Electric vehicle adoption and energy prices: Evidence from four Nordic countries

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Overview

The transport sector accounts for around 25% of the EU's total GHG emissions. To meet its environmental goal, the EU aims to increase the share of electric vehicles (EVs) in the transport sector. Meanwhile, since EVs are more energy-efficient than the ICE (internal combustion engine) vehicles (more than 85% efficiency for EV motors vs. around 20% for ICE vehicles), diffusion of EVs can also reap dividends in the form of energy efficiency improvement and energy saving (Thiel et al.,2016). Under the new regulation of EU, all new cars and vans registered in the EU are set to have zero emissions by 2035 (Mock & Díaz ,2021). Therefore, it is of great significance for the government to shape policies to stimulate the adoption of EVs. In this regard, energy prices, i.e., electricity price and gasoline price, can be considered as instruments for the government to induce consumers into EVs over ICE vehicles, in addition to the widely used subsidies or tax exemption for EV purchases, given that the energy saving from EVs (compared with ICE vehicles) and thus the incentive to switch to EVs will be larger if gasoline price rises or electricity price decreases. Using a unique panel of EV registrations at the product-level from four Nordic countries (Denmark, Finland, Norway, Sweden), this paper investigates how electricity prices and gasoline prices stimulate the adoption of EVs. The results show that gasoline price has a more statistically significant effect on the adoption of EVs, compared with electricity price.

Methods

To utilize the product-level EV sales data, we follow Bushnell et al. (2022) to employ a two-way fixed effects model to examine the impact of energy prices on EV sales. The empirical specification is as follows:

$$ln(Sales_{jct}) = \beta_1 ln\,(Electricity\ price_{ct}) + \beta_2\ ln\,(Gasoline\ Price_{ct}) + \mu_t + \gamma_c \times Year_t + \lambda_j + \varepsilon_{jct} \qquad (1)$$

where the dependent variable $ln(Sales_{jct})$ is the logarithm of monthly sales of BEV model j in country c at time t. The main explanatory variable is the logarithm of $Electricity\ price_{ct}$ and $Gasoline\ Price_{ct}$. $Electricity\ price_{ct}$ is the retail electricity price in country c at time t, measured in EUR/kwh. $Gasoline\ Price_{ct}$ is the average retail gasoline price in country c at time t, measured in EUR/L. The coefficients of interest, β_1 and β_2 , are estimates of the energy price elasticity of EV sales. We expect β_1 to be negative and β_2 to be positive, as an increase in electricity prices could discourage the adoption of EV while an increase in gasoline price could stimulate consumers to shift to EVs from ICE vehicles. Our empirical specification (1) also incorporates a rich set of fixed effects, which include the month-by-year fixed effects to account for time trend effect, the country-by-year fixed effect to control for factors that are unique to each country in each year, and finally a set of fixed effects for each vehicle model, which control for all vehicle attributes common to the specific model.

However, there are potential observables affecting BEV demand, which may be correlated with changes in energy prices, as suggested by Bushnell et al. (2022). In this case, the endogeneity between BEV sales and energy prices would be a concern. To address the potential endogeneity issue, we employed a two-stage least squares (2SLS) estimation using an instrumental variable (IV) approach. Specifically, we utilized the average retail energy prices in other countries as instrumental variables for domestic retail energy prices, following Nevo (2001)'s approach. This instrument correlates with local energy prices due to common cost shifters across Nordic countries (e.g., crude oil price and wholesale electricity price). Meanwhile, the domestic sales of electric vehicles generally do not directly exert influence on the energy prices of another country since the majority of commutes by EVs are domestic travels and charging at another country are not that common.

Results

The results show that gasoline price has a more statistically significant effect on the adoption of EVs, compared with electricity price. On average, 1% increase in gasoline price would increase the sales of EVs by 0.85% and the effect is larger for EV models with relatively lower purchase cost and those with less-known brands. In terms of the implications to emission reduction, our simulation results show that a 1% increase in the gasoline price would reduce the lifecycle GHG emissions of new automobiles by 0.16%, which is slightly smaller than that found by Fridstrøm and Østli (2021) in Norway (-0.19), poentially due to that fact that our dataset includes three other Nordic countries where BEVs are not as popular as in Norway.

Conclusions

Our results have important policy implications. First, our results show that consumers in Nordic countries do respond to energy prices in terms of EV purchase decisions. This implies that higher energy prices (e.g., through increased gasoline taxes) can be used as an instrument to promote EV penetration by enlarging the potential driving-cost savings of EVs (compared to ICE vehicles). Second, our results also highlight the important role of energy prices/taxes in reducing carbon emissions in the transport sector of Nordic countries, through shifting the vehicle fleet towards more EVs.

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