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You can't take it with you: Appliance choices and the energy efficiency gap

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ABSTRACT

In the U.S. real estate market, some types of appliances are expected to convey (be included) with the sale of a house, while other appliances may or may not convey depending on local norms that vary at the state level. An appliance that conveys will be left behind when a homeowner moves, while an appliance that does not convey may be kept until the end of its useful life. I estimate the effect of an appliance conveying using a difference-in-differences across states and appliance types, allowing me to fully control for state-level trends with fixed effects. I find that consumers purchase less expensive refrigerators and clothes washers when those appliances convey. This result indicates that the value of these appliances are not fully capitalized into home prices. I further show that accounting for whether an appliance conveys can substantially reduce or eliminate apparent undervaluation of energy efficiency benefits.

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1. Introduction

There has been considerable debate in the economics literature as to why consumers appear to undervalue energy efficiency when choosing durable goods. Proponents of the “energy efficiency gap” or “energy paradox” hypothesis argue that consumers and firms forego billions of dollars a year in energy savings in the form of investments that would pay for themselves over a short time frame (Jaffe and Stavins, 1994; McKinsey and Company, 2009). If consumers undervalue future energy costs when making a purchase, efforts to encourage energy efficiency present a “win-win” scenario for policy makers. Investments in energy efficiency would save consumers money and reduce the externalities of energy consumption, improving both private and social welfare.

A typical analysis of the benefits of energy efficiency compares the net present value of the energy savings to the upfront cost of an efficient car, appliance or home improvement. Such analyses often find that consumers would need incredibly high discount rates to rationalize failing to adopt the investments in question.² Most explanations for the apparent energy efficiency gap draw on the findings of behavioral economics, such as time-inconsistent preferences.³ Some works also point to conven-

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² See e.g. Train (1985).

³ For instance, Tsvetanov and Segerson (2013) model how self control problems could lead to an energy efficiency gap. Allcott and Wozny (2014) find evidence suggesting consumers undervalue future fuel savings when buying cars. Gillingham and Palmer (2014) review the potential behavioral explanations for the energy efficiency gap, while DellaVigna (2009) reviews recent findings in behavioral economics more generally.

tional market failures.⁴ A more prosaic explanation from recent literature is that the calculations suggesting the existence of an energy efficiency gap are simply wrong.⁵

In this paper, I present evidence that the value of new appliances are not fully capitalized into house prices when they are included in a real estate transaction. This is a market failure, and will lead to over-estimates of the energy efficiency gap. Calculations of the energy efficiency gap generally assume that savings from an energy efficient appliance continue for the entire useful life of the good. If appliances are included in the sale of a house and the value of those goods are not fully capitalized, not all of the benefits of energy efficiency will accrue to the original purchaser.⁶ From the purchaser's perspective, the expected life of an investment in an energy efficient appliance is shorter than engineering estimates would imply, and this will affect consumer choices. The importance of the expected life of an investment for estimates of the energy efficiency gap has not been considered in previous literature.⁷

I show that there is less than full capitalization of appliance values by exploiting a previously undocumented feature of the U.S. real estate market that creates exogenous variation in the expected length of ownership for certain types of appliances. U.S. real estate law requires that "fixtures" convey (be included) with a sale of real estate in the absence of a contract specifying otherwise. The definition of a fixture is sufficiently vague that the status of certain major home appliances is unclear. As a result, the default for whether one of these appliances conveys depends on local real estate norms that are consistent within states, but vary across states. For instance, a homeowner in California purchasing a new refrigerator can expect to keep it when moving to a new house, while homeowners in Maryland almost always leave all appliances with the house.

In a perfectly efficient housing market one would expect the value of any appliance to be capitalized into the house price. In practice, at least for the case of appliances, there are reasons to expect less than full capitalization.⁸ House prices tend to be rounded to the nearest thousand dollars, if not the nearest ten or twenty five thousand, while the difference in price between two alternate appliance choices is in the hundreds of dollars at most (Pope et al., 2015). In addition, consumers may have heterogeneous preferences for appliance features, such that a buyer may not be willing to pay full price for features valued by the seller. In the case of energy efficiency in particular, Houde (2016) shows that some consumers place little or no value on energy efficiency in appliances, while others value it highly.

Using a rich survey dataset capturing more than 200,000 consumer appliance choices, I estimate the effect of an appliance conveying by default on the price of the appliance chosen, estimated energy use, and the probability of choosing an EnergyStar certified appliance. I compare refrigerators and clothes washers, which convey in some states but not others, to dishwashers and water heaters, which always convey in all states. I use MLS real-estate listings to determine the proportion of home sales in each state where a refrigerator or clothes washer conveys. By using always-conveying appliance types as a control group, I am able to estimate a continuous difference-in-differences model with the proportion conveying as the treatment variable. This approach essentially entails comparing across states and appliance types with flexible controls to account for unobserved state-specific level effects and trends, including unrelated state-level policies and energy prices.

I estimate that having an appliance convey by default causes consumers to choose refrigerators that are 12% less expensive and clothes washers that are 7% less expensive. This is consistent with less than full capitalization, leading to a shorter expected length of ownership when the appliances convey, and a lower return to investing in a model with lower per-period energy costs. The effect on upfront costs does not directly translate into choosing less energy efficiency, however. When appliances convey by default, consumers choose refrigerators that are on average *more* energy efficient, with near zero effect on chosen energy efficiency for clothes washers. I estimate the effect of an appliance conveying on EnergyStar adoption, and find a tightly estimated zero effect. Similar to findings in Davis (2008), consumers may respond to appliances conveying in part by selecting smaller appliances with fewer features, leading coincidentally to less energy consumption. I find suggestive evidence that consumers choose smaller and less-fully featured appliances in states where those appliances convey.

I show that an appliance conveying but not being capitalized into house prices can create a substantial energy efficiency gap without any behavioral biases. For example, I show that even if consumers fully value future energy savings, refrigerators

⁴ Golove and Eto (2009) discuss several market barriers, including credit constraints and imperfect information. Davis (2012) shows evidence of a principal-agent problem between renters and landlords that leads to lower investments in energy efficient appliances.

⁵ Hassett and Metcalf (1993) show that if the benefits of energy efficiency are uncertain and investments are irreversible, a failure to adopt energy efficient appliances can be a rational response to the uncertainty (see also Sanstad et al. (1995) disputing this point and Ansar and Sparks (2009) reconciling the two). Metcalf and Rosenthal (1995) show empirically that uncertainty is a factor in the markets for refrigerators and light bulbs. Metcalf and Hassett (1999) find that the engineering estimates of energy savings for attic insulation are overestimated. Fowlie et al. 2015 find that engineering estimates of energy savings from a weatherization program were more than double the actual average energy savings experienced by homeowners. Allcott and Greenstone (2017) also find realized energy savings from a residential energy efficiency program to be substantially less than predicted, but estimate that the welfare benefits of energy efficiency subsidies are still high. Other similar critiques relate to the costs associated with energy efficient investments. Energy efficient durables may sacrifice durability or quality to achieve energy savings, and consumers may rationally decide that these costs outweigh discounted energy benefits. See, for instance, Gerarden et al. (2015). Relatedly, Sallee (2014) shows that to the extent that consumers do not fully evaluate future energy savings, this may reflect rational inattention, rather than an irrational bias.

⁶ Similarly, useful life may itself be uncertain or mis-estimated, leading to a further bias.

⁷ Jacobsen et al. (2016) estimate that ignoring heterogeneity in the longevity of motor vehicles undermines the potential efficiency gains of regulating fuel economy. This paper differs in its focus on individual choice, rather than policy optimality, although the two questions are closely related.

⁸ There is a recent literature showing that energy efficiency improvements are fully capitalized (Harjunen and Liski, 2014; Aydin et al., 2015; Walls et al., 2016; Myers, 2017), however these works are all in the context of major, expensive upgrades to heating or insulation systems. In the context of automobiles, recent studies including Busse et al. (2013), Sallee et al. (2016) and Grigolon et al. (Forthcoming) find that the consumers appear to fully value future fuel economy savings, such that the value of fuel economy is capitalized into car prices.

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