Red Nacional de Investigadores en Economía

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DOCUMENTO DE TRABAJO N° 242

Mayo de 2023

Citar como:
Sandoval, Hector H. y Pedro I. Hancevic (2023). Split Incentives in Emerging Countries. *Documento de trabajo RedNIE N°242.*

Split Incentives in Emerging Countries

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April 4, 2023

Abstract

In this paper we provide empirical evidence of the energy-efficiency gap between homeowners and renters and quantify the magnitude of the split incentives problem in an emerging economy by studying Mexican households. Using micro-level data from the first National Survey on Energy Consumption in Private Homes (ENCEVI-2018) and a regression framework, we show that underinvestment problems occur in multiple categories of residential energy efficiency. Concretely, our results show that renters have significantly less insulation and energy-efficient equipment, that they tend to use some of their equipment more frequently, and that they pay higher utility bills than homeowners. In addition, renters are less aware of government programs that can reduce their energy expenditure and are also less likely to take advantage of them. Finally, a substantial reduction in carbon emissions could be achieved if renters were equally energy efficient as homeowners.

JEL classification: D12; Q15; Q40; Q53

Keywords: Split incentives, principal-agent problem, energy efficiency, Mexico

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The certified tool of the American Economics Association was used to randomize the order of the authors (Confirmation code: z5QH6bbp1ViI).

1 Introduction

There are several reasons why energy-efficient technology adoption and energy consumption differ between owner-occupied and tenant-occupied dwellings. One of these reasons is due to an issue that the literature refers to as a misaligned or split incentives problem. This problem arises when the person who invests in energy-efficient upgrades, such as insulation or efficient appliances, is not the same person who pays the energy bills. This situation creates a disincentive for landlords to make energy efficiency upgrades, as they would not reap the benefits of lower energy bills. In other words, the costs and benefits of energy-efficiency upgrades are not aligned between landlords and tenants, resulting in suboptimal investments in energy-efficiency measures.[1] This underinvestment typically occurs in multiple categories of residential energy efficiency (e.g., space-heating, water-heating, window thickness, insulation, and weatherization) and explains why tenants' energy bills are generally higher than owners, even after controlling for suitable factors (Melvin, 2018). Moreover, this higher energy usage also results in excessive emissions.

Several studies have documented the differences in energy-efficient technology between homeowners and renters, providing empirical evidence of the split incentives problem in several countries, including the U.S., Canada, and Europe. Even though extensive research has been conducted in developed countries, little is known about the extent of this problem in emerging countries and the empirical evidence remains scarce.

This paper is the first to provide empirical evidence of the energy-efficiency gap between homeowners and renters and quantify the magnitude of the split incentives problem in an emerging economy by studying the case of Mexican households. Using micro-level data from the first National Survey on Energy Consumption in Private Homes (ENCEVI-2018, acronym in Spanish) and a regression framework, we first quantify the difference in the insulation of roofs, walls, and windows, as well as the energy-efficiency of the appliance (stove, refrigerator, clothes washer, air conditioning, and water heater) between homeowners and renters.[2] We then provide evidence regarding the homeowner-renter gap in terms of electricity expenditure and the intensity of use of the household equipment. In addition, we provide evidence regarding the awareness between owners and renters of appliance replacement pro-

[1]This type of principal-agent problem also emerges when the landlord pays the utility bill, and therefore the tenant faces zero marginal cost for energy services, leading to over-consumption of energy (Levinson & Nieman, 2004; Gillingham, Harding & Rapson, 2012).

[2]The appliances covered by a landlord-tenant agreement may vary from country to country as well as within a country. Generally, landlords are not required to provide tenants with specific appliances, but market conditions and habits determine what appliances should be provided. For example, dishwashers, stoves, water heaters, and refrigerators are typically included in a rental property in the U.S., whereas only stoves and water heaters are included in Mexico or Argentina.

grams. Lastly, we calculate aggregate effects in terms of potential energy savings and carbon emissions reductions.

Our results show that renters are less likely than homeowners to have roof and wall insulation (1.2% and 0.5% less likely, respectively) and also less likely to have energy-efficient stoves, air conditioners, and water heaters (4.6%, 6.4%, and 8.1%, respectively), all of which are provided by the landlord. For those appliances that are not provided by the landlord and therefore acquired by the tenant, we found no difference in terms of the energy efficiency of the clothes washer as anticipated, but we found evidence that renters are less likely to have energy-efficient refrigerators (4.2%). Moreover, we found that renters made more use of their washer (0.34 more hours per week), air conditioner (123.5 more hours per year), and water heater (8.4 more days per year). As a result, renters have a 7% higher electricity bill than homeowners.[3] In addition, we find evidence that renters are less familiar with government appliance replacement programs than homeowners, as well as less likely to take advantage of them. Importantly, all of our main results are statistically significant at conventional levels and are also robust after controlling for a rich set of household characteristics, housing characteristics and equipment, energy saving practices, environmental attitudes, socioeconomic status, and geographic variables. Finally, considering the aggregate, if renters were equally energy efficient as homeowners, they would save approximately 0.94 billion MXP and 578 GWh each year, which would equate to a reduction of 304,581 tons of CO_2 equivalent.[4]

There is an extensive body of literature examining the issue of split incentives in the residential sector.[5] The empirical literature has documented that homeowners are substantially more likely than renters to possess energy-efficient appliances and better insulation, providing evidence that landlords underinvest in energy efficiency measures. For instance, renters in the U.S. are less likely to have energy-efficient refrigerators, washing machines, and dishwashers (Davis, 2012), less likely to have insulation in their attic or ceiling and exterior walls (Gillingham, Harding & Rapson, 2012), less likely to have high-efficiency options of space-heater systems, wall insulation, window thickness, water-heater systems, water-heater insulation, weatherization, and airtightness (Melvin, 2018), as well as other EnergyStar appliances (Souza, 2018). There is also evidence that landlords in the U.S. underinvest in energy efficiency as they are unable to recoup those investments through higher rental rates (Myers, 2020). Additionally, there is evidence that renters use more electricity than non-renters after

[3] Similarly to Best, Burke & Nishitateno (2021), we observe that when appropriate controls are included, a negative unconditional effect of renting on electricity becomes a positive conditional effect.

[4] As reference, in 2018 (the year of our sample), the average exchange rate was 19.24 Mexican Pesos per US Dollar.

[5] As far as we are aware, the only study quantifying the extent of split incentives in the commercial sector is Jessoe, Papienau & Rapson (2020).

controlling for relevant factors (Best, Burke & Nishitateno, 2021) and there is also evidence of a gap between homeowners and renters when it comes to electrical appliances (Davis, 2023). Notably, a similar situation has been documented in other developed countries, including eleven OECD countries (Krishnamurthy & Kriström, 2015), France (Charlier, 2015), and Ireland (Petrov & Ryan, 2021).

The empirical literature has also documented the issue of split incentives leading to overconsumption of energy when utilities are included in the rent. In the U.S., tenants living in utility-included dwellings set their thermostats warmer during winter months when they are away (Levinson & Nieman, 2004) and they are less likely to change the temperature setting (Gillingham, Harding & Rapson, 2012). Similarly, in Canada, when a household is not responsible for paying for heat, temperatures are set higher during daylight hours and the thermostat is less likely to be lowered when the dwelling is unoccupied (Maruejols & Young, 2004). Finally, evidence from Sweden indicates that making renters responsible for their energy bills can significantly reduce energy consumption (Elinder, Escobar & Petré, 2017).[6]

Unlike previous studies, this paper improves our understanding of energy consumption in less developed countries and makes several key contributions to the literature. First, this is the first paper to study the split incentives problem and quantify its magnitude in a developing country. Most of the empirical evidence has come from developed countries, primarily from the U.S. and to a lesser extent Europe and Canada.[7,8] Second, this is the first paper to provide evidence regarding a homeowner-renter gap in the intensity use of household equipment and appliance, and therefore is the first to highlight that the effects of the split incentives issue could be more pronounce when taking into account that renters tend to use their less efficient appliance more often. Finally, this paper provides evidence that renters are less aware of and do not benefit as much from appliance replacement programs compared to homeowners. This lack of access and awareness further exacerbates the energy-efficiency gap as renters are less likely to replace outdated and inefficient appliances. This issue highlights the need for policies and programs that target the rental market to bridge

[6] Moreover, there have long been theoretical discussions concerning the issue of split incentives in residential energy consumption between landlords and tenants, highlighting market failures that hinder the adoption of energy-efficient technologies (see, for instance, Fisher & Rothkopf 1989; Jaffe & Stavins 1994a and 1994b; Nadel 2002; and Gillingham, Newell & Palmer, 2009).

[7] Krishnamurthy & Kriström (2015) use a representative sample from eleven OECD countries, one of them Chile, to quantify the magnitude of the split incentives. While their dataset considers multiple countries, the authors do not provide country-specific results in the interests of both interpretation and parsimonious estimation.

[8] Additionally, there is evidence from Mexico that small and medium-sized businesses that rent their premises are less likely to install solar photovoltaic systems than those who own them (Hancevic & Sandoval, 2023).

the energy-efficiency gap.

The remainder of the paper is organized as follows. Section 2 presents the background. Section 3 analyzes the data providing summary statistics. Section 4 presents the empirical strategy and the results of different specifications. Section 5 shows the aggregate effects in terms of potential energy savings and carbon emissions reductions. Finally, Section 6 concludes the paper.

2 Background

2.1 Rental Contracts in Mexico

Here we describe how Mexican rental contracts for housing are typically drafted. Usually, contracts last one or two years with the option of renewal. In accordance with the Federal Civil Code (article 2412), the landlord is responsible for maintaining the rented property throughout the term of the lease agreement and is therefore responsible for any major repairs to the property. Typical repairs covered by the landlord include waterproofing, repairs to doors, windows, walls, and hallways, as well as renovations to pipes, pumps, and water tanks. The landlord is responsible for any issue with gas or electric installations, as well as for maintaining and resolving plumbing and heating problems. On the other hand, the tenant is typically responsible for the payment of all individual metered consumption services, such as water, electricity, gas, telephone, and Internet. Furthermore, the tenant is responsible for minor repairs resulting from the daily use of the property, such as changing light bulbs, cleaning, and damage caused by overloading the electrical system. Our empirical analysis in the following sections considers that electricity is not included in the rent since we do not observe who pays the electric bill in our sample.

Mexican rental houses are typically equipped with only stoves and water heaters provided by the landlord (usually liquefied petroleum gas, LPG). Other appliances, such as refrigerators, washers, dryers, and dishwashers, must be purchased by the tenant.[9] The use of heating and air conditioning is much less common in most parts of the country. In most cases, air conditioning units are installed as part of a house, while heating units are portable devices that use electricity or LPG and are purchased by tenants. The data and summary statistics about appliances and amenities available to Mexican homeowners and renters are presented in section 3.

[9] Our data does not allow us to determine whether a particular equipment was purchased by the tenant or the owner. Our analysis is based on inquiries from real estate companies that manage multiple rental properties.

2.2 Energy Efficiency Labels in Mexico

The Official Mexican Standard (NOM-029-ENER-2017), which has been in effect since 2017, refers to the energy efficiency of external power sources.[10] Indelible markings and labels must be attached to the product or on a legible plate (Official Mexican Norm NOM-008-SCFI-2002). It is necessary to include the name of the manufacturer, distributor, or trademark logo; business model or identification; nominal electrical data for input voltages and frequencies; energy efficiency level marking; nominal electrical data for output voltages, electrical powers, and/or output current intensity. All individually marketed products (not accessories of end-use products) are labeled. The official label is known as the yellow label and is regulated by the National Commission for the Efficient Use of Energy (CONUUE). The appliances included are: water heaters (electric, solar, and gas); water pumps; washing machines; refrigerators and freezers; air conditioners of all types; building envelopes; thermal and optical characteristics of glass and glazing systems for buildings; cooking appliances that use LPG or natural gas; refrigeration condensing and evaporating systems.[11]

In addition to the yellow label described above, there is a seal from the Electric Energy Saving Trust (FIDE).[12] There are two types of FIDE seals, 'A' and 'B'. The FIDE 'A' seal is awarded to electrical or electronic equipment that consumes energy efficiently. The FIDE 'B' seal is awarded to products that do not save electricity on their own, but may create conditions that lead to electricity savings when used or installed. Contrary to the yellow label, the FIDE seal is not mandatory, and has been granted since 1992. Among the main benefits of having a FIDE seal are the publicity that the brand receives, the opportunity to participate in FIDE-sponsored programs and projects, and the value added to the company whose products adhere to tenders of public organizations that require the FIDE seal, as is the case with programs financed by the Institute of the National Housing Fund for Workers (INFONAVIT) or the Federal Electricity Commission (*Comisión Federal de Electricidad*, CFE), which is the national electric company in Mexico.

The empirical section compares the energy efficiency of selected appliances between tenants and homeowners based on the FIDE seal and yellow labels.

[10]Available at: https://www.dof.gob.mx/nota_detalle.php?codigo=5502802&fecha=27/10/2017#gsc.tab=0

[11]Currently, there are 17 labels of this type. More information is available at: https://www.conuee.gob.mx/transparencia/etiquetas/etiquetas.html

[12]FIDE is a private organization with mixed participation that develops and implements actions that promote efficient use of electricity and the generation of renewable energy to contribute to the social and economic development and the protection of the environment.

3 Data and Summary Statistics

The main source of data used in this paper is the National Survey on Energy Consumption in Private Homes (ENCEVI-2018) which was conducted by the National Institute of Statistics and Geography (INEGI) during the first semester of 2018. Its primary purpose is to identify the consumption patterns of different energy sources in homes as well as the main habits and practices in energy consumption and management. The survey covers a variety of topics including housing characteristics, energy consumption, food preparation and preservation, hygiene and cleanliness, technology and entertainment, air conditioning, water heating, water pumping, appliance energy efficiency, willingness to change energy sources, energy saving practices and programs, and perceptions of a variety of energy-related topics.[13] The ENCEVI is representative at the national level, at the rural and urban levels (i.e., fewer than 14,999 inhabitants or over 15,000, respectively), as well as at three climatic regions. There are 32,047 homes in the original sample. As we are primarily interested in the potential homeowner-renter gap, we excluded households who live in borrowed, intestate, or contested houses. In addition, we removed observations of households with less than 12 months of residence and households with commercial premises within their homes. We also eliminated households with a household head who is single and attends school (excluding those who attend only on Saturdays or during flexible hours). The idea behind this is to exclude people who only live in homes for a relatively short period of time. Following the aforementioned eliminations, our analytical sample consists of 21,984 observations. The survey sample is selected using stratified sampling, therefore the sampling weights are used in all of our results. Tables 1 and 2 report descriptive statistics for our outcome and control variables, respectively.

[13] ENCEVI questionnaires were completed both on paper and electronically. More information is available at https://www.inegi.org.mx/programas/encevi/2018/

Table 1: Summary Statistics: Outcome variables

	Renter		Owner				
	Mean	SD	Mean	SD	Diff.	p-value	# Obs.
Insulation							
Roof insulation	0.028	(0.166)	0.048	(0.214)	-0.02	0.000	21,897
Wall insulation	0.005	(0.07)	0.014	(0.116)	-0.009	0.000	21,905
Window insulation	0.005	(0.071)	0.008	(0.088)	-0.003	0.118	21,920
Energy efficient							
Stove	0.411	(0.492)	0.437	(0.496)	-0.027	0.063	18,792
Refrigerator	0.741	(0.438)	0.765	(0.424)	-0.024	0.046	19,726
Washing machine	0.676	(0.468)	0.663	(0.473)	0.012	0.407	16,276
A/C	0.538	(0.499)	0.589	(0.492)	-0.05	0.068	4,344
Water heater	0.502	(0.5)	0.535	(0.499)	-0.032	0.133	8,858
Electricity expenditure							
Exp. per capita	129.04	(172.71)	142.65	(283.97)	-13.6	0.004	19,448
Exp. per capita (logs)	4.449	(0.856)	4.447	(0.951)	0.003	0.903	19,448

This table reports descriptive statistics of the main outcome variables. The insulation and energy efficient variables are binary. When a dwelling is equipped with an insulated roof, wall, or window, or an energy-efficient appliance, the corresponding variable equals one. Energy-efficient appliances are those that have the FIDE seal and/or the yellow label (see text for details). Electricity expenditure is in Mexican pesos (with an annualized volatility of 12.86%, the exchange rate in 2018 fluctuated between 17.94 pesos per dollar and 20.96 pesos per dollar). The p-value comes from a t-test of equality of means between renter- and owner-occupied units. All the results use the survey sampling weights. Source: ENCEVI-2018.

In table 1 we report the mean and standard deviations of the main outcome variables for renters and owners, as well as the differences (Diff.) between the two groups and p-values from a t-test of equality of means. In general, owner-occupied homes are more likely to have wall, window, and roof insulation. In the case of walls and roofs, the differences are statistically significant at 1%. In terms of energy efficient appliances –i.e., those with the FIDE seal and/or the yellow label–, owner-occupied homes tend to have more efficient stoves, refrigerators, and air conditioners. When it comes to washing machines and water heaters, the mean differences between owners and renters are not statistically significant at conventional levels. Finally, table 1 compares electricity expenditure per capita –i.e., electricity expenditure divided by the number of household members, and shows that the unconditional mean of expenditure is larger for the group of homeowners.[14]

Table 2 presents summary statistics for different categories of variables that help characterize the households in our sample and will be used as control variables in the regression analysis of the next section.[15] In terms of demographic variables, the most noticeable differ-

[14]Ideally, one would like to consider electricity consumption in kWh/month. However, the ENCEVI-2018 only reports monetary expenditures and since the municipality and month are not reported we cannot retrieve the quantity consumed by inverting the tariff formula.

[15]In other words, to make the conditional comparisons of the outcome variables in table 1 more relevant, we will use the variables in table 2 and 8 as controls.

ences are in the household size (number of people living in the house), the age and education level of the household head. In general, homeowners have a larger household size, and their household head is older and has less formal education. Regarding housing characteristics, owners tend to live in single-family homes with one level and more rooms than renters. Among variables related to energy saving practices and environmental attitudes, homeowners are more likely than renters to leave the lights on at night, when going out, and also for non-security reasons. When assessing the impact of fossil fuels on health and the environment, renters are more likely than homeowners to report greater impacts.[16] The bottom part of the table reports the homeowner-renter gap for energy-related equipment. Rented homes have not solar panels installed whereas they are very scarce in owner-occupied properties.[17] Ownership of voltage regulators and no-breaks is relatively similar between the two groups. Additionally, homeowners are more likely to have a vehicle and a water pump, as well as more light bulbs in their homes.

In the appendix, table 8 reports additional summary statistics for a large set of electrical equipment that are also used as control variables in our regression analysis in the following section. The main takeaway from that table is that even though there is no difference in the saturation of household electronics such as a toaster, dryer, iron, microwave, stereo system, and TV, which are generally more affordable, there are significant differences in the use of electronic devices for entertainment, such as electric grills, tablets/iPads, DVD/Blu ray players, and video game consoles, some of which are high-end devices.

[16] The survey questions were as follows: *How much does the use of firewood and coal in the home affect health? How much does the use of firewood and coal affect the environment? How much does the use of gasoline in vehicles affect the environment?*

[17] According to CFE data, the number of homes with solar panels was slightly more than 0.6% as of the end of 2022.

Table 2: Summary Statistics: Controls

	Renter		Owner				
	Mean	SD	Mean	SD	Diff.	p-value	# Obs.
Demographic characteristics							
Household size	3.385	(1.608)	3.83	(1.871)	-0.445	0.000	21,984
Female share	0.504	(0.256)	0.515	(0.233)	-0.011	0.078	21,984
Household head's age	41.775	(13.287)	52.749	(14.983)	-10.974	0.000	21,984
Household head female	0.31	(0.463)	0.285	(0.452)	0.025	0.047	21,984
Household head illiterate	0.024	(0.152)	0.077	(0.266)	-0.053	0.000	21,984
Household head married	0.677	(0.468)	0.71	(0.454)	-0.034	0.006	21,984
Household head's education							
Incomplete basic education	0.096	(0.294)	0.229	(0.42)	-0.133	0.000	21,984
Incomplete secondary educ.	0.171	(0.376)	0.205	(0.404)	-0.035	0.001	21,984
Incomplete high school	0.293	(0.455)	0.262	(0.44)	0.031	0.009	21,984
High school or more	0.44	(0.497)	0.304	(0.46)	0.137	0.000	21,984
Housing characteristics							
Single-family home	0.749	(0.434)	0.948	(0.221)	-0.199	0.000	21,984
Elevator	0.012	(0.107)	0.003	(0.057)	0.008	0.014	21,984
One level	0.525	(0.499)	0.628	(0.483)	-0.102	0.000	21,984
Two levels (stories)	0.331	(0.471)	0.319	(0.466)	0.012	0.346	21,984
Three or more levels (stories)	0.143	(0.351)	0.053	(0.224)	0.09	0.000	21,984
Durable walls	0.997	(0.051)	0.991	(0.097)	0.007	0.000	21,984
Durable roof	0.91	(0.286)	0.802	(0.399)	0.108	0.000	21,984
Durable floor	0.998	(0.049)	0.977	(0.149)	0.02	0.000	21,984
# of rooms	3.46	(1.41)	4.19	(1.632)	-0.73	0.000	21,984
Piped water	0.98	(0.141)	0.943	(0.232)	0.037	0.000	21,984
Energy saving practices & Environmental attitudes							
Lights on at night	0.294	(0.456)	0.367	(0.482)	-0.073	0.000	21,981
Lights on when going out	0.19	(0.392)	0.238	(0.426)	-0.048	0.000	21,980
Lights on but not for security	0.286	(0.452)	0.33	(0.47)	-0.044	0.000	21,982
Firewood/charcoal affects health							
A lot	0.776	(0.417)	0.745	(0.436)	0.031	0.004	21,494
Some	0.106	(0.308)	0.098	(0.298)	0.008	0.355	21,494
Little	0.067	(0.25)	0.089	(0.285)	-0.022	0.000	21,494
Nothing	0.051	(0.22)	0.068	(0.251)	-0.017	0.002	21,494
Firewood/charcoal affects environment							
A lot	0.826	(0.379)	0.798	(0.402)	0.028	0.004	21,445
Some	0.094	(0.291)	0.09	(0.287)	0.003	0.668	21,445
Little	0.052	(0.222)	0.078	(0.268)	-0.026	0.000	21,445
Nothing	0.028	(0.166)	0.034	(0.181)	-0.006	0.186	21,445
Gasoline affects environment							
A lot	0.86	(0.347)	0.813	(0.39)	0.047	0.000	21,075
Some	0.086	(0.28)	0.102	(0.303)	-0.016	0.030	21,075
Little	0.037	(0.188)	0.058	(0.233)	-0.021	0.000	21,075
Nothing	0.018	(0.132)	0.028	(0.165)	-0.01	0.001	21,075
Equipment							
Solar panel	0	(0)	0.002	(0.042)	-0.002	0.000	21,984
Regulator	0.116	(0.321)	0.128	(0.334)	-0.012	0.198	21,967
Regulator (no break)	0.031	(0.173)	0.027	(0.162)	0.004	0.471	21,953
Water pump	0.105	(0.306)	0.196	(0.397)	-0.091	0.000	21,984
Vehicle	0.444	(0.497)	0.511	(0.5)	-0.068	0.000	21,984
# of bulbs	6.195	(3.669)	7.364	(4.724)	-1.169	0.000	21,984

This table reports descriptive statistics of control variables. Except for household size, female share, household head's age, number of rooms, and number of bulbs, all variables are binary. The p-value comes from a t-test of equality of means between renter- and owner-occupied units. All the results use the survey sampling weights. Source: ENCEVI-2018.

4 Empirical Analysis

To quantify the split incentives problem, we use a regression framework. Specifically, we use the following linear probability model,

$$Y_i = \alpha + \beta\ Renter + \gamma \mathbf{X}_i + \epsilon_i \tag{1}$$

where Y_i is an indicator variable that equals one if household i has insulation or an appliance that has an energy-efficiency label. We estimate separate regressions for each type of insulation: roof, wall, and windows, and each type of appliance: stove, refrigerator, washing machine, A/C, and water heater. The variable *Renter* is an indicator variable for renter. The coefficient of interest is β, which captures the difference in insulation or appliance energy efficiency between renters and homeowners. A negative coefficient implies that homeowners are more likely to have insulation or appliance with an energy efficiency label. The vector $\mathbf{X}_i$ is a set of control variables that includes the demographic and housing characteristics, energy saving practices, environmental attitudes, and stock of equipment reported in table 2, as well as the set of all electric appliances reported in table 8 in the appendix. We also include state fixed effects, locality size fixed effects, and socioeconomic status (SES) fixed effects.[18] In some specifications, we include instead stratum-level fixed effects. There are a total of 683 strata nationwide that the National Institute of Statistics and Geography uses in the sampling design.[19] It is not possible to include state, locality size, and SES fixed effects along with stratum fixed effects because the latter level is nested within the state, locality, and SES. That is, by employing stratum-level fixed effects we can effectively control for geographical location, urban-rural differences, and socioeconomic status, as well as to some extent for climate and energy prices due to its finer geographical disaggregation.[20] In addition to OLS, we also report estimates from a logit model. In all of our specifications,

[18] Mexico has 32 states, all of which are contained in the survey. The survey distinguishes between four locality sizes: less than 2,500 inhabitants; 2,500 - 14,999; 15,000 - 99,999; and more than 100,000. The National Institute of Statistics and Geography divides dwellings within the country into four sociodemographic groups using 34 sociodemographic indicators from the 2010 Census and multivariate statistical methods. This categorical variable is also available in the dataset.

[19] A stratum can be seen as a collection of census tracts that do not cross state boundaries.

[20] Residential electricity rates are calculated by the Energy Regulatory Commission (CRE) and authorized by the Ministry of Finance and Public Credit (SHCP). There are seven tariffs across the country: 01, 1A, 1B,...,1F. Each of them is an increasing block pricing scheme with no fixed charged. There are three blocks in the first five tariffs, and four blocks in tariffs 1E and 1F. Additionally, the blocks differ in size (number of kWh) and marginal price. What determines that a municipality has a specific rate is the record of average temperatures during the summer months. Furthermore, there is a high-consumption tariff, DAC, which penalizes consumption above a certain threshold, making the tariff schedule very complex. See Hancevic et al (2022) for more information on residential rates. Importantly, households within the same stratum will face the same tariff.

we use robust standard errors and the survey sampling weights.

4.1 Results: Insulation and Energy Efficiency

Table 3 reports estimates of β for the different types of insulation and appliances considering different specifications. Column (1) reports the unconditional difference, and therefore the coefficient is exactly the same as the difference between renters and homeowners reported in table 1. Column (2) reports estimates from a specification that includes demographic and housing characteristics, as well as the state, locality size, and SES fixed effects. Column (3) reports estimates that include in addition energy saving practices and environmental attitudes as controls, while estimates in column (4) include the stock of electric equipment. Column (5) reports estimates from our most comprehensive specification, which use stratum fixed effects instead of state, locality size, and SES fixed effects. Finally, column (6) and (7) report estimates considering a logit model and the corresponding marginal effects, respectively.

Table 3: Estimation Results: Insulation and Energy Efficiency

	(1) No Controls	(2) D&H	(3) Eco-friendly	(4) Equipment	(5) Stratum	(6) Logit	(7) dydx
Insulation							
Roof insulation	-0.020***	-0.014***	-0.014***	-0.011**	-0.012***	-0.517***	-0.011***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.000)
Wall insulation	-0.009***	-0.007***	-0.007***	-0.005**	-0.005**	-0.884***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.009)	(0.000)
Window insulation	-0.003	-0.001	-0.001	-0.000	-0.001	-0.218***	-0.001***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.009)	(0.000)
Energy efficient							
Stove	-0.026*	-0.058***	-0.053***	-0.040***	-0.046***	-0.203***	-0.050***
	(0.014)	(0.015)	(0.015)	(0.015)	(0.016)	(0.001)	(0.000)
Refrigerator	-0.024**	-0.059***	-0.053***	-0.042***	-0.042***	-0.253***	-0.040***
	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.002)	(0.000)
Washing machine	0.012	-0.031**	-0.024	-0.016	-0.013	-0.067***	-0.014***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.002)	(0.000)
A/C	-0.050*	-0.086***	-0.085***	-0.072**	-0.081***	-0.375***	-0.090***
	(0.028)	(0.028)	(0.029)	(0.028)	(0.029)	(0.004)	(0.001)
Water heater	-0.032	-0.072***	0.071***	-0.061***	-0.064***	-0.284***	-0.071***
	(0.022)	(0.023)	(0.024)	(0.023)	(0.023)	(0.002)	(0.001)
Demographic & Housing	N	Y	Y	Y	Y	Y	Y
Energy sav. & Env. att.	N	N	Y	Y	Y	Y	Y
Equipment stock	N	N	N	Y	Y	Y	Y
State, Loc. & SES FE	N	Y	Y	Y	N	N	N
Stratum FE	N	N	N	N	Y	Y	Y

This table reports coefficient estimates of β from equation (1). The dependent variable is an indicator variable that equals one if the household has the insulation or energy efficiency appliance. The control variables are those reported in table 2 and table 8 in the appendix. State, Loc. & SES FE stands for state, locality size, and socioeconomic status fixed effects. Robust standard errors are in parentheses. All the results use the survey sampling weights. Significance levels: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Source: ENCEVI-2018.

To begin, let's examine the variables that are indicative of energy efficiency in the house structure. Considering our most comprehensive and therefore preferred specification in Column (5), the probability of having roof insulation and wall insulation are 1.2% and 0.5% lower in rented homes, and these results are statistically significant at 1% and 5%, respectively. In the case of window insulation, the coefficient has the expected sign indicating again that rented homes are less likely to have insulated windows. However, in most specifications the coefficient for this variable are not significant at conventional levels. Overall, these results support the hypothesis that structural improvements are not carried out in rented houses because energy expenditures are borne by the tenant, so the owner doesn't have a reason to improve the energy efficiency. When it comes to energy efficiency labeling, the devices provided by the owner (stove) and those that are structural parts of the home (water heater and air conditioner) are less efficient in rented apartments. Concretely, the probability of having an efficient stove, water heater, and AC are 4.6%, 6.4% and 8.1% lower in rented homes, respectively. The three coefficients are sizeable and are statistically significant at the 1% level in the preferred specification. As expected, the effect on washing machines is not significant since they are typically purchased by the tenant. The case of refrigerators is somewhat striking because although in most cases it is the tenant who buys the appliance, it has a negative and statistically significant effect. However, it is important to note that refrigerators tend to be larger and more expensive than washing machines. Moreover, as renters tend to move out of their homes more frequently than homeowners, it is likely that they prefer less efficient refrigerators, which are less expensive. This is because they will not incur a considerable financial loss in case of damage or wear and tear during the move-out process. As mentioned earlier we are unable to determine whether the equipment was purchased by the tenant or the owner, and while our analysis is based on inquires with real estate companies, we can not rule out that some refrigerators may have been provide by the owner in some cases. Overall, the coefficients obtained are well eloquent for stoves, air conditioners, and water heaters, which are typically provided by the landlord, as well as for washers, which are usually bought by tenants.

4.2 Results: Energy Expenditure and Intensity of Use

We have shown that tenants' houses are less likely to have insulation on the walls, windows, and roofs, and that they possess less energy-efficient appliances, some of which are typically provided by the landlord. We now analyze and compare electricity expenditure. Before analyzing the results, it is worth mentioning that a problem of reverse causation could arise if high electricity use relates to subsequent energy efficiency upgrades. Some households may have purchased energy-efficient appliances in response to high electricity usage in the past or current high electricity consumption may lead them to purchase energy-efficient appliances in the future. In the context of the ENCEVI, the variables provided in the cross section are generally contemporaneous, so this should not be a major problem - i.e., it is unlikely that high electricity use during the first semester of 2018 contributed to appliance purchases during that same time period.

In table 4, the dependent variable is expenditure per capita (i.e., total electricity bill divided by the number of household members), expressed in both levels and logarithms. Column (1) presents unconditional estimates. Column (2) adds demographics, housing characteristics, energy savings practices, environmental attitudes, and electrical equipment. It also includes state, locality size, and SES fixed effects (it is therefore equivalent to Column (4) in table 3). Column (3) includes stratum fixed effects instead of state, locality size and SES fixed effects (equivalent to Column (5) in table 3). Furthermore, we would like to explore differential behavior (i.e., consumption patterns) between owners and tenants once we take efficiency status into account. Hence, Column (4) adds insulation variables for roofs, walls, and windows, while Column (5) includes energy-efficient stoves and refrigerators. Finally, Column (6) includes efficient washers.[21] By assessing the effects both with and without energy appliance controls we are able to informally evaluate the potential reverse causation problem mentioned before.

Table 4: Estimation Results: Electricity Expenditure

	(1) No Controls	(2) All Controls	(3) Stratum	(4) Insulation	(5) Stove & Fridge	(6) Washer
Exp. per capita	-13.604***	12.082**	10.356**	10.301**	10.028**	13.820**
	(4.774)	(4.760)	(4.744)	(4.774)	(4.948)	(5.749)
Exp. per capita (logs)	0.003	0.084***	0.072***	0.072***	0.071***	0.099***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.025)	(0.029)
Demographic & Housing	N	Y	Y	Y	Y	Y
Energy sav. & Env. att.	N	Y	Y	Y	Y	Y
Equipment stock	N	Y	Y	Y	Y	Y
State, Loc. & SES FE	N	Y	N	N	N	N
Stratum FE	N	N	Y	Y	Y	Y
Insulation	N	N	N	Y	Y	Y
Effic. Stove & Fridge	N	N	N	N	Y	Y
Effic. Washing machine	N	N	N	N	N	Y

This table reports coefficient estimates of β from equation (1). The dependent variable is electricity expenditure per capita in levels and logs. The control variables are those reported in table 2 and table 8 in the appendix. State, Loc. & SES FE stands for state, locality size, and socioeconomic status fixed effects. Robust standard errors are in parentheses. All the results use the survey sampling weights. Significance levels: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Source: ENCEVI-2018.

Based on our preferred specification for our previous results –Column (3) using stratum fixed effects–, the average electric bill of a renter is \$10.36 (7.2%) higher than that of an owner. When we control for efficient appliances and structural improvements in thermal insulation –Columns (4) to (6)–, we see similar results. Nevertheless, it is possible that there are behavioral issues and/or unobserved characteristics that might explain the difference in electricity expenditure between tenants and owners. Best, Burke, and Nishitateno (2021) study the homeowner-renter gap in electricity use inquiring into the motives. The classification includes: i) split incentives (including energy consumption and bill payment responsibilities, and appliance efficiency level; ii) behavioral factors; and iii) renters' dependence on certain electric appliances.[22] In order to shed some light on these issues, table 5

[21] We do not include AC or water heater, as this reduces the sample substantially. Including AC reduces the sample to 1,751 observations (9% of our analytical sample).

[22] In Mexico, for example, renters are more familiar with portable space heaters, fans, and air conditioners due to the fact that they move more often and already own these appliances. In contrast, homeowners may have central heating and air conditioning embedded in their homes

below evaluates whether there are differences in the intensity of use of the devices. In this table, the column headings are the same as in table 3. Using the preferred specification in Column (5) which incorporates the rich set of control variables and the stratum fixed effects, there are statistically significant differences between owners and renters regarding the intensity of washer, air conditioner, and water heater use. On average, renters use them more often in all three cases. Specifically, tenants use their washers 0.335 more hours per week, their AC units 107.1 more hours per year, and their water heaters around 8 more days per year. The coefficients for stove and bathe are not significant at conventional levels.

All the results presented so far help explain the differences in electricity spending (and presumably consumption) between tenants and owners. The first observation we make is that tenants are less likely to have energy-efficient appliances and insulated walls, windows, and roofs. On the other hand, we saw that tenants use the devices more intensively. These two factors result in tenants using more energy and spending more on energy. It emerges, for instance, that some homes that have inadequate insulation in walls, windows, or roofs, and less efficient air conditioners, use them more hours and less efficiently (in part due to the lack of insulation). This argument goes in line with previous studies such as Krishnamurthy and Kriström (2015). Thus, the evidence supports the hypothesis that landlords do not make energy efficiency investments due to the split incentives problem: Landlords cannot recover savings from reduced energy use that accrue to tenants and therefore do not invest. And the latter end up using more energy because their equipment and the building structure are less energy-efficient.

Table 5: Estimation Results: Intensity of Use

	(1) No Controls	(2) D&H	(3) Eco-friendly	(4) Equipment	(5) Stratum
Stove (hours per week)	-0.913***	0.038	0.187	0.301	0.144
	(0.244)	(0.246)	(0.253)	(0.253)	(0.255)
Washing machine (hours per week)	0.443***	0.222	0.295*	0.375**	0.335**
	(0.142)	(0.156)	(0.161)	(0.161)	(0.163)
A/C (hours per year)	149.072**	99.467*	126.754**	123.543**	107.061*
	(58.258)	(55.140)	(56.345)	(56.226)	(56.049)
Water heater (days per year)	15.052***	5.361	5.905*	8.376**	7.946**
	(3.518)	(3.515)	(3.534)	(3.557)	(3.546)
Bathe (hours per day per person)	-0.010	-0.010	-0.008	-0.007	-0.006
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
Demographic & Housing	N	Y	Y	Y	Y
Energy sav. & Env. att.	N	N	Y	Y	Y
Equipment stock	N	N	N	Y	Y
State, Loc. & SES FE	N	Y	Y	Y	N
Stratum FE	N	N	N	N	Y

This table reports coefficient estimates of β from equation (1). The dependent variable is number of hours used per week, per year, or per day per person as indicated. The control variables are those reported in table 2 and table 8 in the appendix. State, Loc. & SES FE stands for state, locality size, and socioeconomic status fixed effects. Robust standard errors are in parentheses. All the results use the survey sampling weights. Significance levels: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Source: ENCEVI-2018.

4.3 Results: Awareness of Appliance Replacement Programs

In most emerging countries, the lack of resources or inadequate financing can pose a major obstacle to the purchase or replacement of electrical appliances and structural investments in energy efficiency. Furthermore, not much information is available to consumers about government programs that finance such energy efficiency improvements. In a recent study, Hancevic & Sandoval (2023) find that the lack of resources and access to financing are the main barriers to the adoption of solar panels among small and medium-sized businesses in Mexico. They note that disinformation does not only revolve around financing programs or subsidies, but also about how the technology works, where it is sold, and at what prices. Most importantly, the authors find that tenants are less likely to adopt the technology. There is a possibility that the mechanisms that prevent solar panels from being adopted are similar to those that prevent energy efficiency upgrades from being implemented. As a result, energy efficiency in emerging countries may be inadequate in both residential and non-residential sectors. In this paper, we find it interesting to compare homeowners and renters awareness of appliance replacement programs, and whether they have taken advantage of them. In Appendix B we provide a list of the different energy efficiency programs referred to in the ENECEVI survey. Table 6 presents the estimation results considering the appliances analyzed in this document using the estimating equation (1) but now Y_i is an indicator variable that equals one if household i is aware of any government program to replace the corresponding appliance. In a second specification, Y_i assumes the value 1 if household i has benefited from such program. Results are quite eloquent. Tenants are less familiar with government programs in all specifications and equipment (refrigerators, air conditioners, water heaters, and low consumption light bulbs), and not surprisingly, tenants are much less likely to benefit from the program than owners. These findings clearly demonstrate the need to disseminate government programs appropriately.

Table 6: Estimation Results: Government Programs

	(1) No Controls	(2) D&H	(3) Eco-friendly	(4) Equipment	(5) Stratum
Refrigerator	-0.068***	-0.051***	-0.045***	-0.042***	-0.041***
	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)
Beneficiary	-0.039***	-0.024***	-0.025***	-0.024***	-0.025***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Water heater	-0.022***	-0.017***	-0.016***	-0.016***	-0.013**
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Beneficiary	-0.011***	-0.008***	-0.008***	-0.008***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
A/C	-0.013***	-0.009***	-0.009***	-0.009***	-0.009**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Beneficiary	-0.004***	-0.002**	-0.003**	-0.003**	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bulbs	-0.112***	-0.055***	-0.053***	-0.048***	-0.045***
	(0.011)	(0.012)	(0.013)	(0.013)	(0.013)
Beneficiary	-0.114***	-0.045***	-0.044***	-0.042***	-0.043***
	(0.007)	(0.009)	(0.009)	(0.009)	(0.009)
Demographic & Housing	N	Y	Y	Y	Y
Energy sav. & Env. att.	N	N	Y	Y	Y
Equipment stock	N	N	N	Y	Y
State, Loc. & SES FE	N	Y	Y	Y	N
Stratum FE	N	N	N	N	Y

This table reports coefficient estimates of β from equation (1). The dependent variable is an indicator variable that equals one if the household is aware of a government program to replace the corresponding appliance, and in a separate regression whether it has benefited from it. The control variables are those reported in table 2 and table 8 in the appendix. State, Loc. & SES FE stands for state, locality size, and socioeconomic status fixed effects. Robust standard errors are in parentheses. All the results use the survey sampling weights. Significance levels: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Source: ENCEVI-2018.

5 Estimated Savings in Energy and Emissions

The purpose of this section is to quantify the implied total electricity consumption, expenditure, and CO_2 emissions resulting from the landlord-tenant conflict. The assessment of the overall scope of this problem is based on the estimates provided in Section 4 as well as additional information from a variety of official sources. Specifically, we use the Energy Information System of the Ministry of Energy to calibrate the number of residential consumers, electricity consumption, and expenditure by tariff category and state. For the purpose of calculating carbon emissions, we use the average emission factor of the National Electric System, which in 2018 was 0.527 tCO2e/MWh.[23]

The back of the envelope estimates that we present in table 7 should be regarded as approximations rather than precise calculations. Nevertheless, we believe they are helpful for getting a sense of the overall impacts.

Table 7: Implied Total Savings: Electricity Consumption and Carbon Emissions of Rented Homes

Observed		Estimated savings		
Expenditure (Million $/year)	Consumption (GWh/year)	Expenditure (Million $/year)	Consumption (GWh/year)	Emissions (tCO2e/year)
$13,394	8,257	$938	578	304,581

This table reports the aggregate electricity expenditure, consumption, and carbon emissions for rented homes during 2018. In addition it reports the counterfactual savings assuming rented homes behave as owner-occupied homes. Monetary numbers are in Mexican Pesos (with an annualized volatility of 12.86%, the exchange rate in 2018 fluctuated between 17.94 pesos per dollar and 20.96 pesos per dollar).
Source: own calculations based on ENCEVI and SENER data.

The electric consumption of rented homes accounted for 13.4 billion MXP and 8,257 GWh in 2018. By being equally energy efficient as homeowners, they would have saved 0.94 billion MXP and 578 GWh. This implies a reduction of 304,581 tCO2e in emissions. As rented homes account for 16% of total properties, the potential savings in consumption in the residential sector represent slightly more than 1% of total consumption. Note that we are implicitly not assuming a complete replacement of all conventional appliances with energy-efficient ones. In our calculations, the saturation of energy efficient technologies is only increasing by a few percentage points since we assume renters are similarly efficient to

[23]Ideally, we would imput marginal emissions avoided as a result of energy efficiency improvements using hourly consumption data. However, the ENCEVI provides information on residential energy consumption based on the last bill available, which typically covers two months of energy consumption. As a result, the average emission factor is an appropriate approximation given the limitations of our data.

owners. To put our results into perspective, Davis (2012) estimates that between 0.5% and 1% of the total energy consumption in rental housing in the United States can be attributed to the homeowner-renter gap whereas Melvin (2018) finds that renters who pay their own utility bills use 1.9% more energy overall (electricity, natural gas, LPG and fuel oil) than owners.

6 Concluding Remarks

Split incentives occur in residential energy consumption when the person who invests in energy-efficient upgrades, such as insulation or efficient appliances, is not the same person who pays the energy bill. Landlords are disincentivized from making energy-efficient upgrades since they would not be able to reap the benefits of lower utility bills, while tenants have little incentive to make these investments since they do not own the property and are unlikely to recoup the investment. Addressing the split incentives issue is important to reducing the energy efficiency gap as it can help ensure that the parties responsible for making energy efficiency improvements have the incentives to do so.

Extensive research has been conducted in developed countries documenting the differences in energy-efficient technology between homeowners and renters, quantifying the split incentives problem. However, little is known about this issue in less developed countries. Studying the split incentive issue in residential energy consumption in less developed economies is important for understanding the unique challenges and barriers to energy efficiency in these contexts and developing effective policies and interventions that can help to overcome them.

This paper is the first to provide empirical evidence of this gap and to quantify the magnitude of the split incentives problem in an emerging economy. Specifically, this paper uses the first National Survey on Energy Consumption in Private Homes (ENCEVI-2018) to provide evidence from Mexico, the 13th largest greenhouse gas (GHG) emitter in the world and the second largest in Latin America and Caribbean –behind Brazil.[24]

Our results indicate that renters have less insulation and energy-efficient equipment, that they tend to use some of their equipment more frequently, and that they pay more in utility bills. In addition, renters are less aware of government programs that may be beneficial in reducing their energy expenditures. This lack of awareness results in missed opportunities to improve energy efficiency and reduce energy consumption. Collectively, all these issues exacerbate the energy efficiency gap and hinder the efforts to conserve energy and reduce

[24] Source:
https://www.usaid.gov/sites/default/files/2022-05/USAID-Climate-Change-Fact-Sheet-Mexico.pdf

greenhouse gas emissions.

The split incentives problem poses a significant barrier to achieving energy efficiency in the residential sector, especially in the rental market, and it has important policy implications. Since residential buildings are responsible for a significant portion of energy consumption and GHG emissions and a substantial portion of households are renters,[25] addressing this problem is crucial for promoting energy efficiency and reducing energy consumption and emissions.

Previous studies have indicated that addressing this problem may require a combination of policy interventions, such as minimum efficiency standards and financial incentives for landlords to make energy efficiency upgrades, as well as educational programs for both landlords and tenants about the benefits of energy efficiency measures. Our findings further suggest that even when government programs are available, renters are less aware of them and also benefit less from them. Therefore, efforts to solve the split incentives problem should also include informational campaigns targeting the renters.

[25] For instance, one in five Latin American households are renters, and this proportion has been increasing since the 1990s (Blanco, Cibils & Muñoz, 2014).

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A Appendix

Table 8: Survey Data: Summary Statistics: Stock of Electrical Equipment

	Renter		Owner				
	Mean	SD	Mean	SD	Diff.	p-value	# Obs.
Microwave	0.409	(0.492)	0.398	(0.49)	0.011	0.417	21,984
Blender	0.869	(0.337)	0.888	(0.315)	-0.019	0.019	21,984
Mixer	0.177	(0.382)	0.17	(0.375)	0.007	0.510	21,984
Coffee maker	0.12	(0.325)	0.101	(0.301)	0.019	0.029	21,984
Toaster	0.109	(0.312)	0.106	(0.308)	0.004	0.679	21,984
Electric grill/oven	0.086	(0.281)	0.056	(0.23)	0.031	0.000	21,984
Hair dryer	0.19	(0.392)	0.159	(0.366)	0.031	0.003	21,984
Hair/curling iron	0.272	(0.445)	0.201	(0.4)	0.071	0.000	21,984
Dryer	0.068	(0.252)	0.071	(0.256)	-0.003	0.670	21,984
Sewing machine	0.037	(0.19)	0.052	(0.222)	-0.015	0.004	21,984
Iron	0.612	(0.487)	0.629	(0.483)	-0.017	0.190	21,984
TV	0.927	(0.26)	0.926	(0.262)	0.002	0.805	21,984
Modem	0.438	(0.496)	0.426	(0.494)	0.013	0.347	21,976
Set top box for TV	0.34	(0.474)	0.372	(0.483)	-0.032	0.012	21,978
Tablet/iPad	0.189	(0.392)	0.154	(0.361)	0.035	0.001	21,974
Laptop	0.266	(0.442)	0.249	(0.433)	0.016	0.161	21,975
Desktop	0.09	(0.286)	0.107	(0.31)	-0.018	0.030	21,977
Printer	0.08	(0.272)	0.103	(0.304)	-0.023	0.002	21,975
Radio	0.104	(0.305)	0.144	(0.352)	-0.041	0.000	21,974
Stereo system	0.25	(0.433)	0.246	(0.431)	0.004	0.745	21,978
DVD/Blu ray player	0.302	(0.459)	0.212	(0.408)	0.09	0.000	21,974
Video game console	0.12	(0.325)	0.101	(0.301)	0.019	0.026	21,978

This table reports descriptive statistics of additional control variables. All variables are binary. The p-value comes from a t-test of equality of means between renter- and owner-occupied units. All the results use the survey sampling weights. Source: ENCEVI-2018.

B Appendix

Aside from the labeling program already mentioned, several energy efficiency packages have been implemented in the form of appliance replacement programs. Here are the main federal programs[26]:

1. Program for the Replacement of Home Appliances to Save Electricity "Change your old one for a new one". This program was created in 2009 by the Ministry of Energy (SENER) and operated by FIDE until 2012. Its objective was to replace refrigerators or air conditioning equipment with more than 10 years of use for more efficient equipment. This program granted 1.8 million loans to residential users.

[26] See CEPAL, 2018.

2. Sustainable Light Program. Developed jointly by SENER and FIDE in the period 2009 to 2012, it comprises two phases. The objective of the program was to replace incandescent light bulbs with saving lamps free of charge, and it achieved a distribution of 47.2 million saving lamps across the country.

3. Save a light program. This SENER program was operated by FIDE with the support of the private firm Diconsa. Its objective was to deliver 40 million saving lamps (LFCA) to the inhabitants of towns with less than 100,000 inhabitants to support their family economy, reduce their consumption and contribute to caring for the environment by reducing polluting gases emitted into the atmosphere.

4. Green Mortgage Program. The Institute of the National Housing Fund for Workers (INFONAVIT) started this program in 2009 with the purpose of granting loans to buy, build, expand or remodel a home with light, gas and water saving accessories such as thermal insulation, saving lamps, solar heaters and saving keys, among others.

5. Program for Sustainable Improvement in Existing Housing. Its purpose is to support the residential sector in the acquisition of sustainable and efficient technology in order to reduce family spending on electricity consumption. The participating technologies are photovoltaic systems, efficient gas heaters, solar heaters, air conditioners and thermal insulation, among others.