributes.

Anecdotally, we know that the green homes in our sample are mostly "production homes" and not high-end custom homes–many large residential developers, such as KB Homes, are now constructing Energy Star and GreenPoint Rated homes. But, it is important to note that we do not have further information on the characteristics of the developers of "green" homes and conventional homes. Therefore, we cannot control for the possibility that some developers choose to systematically bundle green attributes with other amenities, such more valuable appliances in green homes or a higher-quality finishing. We assume that such unobservables are not systematically correlated with green labels. Otherwise, we would overestimate the effects of "green" on housing prices.

[3] In model (2), we replace the zip-code-fixed effects for county fixed effects, as data on Prius registrations, electricity prices and the clustering of green homes is measured at the zip code level. To further control for the quality of the neighborhood and the availability of local public goods, we include a set of demographic variables from the Census bureau, plus distance to the central business district (CBD) and distance to the closest public transportation hub.

[4] This is comparable to private investors' preference for socially responsible investments (Jeroen Derwall *et al.*, 2011).

[5] See Matthew E. Kahn (2007) for a discussion of Prius registrations as proxy for environmentalism.

3 DATA

A. Green Homes: *Measurements and Data Sources*

In the U.S., there are multiple programs that encourage the development of energy efficient and sustainable dwellings through systems of ratings to designate and publicize exemplary buildings. These labels are asset ratings: snapshots in time that quantify the thermal and other sustainability characteristics of the building and predict its energy performance through energy modeling. They neither measure actual performance, nor take occupant behavior into account. The Energy Star program, jointly sponsored by the U.S. Environmental Protection Agency and the U.S. Department of Energy, is intended to identify and promote energy-efficient products, appliances, and buildings. The Energy Star label was first offered for residential buildings in 1995.[6]

The Energy Star label is an asset rating touted as a vehicle for reducing operational costs in heating, cooling, and water-delivering in homes, with conservation claims in the range of 20 to 30 percent, or $200 to $400 in annual savings. In addition, it is claimed that the label improves comfort by sealing leaks, reducing indoor humidity and creating a quieter environment. But the Energy Star label is also marketed as a commitment to conservation and environmental stewardship, reducing air pollution.

In a parallel effort, the US Green Building

[6] Under the initial rating system, which lasted until 2006, buildings could receive an Energy Star certification if improvements were made in several key areas of the home, including high-performance windows, tight constructions and ducts, and efficient heating and cooling equipment. An independent third-party verification by a certified Home Energy Rater was required. Homes qualified under Energy Star Version 1 had to meet a predefined energy efficiency score ("HERS") of 86, equating more than 30 percent energy savings as compared to a home built to the 1992 building code. From January 2006 until the end of 2011, homes were qualified under Energy Star Version 2. This version was developed in response to increased mandatory requirements in the national building codes and local regulations, as well as technological progress in construction practices. The updated guidelines included a visual inspection of the insulation installation, a requirement for appropriately sized HVAC systems, and a stronger promotion of incorporating efficient lighting and appliances into qualified homes. An additional "thermal bypass checklist" (TBC) became mandatory in 2007. As of 2012, Energy Star Version 3 has been in place, including further requirements for energy efficiency measures and strict enforcement of checklist completion.

Council, a private non-profit organization, has developed the LEED (Leadership in Energy and Environmental Design) green building rating system to encourage the "adoption of sustainable green building and development practices." Since adoption in 1999, separate standards have been applied to new buildings and to existing structures.

The LEED label requires sustainability performance in areas beyond energy use, and the requirements for certification of LEED buildings are substantially more complex than those for the award of an Energy Star rating. The certification process for homes measures six distinct components of sustainability: sustainable sites, water efficiency, materials and resources, indoor environmental quality, innovation, as well as energy performance. Additional points can be obtained for location and linkages, and awareness and education.[7]

Whereas LEED ratings for commercial (office) space have diffused quite rapidly over the past 10 years (see Nils Kok et al., 2011, for a discussion), the LEED for Homes rating began in pilot form only in 2005, and it was fully balloted as a rating system in January 2008.

It is claimed that LEED-certified dwellings reduce expenses on energy and water, have increased asset values, and that they provide healthier and safer environments for occupants. It is also noted that the award of a LEED designation "demonstrate[s] an owner's commitment to environmental stewardship and social responsibility."

In addition to these national programs intended for designating exemplary performance in the energy efficiency and sustainability of (single-family) homes, some labeling initiatives have emerged at the city or state level. In California, the most widely adopted of these is GreenPoint Rated, developed by Build It Green, a non-profit organization whose mission is to promote healthy, energy- and resource-efficient homes in California.

The GreenPoint Rated scheme is comparable to LEED for Homes, including multiple components of "sustainability" in the rating process, with minimum rating requirements for energy, water, indoor air quality, and resource conservation. Importantly, the GreenPoint Rated scheme is available not just for newly constructed homes, but it is applicable to homes of all vintages. The label is marketed as "a recognizable, independent seal of approval that verifies a home has been built or remodeled according to proven green standards." Comparable to other green rating schemes, proponents claim that a GreenPoint rating can improve property values at the time of sale.

[7] For more information on the rating procedures and measurements for LEED for Homes, see: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=147.

B. Data on Homes Prices and Their Determinants

We obtain information on LEED-rated homes and GreenPoint Rated homes using internal documentation provided by the USGBC and Build It Green, respectively. Energy-Star-rated homes are identified by street address in files available from local Energy Star rating agencies. We focus our analysis on the economically most important state of California, covering the 2007–2012 time period.

The number of homes rated by the green schemes is still rather limited — 4,921 single-family homes rated with GreenPoint Rated and 489 homes rated with LEED for Homes (as of January 2012). The number of homes that obtained an Energy Star label is claimed to be substantially larger, but we note that data on Energy Star Version 1 has not been documented, and information on homes certified under Energy Star Version 2 is not stored in a central database at the federal level. Therefore, we have to rely on information provided by consultants who conduct Energy Star inspections. We obtained details on 4,938 single-family dwellings that have been labeled under the Energy Star Version 2 program.

We matched the addresses of the buildings rated in these three programs as of January 2012 to the single-family residential dwellings identified in the archives maintained by DataQuick. The DataQuick service and the data files maintained by DataQuick are advertised as a "robust national property database and analytic expertise to deliver innovative solutions for any company participating in the real estate market."[8] Our initial match yielded 8,243 certified single-family dwellings for which an assessed value or transaction price, and dwelling characteristics could be identified in the DataQuick files; of those homes, 4,231 transacted during the sample period.[9]

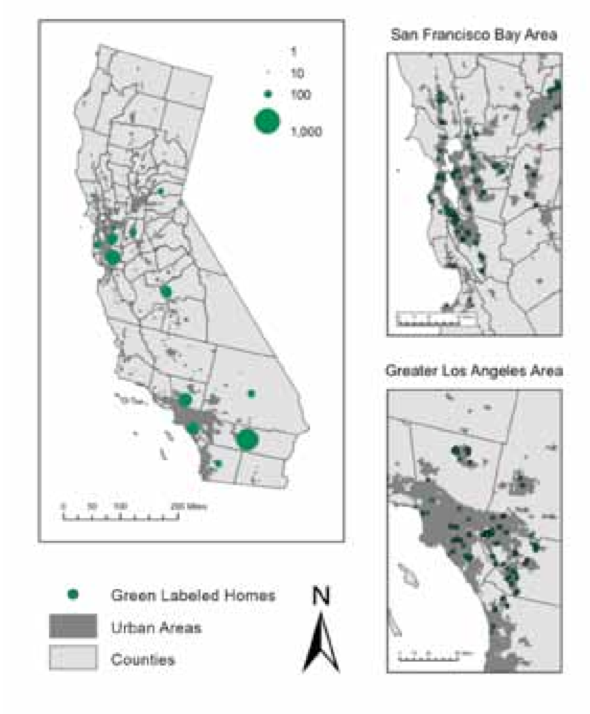
[8] DataQuick maintains an extensive micro database of approximately 120 million properties and 250 million property transactions. The data has been extensively used in previous academic studies. See, for example, Raphael W. Bostic and Kwan Ok Lee (2008) and Fernando Ferreira *et al.* (2010).

[9] We were not able to match the remaining 2,105 certified properties to the DataQuick files. Reasons for the missing observations include, for example, properties that were still under construction, and incomplete information on certified properties.

Figure 1 shows the geographic distribution of the certified homes in our sample. There is a clustering of green rated homes in certain areas, such as the Los Angeles region and the San Francisco region. The geographic distribution is correlated with higher incomes (e.g., in the San Francisco Bay Area), but also with higher levels of construction activity in recent years (e.g., in the Central Valley). As shown by the maps, in the case of Los Angeles, many of the "green label" homes are built in the hotter eastern part of the metropolitan area. It is important to note that there is little new construction in older, richer cities such as Berkeley and Santa Monica (Matthew E. Kahn, 2011). This means that it is likely to be the case that there will be few single-family "green homes" built in such areas.

FIGURE 1.

Certified Homes in California *(2007-2012)*



Sources: Build It Green, EPA, and USGBC

GEOGRAPHIC DISTRIBUTION *of* **GREEN-LABELED HOMES** *is correlated with*

- *Higher incomes (e.g., San Francisco Bay Area)*
- *Higher levels of construction activity (e.g., Central Valley)*
- *Hotter local climate (e.g., inland areas around Los Angeles and Central Valley)*

HEDONIC VARIABLES CONSIDERED:

- *size*
- *quality*
- *number of bedrooms*
- *renovations*
- *garage*
- *swimming pool*
- *air conditioning*
- *view*

To investigate the effect of energy efficiency and sustainability on values of dwellings as observed in the market, we also collect information on all non-certified single-family dwellings that transacted during the same time period, in the same geography. In total, there are nearly 1.6 million dwellings in our sample of green buildings and control buildings with hedonic and financial data.

Besides basic hedonic characteristics, such as vintage, size and presence of amenities, we also have information on the time of sale. Clearly, during the time period that we study, many homes in our geography were sold due to financial distress (i.e., foreclosure or mortgage delinquency). This, of course, has implications for the transaction value of homes (John Y. Campbell et al., 2011). We therefore create an indicator for a "distressed" sale, based on information provided by DataQuick.

We also collect data on environmental ideology, proxied by the registration share of Prius vehicles in each zip code.[10] Local climatic conditions are assessed by the total annual cooling degree days at the nearest weather station (measured by the longitude and latitude of each dwelling and each weather station) during the year of sale.[11] Information on electricity prices is collected at the zip code level.[12]

C. Descriptive Statistics

Table 1 summarizes the information available on the samples of certified and non-certified dwellings. The table reports the means and standard deviations for a number of hedonic characteristics of green buildings and control buildings, including their size, quality, and number of bedrooms, as well as indexes for building renovation, the presence of on-site amenities (such as a garage or carport, swimming pool, or presence of cooling equipment), and the presence of a "good" view.[13]

Simple, non-parametric comparisons between the samples of certified and non-certified homes show that transaction prices of green homes are higher by about $45,000, but of course, this ignores any observable differences between the two samples. Indeed, green homes are much younger–70 percent of the dwellings in the green sample have been constructed during the last five years.

More than two-thirds of the stock of green homes are those certified by Energy Star, but there is substantial overlap among the green certifications–about 20 percent of the green homes have multiple labels.

[10] We calculate the Toyota Prius share of registered vehicles from zip code totals of year 2007 automobile registration data (purchased from R.L. Polk).

[11] Data retrieved from http://www.ncdc.noaa.gov/cdo-web/.

[12] Data retrieved from http://www.energy.ca.gov/maps/serviceareas/electric_service_areas.html. We thank the California Energy Commission for providing a list containing each zip code in California and the corresponding local electric utility provider.

[13] DataQuick classifies the presence and type of view from the property. A "good" view includes the presence of a canyon, water, park, bluff, river, lake or creek

4 RESULTS

Table 2 presents the results of a basic regression model relating transaction prices of single-family dwellings to their observable characteristics and a green rating. Zip-code-fixed effects account for cross-area differences in local public goods, such as weather, crime, neighborhood demographics and school quality. The analysis is based upon more than 1.6 million observations on rated and unrated dwellings. Results are presented for ordinary least squares regression models, with errors clustered at the zip code level. Coefficients for the individual location clusters and the time-fixed effects are not presented.

Column 1 reports a basic model, including some hedonic features: dwelling size in thousands of square feet, the number of bed and bathrooms, and the presence of a garage or carport. We also include zip-year/month fixed effects. The model explains about 85 percent of the variation in the natural logarithm of home prices.

Larger homes command higher prices; 1,000 square feet increase in total dwelling size (corresponding to an increase of about 50 percent in the size of typical home) leads to a 31 percent higher transaction price. Controlling for dwelling size, an additional bathroom adds about 10 percent to the value of a home, and a garage yields about 6 percent, on average.

In column 2, we add a vector of vintage indicators to the model. Relative to homes constructed more than 50 years ago (the omitted variable), recently developed homes fetch significantly higher prices. The relation between vintage and price is negative, but homes constructed during the 1960-1980 period seem to transact at prices similar to very old ("historic") homes. Renovation of dwellings is capitalized in the selling prices, although the effect is small; prices of renovated homes are just one percent higher.[14]

[14] We replace the original "birth year" of a home with the renovation date in the analysis, so that vintage better reflects the "true" state of the home. This may explain the low economic significance of the renovation indicator.

Column 3 includes a selection of dwelling amenities in the model. The results show that homes that were sold as "distressed," for example following mortgage default, transact at a discount of 16 percent, on average. The presence of a swimming pool, cooling system or a "view" contributes significantly to home prices.

Importantly, holding all hedonic characteristics of the dwellings constant, column 4 shows that a single-family dwelling with a LEED, GreenPoint Rated or Energy Star certificate transacts at a premium of 12 percent, on average. This result holds while controlling specifically for all the observable characteristics of dwellings in our sample. The green premium is quite close to what has been documented for properties certified as efficient under the European energy labeling scheme. A sample of 32,000 homes classified with an energy label "A" transacted for about 10 percent more as compared to standard homes (Dirk Brounen and Nils Kok, 2011). In the commercial property market, green premiums have been documented to be slightly higher – about 16 percent (Piet Eichholtz, et al., 2010).

A. Robustness Checks

In Table 3, the green rating is disaggregated into three components: an Energy Star label, a LEED certification, and a GreenPoint Rated label. The (unreported) coefficients of the other variables are unaffected when the green rating is disaggregated into these component categories. The estimated coefficient for the Energy Star rating indicates a premium of 14.5 percent. The GreenPoint Rated and LEED rating are associated with insignificantly higher transaction prices. Energy efficiency is an important underlying determinant of the increased values for green certified dwellings.[15] But of course, sample sizes for homes certified under the alternative rating schemes are quite limited, and just a small fraction of those homes transacted over the past years. An alternative explanation for the lack of significant results for the GreenPoint Rated and LEED schemes is the still limited recognition of those "brands" in the marketplace[16]

The downturn in housing markets and the subsequent decrease in transaction prices may also have an impact on the willingness to pay for more efficient, green homes. It has been documented that prices are more procyclical for durables and luxuries as compared to prices of necessities and nondurables (see Mark Bils and Peter J. Klenow, 1998). To control for the time-variation in the value attributed to green, we include interaction terms of year-fixed effects and the green indicator in column 4. When interaction terms of year-fixed effects are included in the model (the years 2007 and 2012 are omitted due to the lack of a sufficient number of observations in those years), we document substantial variation in the premium for green dwellings over the sample period.

[15] The fundamental energy efficiency requirement is identical across the three different labeling schemes, and the mechanisms for verification are almost entirely similar. The three labels require design for 15 percent energy savings beyond building code requirements and all schemes require various on-site verifications to confirm the delivered home was built to that standard. GreenPoint Rated and LEED offer the highest number of credits for exceeding that minimum requirement. Energy Star rated homes are thus not necessarily better energy performers as compared to the other rating schemes.

[16] The Energy Star label is recognized by more than 80 percent of U.S. households, and 44 percent of households report they knowingly purchased an Energy Star labeled product in the past 12 months (see http://www.cee1.org/eval/00-new-eval-es.php3). Energy Star is one of the most widely recognized brands in the U.S. While similar data is not available for GreenPoint Rated or LEED, both were introduced as building labels much more recently, and do not benefit from near ubiquitous cobranding in consumer products.

In the first years of the sample, labeled homes sold for a discount, albeit insignificantly (which may be related to the lack of demand for newly constructed homes during that time period), whereas the premium is large and significant in later years. The parallel with the business cycle suggests that, among private homeowners, demand for green is lower in recessions, but increases as the economy accelerates. This is contrasting evidence for the commercial market: It has been documented that green-certified office buildings experienced rental decreases similar to conventional office buildings during the most recent downturn in the economy (Eichholtz et al., in press).

As noted in Table 1, most homes certified by one of three rating schemes have been construced quite recently — some 70 percent of the green homes were constructed less than six years ago. Recognizing this point, we seek a similar control sample of non-certified single-family transactions, restricting the analysis to dwellings that are five years old or younger.[17]

Table 4 presents the results of this simple robustness check. Control variables, location-fixed effects and time-fixed effects are again omitted. The results presented in Table 4 are not consistently different from the results in Table 3, but the green premium is slightly lower: On average, green-rated homes that were constructed during the last five years transact at a premium of some 9 percent. The Energy Star label is significantly different from zero. We note that the estimated coefficient for the LEED rating indicates a premium of some 10 percent in transaction prices, but this is not statistically significant at conventional levels.

[17] Quite clearly, this paper mostly deals with labeled developer homes rather than existing homes that went through the labeling process. As noted in Section 2, this raises the possibility of a "developer effect" in explaining the price variation between green and conventional homes. More information on the identity of developers of labeled and non-labeled homes would allow us to further disentangle this effect, but we have information on the developers of green homes only. About one third of the homes in the labeled sample have been constructed by KB Homes. Regressions that exclude homes constructed by KB Homes lead to similar results, with the green premium decreasing to about 6 percent.

B. Testing for Heterogeneity in "Green Label" Capitalization

As demonstrated in the statistical models reported in Tables 2–4, there is a statistically significant and rather large premium in the market value for green-certified homes. The statistical analysis does not identify the source of this premium, or the extent to which the signal about energy efficiency is important relative to the other potential signals provided by a building of sufficient quality to earn a label. Of course, the estimates provide a common percentage premium in value for all rated dwellings. But the value of green certification may be influenced by factors related to the location of homes: Figure 1 suggests that the distribution of green-rated dwellings is not random within urban areas in California, and this may affect the geographic variation in the value increment estimated for green-certified homes. For example, non-financial utility attributed to green certification may be higher for environmentally conscious households (comparable to the choice for solar panels, see Samuel R. Dastrup et al., 2012, for a discussion) or in areas where such homes are clustered (This peer effect is referred to as "conspicuous conservation" in a recent paper by Steven E. Sexton and Alison L. Sexton, 2011).

But, the financial utility of more efficient homes may also be affected by other factors related to the location of a dwelling. The financial benefits of a more efficient home should increase with the temperature of a given location, keeping all other things constant. (Presumably, more energy is needed for the heating of dwellings in areas with more heating degree days, and more energy is needed for the cooling of buildings in areas with more cooling degree days.) To test this hypothesis, we interact the green indicator with information on cooling degree days for each dwelling in the transaction year, based on the nearest weather station in the database of the National Oceanic and Atmospheric Administration (NOAA). Similarly, in areas with higher electricity costs, the return on energy efficiency should be higher. We therefore interact the climate variable with information on the retail price of electricity in the electric utility service area.

KEY FINDING

Homeowners in areas with a hotter climates are willing to pay more for a green, energy-efficient home.

Table 5 presents a set of models that include a proxy for ideology, green home density, climatic conditions and local electricity prices. In this part of the analysis, we seek to (at least partially) distinguish the effects of the energy-saving aspect of the rating from other, intangible effects of the label itself. The results in column 1 show that more efficient homes located in hotter climates (e.g., the Central Valley) are more valuable as compared to labeled homes constructed in more moderate climates (e.g., the coastal region). At the mean temperature level (6,680 cooling degree days), the green premium equals about 10 percent. But for every 1000 cooling degree day increase, the premium for certified homes increases by 1.3 percent, keeping all other things constant. **This result suggests that private homeowners living in areas where cooling loads are higher are willing to pay more for the energy efficiency of their dwellings.**[18]

There is a statistically significant premium in the market value for of green-certified homes.

In column 2, we add an interaction of climatic conditions with local electricity prices. (In models 2-4, we control for location using county-fixed effects.) Presumably, energy savings are more valuable if the price of electricity per kWh is higher. **However, our results do not show a difference in the capitalization of energy savings between consumers paying high rates** (the maximum rate in our sample equals 0.27 cent/kWh) **and those paying lower rates** (the minimum rate in our sample equals 0.07 cent/kWh). This may be because the true driver of consumer behavior is their overall energy outlay rather than the unit cost per kWh.

[18] While we do not have household level data on electricity consumption, the "rebound effect" would predict that such homeowners might respond to the relatively lower price of achieving "cooling" by lowering their thermostat. In such a case, the actual energy performance of the buildings would not necessarily be lower, because of this behavioral response.

Homeowners in environmentally-conscious communities place a higher value on homes with a green label.

In Column 3, we include the share of Prius registrations for each zip code in the sample, interacted with the indicator for green certification. Quite clearly, the capitalization of green varies substantially by heterogeneity in environmental idealism: **In areas with higher concentrations of hybrid vehicle registrations, the value attributed to the green certification is higher.** These results on the larger capitalization effect of green homes in more environmentally conscious communities are consistent with empirical work on solar panels (Samuel R. Dastrup, et al., 2012) and theoretical work on the higher likelihood for the private provision of public goods by environmentalists (Matthew J. Kotchen, 2006).

In column 4, we include a variable for the "density" of green homes in a given street and zip code, and built by the same developer. One could argue that in areas with a larger fraction of green homes, there is a higher value attributed to such amenity by the local residents. Households who purchase a home on this street know that their neighbors also will be living in a green home and this will create a type of Tiebout sorting as those who want to live near other environmentalists will be willing to pay more to live there. In this sense, the "green label" density acts as a co-ordination device. However, competition in the share of green homes in a given neighborhood may also negatively affect the willingness to pay for green, as such feature is becoming a commodity (see Andrea Chegut et al., 2011, for a discussion).

When including the density indicator, the point estimate for green certification does not change significantly, but the coefficient on green home density is pointing to a negative relation between the intensity of local green development and the transaction increment paid for green homes. This finding is not significant, but the sign of the coefficient is in line with evidence on green building competition in the UK. As more labeled homes are constructed, the marginal effect relative to other green homes becomes smaller, even though the average effect, relative to non-green homes, remains positive.

KEY FINDING

No evidence that homeowners in areas with higher electricity prices are willing to pay more for a green, energy-efficient home.

5 DISCUSSION & CONCLUSIONS

The economic significance of the green premium documented for labeled homes is quite substantial. **Considering that the average transaction price of a non-labeled home equals $400,000 (see Table 1), the incremental value of 9 percent for a certified dwelling translates into some $34,800 more than the value of a comparable dwelling nearby.**

Of course, this raises the issue of relative input costs. The increment in construction costs of more efficient, green homes is open to popular debate, and there is a lack of consistent and systematic evidence. Anecdotally, a recent industry report shows that estimated cost to reach a modeled energy efficiency level of 15 percent above California's 2008 energy code is between $1,600 and $2,400 for a typical 2,000 sq. ft. dwelling, depending on the climate zone. To reach a modeled energy efficiency level of some 35 percent above the 2008 code, estimated costs range from $4,100 to $10,000 for a typical 2,000 sq. ft. dwelling, again depending on the climate zone.[19] (Some of these costs are offset by incentives, and it is estimated that about one-third of the costs could be compensated for by rebates.) These admittedly rough estimates suggest that the capitalization of energy efficiency features in the transaction price (about $35,000) far exceeds the input cost for the developer (about $10,000, at most).

[19] Source: Gabel Associates, LLC. (2008). "Codes and Standards: Title 24 Energy-Efficient Local Ordinances."

From the perspective of a homeowner, the benefits of purchasing a labeled home, or of “greening” an existing dwelling, include direct cost savings during tenure in the home. Indeed, we document some consumer rationality in pricing the benefits of more efficient homes, as reflected in the positive relation between cooling degree days in a given geography and the premium rewarded to a certified home. Presumably, the capitalization of the label should at least reflect the present value of future energy savings. Considering that the typical utility bill for single-family homes in California equals approximately $200 per month, and savings in a more efficient home are expected to yield a 30 percent reduction in energy costs, the annual dollar value of savings for a typical consumer is some $720. Compared to the increment for green-labeled homes documented in this paper, that implies a simple payback period of some 48 years.

Quite clearly, there are other (unobservable) features of green homes that add value for consumers. This may include savings on resources other than energy, such as water, but the financial materiality of these savings is relatively small. **However, there are also other, intangible benefits of more efficient homes, such as better insulation, reducing draft, and more advanced ventilation systems, which enhance indoor air quality. These ancillary benefits may be appealing to consumers through the comfort and health benefits they provide.**

The results documented in this paper also show that the premium in transaction price associated with a green label varies considerably across geographies. **The premium is positively related to the environmental ideology of the neighborhood.** In line with previous evidence on the private value of green product attributes, some homeowners seem to attribute non-financial utility to a green label (and its underlying features), explaining part of the premium paid for green homes.

B. Conclusion

Buildings are among the largest consumers of natural resources, and increasing their energy efficiency can thus play a significant role towards achieving cost savings for private consumers and corporate organizations, and can be an important step in realizing global carbon reduction goals. With these objectives in mind, an ongoing effort has sought to certify buildings that have been constructed more efficiently. Considering the lack of "energy literacy" among private consumers, if homebuyers are unaware of a building's steady state (modeled) energy consumption, then they will most likely not appropriately capitalize energy savings in more efficient dwellings.

Comparable to evidence documented for the commercial sector in the U.S., and for the residential sector in Europe, the results in this paper provide the first evidence on the importance of publicly providing information about the energy efficiency and "sustainability" of structures in affecting consumer choice.

Green homes transact for significantly higher prices as compared to other recently constructed homes that lack sustainability attributes. This is important information for residential developers and for private homeowners: Energy efficiency and other green features are capitalized in the selling price of homes.

We note that the green homes in our sample are not high-end, custom homes, but rather "production homes" built by large developers. From the developer's perspective, there are likely to be economies of scale from producing green homes in the same geographic area. If green communities command a price premium and developers enjoy cost savings from producing multiple homes featuring similar attributes, then for-profit developers will be increasingly likely to build such complexes. This has implications for the green premium, as the marginal effect relative to other green homes becomes smaller.

The findings in this paper also have some implications for policy makers. Information on the energy efficiency of homes in the U.S. residential market is currently provided just for exemplary dwellings.[20] The mandatory disclosure of such information for all homes could further consumers' understanding of the energy efficiency of their (prospective) residence, thereby reducing the information asymmetry that is presumably an important explanation for the energy-efficiency gap.

An effective and cheap market signal may trigger investments in the efficiency of the building stock, with positive externality effects as a result.

Of course, we cannot disentangle the energy savings required to obtain a label from the unobserved effects of the label itself, which could serve as a signaling measure of environmental ideology and other non-financial benefits from occupying a green home. Future research should incorporate the *realized* energy consumption in green homes and conventional homes to further disentangle these effects. Reselling of green-labeled homes will also offer an opportunity to further study the value persistence of certified homes, unraveling the effect of developer quality on the green premium documented in this paper.

It also important to note that this paper focuses just on the market for owner-occupied single-family dwellings. While this represents an important fraction of the housing market, the market for rental housing has been growing considerably over the course of the housing crisis, and represents the majority of the housing stock in large U.S. metropolitan areas such as New York and San Francisco. Addressing the signaling effect of green labels for tenants in multi-family buildings should thus be part of a future research agenda.

[20] At the time of writing, the City and County of San Francisco's Office of the Assessor-Recorder is beginning to record and publish the presence or absence of green labels in the county property database. Their stated objective is to increase the incentive to make green upgrades in new and existing properties by using transparency to increase market actors' ability to act upon label information.

REFERENCES

Allcott, Hunt. 2011. "Social Norms and Energy Conservation." *Journal of Public Economics*, 95(5), 1982-095.

Bajari, Patrick L. and Lanier C. Benkard. 2005. "Hedonic Price Indexes with Unobserved Product Characteristics." *Journal of Business and Economic Statistics*, 23(1), 61-75.

Bils, Mark and Peter J. Klenow. 1998. "Using Consumer Theory to Test Competing Business Cycle Models." *Journal of Political Economy*, 106(2), 233-61.

Bostic, Raphael W. and Kwan Ok Lee. 2008. "Mortgages, Risk, and Homeownership among Low- and Moderate-Income Families." *American Economic Review*, 98(2), 310-14.

Brounen, Dirk and Nils Kok. 2011. "On the Economics of Energy Efficiency in the Housing Market." *Journal of Environmental Economics and Management*, 62, 166-79.

Brounen, Dirk; Nils Kok and John M. Quigley. 2011. "Residential Energy Literacy and Conservation," Chicago: *47th Annual AREUEA Conference Paper*.

Campbell, John Y.; Stefano Giglio and Parag Pathak. 2011. "Forced Sales and House Prices " *American Economic Review*, 101(5), 2108-31.

Chegut, Andrea; Piet M. Eichholtz and Nils Kok. 2011. "Supply, Demand and the Value of Green Buildings," Chicago: *47th Annual AREUEA Conference Paper.*

Dastrup, Samuel R.; Joshua S. Graff Zivin; Dora L. Costa and Matthew E. Kahn. 2012. "Understanding the Solar Home Premium: Electricity Generation and green Social Status." *European Economic Review*, 56(5), 961-73.

Derwall, Jeroen; Kees Koedijk and Jenke Ter Horst. 2011. "A Tale of Values-Driven and Profit-Seeking Social Investors." *Journal of Banking and Finance*, 35(8), 2137-47.

Eichholtz, Piet M.A.; Nils Kok and John M. Quigley. 2010. "Doing Well by Doing Good: Green Office Buildings." *American Economic Review*, 100(5), 2494–511.

____. in press. "The Economics of Green Building." *Review of Economics and Statistics.*

Ferreira, Fernando; Joseph Gyourko and Joseph Tracy. 2010. "Housing Busts and Household Mobility." *Journal of Urban Economics*, 68(1), 34-45.

Gilmer, Robert W. 1989. "Energy Labels and Economic Search." *Energy Economics*, 213-18.

Gyourko, Joseph; Matthew E. Kahn and Joseph Tracy. 1999. "Quality of Life and Environmental Comparisons," P. C. Cheshire and E. S. Mills, *Handbook of Regional and Urban Economics*. Elsevier, 1413-54.

Kahn, Matthew E. 2007. "Do Greens Drive Hummers or Hybrids? Environmental Ideology as a Determinant of Consumer Choice." *Journal of Environmental Economics and Management*, 54, 129-45.

____. 2011. "Do Liberal Cities Limit New Housing Development? Evidence from California." *Journal of Urban Economics*, 69(2), 223-28.

Kain, John F. and John M. Quigley. 1970. "Measuring the Value of House Quality." *Journal of American Statistical Association*, 65(330), 532-48.

Kok, Nils; Marquise McGraw and John M. Quigley. 2011. "The Diffusion of Energy Efficiency in Building." *American Economic Review*, 101(3), 77–82.

Kotchen, Matthew J. 2006. "Green Markets and the Private Provision of Public Goods." *Journal of Political Economy,* 114(4), 816-34.

Quigley, John M. and Daniel L. Rubinfield. 1989. "Unobservables in Consumer Choice: Residential Energy and the Demand for Comfort." *Review of Economics & Statistics*, 71(3), 415-25.

Rosen, Sherwin. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy*, 82(1), 34-55.

Sexton, Steven E. and Alison L. Sexton. 2011. "Conspicuous Conservation: The Prius Halo and Willingness to Pay for Environmental Bona Fides," *UC Center for Energy and Environmental Economics Working Paper Series.* Berkeley: University of California at Berkeley.

TABLE 1. Comparison of Green-Labeled Buildings and Nearby Control Buildings
(standard deviations in parentheses)

	RATED BUILDINGS	CONTROL BUILDINGS
Sample Size	4,321	1,600,558
Sales Price	445.29	400.51
(thousands of dollars)	(416.58)	(380.47)
Assessed Value	425.95	355.21
(thousands of dollars)	(376.86)	(347.34)
Dwelling Size	2.06	1.80
(thousands of sq. ft.)	(0.69)	(0.86)
Lot Size	8.40	16.94
(thousands of sq. ft.)	(14.01)	(41.23)
Age	1.68	32.23
(years)	(9.49)	(24.39)
VINTAGE:		
Vintage < 6 years	0.70	0.18
(percent)	(0.46)	(0.38)
Vintage > 5 years < 11	0.00	0.08
(percent)	(0.02)	(0.28)
Vintage >10 years < 21	0.00	0.11
(percent)	(0.00)	(0.31)
Vintage > 20 years < 31	0.00	0.14
(percent)	(0.02)	(0.35)
Vintage > 30 years < 41	0.00	0.12
(percent)	(0.02)	(0.33)
Vintage > 40 years < 51	0.00	0.09
(percent)	(0.02)	(0.29)
Vintage > 50 years	0.01	0.20
(percent)	(0.08)	(0.40)
Renovated Building	0.04	0.12
(percent)	(0.19)	(0.33)
Garage	0.15	0.61
(number)	(0.55)	(0.94)
Number of Bedrooms	2.64	2.96
(percent)	(1.63)	(1.18)
Number of Bathrooms	2.03	2.11
(percent)	(1.26)	(0.94)
GREEN LABEL		
Energy Star	0.68	-
(percent)	(0.47)	-
GreenPoint Rated	0.47	-
(percent)	(0.50)	-
LEED for Homes	0.03	0.49
(percent)	(0.16)	(0.50)
Multiple Certifications	0.17	0.39
(percent)	(0.38)	(0.49)
Distressed Sale	0.08	0.11
(1 = yes)	(0.26)	(0.31)
Cooling Equipment	0.45	0.02
(1 = yes)	(0.50)	(0.15)
Swimming Pool	0.01	0.42
(1 = yes)	(0.09)	(0.41)
View	0.00	6.37
(1 = yes)	(0.02)	(4.34)
Prius Registration Share	0.45	14.94
(percent x100)	(0.38)	(1.37)
Cooling Degree Days Per Year	6.86	
(thousands)	(3.86)	
Electricity Price	15.06	
(cents/kWh)	(0.84)	

	RATED BUILDINGS	CONTROL BUILDINGS
TRANSACTION YEAR		
2007	0.01	0.13
(percent)	(0.09)	(0.34)
2008	0.04	0.19
(percent)	(0.20)	(0.39)
2009	0.15	0.23
(percent)	(0.36)	(0.42)
2010	0.55	0.21
(percent)	(0.50)	(0.41)
2011	0.23	0.21
(percent)	(0.42)	(0.41)
2012	0.01	0.02
(percent)	(0.08)	(0.14)

TABLE 2. Regression Results

Dwelling Characteristics, Amenities, and Sales Prices

(California, 2007 – 2012)

	(1)	(2)	(3)	(4)
Green Rating				0.118***
(1 = yes)				[0.023]
Dwelling Size	0.309***	0.289***	0.273***	0.273***
(thousands of sq. ft.)	[0.008]	[0.008]	[0.007]	[0.007]
Number of Bathrooms	0.095***	0.070***	0.066***	0.066***
	[0.005]	[0.005]	[0.005]	[0.005]
Number of Bedrooms	0.015***	0.019***	0.022***	0.022***
	[0.003]	[0.003]	[0.003]	[0.003]
Number of Garages	0.059***	0.062***	0.058***	0.058***
	[0.005]	[0.005]	[0.005]	[0.005]
AGE#				
New Construction		0.248***	0.190***	0.186***
(1 = yes)		[0.017]	[0.016]	[0.016]
1 – 2 years		0.259***	0.209***	0.206***
(1 = yes)		[0.015]	[0.015]	[0.015]
2 – 3 years		0.239***	0.223***	0.221***
(1 = yes)		[0.015]	[0.015]	[0.015]
3 – 4 years		0.207***	0.219***	0.219***
(1 = yes)		[0.014]	[0.014]	[0.014]
4 – 5 years		0.195***	0.213***	0.213***
(1 = yes)		[0.014]	[0.014]	[0.014]
5 – 6 years		0.186***	0.203***	0.203***
(1 = yes)		[0.014]	[0.014]	[0.014]
6 – 10 years		0.191***	0.193***	0.193***
(1 = yes)		[0.014]	[0.014]	[0.014]
10 – 20 years		0.158***	0.149***	0.149***
(1 = yes)		[0.012]	[0.012]	[0.012]
20 – 30 years		0.072***	0.064***	0.064***
(1 = yes)		[0.011]	[0.011]	[0.011]
30 – 40 years		0.009	0.001	0.001
(1 = yes)		[0.010]	[0.010]	[0.010]
40 – 50 years		0.007	-0.002	-0.002
(1 = yes)		[0.008]	[0.007]	[0.007]
Renovated		0.012**	0.011**	0.011**
(1 = yes)		[0.005]	[0.005]	[0.005]
Distressed Sale			-0.161***	-0.161***
(1 = yes)			[0.003]	[0.003]
View			0.063***	0.063***
(1 = yes)			[0.011]	[0.011]
Swimming Pool			0.086***	0.086***
(1 = yes)			[0.005]	[0.005]
Cooling Systems			0.060***	0.060***
(1 = yes)			[0.008]	[0.008]
TIME-ZIP-FIXED EFFECTS	Y	Y	Y	Y
Constant	11.743***	11.651***	11.795***	11.681***
	[0.203]	[0.177]	[0.161]	[0.163]
N	1,609,879	1,609,879	1,609,879	1,609,879
R^2	0.849	0.854	0.864	0.864
Adj R^2	0.856	0.861	0.871	0.871

Notes:

Omitted variable: vintage > 50 years

Regressions include: fixed effects by quarter year, 2007I–2012I, interacted with fixed effects by zip code. (Coefficients are not reported.)

Standard errors, clustered at the zip code level, are in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and ***, respectively.

TABLE 3. Regression Results
Green Labeling Schemes and Sales Prices
(Energy Star, GreenPoint Rated and LEED for Homes)

	(1)	(2)	(3)	(4)
Energy Star	0.145***			
(1 = yes)	[0.027]			
GreenPoint Rated		0.024		
(1 = yes)		[0.024]		
LEED for Homes			0.077	
(1 = yes)			[0.082]	
Green*Year 2008				-0.011
(1 = yes)				[0.057]
Green*Year 2009				0.052
(1 = yes)				[0.033]
Green*Year 2010				0.144***
(1 = yes)				[0.024]
Green*Year 2011				0.131***
(1 = yes)				[0.029]
Time-ZIP-Fixed Effects	Y	Y	Y	Y
Control Variables	Y	Y	Y	Y
Constant	11.759***	11.778***	11.795***	11.668***
	[0.162]	[0.162]	[0.161]	[0.165]
N	1,609,879	1,609,879	1,609,879	1,609,879
R^2	0.871	0.871	0.871	0.871
Adj R^2	0.864	0.864	0.864	0.864

Notes:

Regressions include: fixed effects by quarter year, 2007I–2012I, interacted with fixed effects by zip code; as well as vintage, amenities and other measures reported in Table 2 (column 4). (Coefficients are not reported.)

Standard errors, clustered at the zip code level, are in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and ***, respectively.

TABLE 4. Regression Results

Robustness Check: Recently Constructed Homes #

	(1)	(2)	(3)	(4)
Green Rating	0.087***			
(1 = yes)	[0.018]			
Energy Star		0.112***		
(1 = yes)		[0.017]		
GreenPoint Rated			-0.016	
(1 = yes)			[0.026]	
LEED for Homes				0.097
(1 = yes)				[0.074]
Time-ZIP-Fixed Effects	Y	Y	Y	Y
Control Variables	Y	Y	Y	Y
Constant	12.044***	12.059***	12.119***	12.114***
	[0.245]	[0.240]	[0.222]	[0.223]
N	314,759	314,759	314,759	314,759
R^2	0.884	0.884	0.883	0.883
Adj R^2	0.899	0.899	0.899	0.899

Notes:

Sample restricted to dwellings constructed during the 2007-2012 period.

Regressions include: fixed effects by quarter year, 2007I–2012I, interacted with fixed effects by zip code; as well as vintage (ranging from 1–5 years), amenities and other measures reported in Table 2 (column 4). (Coefficients are not reported.)

Standard errors, clustered at the zip code level, are in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and ***, respectively.

TABLE 5. Regression Results

Green Labels, Climatic Conditions, Electricity Costs, and Sales Prices #

	(1)##	(2)###	(2)###	(3)###
Green Rating	-0.013	0.098*	-0.057	0.082**
(1 = yes)	[0.026]	[0.054]	[0.039]	[0.033]
Green Rating*Cooling Degree Days	0.014***	0.006		
	[0.003]	[0.075]		
Green Rating*Cooling Degree Days*Electricity Price		-0.001		
		[0.005]		
Green Rating*Prius Registration			21.957***	
			[5.355]	
Green Rating*Green Density				-0.002
				[0.001]
Distance to Closest Rail Station		-0.004***	-0.004***	-0.004***
(in kilometers)		[0.001]	[0.001]	[0.001]
Distance to CBD		-0.001	-0.001	-0.001
(in kilometers)		[0.001]	[0.001]	[0.001]
Time-ZIP-fixed Effects	Y	N	N	N
Time-FIPS-Fixed Effects	N	Y	Y	Y
Control Variables	Y	Y	Y	Y
Constant	12.055***	12.494***	12.378***	12.759***
	[0.023]	[0.067]	[0.161]	[0.240]
N	323,840	238,939	242,678	286,325
R^2	0.877	0.758	0.758	0.747
Adj R^2	0.893	0.760	0.761	0.749

Notes:

Sample restricted to dwellings constructed during the 2007-2012 period.

Regression in column 1 includes fixed effects by quarter year, 2007I–2012I, interacted with fixed effects by zip code; as well as vintage, amenities and other measures reported in Table 2 (column 4). (Coefficients are not reported.)

Regressions in columns 2 - 4 include fixed effects by quarter year, 2007I–2012I interacted with fixed effects by Census tract; the following Census variables at the zip code level: percentage of the population with at least some college education, percentage blacks, and percentage Hispanics, percentage in age categories 18-64, > 64; as well as vintage, amenities and other measures reported in Table 2 (column 4).
(Coefficients are not reported.)

Standard errors, clustered at the zip code level, are in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and ***, respectively.