Blog Post

Project: E-cars Taxation Analysis

Asta Björk
Tuula Jakobsson Peralta
Matias Brax

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Can We Predict How Many Electric Cars Will Be Sold After 2025?

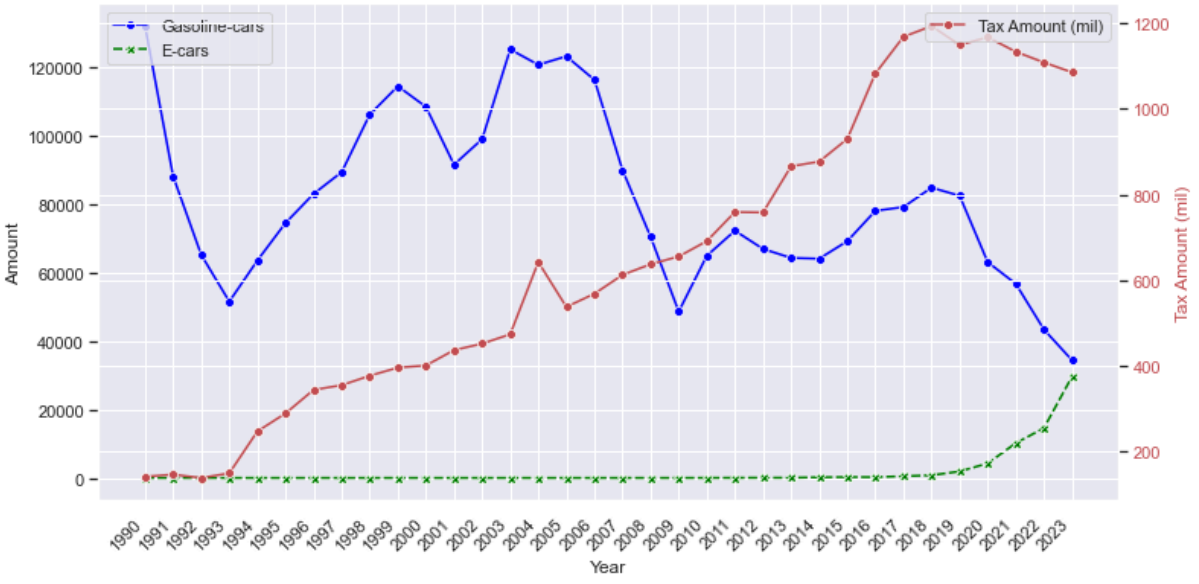
Electric cars (or e-cars) are becoming more popular, and many countries, including Finland, are encouraging people to make the switch by offering tax incentives. But what happens when those tax breaks end? In Finland, the tax-free period for electric cars will end in 2025, so we wanted to see if we could predict how this might affect e-car sales in the future.

We used some simple mathematical models to help us predict how many e-cars might be sold between 2025 and 2034. We tried two approaches: one that assumed a linear relationship between the data and a polynomial relationship that could account for more complexity. We added the cost of living to see if it made the predictions more accurate.

Here's what we found.

The Challenge of Making Predictions

The problem we were trying to solve sounds simple: predict how many e-cars will be sold based on historical data about car sales and taxes. But the reality is much more complicated. There are many factors that influence someone's decision to buy an electric car. While taxes are one part of the picture, things like the cost of living, technology improvements, and consumer preferences all play a role. We started by looking at how past e-car sales were influenced by taxes on gasoline cars and e-cars.

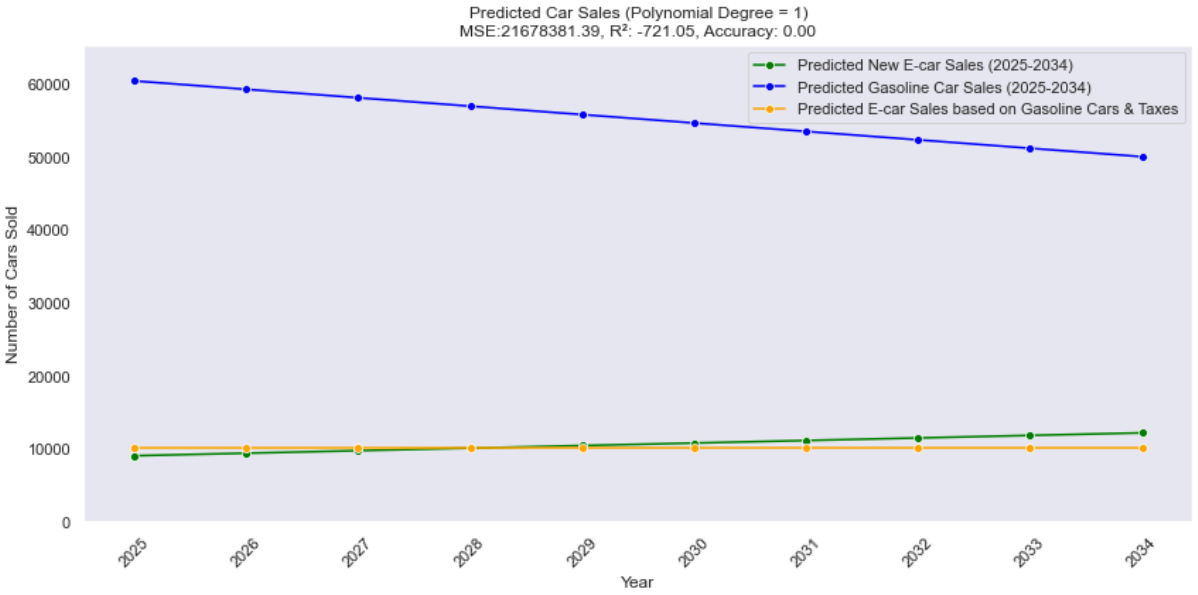


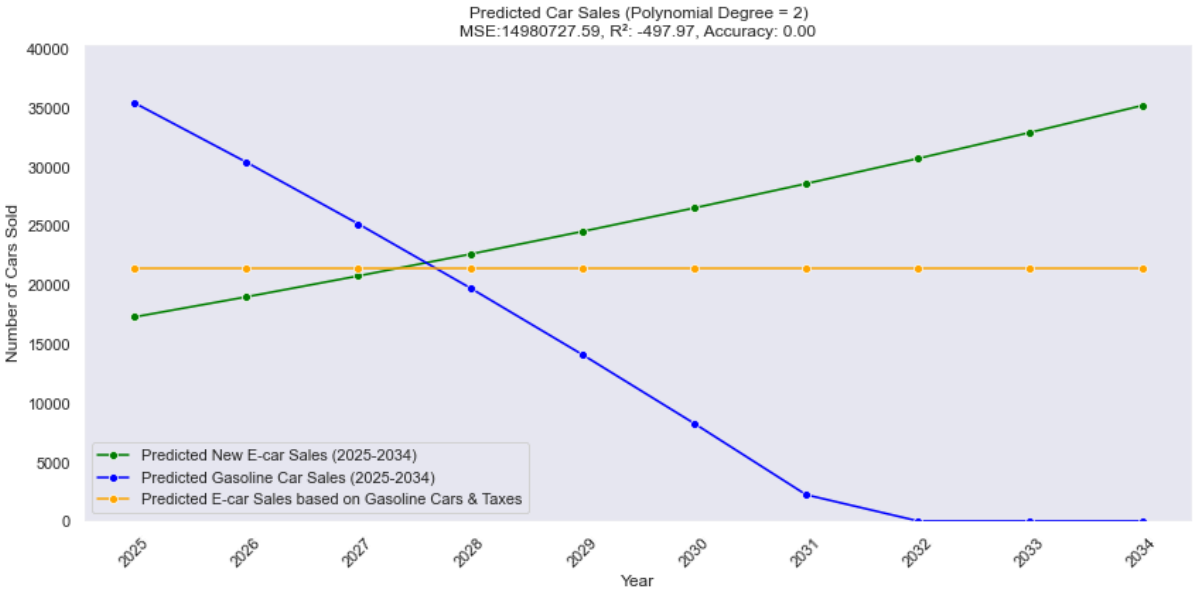
Gasoline and Electric cars | Amounts of newly registered cars and tax amounts in millions

Data is from Statistics of Finland

What Our Initial Models Showed

When we ran our first set of predictions, the results weren't great. Both the **linear model** (the one that assumes a straight-line relationship) and the **polynomial model** (which allows for more complexity) had large errors. In the **Linear model** the predictions were way off, and the error score (MSE) was 21.6 million. The model couldn't explain any of the sales patterns (R^2 was a shocking -721). The **Polynomial model** did a little better, but the predictions were still far from good. The error score (MSE) was 14.9 million, and the R^2 score was -497, which means it still wasn't explaining what was going on. To put this simply: both models were struggling to understand the relationship between taxes and car sales, and their predictions weren't accurate.





Adding Cost of Living

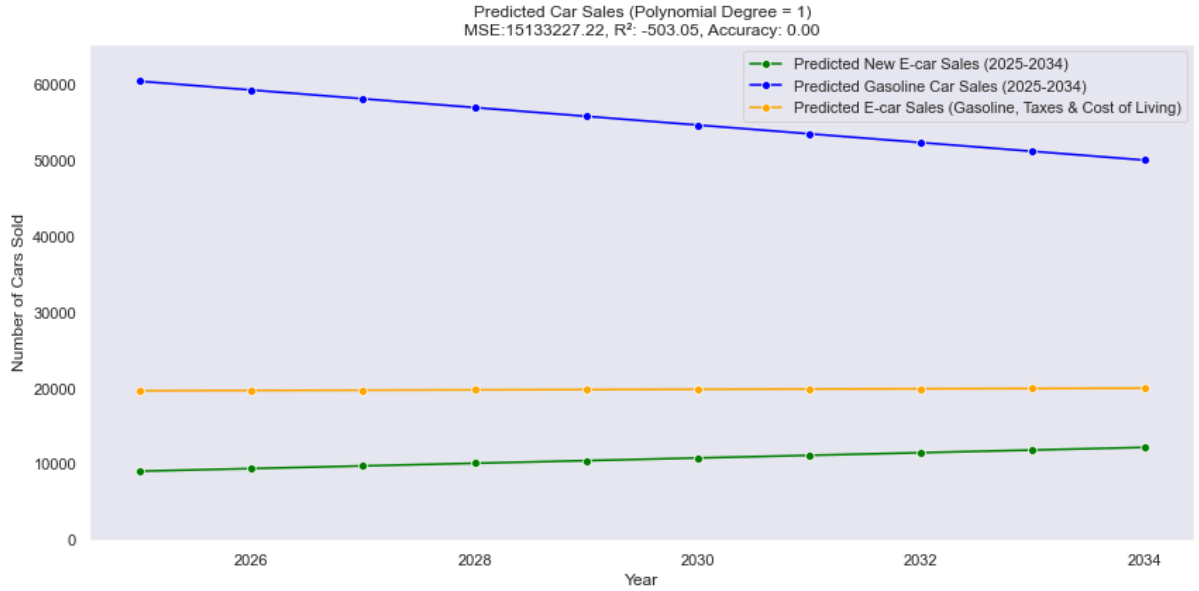
Next, we thought about what else could influence car sales. The cost of living, for instance, might play a big role. When everyday expenses like housing, groceries, and energy bills rise, people have less money to spend on big-ticket items like cars. So, we added cost of living data to our models to see if that would help.

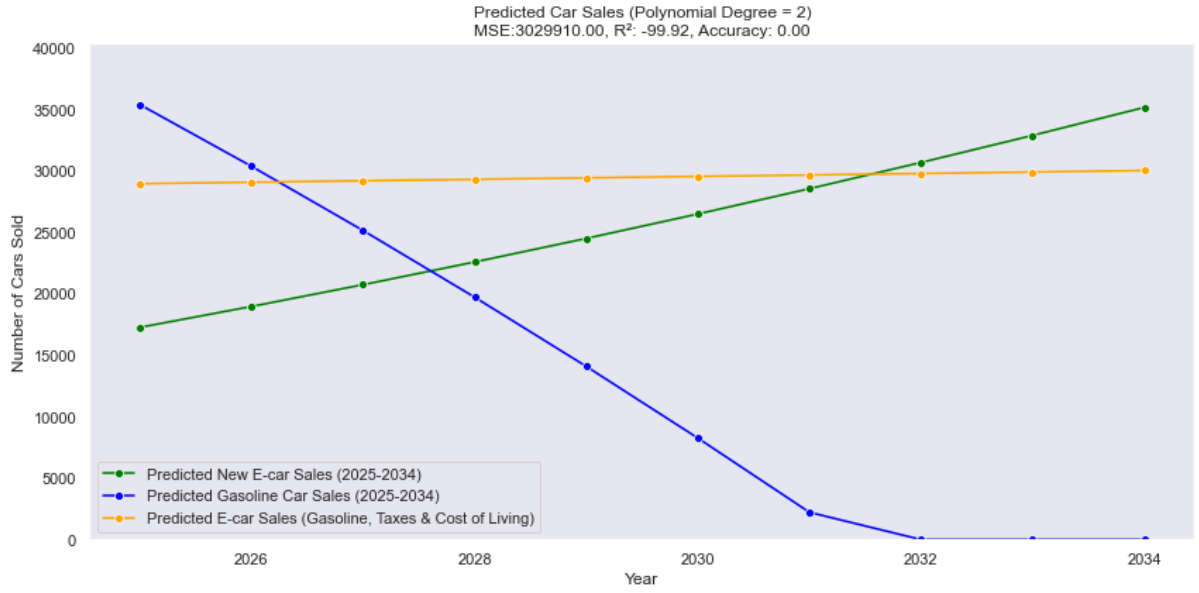
After including cost of living data, the models performed **better**, though still not great. The **Linear model with cost of living** had the error score (MSE) improved to 15.1 million, which is better than before, but still far from ideal. The R^2 score went from -721 to -503, showing some improvement, but it still wasn't a useful prediction tool. The **Polynomial model with cost of living** had the most improvement. The error score (MSE) dropped to just over 3 million, and the R^2 score improved significantly to -99.9. While this is still far from perfect, the improvement was noticeable.

In short, adding the cost of living helped the models make slightly better predictions, especially the polynomial model. But even with this improvement, the models were still missing the mark and are still far from reliable. This highlights just how difficult it is to predict future e-car sales based solely on a few factors like taxes and living costs.

To get more accurate predictions, we'd need to include a broader range of factors, like technological advancements, policy changes, and more granular data on consumer behavior. The bottom line is that while taxes and economic conditions are

important, the future of e-car sales likely depends on a much more complex set of factors than we initially considered.





Why Were the Predictions Still Inaccurate?

There are a few reasons why the models didn't perform as well as we'd hoped:

1. **Too few factors considered**: While taxes and cost of living are important, other factors - like government policies, the availability of charging infrastructure, or even changes in car prices - weren't included in the model. These could have a huge impact on whether people decide to buy an electric car.

2. **The relationship is complicated**: The switch from gasoline cars to e-cars isn't just a straight cause-and-effect relationship. It's influenced by a mix of economic, social, and technological changes that are hard to capture in a simple model.

3. **The data**: Predicting the future based on past trends is always tricky. The past data we used might not be a good guide for what will happen after 2025 when the tax-free period ends. Consumer behavior could change dramatically, making historical patterns less useful.

Conclusion: The Future Is Still Unclear

It might seem surprising that both the Linear Regression and Polynomial Regression models predict that more electric vehicles (e-cars) will be sold as living costs rise and taxes increase. This outcome may seem counterintuitive at first, but several factors could explain why these models make such predictions.

One explanation lies in economic theory, particularly the concept of **income elasticity of demand**. As the cost of living rises, disposable income may increase for some consumers. E-cars, often seen as premium or environmentally friendly options, could become more appealing to those with higher income, who are willing to invest in sustainability, even when prices rise. Additionally, higher taxes often coincide with better public services, infrastructure, or higher average income, making it easier for consumers to afford e-cars.

Government incentives play a crucial role as well. Higher taxes on gasoline-powered cars are often accompanied by subsidies or tax breaks for electric vehicles, making e-cars a more financially attractive choice despite the rise in overall costs. Furthermore, increased tax revenues can be funneled into public infrastructure, such as charging stations, making e-cars more practical for daily use and appealing to a broader audience.

Another key factor is the growing **awareness of climate change** and environmental concerns. As people become more conscious of their environmental impact, many are inclined to choose more sustainable options, like e-cars, even as costs rise. Higher living costs may also drive people in urban areas to seek cheaper long-term alternatives, and e-cars often offer lower operational costs over time, especially when it comes to fuel savings.

From a market perspective, as demand for e-cars grows, manufacturers can ramp up production, leading to **economies of scale** that reduce the cost of producing these vehicles. This could result in a wider variety of affordable e-car models, catering to different consumer segments and increasing sales despite the overall economic climate. As the e-car market grows, consumers may have more choices at different price points, further boosting sales.

There's also a **behavioral economics** element to consider. Higher taxes on gasoline cars might serve as a psychological nudge, pushing consumers to explore e-cars as an alternative. Over time, as more people adopt e-cars, a social shift could occur, where owning an electric vehicle becomes more desirable or even a status symbol. This shift could drive sales upward, even when living costs rise.

When interpreting these model results, it's important to recognize that interactions between various factors, such as how taxes and cost of living influence each other, can create complex outcomes. For instance, higher taxes on gasoline may be enough to push consumers toward e-cars, even as living costs rise. Additionally, the models are based on historical data and trends, which may not fully reflect future changes in consumer behavior or government policy.

In summary, **the models suggest that higher living costs and taxes could lead to increased e-car sales, but this is likely due to a mix of economic, social, and behavioral factors**. The transition to electric vehicles is influenced by evolving consumer preferences, government policies, and market forces, all of which work together to shape demand. Although **the models do not perfectly explain the variance in e-car sales, the inclusion of cost of living as a factor clearly improved their performance**, particularly in the case of the polynomial regression model. This improvement highlights **the importance of considering broader economic factors**, but the models' limitations, such as poor R^2 scores and MSE values, show that there's still much to uncover about the full relationship between taxes, living costs, and e-car sales.

So, while we can make educated guesses, the future of e-car sales after 2025 remains uncertain—but one thing's for sure, it'll be exciting to see how things unfold!