THE IMPACT OF FUEL PRICES, ELECTRICITY PRICES, AND PRICE SHOCKS ON THE ADOPTION OF ELECTRIC VEHICLES: EVIDENCE FROM NEW ZEALAND

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Overview

With the growing global focus on sustainable development and reducing greenhouse gas emissions, the New Zealand government has set ambitious goals to promote the widespread adoption of electric vehicles (EVs). This initiative aims to reduce carbon emissions in the transportation sector, paving the way for achieving net-zero emissions by 2050 and a 100% renewable energy supply by 2035 (EECA, 2024). EV adoption plays a critical role in this transition, with the government setting specific targets to accelerate the process. However, the adoption of EVs is influenced not only by policy support but also by economic factors, particularly fluctuations in fuel and electricity prices. Additionally, fluctuations in these prices can affect consumer sentiment, which significantly impacts EV purchasing decisions and adoption rates across different regions.

This study examines the impact of fuel and electricity price fluctuations on EV registration rates in New Zealand and investigates whether these price fluctuations influence consumer sentiment in this process. Beyond increasing the number of EVs, New Zealand aims to promote sustainable transportation, reduce reliance on fossil fuels, and enhance energy efficiency. By analyzing the effects of price fluctuations on EV adoption, this study provides valuable insights for policymakers to develop more effective strategies to encourage EV adoption.

Methods

Specifically, we analyze data from 40 cities in New Zealand spanning January 2015 to January 2024. This dataset includes EV-related news across New Zealand during the period, census data from 2013, 2018, and 2023, and vehicle registration data. Additionally, we constructed an EV sentiment index using EV-related news articles in New Zealand, leveraging the Llama 3.2 and Bidirectional Encoder Representations from Transformers (BERT) models (Wang et al., 2024). Using the Time-Varying Parameter Vector Autoregression (TVP-VAR) method (Sevillano et al., 2024), we created fuel and electricity price shock indices to quantify the impact of price fluctuations on EV sentiment in New Zealand's 40 cities. Our methodology begins with the ordinary least squares (OLS) regression, two-way fixed effects regression, and GMM regression to preliminarily analyze the effects of fuel and electricity prices, as well as price shock indices, on EV adoption rates. The dataset was divided into two periods: January 2015–February 2022 (pre-subsidy period) and February 2022–January 2024 (subsidy period), based on the introduction of EV subsidies in New Zealand.

Results

Our results indicate that prior to subsidies, higher fuel prices significantly boosted EV adoption rates, while higher electricity prices suppressed them. Post-subsidy, the impact of fuel prices remained consistent, but the relationship between electricity prices and EV adoption became insignificant. Similar trends were observed for fuel and electricity price shocks. After addressing endogeneity concerns and conducting robustness checks, we found a nonlinear relationship between fuel and electricity prices, price shocks, and EV adoption. To explore this further, we employed the panel Quantile Autoregressive Distributed Lag (QARDL) model (Cho et al., 2015). The QARDL quantile regression results reveal significant asymmetry and nonlinearity in the response of EV penetration to price shocks across different quantiles (low vs. high). At lower penetration levels (lower quantiles), insufficient infrastructure and lack of awareness amplify consumer concerns, with price fluctuations further driving penetration rates away from the original trend through "negative sentiment" channels. Conversely, at higher penetration levels (higher quantiles), market-scale effects and network externalities strengthen the market's "self-correction" mechanism, allowing it to absorb price shocks and return to equilibrium.

The quantile regression results demonstrate not only differences in the direction and intensity of short- and long-term price effects on EV penetration but also reveal that at lower penetration levels and with less developed infrastructure, rising fuel and electricity prices tend to hinder EV adoption through "conservative sentiment" (with more pronounced short-term negative effects). However, when penetration reaches a certain level, further increases in fuel prices prompt more potential consumers to switch to EVs, showing short-term positive substitution effects.

This dynamic process remains robust across the multi-city dimension of panel data. Prices do not directly and unilaterally influence EV penetration; instead, they are transmitted through the chain of "price shocks – sentiment reactions – purchasing behavior." Fluctuations in fuel or electricity prices influence consumer expectations regarding the economic environment, travel costs, and policy sustainability, triggering significant "amplification" or "dampening" effects at the sentiment level. Particularly at low penetration levels, insufficient market awareness amplifies negative sentiment, causing deviations from equilibrium in the short term. At higher penetration levels, positive sentiment and scale effects combine to enhance market resilience.

The study separately examined panel data before and after the government implemented EV subsidies. Before subsidies, high initial EV costs and underdeveloped infrastructure meant that price shocks only significantly influenced penetration at certain quantiles. After subsidies were introduced, the lower purchase threshold widened the “total cost gap” between fuel vehicles and EVs. As a result, fluctuations in fuel or electricity prices were more easily "amplified" via sentiment channels, quickly impacting demand growth. Across different quantiles, the range of significant positive impacts expanded substantially. However, this also made certain quantiles more sensitive to policy and price changes, weakening the "self-correction" ability in some cases.

To further validate robustness, the study combined the TVP-VAR method with more granular sentiment indicators and regional "price shock indices" to reanalyze the panel data from 40 cities and regions. The results were broadly consistent with the baseline QARDL analysis: lower penetration levels exhibited greater sensitivity to price shocks and negative sentiment, while higher penetration levels benefited from network externalities and scale effects to buffer shocks and return to long-term equilibrium. Subsidies accelerated market expansion but also heightened sensitivity to prices and policies across most quantiles. Although minor differences in coefficients and significance were observed for certain quantiles, the primary conclusions remained unchanged, demonstrating the relative stability of price sensitivity and sentiment transmission mechanisms across different penetration levels in New Zealand's EV market.

Conclusions

In conclusion, this study analyzes data from January 2015 to January 2024, covering 40 cities and regions in New Zealand, to investigate the relationship between fuel prices, retail electricity prices, and EV adoption rates. To further explore the pathways through which prices affect adoption, we collected all EV-related news from 2015 to 2024 and used advanced language models, including Llama 3.2 and BERT, to construct sentiment indicators. Using the TVP-VAR approach, we derived price shock indices for fuel and electricity prices in the 40 cities and regions. Subsequently, we employed OLS, two-way fixed effects, GMM, and QARDL methods to conduct a comprehensive analysis of how prices and price shocks influence adoption rates. The results reveal that fuel prices generally have a long-term negative impact on EV adoption but can serve as a short-term positive driver during high adoption phases. Retail electricity prices, on the other hand, often weaken EVs’ cost advantage, particularly as the market scales up. Subsidies effectively lower the initial purchasing threshold while amplifying the sensitivity of certain market segments to price shocks, making these segments more reactive to policy and price changes. Markets with low adoption rates are more vulnerable to negative price shocks, whereas high adoption phases benefit from robust infrastructure and economies of scale, enabling better absorption of shocks and quicker recovery to equilibrium. Overall, these findings highlight the significant non-linear and quantile-specific effects of prices on EV adoption. The results underscore the importance of designing tailored subsidy and regulatory policies, enhancing infrastructure development, and dynamically monitoring prices and market sentiment to ensure the sustainable growth of the EV sector.

References

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