

# Optimal subsidization of electric vehicles: Network externality vs. environmental externality

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## Abstract:

The market for personal vehicles exhibits network effects, thus it is difficult for new, environmentally friendly, technologies to gain significant market share. This is often the reasoning behind government subsidies on electric vehicles (EV's). Temporary subsidies lower the price enough to entice sufficient consumers to buy and thereby create a customer base, after which the subsidies are no longer necessary. Governments are interested in building a customer base, since EV's create less pollution and thereby increase societal welfare relative to standard vehicles with internal combustion engines (ICV's). In this paper we investigate optimal subsidy policies of governments when they can subsidize EV's in multiple ways.

We assume there are two products in the market, an ICV and an EV, each produced by a different firm. A consumer in this market decides whether to buy the ICV or the EV based on which option gives the higher utility. For a specific consumer, utility of a vehicle depends on the preference for environmentally friendly technologies of the consumer, on the purchase price of the vehicle, and on expected search costs associated with that type of vehicle. Search costs stem from the fact that a consumer needs to refuel frequently. When there are more refueling stations available, search costs decrease. We assume that the number of refueling stations of a technology increase with the number of consumers buying that technology, thereby introducing network effects into the model. Thus, utility of a technology depends on the expected number of consumers buying a car of that same technology, through expected search costs.

We assume that the environmental preference parameter is distributed among the population according to the type 1 extreme value distribution. Thus, consumers make decisions on which car to buy as in a multinomial logit model, where deterministic utility of each option is determined by purchase price and expected search costs (which is determined by expected demand).

We then solve the model using the rational expectations equilibrium, where expectations are correct and equal actual demand.

Additionally, we assume that the government can subsidize EV's in two different ways. The government can set a direct subsidy for consumers on the purchase price of the EV. Additionally, the government can build refueling stations, in addition to the ones created through demand, thereby lowering expected search costs.

We are interested in how the government will trade off between the cost of subsidies and the societal cost of pollution. Additionally, we investigate how the government combines both instruments for EV subsidization. We compare welfare in the cases of no subsidies, only one instrument, or both. Even though the model used is a simplification of actual markets, the results will be able to shed light on the effectiveness of several policy instruments available to governments in the subsidization of EV's.