ELECTRIC VEHICLES AND ELECTRICITY CONSUMPTION: HONEY, DID I PLUG IN THE CAR?

Jacobus Nel, University of Pretoria, +27 72 915 6721, neljaco380@gmail.com
Roula Inglesi-Lotz, University of Pretoria, +27 12 420 4504, roula.inglesi-lotz@up.ac.za

Overview

We analyse the effect of electric vehicle (EV) adoption on electricity consumption for a sample of 29 European countries. We employ a difference-in-difference approach to determine the impact of low adoption rates against high adoption rates on electricity consumption. Detecting statistically significant relationships while the market is still in its infancy, we can conclude that the effect will be much more significant once EV sales rival those of internal combustion engine vehicles (ICEVs).

The literature on EVs and electricity consumption is divided into two groups; firstly, the studies forecasting electricity demand increases from simulations and models (ex-ante). Secondly, some studies look at the load-shifting potential of EVs (using EVs as moving storage devices to smooth peak electricity demand). To our knowledge, no study has investigated this issue ex-post. Perujo and Ciuffo (2010) and Dhar et al. (2017) are two studies that form part of the first group of studies. Both these studies outline that there will be some increase in electricity consumption, while Perujo and Ciuffo (2010) state that this is insignificant; however, their study was conducted in 2010, well before the legislation passed to ban the sale of ICEVs from 2030.

Methodology

We use a difference-in-difference model to analyse the data, with the treatment group being countries with EV sales above a threshold for that particular year. In contrast, the control group are the countries below this threshold for a particular year. EV sales data in all countries start in 2008, as a result, 2002-2007 is in the control group for all countries and acts as the pre-treatment period. The effective sample period is 2002-2017. We account for both country and time-fixed effects and a lagged dependent variable to avoid misspecification due to omitted variables.

$$Elect_{i,t} = \alpha + \beta_1 Elect_{i,t-1} + \beta_2 d_{i,t} + \beta_3 EV_{i,t} + \beta_4 d_{i,t} \times EV_{i,t} + \beta_5 p_{i,t} + \mu_i + \mu_t + \epsilon_{i,t}$$

Where $Elect_{i,t}$ is the log of electricity consumption growth of country i in period t, $EV_{i,t}$ is EV sales growth (as the measure for EV adoption rate), $d_{i,t}$ is the indicator variable for when the value of EV sales is high for a particular observation, and $p_{i,t}$ is electricity price growth (log returns). Note that we model the effect of EV sales on electricity consumption contemporaneously, as the lagged dependent variable already accounts for the previous year's sales. The difference in difference estimate β_4 then gives the effect of high EV sales on electricity consumption and is our main coefficient of interest. We also use the year Tesla superchargers become available in a country as a proxy for when Tesla officially enters a market, as a shock. Given that our identification strategies cannot be argued to be exogenous, our results are non-causal. However, they still yield essential results for policymakers.

Results

We analyse the relationship between EV sales growth and sectoral and total electricity consumption growth. We find no statistically significant evidence of a relationship between the two variables for households. Given that this result might be due to the owners not charging their vehicles at home, we also consider electricity consumption for the transport sector. Here we find a statistically significant, negative relationship between the variables, or that lower EV growth rates are associated with higher electricity consumption growth rates. This is concerning as it could indicate that individuals are substituting away from public transport in favour of private transport. The relationship between total electricity consumption growth and EV sales growth has a similar trend as the transport sector. However, these results are not robust once we account for electricity price and population size. The results with Tesla superchargers as the shock show the same pattern as that of high and low EV adoption, indicating that the results are robust against a different identification strategy.

Conclusion

Given the current energy crisis mainly driven by the economic sanctions imposed by the West, we investigate the effect of EV adoption on electricity consumption and find a statistically significant relationship for total electricity consumption and the transport sector's electricity consumption. Our results indicate that even now, with EVs only accounting for a country maximum of 0.97% of new vehicle sales in the EU in 2019, there is a statistically significant relationship between EV adoption and electricity consumption. This makes it important for policymakers and strategic decision-makers to also model EV adoption and its effect on electricity consumption to avoid future electricity supply deficits. We also find evidence that consumers are substituting away from public transportation, which could have far-reaching consequences, however, this needs to be investigated from a causal point of view to confirm this deduction and to ensure that policies are put in place to prevent this.

Being the first to investigate the relationship in the ex-post fashion, our study lays the foundation for academics to improve upon our methodology to deduce a causal relationship.

References

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