

Modelling the Relationship between Energy Efficiency Attributes and House Price: The Case of Detached Houses Sold in the Australian Capital Territory in 2005 and 2006

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ABSTRACT

In a world that is increasingly moving to mandate the disclosure of building energy performance, does the market recognize the benefit of better energy efficiency?

The thermal performance of building shells of houses in Australia has been modelled for voluntary and regulatory purposes using software under the Nationwide House Energy Rating Scheme since the mid-1990s. In 1995 the Australian Capital Territory (ACT) introduced a requirement that new houses reach a 4 star energy standard, and this stringency was increased to 5 stars through the Building Code of Australia in 2006.

From 1999 mandatory disclosure of energy performance was required for all houses sold in the ACT, as a policy to influence the energy performance of existing houses. The resulting data represents a unique opportunity to establish whether information on House Energy Ratings (HER) affects sale price. This policy analysis was undertaken in the context of commitments by all governments in Australia in 2004 to develop mandatory disclosure of energy performance for all residential and commercial buildings.

The Analytical Services Branch of the Australian Bureau of Statistics was commissioned to undertake a project using Hedonic analysis. The prices of detached houses sold in the ACT in 2005 and 2006 were modelled as a function of land, distance, neighbourhood, socio-economic and HER data. The results provide a clear indication of a robust Hedonic price model ($R^2 > 0.8$), with a highly significant coefficient for HER, and evidence that the market values energy performance; for example: for a detached house sold in Canberra in 2005 at the median price of AUD365,000, increasing the HER rating by one star would be associated with, on average, an additional price increase of about AUD11,000.

This research will be of strong interest to all countries considering disclosure as a means to drive energy efficiency improvements in the existing building stock.

Policy Context

Governments in Europe and elsewhere have recently considered that mandating the disclosure of energy or environmental performance of buildings would facilitate a more efficient real estate market where all players could recognize the inherent performance characteristics and be better able to determine value.

In Europe, the Energy Performance in Buildings Directive has moved mandatory energy performance disclosure to the forefront of the energy and climate change policy agenda.

Securing Australia's Energy Future, the Energy White Paper released by the Australian Government in 2004, committed to ensuring that all commercial and residential building owners disclose the building's energy performance prior to sale or lease. This concept has been

supported by all Australian State and Territory jurisdictions through the Ministerial Council on Energy, and is part of the National Framework for Energy Efficiency (NFEE).

The Department of the Environment, Water, Heritage and the Arts (formerly the Australian Greenhouse Office), on behalf of all jurisdictions, was asked to develop a nationally consistent framework that will allow the mandatory disclosure of energy performance on sale or lease of buildings. This study of the relationship between house price and energy efficiency was conducted as a key part of that research with the goal of understanding the effectiveness of providing energy performance information to a mature housing market place.

The ACT Housing Market

In 1999 the government of the Australian Capital Territory (ACT) mandated that the energy performance of houses be calculated and disclosed as a part of all house sales, as a policy to encourage improvements in the energy performance of existing houses. This policy has created a large data set of building energy performance and sales information unparalleled in the world, and represents a unique opportunity to establish whether the provision of information on house energy rating (HER) affects sale price.

Mandatory disclosure of building energy performance ratings, as required in the ACT, is designed to provide accurate and standardised information about inherent building energy efficiency to the market, similar to energy labelling of appliances such as refrigerators.

The ACT housing market is small but robust, servicing the needs of a population just over 330,000 who live in Canberra, Australia's national capital. Canberra was settled from 1912 but grew rapidly during the 1960s and 1970s.

The ACT market represents a relatively homogeneous stock of detached housing in suburban neighbourhoods. Over 87 percent of existing homes sold in 2005 and 2006 were detached dwellings, mostly with 3 to 4 bedrooms. The average dwelling size in the study sample was around 141 m² on a block of 836 m² located in a suburban setting averaging 11 km from the central business district.

The cool temperate climate of the ACT is one of extremes. With its major city Canberra elevated at 580 metres above sea level in the Great Dividing Range, winter night-time conditions can reach minus 10°C while summer daytime temperatures can exceed 35°C. The main climate characteristics that impact energy efficient design are: low humidity; high diurnal temperature range; four distinct seasons; summer and winter conditions that regularly exceed human comfort range; cold to very cold winters; hot dry summers; and variable spring and autumn conditions.

Process of Disclosure

The process of disclosure in the ACT consists of a house energy rating (HER) of the building fabric using a nominated thermal performance software package. The disclosure is provided in the form of a star rating, from 0 to 6 stars (recently extended to 10 stars) in half star increments, 0 stars being very poor and 6 stars being significantly more thermally comfortable.

The HER rating is required in all advertising material. Additionally the full HER certificate, which indicates possible energy performance improvements to the building, is required to be provided during the sales transaction process.

The thermal performance of building shells of houses in Australia has been modelled for voluntary and regulatory purposes using software under the Nationwide House Energy Rating

Scheme since the mid-1990s. In 1995 the Australian Capital Territory (ACT) introduced a requirement that new houses reach a 4 star energy standard, and this stringency was increased to 5 stars through the Building Code of Australia in 2006.

Prior to the introduction of minimum energy performance standards homes were typically built to a standard lower than 2 stars. The study sample of over 5,000 house sales, which excluded those impacted by new building standards, found that the average performance of existing homes was just below 1.7 stars, with examples ranging from 0 to 6 stars.

The disclosure of energy efficiency performance in the ACT does not include the assessment of the hot water system, lighting system or other fixed appliances.

Purpose of the Study

This study examines the relationship between the energy rating and house price. In other words, does a higher HER rating lead to a higher sales price? For example, if a person buying a house knows from the disclosed energy performance rating that a building is energy efficient relative to available alternatives, they may be willing to pay more for the property because the additional cost will be offset by expected savings in energy bills, or conversely, they may wish to pay less for homes with a low rating, recognising the ongoing energy costs to maintain thermal comfort.

If it could be established that there is a positive relationship between HER and sales price, knowing there may be a return in a higher sale price creates an incentive for property owners to invest in improved energy efficiency. This in turn could drive improvements in the energy performance of the existing housing stock, and encourage builders of new residential buildings to create homes above the minimum energy performance requirement.

Unique Data Set

To build the data set the ACT Planning and Land Management Agency (ACTPLA) was commissioned to examine all house data files that matched house sales records in the calendar years 2005 and 2006 to collate relevant house characteristics necessary for the hedonic model. These characteristics included: house size, block size, window area, floor and wall material, number of floors, the potential for cross ventilation, the presence of shading devices, and many others. ACT Government held sales information was collated for the same dwellings including settlement date, transfer date, and transfer price. After the necessary data cleaning and quality checks, removal of unexplained outliers, and the linking of the ACTPLA and HER records using the suburb, block and section information, the final dataset consisted of 2,385 and 2,719 house records for 2005 and 2006, respectively.

The years 2005 and 2006 were considered for this study because they represented the latest possible complete data set for a mature market. Earlier periods were avoided to reduce the likelihood of program start-up influences. All houses built after 1995 were excluded from the dataset to avoid any impact of the new minimum performance standards.

As per all hedonic models, it is impossible to collect a dataset that contains every possible influence in the sales price, and the limitations of the dataset are acknowledged. However, it should be emphasised that, despite these limitations, it is nevertheless a large, high-quality sample, probably unique in the world, certainly in Australia.

The Hedonic Model

The Analytical Services Branch of the Australian Bureau of Statistics (ABS), the Australian Government's primary statistical collection and analysis agency, was commissioned to undertake a project using hedonic analysis (Chen *et al* 2004, Hansen 2006). The prices of detached houses sold in the ACT in 2005 and 2006 were modelled as a function of land, distance, neighbourhood, socio-economic and HER data. This study was careful to allow all major influences such as location, size and construction of house, value of land, etc, to be treated in a consistent manner to that of the energy efficiency rating.

Hedonic regression regresses price against a host of explanatory variables, where in this case it decomposes the house price into its constituent characteristics, and obtains estimates of the value of each characteristic. For this study, five main categories of variables were considered: (a) structural variables which covered the design and construction features; (b) distance variables which described the relative location to shops, schools, hospitals, and the central business district; (c) neighbourhood variables which cover key social and economic conditions surrounding the home; (d) locational variables which can explain elements of suburb prestige; and (e) energy efficiency characteristics.

The impact of house price inflation was removed from the house price data using the ABS house price index for the ACT.

The Results

The study has found that there is a statistically significant relationship between the house price and the following house characteristics: floor area, block area, distance to CBD, socio-economic advantage, window area, percentage of 5 bedroom homes in the local area, whether the house had previously been a government rental property, and the HER.

HER was found to be positively associated with house price and had a strongly significant relationship. The association on average for 2005 was 1.23 percent for each 0.5 HER star, and 1.91 percent in 2006, holding all other variables constant.

The results provide evidence of a powerful hedonic price model ($R^2 > 0.82$), with a highly significant coefficient for HER ($p < 0.0001$, $t\text{-Statistic} > 4$), and substantiates that the market values energy performance.

Factors such as double glazing, which also provides a noise benefit, was found to have a strongly positive benefit, while ceiling and wall vents were found to have a negative relationship with house price. Attributes pertaining to the HER such as brick wall, timber flooring, largest window facing north, were not found to have a significant relationship with price.

What Do the Results Mean?

While there is a statistically significant relationship between HER and house price, the energy rating explains only a small proportion of the total value of a house. As is to be expected, factors such as block and house size, and location have a greater influence on house price. However, *all other things being equal*, a house with a high HER will command a higher price than one with a low HER.

This study shows that mandatory disclosure of energy performance on sale of property in the ACT has been a successful mechanism for allowing the housing market to recognize the

value of energy efficiency. It is clear that the ACT market place has shifted from the traditional real estate industry trio of factors *location, location, location*, to a scenario that rewards *location, location, HER*.

This study concludes that if the energy performance of a house is improved by one star level, on average its market value will increase by about 3 percent (range 2.5 – 3.8). For example: for a detached house sold in Canberra in 2005 at the median price of AUD365,000, increasing the HER rating by one star would be associated with, on average, an additional price increase of about AUD11,000.

This creates multiple incentives to invest in energy efficiency. First, there are benefits of reduced operational energy costs. Second, the higher capital value of the property due to the improvement in energy efficiency is likely to be greater than the cost involved in achieving the improvement. Third, there are direct and indirect consumer benefits of energy efficiency including thermal comfort, physical health, and mental satisfaction associated with lower environmental impacts.

For example, installing R4 ceiling insulation will cost approximately AUD1,200 and improve the average energy performance of a poorly insulated home by at least 1 star. That increase in energy performance corresponds to an average increase in sales price of over AUD11,000. Of course, each house sale transaction is impacted by many circumstances and the exact premium for performance can not be calculated from this study, nevertheless, the study has found that the ACT market strongly favours better energy performance when the information is disclosed.

The research will be of strong interest to all governments considering disclosure as a means to drive energy efficiency improvements in the existing building stock.

Thanks

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