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ARTICLE

Evidence of a homeowner-renter gap for electric vehicles

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ABSTRACT
This paper provides the first empirical analysis of the homeowner-renter gap for electric vehicles. Using newly-available U.S. nationally representative data, the analysis shows that homeowners are three times more likely than renters to own an electric vehicle. The gap is highly statistically significant, and remains even after controlling for income. For example, among households with annual income between $75,000 and $100,000, 1 in 130 homeowners owns an electric vehicle, compared to 1 in 370 renters. Additional controls do little to narrow the gap. The paper argues that this is a version of what economists have called the "landlord-tenant" problem, and briefly discusses potential policy implications.

KEYWORDS
Electric vehicles; EVs; plug-in hybrids; landlord-tenant problem; charging stations

JEL CLASSIFICATION
Q41; D12; L62; Q54

I. Introduction

Americans have now purchased more than 800,000 electric vehicles, counting both plug-in hybrids and all-electric models. This a large increase compared to the fewer than 5,000 that were on the road in 2010 (Inside EVs 2018), but this is still less than one percent of all U.S. registered vehicles.

Policymakers nonetheless see electric vehicles as having great potential to reduce carbon dioxide emissions and other forms of pollution, and are supporting tax credits and other policies to encourage people to buy electric vehicles. California, for example, aims to have 5 million electric vehicles on the roads by 2030 (California Office of the Governor 2018).

But to meet such ambitious goals, electric vehicles would need to stop being a niche product and appeal to as many drivers as possible. This paper uses newly-available nationally representative data from the U.S. Department of Transportation's National Household Travel Survey, to provide the first empirical analysis of the homeowner-renter gap for electric vehicles.

Figure 1 plots electric vehicle ownership rates for U.S. homeowners and renters. Nationwide, homeowners are more than three times more likely than renters to own an electric vehicle. In particular, 0.87% (less than 1%) of homeowners own an electric vehicle, compared to 0.25% (one-quarter of 1%) of renters.

The rest of the paper shows that this homeowner-renter gap is highly statistically significant, and appears both in California and in the rest of the United States. Moreover, the homeowner-renter gap remains economically and statistically significant even after controlling flexibly for income, household characteristics, and other factors. The paper concludes with a brief discussion of potential mechanisms and policy implications.

II. Preliminary evidence

Figure 2 shows electric vehicle ownership rates for California and the rest of the United States. Almost half of all U.S. electric vehicles are in California, so this particular state is of significant intrinsic interest.

In California, homeowners are three times more likely than renters to own an electric vehicle. The gap is even wider for the rest of the United States, where homeowners are six times more likely than renters to own an electric vehicle. Thus the homeowner-renter gap is pronounced in both subsamples.

All analyses in this paper are based on the newly-available 2017 National Household Travel Survey. These data are nationally representative and provide rich household-level information

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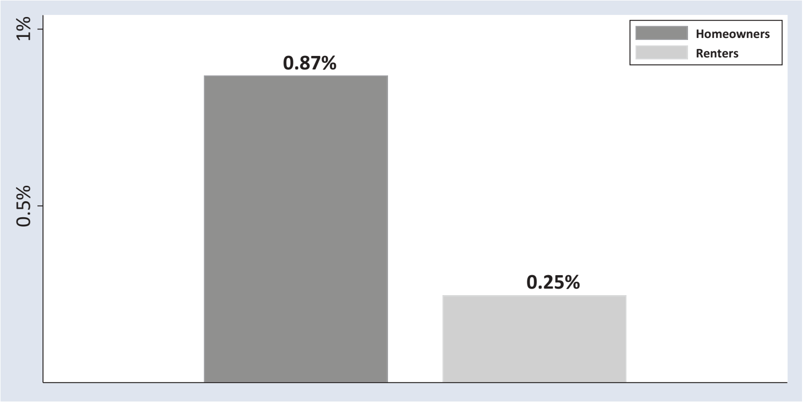

Figure 1. U.S. Electric Vehicle Ownership Rates.

Note: Constructed using data from the 2017 National Household Travel Survey. All estimates calculated using sampling weights. Electric vehicles include plug-in hybrids and all-electric vehicles.

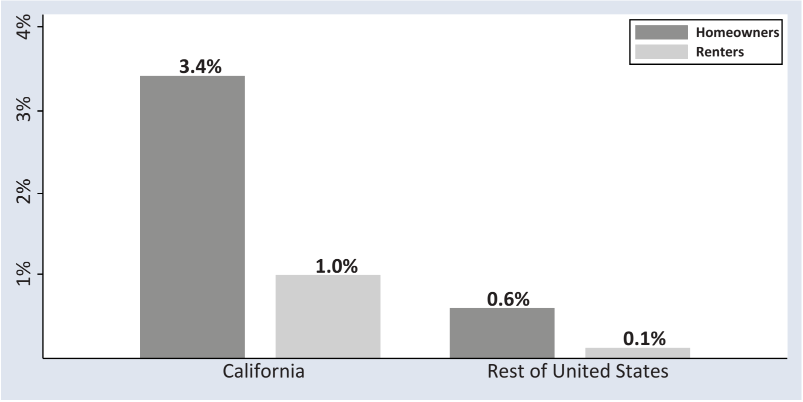

Figure 2. Electric Vehicle Ownership Rates, California vs Rest of U.S.

Note: Constructed using data from the 2017 National Household Travel Survey. All estimates calculated use sampling weights. Electric vehicles include both plug-in hybrids and all-electric vehicles.

about U.S. households' transportation choices, as well as about household income and other characteristics. The sample for the National Household Travel Survey is selected using stratified sampling, so sampling weights are used in all calculations.

A notable advantage of the National Household Travel Survey is the large sample size – 129,696 households in the 2017 survey. This large sample size is reflected later in the paper in the regression analysis. Specifically, the large sample size results in small standard errors and highly statistically significant differences between homeowners and renters. Previous waves of the National Household Travel Survey had effectively zero households with electric vehicles.

A limitation of the National Household Travel Survey is the low response rate. This latest 2017 wave has a lower response rate than previous waves, only 15.6% according to the survey documentation. The sample weights provided by the survey designers attempt to correct for non-response by balancing observable household characteristics. Still, it is impossible to rule out concerns about non-response bias, so this is worth highlighting as an important caveat.

It is worth noting, however, that the aggregate electric vehicle ownership rates implied by the National Household Travel Survey are consistent with aggregate data about electric vehicle sales. Specifically, the ownership rates in Figure 1 imply that there are about 740,000 electric vehicles in the United States. This is quite similar to cumulative U.S. electric vehicle sales to date (Inside EVs 2018). While this simple back-of-the-envelope calculation does not eliminate all concerns about the low-response rate, it does provide some reassurance that the data provide a reasonable description of the broader patterns.

III. Controlling for income

Figures 1 and 2 show that homeowners are at least three times more likely than renters to own an electric vehicle. But, of course, homeowners and renters are different in many ways, so it is not clear whether this observed gap reflects homeownership itself, or some other difference between the two groups. Perhaps most importantly, homeowners tend to have much higher incomes than renters.

This section tests whether the homeowner-renter gap can be explained by income. Previous research has shown that electric vehicle ownership is strongly correlated with income. Borenstein, and Davis (2016), for example, shows using data from U.S. income tax returns, that the top income quintile has received 90% of all electric vehicle tax credits. Electric vehicles cost more to buy than comparable gasoline-powered vehicles so it may just be that, at least for the moment, electric vehicles are more affordable for relatively high-income households.

Purchasing any vehicle requires a buyer to make an intertemporal tradeoff between purchase price and operating costs. Relative to gasoline-powered vehicles, electric vehicles tend to cost more to purchase but less to operate. A related literature on gasoline-powered vehicles finds that vehicle buyers are relatively attentive to future operating costs (Busse, Knittel, and Zettelmeyer 2013; Allcott, and Wozny 2014; Sallee, West, and Fan 2016). There could be differences, however, between high-income and low-income households in how they assess this tradeoff. An older literature, for example, finds that low-income households tend to discount the future more when making energy-related investments (Hausman, 1979; Dubin, and McFadden 1984), so this may be part of the explanation.

Figure 3 plots electric vehicle ownership by income level for both homeowners and renters. There is indeed a strong positive correlation between electric vehicle ownership and annual household income. For both homeowners and renters, electric vehicle ownership increases steadily with income, with the most significant increase in the highest income category. In all eight income categories, however, electric vehicle ownership is higher for homeowners than renters. For example, among households earning between $75,000 and $100,000 per year, 1 in 130 homeowners owns an electric vehicle, compared to 1 in 370 renters. Thus the homeowner-renter gap remains economically significant even after controlling for income.

IV. Regression results

This section uses a regression framework to include additional control variables and to assess statistical significance. Table 1 presents estimates from a linear probability model of the following form,

$$1(electricvehicle)_i = \beta_0 + \beta_1 1(Homeowner)_i + \beta_2 X_i + \epsilon_i.$$

The dependent variable $1(electricvehicle)_i$ is an indicator variable equal to one if the household has an electric vehicle. As in the graphical analyses

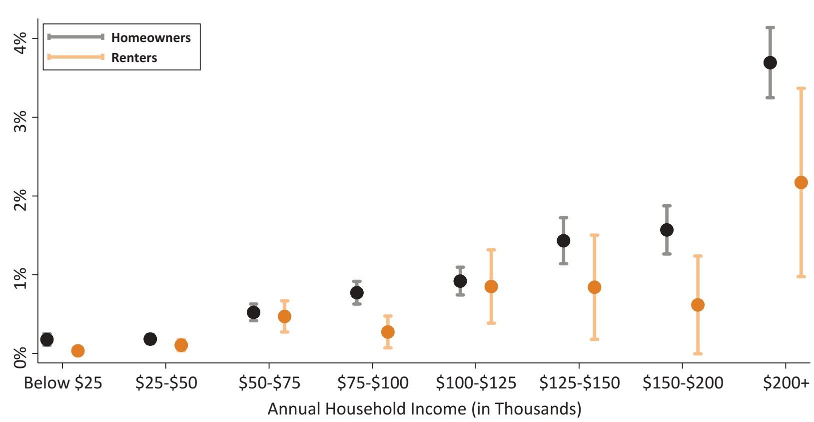

Figure 3. Electric Vehicle Ownership for Homeowners and Renters, by Income.

Note: Constructed using data from the 2017 National Household Travel Survey. All estimates calculated using sampling weights. Electric vehicles include both plug-in hybrids and all-electric vehicles. Bars indicate 95% confidence intervals.

above, electric vehicles include both plug-in hybrid and fully electric vehicles. The regressor of interest is $1(Homeowner)$, an indicator variable for homeowners. Thus, the coefficient of interest β_1 is the difference in electric vehicle ownership between homeowners and renters with a positive coefficient indicating that homeowners are more likely to have an electric vehicle.

Table 1 reports estimates of β_1 from five difference specifications. Panel (A) reports estimates using all households in the 2017 National Household Travel Survey. In column (1) without controls, homeownership is associated with a 0.006 increase in the probability that a household has an electric vehicle. This is a large effect; identical to the difference in mean ownership rates between homeowners and renters in Figure 1, and indicating that without any controls, homeowners are three times more likely than renters to own an electric vehicle.

When controlling flexibly for income in column (2), the estimate shrinks but remains economically and statistically significant. The estimate is largely unchanged after adding household characteristics in column (3), state fixed effects in column (4), and restricting the sample to include only households with at least one vehicle in column (5). In the richest specification, the homeowner-renter gap is about half as large as the unconditional difference in column (1). In all five columns the estimate of β_1 is statistically significant at the 1% level.

Table 1. The Homeowner-Renter Gap for Electric Vehicles.

	(1)	(2)	(3)	(4)	(5)
A. United States					
1(Homeowner)	0.006**	0.002**	0.002**	0.003**	0.003**
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Sample Size	129,696	129,696	129,696	129,696	123,447
R-squared	.00	.01	.01	.02	.02
B. California Only					
1(Homeowner)	0.024**	0.011**	0.009**	0.009**	0.010**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Sample Size	26,099	26,099	26,099	26,099	24,929
R-squared	.01	.03	.03	.03	.03
Flexible Controls for Income	no	yes	yes	yes	yes
Household Characteristics	no	no	yes	yes	yes
State Fixed Effects	no	no	no	yes	yes
Vehicle Owners Only	no	no	no	no	yes

Note: This table reports coefficient estimates and standard errors from ten separate least squares regressions. The dependent variable in all regressions is an indicator variable equal to one if the household has an electric vehicle. Panel (A) includes all households from the 2017 National Household Travel Survey and Panel (B) restrict the sample to include only California households. Flexible controls for income include separate indicator variables for each of the 14 different discrete categories for household family income in the 2017 National Household Travel Survey. Household characteristics include household size, number of drivers, number of vehicles, population density in the census tract, and an indicator variable for households living in urban areas. State fixed effects are irrelevant for the California regressions so in Panel (B) the estimates in columns (3) and (4) are identical. Column (5) restricts the sample to include only households with at least one vehicle. All regressions are estimated using sampling weights. Robust standard errors are reported. Double asterisks indicate estimates that are statistically significant at the 1% level.

Panel (B) restricts the sample to include only California households. Results are qualitatively similar, but larger in magnitude reflecting the higher ownership rate of electric vehicles. In the richest specification in column (5), homeownership is associated with a 0.010 increase in the probability that a household has an electric vehicle. This is a large effect compared to the ownership rate for renters which is about 1%, implying that even after controlling for these covariates, homeowners are about twice as likely as renters to own an electric vehicle. Again, the estimate of β_1 is statistically significant at the 1% level in all five columns.

Thus in all ten specifications the homeowner-renter gap is highly statistically significant. There could, of course, be additional differences between homeowners and renters. For example, these data do not include a measure of household wealth and it could be that annual household income is an insufficient proxy for household lifetime income. Still, it is striking that even after these available controls there remains a large homeowner-renter gap. Moreover, while household income clearly matters, it is notable that the estimates are largely unchanged by the inclusion of the other control variables.

V. Policy implications

This evidence on the homeowner-renter gap is far from definitive, but does suggest that there is something different about renting which makes electric vehicle ownership more difficult. This section provides a brief discussion of potential mechanisms and policy implications.

Perhaps most obviously, renters tend to have less access to a convenient parking spot. Most homeowners have a garage or driveway, or both, which makes charging extremely convenient because they can park in that dedicated spot while charging their electric vehicle at night. In contrast, many renters live in multi-unit buildings. Parking spots may not be assigned, or there may not be parking spots at all. The National Household Travel Survey does not provide information about parking availability, but it seems likely that access to a convenient parking spot is part of the explanation for the homeowner-renter gap.

Relatedly, it is also harder for renters to invest in charging equipment. For homeowners, it is relatively straightforward to invest in a 240 volt outlet, electric panel upgrades, and other improvements to speed up charging. But for renters these investments are trickier. Most renters don't want to make expensive investments in a property they don't own, and landlords may be unwilling to make these investments on their behalf.

This is a version of what economists have called the "landlord-tenant" problem (see, e.g. Blumstein et al. 1980; Fisher, and Rothkopf 1989; Jaffe, and Stavins 1994). Several studies have found that landlords tend to underinvest in energy-related investments relative to homeowners (Davis, 2012; Gillingham, Harding, and Rapson 2012; Myers 2015; Melvin 2018). In theory, a landlord could make investments in electric vehicle charging infrastructure, and then increase the rent to recoup the cost. This may not happen in practice, however.

The main reason landlords may be hesitant to make electric vehicle-related investments is that even if the current tenant has an electric vehicle, the next tenant may not. In a market in which most renters don't have electric vehicles, it doesn't make sense for landlords to make expensive investments in electric vehicle chargers. It may also be difficult for landlords to effectively convey information about electric vehicle charging investments. Landlords have an incentive to inform tenants about these investments, but there may be asymmetric information or other barriers that make it difficult for tenants to evaluate these claims.

Policymakers are beginning to think about these challenges. For example, California has committed to spending $2.5 billion to bring 250,000 charging stations statewide by 2025 (California Office of the Governor 2018). Much of this funding is aimed at building charging stations in communities with renters. The investor-owned utility Pacific Gas & Electric, for example, is making multifamily residences a high priority as it builds thousands of new charging stations across the state.

As this charging infrastructure grows, the electric vehicle market is bound to expand as well (Li, et al. 2017; Li 2018). Landlords who can receive subsidies to install charging equipment will undoubtedly be more willing to install. Moreover, additional public charging in general will make electric vehicles more attractive to drivers who do not have a place at home where they can charge. While most current electric vehicle owners charge their vehicles at home this is, in part, because public charging stations are still relatively uncommon. It will be interesting to see whether these investments will narrow the homeowner-renter gap.

The harder and probably more interesting question is whether policymakers *should* be aiming policies at renters. In particular, it is not clear whether the homeowner-renter gap is a market failure. Most economists would like to see a higher price on carbon dioxide emissions and/or a higher tax on gasoline, but this would increase electric vehicle ownership among both homeowners and renters. Whether there should be additional policy steps to address renters specifically hinges on whether the gap reflects a market failure, or simply higher costs and lower demand.

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