



# Effectiveness of policy incentives on electric vehicle acceptance in China: A discrete choice analysis



Ning Wang, Linhao Tang\*, Huizhong Pan

Room B204, School of Automotive Studies, Tongji University, 4800 Caoan Road, Shanghai, People's Republic of China

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## ABSTRACT

The Chinese Government has introduced numerous policy incentives to promote the development and adoption of electric vehicles (EVs), especially aggressive subsidization policies. Stimulated by such policies, sales of EVs exceeded 500,000 in 2016. However, the subsidies for EVs will be abrogated after 2020. In order to maintain market stability, the EV-related policy system needs innovation. Nonetheless, it is still unclear how effective different policy incentives are.

By conducting a discrete choice experiment involving 247 respondents and using a mixed logit model, this paper investigates the effectiveness of several potential policy incentives except subsidization policies, as well as the influence of socio-psychologist determinants. The results help to offer suggestions for the EV-related policy reformation.

As expected, the probability of stated EV-acceptance increases if policy incentives are provided in the choice experiment. EVs are exempted from purchase restrictions (license plate control policy) and driving restrictions in China, and these two transport policy incentives have the most significant positive effects on the EV-acceptance. Discounted/free electric charging also has great contribution. Preferential bus lane access gains increasing attention. Vehicle purchase tax exemption should be resumed because of its positive influence. Comparatively speaking, the financial incentives (e.g., reduced parking fees) in the EV using stage play a weaker role.

## 1. Introduction

According to the Bureau of Traffic Administration, Ministry of Public Security, car ownership in China has already reached 194 million by the end of 2016, which is nearly ten times that of 2002. The exhaust gas emitted by automobiles, including carbon monoxides, hydrocarbons, and nitrogen oxides, currently accounts for 70–80% of atmospheric pollution in the metropolitan areas (Tang, 2015). Moreover, the transportation sector is responsible for 8% of the total greenhouse gas (GHG) emissions nationwide (Hao et al., 2015). Meanwhile, China's external dependency ratio of oil is 60.6% in 2015, far above the acknowledged safety level of 50% (Sun et al., 2015). The energy consumption of the transportation sector accounts approximately 1/3 of the total energy consumption in China, and the proportion will exceed 50% in 2020 under the circumstance of increasing car ownership (SAE-China, 2016).

As a solution to easing air pollution, greenhouse gas emission and national energy security, a clear transportation system with vehicles using electricity for propulsion has received increasing attention. EVs are vehicles that partly or fully powered by electricity, as known as new energy vehicles in China, and include battery electric vehicles (BEVs), plug-in hybrid vehicles (PHEVs) and fuel cell electric vehicles (FCEVs) (Li et al., 2016). They produce much less GHG emissions compared to internal combustion engines vehicles

\* Corresponding author.

E-mail addresses: [wangning@tongji.edu.cn](mailto:wangning@tongji.edu.cn) (N. Wang), [tanglinhao228@outlook.com](mailto:tanglinhao228@outlook.com) (L. Tang), [huizhong\\_pan@hotmail.com](mailto:huizhong_pan@hotmail.com) (H. Pan).

(ICEVs), especially when the used electricity is generated by renewable sources and many EVs are charged in off-peak electricity demand hours (Jochem et al., 2015). EVs also possess an apparent advantage in terms of energy-efficiency, energy security, lower user costs/km, noise and local pollution (Grauers and Sarasini, 2013). However, EV adoption is deemed very limited without stimulation from external such as stringent emission regulations, rising fuel prices, or financial incentives (Sierzchula et al., 2014).

In 2016, China continues to be the largest market of EVs, whose production and sales volume of EVs exceeded 500,000. Nevertheless, the market share of EVs only accounts for approximately 1.8%, and this achievement falls well short of the goals proposed by the Industry Development Plan of Energy Saving and New Energy Vehicles. In this plan, the cumulative production and sales volume of EVs were targeted to reach 5 million by the end of 2020 (State Council, 2012). In order to realize this target, the Chinese Government has launched a series of encouragement policies. A policy framework including EV research and development, industrialization, and commercialization has been preliminarily established (Li et al., 2016). Nonetheless, the relative impact of different incentive is not yet clear. Among these encouragement policies, financial incentives have attracted too much attention because of the higher initial cost of EVs compared to ICEVs. And most of the leading EV markets in the world provide substantial public subsidies and taxation reductions for EVs (Yang et al., 2016). Although subsidy schemes for EVs play an important role in promoting EV-adoption, they are doomed to be terminated in the future because of the massive financial expenditure. The Chinese Government intends to eliminate EVs subsidy schemes after 2020. But it is likely that EV sales will collapse when substantial incentives are repealed. For instance, the U.S. state of Georgia in the United States was a leading electric vehicle market but then it saw sales drop by over 80% after repealing its state-level tax credit (Badertscher, 2015). Therefore, it deserves deep discussions to find other substitute policies to avoid this happening.

## 2. Literature review

Literature addressing EV policies can be distinguished whether they are based on actual or simulated data or whether they utilize surveying techniques.

One category analyzes the relationship between the sales of EVs and EV incentive measures based on the historical data, and usually uses a mathematical formula and model. Mersky et al. (2016) concluded that access to BEV charging infrastructure had the greatest predictive power to promote BEV in Norway while toll exemptions and the right to use bus lanes seem to have statistically little predictive power in their linear municipal-level models. Massiani (2013) proposed a thorough cost-benefit analysis of policies for the promotion of EVs in Germany, but they found that most of the investigated policies had a negative benefit-cost balance. Jenn et al. (2013) applied econometric methods to assess the effectiveness of Energy Policy Act of 2005 and they deemed that the act indeed increased the sales of hybrids in American. Nonetheless, this incentive was only effective when the amount provided was large enough. Considering the intangible cost, Diao et al. (2016) perorated that the advantages of traffic policies (license plate control policy and driving restrictions) were prominent in China's mega-cities by conducting a life-cycle private-cost-based competitiveness analysis of EVs. Sierzchula et al. (2014) used multiple linear regression method to evaluate financial incentives and other factors related to EV adoption in 30 countries. Results suggested that charging infrastructure was the most strongly related. These papers using historical data based on RP (Revealed Preference) theory are merely able to judge the existing policies without considering their time lag and their results of Willingness to Pay (WTP) may seem inappropriate, especially for that does not exit (Braidert et al., 2015).

The other category focuses on consumers' attitude towards different policy by issuing surveys. Consumers are the acceptors of government policies, and their evaluation of EVs-related policy incentives is of importance. Rezvani et al. (2015) has listed some advances in consumer electric vehicles adoption research. Bjerkan et al. (2016) issued a survey among nearly 3400 BEV owners in Norway. Their conclusions showed that exemptions from purchase tax and value added tax (VAT) were critical incentives, however, exemption from road tolling or bus lane access was the only decisive factor to lots of BEV owners. Li et al. (2016) used a four-paradigm model based on questionnaire data to analyze the consumers' evaluation of each policy and found that the subsidization, technical support, and infrastructure policies in China need urgent improvement. The results of a survey conducted in 20 countries by Lieven (2015) revealed that a charging network on freeway was absolutely necessary. However, most of these papers discuss policies in isolation with EVs' characteristics. Langbroek et al. (2016) found that free parking or access to bus lanes would be an efficient alternative to expensive subsidies through a stated choice experiment considering policies, EVs' characteristics, and socio-psychological. And yet, it just took 3 incentives into consideration. Moreover, in all likelihood, its conclusions do not apply to China because of the unique ICEVs purchase restrictions and other factors.

There are few studies about Chinese consumers' stated preference for EV-related incentives. Consequently, this paper investigates the effectiveness of several potential policies on Chinese consumers' EV-acceptance by using a discrete choice analysis, as well as the influence of socio-psychologist determinants.

The rest of this paper is arranged as follows: Section 3 discusses the design of survey and the description of the sample data used in the paper, Section 4 describes the methodology used, Section 5 reports the results and Section 6 draws conclusions and notes the paper's limitations and potential future work.

## 3. Survey design and data

### 3.1. Policy incentives

To increase the adoption and development of EVs, the Chinese Government has been continuously introducing incentivizing

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