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The split incentives energy efficiency problem: Evidence of underinvestment by landlords☆

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ABSTRACT

Due to asymmetric information between landlords and renters, landlords with tenants who pay the utility bill underinvest in energy efficiency measures. Using data from the 2009 Residential Energy Consumption Survey, I present empirical evidence that this underinvestment occurs in multiple categories of residential energy efficiency: space-heating, water-heating, window thickness, insulation, and weatherization. Because these landlords did not invest at the same rate as homeowners and landlords who pay the energy bill, their tenants' energy bill was higher by nearly 2%. When combined with other researchers' estimations for appliances (Davis, 2010), insulation, and thermostat responsiveness for tenants (Gillingham et al., 2012), our results imply that renters use approximately 2.7% more energy overall due to the landlord-tenant split incentive issue.

1. Introduction

The issue of sharing utility costs is well known for the landlord-tenant split incentive issue. Prior to a lease being signed, the landlord must make investment decisions regarding the energy efficiency of the housing unit, such as the quality of the space-heating system or the thickness of the insulation. After the lease is signed, the tenant must make energy-consumption decisions: should I open the windows or use the air conditioner? Thus, both entities must make decisions that impact the monthly utility bill for that household. However, only one entity actually pays the utility bill. Thus, whoever is not paying for the energy does not have to suffer the costs of any inefficient decision-making, and therefore will not behave optimally. This results in unnecessarily high energy usage, leading to higher utility bills and excessive carbon emissions.

According to the US Energy Information Administration in 2009, approximately a third of U.S. households were occupied by renters, and they represented nearly a quarter of residential energy consumption. Of these rental households, the majority of the tenants (roughly three quarters) are responsible for paying their own energy bill. There is a broad literature that discusses the potential for landlords to underinvest in energy efficiency measures in this situation, leading to excessive energy usage (Blumstein et al., 1980; Fisher and Rothkopf 1989; Jaffe and Stavins, 1994; Gillingham et al., 2009).

Recently, there have been several empirical studies to support their assertions. Using data from the American Housing Survey, Myers' (2015) analysis of the Northeast United States revealed that landlords who pay the heating bill are more likely to replace oil-fired space-heaters with cost-effective natural gas-fired space-heaters, relative to households where tenants pay the heating bill. She also found that, when renters paid the energy bill, rental prices were not affected by fuel price changes and high cost units had faster turnover, both indicating asymmetric information between the landlord and tenants; a conclusion shared by Irish researchers (Carroll et al., 2016).

Using data from the 2009 Residential Energy Consumption Survey (RECS), researchers created an energy efficiency index for households based on how many energy efficiency measures – such as a programmable thermostat – were present in the housing unit (Miller et al., 2014). They found that households in which tenants paid the energy bill had a worse index rating than their counterparts, after controlling for other factors. French researchers, studying energy efficiency expenditures rather than an index, also found a negative relationship with renter status (Charlier, 2015).

Davis (2010) examined whether landlords invested in energy efficient appliances at the same rate as homeowners. Using 2005 RECS data, he showed that rental households were less likely to have front-loading clothes washers and appliances with the EnergyStar rating, after controlling for demographic and structural characteristics. His analysis revealed that millions of households are affected by this underinvestment, causing renters to use excessive energy roughly equal to 0.5% of total rental residential usage.

Researchers used data from the 2003 California Statewide

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Residential Appliance Saturation Study in order to investigate both sides of the split incentive issue (Gillingham et al., 2012). They found that when landlords pay the household's energy bill, the tenants were significantly less likely to turn their thermostat down at night. On the flip side, when tenants pay the energy bill, landlords are much less likely to install insulation in the ceiling and exterior walls. Overall, they calculated that the split incentive issue, in terms of setting the thermostat and existence of insulation, caused Californians to use approximately 2% more natural gas and 1% more electricity.

This paper has three objectives. First, I set out to provide evidence of external validity for the analyses conducted by Myers (2015) on space-heating in the Northeast U.S., and Gillingham et al. (2012) on insulation in California. Second, the empirical analysis I present in this article fills in the gaps by examining whether landlords underinvest in other energy efficiency measures that have not yet been studied for the split incentive issue: water-heating, window thickness, and weatherization. Third, I provide back-of-the-envelope estimations of the aggregate impact of the split incentive issue by combining my estimations with those provided by Davis (2010) for appliances and Gillingham et al. (2012) for insulation and thermostat responsiveness.

I use data from the 2009 RECS to empirically test whether landlords with tenants who pay the utility bill are less likely to invest in seven different "high-efficiency" measures – space-heater system, wall insulation, window thickness, water-heater system, water-heater insulation, weatherization, and air-tightness – than homeowners and landlords who pay the energy bill. It is important to note that there are significant differences between homeowners and renters. Although I control for demographic, structural, climatological, and market characteristics, there is a strong possibility for omitted variable bias.

Using logit, probit, and OLS regression analyses, I find that these households were significantly less likely to have the "high-efficiency" option for all seven of these measures. Due to this underinvestment, millions of rental households did not have natural gas-fired boilers, well insulated walls, multi-paned windows, and caulking/weatherstripping. The split incentive issue also caused hundreds of thousands of housing units to not employ cost-effective tankless water-heaters and water-heater insulative blankets.

By combining my regression results with engineering and market estimates from the U.S. Department of Energy (DOE) and the Energy Information Administration (EIA), I find that the underinvestment in natural gas-fired boilers, multi-paned windows, and caulking has caused tenants who pay their own energy bill to spend approximately 4% more for space-heating, 2.8% more for air-conditioning, and 0.6% more for water-heating than they would had their landlord employed these measures at the same rate as homeowners and landlords who pay the bill. Overall, underinvestment in these five measures caused these households to use approximately 1.9% more energy.

When combined with the estimates put forth by Davis (2010) for appliances and Gillingham et al. (2012) for insulation and thermostat responsiveness, our results imply that the split incentive issue causes the rental market to spend around 2.7% more energy than it would have otherwise. In a breakdown by fuel, the market distortion causes renters to use approximately 3.9% more natural gas, 1.2% more electricity, 2.2% more propane/LP, and 2.6% more fuel oil. The environmental impact of this is small: back-of-the-envelope calculations suggest that the landlord-tenant split incentive issue is responsible for roughly 0.1% of total U.S. carbon emissions. It is important to note that these are very general approximations, future research could increase greatly accuracy.

2. Background

2.1. Overview of U.S. residential energy sector

According to the U.S. Energy Information Agency, the residential sector consumed 21% of the overall energy that was used in the United States in 2009, which amounted to a total of 10.18 quadrillion British Thermal Units (BTUs). Fig. 1 (in the Appendix) shows the breakdown of residential energy usage and reveals that, at 42%, space-heating accounts for the largest proportion of residential energy consumption. There are several types of central space-heating systems that utilize different fuels. The fuel types that are most commonly seen in the United States are natural gas, electricity, fuel oil, and propane/LP. The utilization of these fuel types in the residential sector is presented in Fig. 2 (in the Appendix). The most used fuel types are natural gas and electricity, which can be attributed to their low annual usage costs relative to propane/LP and fuel oil (approximately $800/year cheaper on average according to the US EIA).

There is a wide array of furnaces and distribution systems available to the modern property owner. Furnaces that rely on combustion require a flue/exhaust system, as well as a pipeline connection or trucking service to deliver the fuel to the housing unit. An electric space-heater merely needs to be connected to the house's power grid, and does not require an exhaust system. In terms of distribution systems, a property owner installing a combustion-powered furnace has two options: "forced air" ductwork or "boiler" pipework. With a "forced air" system, air is heated by the furnace and circulated via fans through ductwork into the climate-controlled space. A "boiler" system works by heating up water in the furnace, which turns to steam. The steam is self-propelled through pipes which distribute the heat throughout the house through baseboard radiators, steam radiators, or other similar systems. While a "forced-air" system is less expensive to install, it is approximately 20–30% less energy efficient due to air leakage in the ductwork (US EIA).

There is significant regional variation on space-heating (and cooling) demands throughout the United States; a resident of Chicago will heat their home more intensely than a resident of New Orleans. Fig. 3 (in the Appendix) presents the geographical historical average of annual heating-degree-days (HDD65) across the nation.[1] It provides a useful measure that indicates roughly how much heating a household is going to need throughout the year, and shows that certain parts of the nation have a much stronger demand for space-heating than others.

The second highest use of residential energy comprises of lighting, appliances, and refrigeration. Through various subsidies and efficiency regulations, the United States government has been active in instituting policy to encourage the adoption of more efficient lighting and appliances. While these measures have been largely successful, appliance use has been a growing share of residential energy use over the past couple of decades due to an "increased number of devices that consume energy." (US EIA) This category is distinctly different from the previous one for two reasons: electricity is the only source of power for lighting and appliances, and the weather has a negligible impact on energy usage.

Water-heating is the third largest category, accounting for approximately one sixth of all residential energy consumption. Nearly all water-heating systems use natural gas combustion or electric resistance to heat water above 120°F and send it to the faucet, although there are some systems that use solar power or other alternative means. The average American household uses between 40 and 50 gallons of heated water each day, but there are several factors that introduce variation in consumption. (Parker et al., 2016) Excluding the head of the household, there is a nearly proportional relationship between hot water usage and the number of occupants in the household. (Merrigan, 1988) A water-heater's ability to retain heated water is affected by the external temperature, thus there is significant seasonal variance: a study of North Carolinian homes observed that water-heating usage rises by 25% in the winter relative to summer, and a study of Canadian homes recorded a

[1] Heating-degree-days are calculated as follows: record the temperature every hour, subtract that value from 65°F, and divide by 24. If the temperature is above 65°F, a value of zero is recorded. Once the year is complete, one sums up all of these observations to find the annual HDD65 for a location.