A Review of International and Korean EV Policies and Implications

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1. Introduction

Electric Vehicles (EVs) usually reduce or substantially negate fossil fuel use in the vehicle. EVs are also a potentially significant technology to help abate greenhouse gas (GHG) emissions and local air pollutions such as PMs. In recognition of these benefits. Most countries set national goals of putting EVs on the road with strong policy supports. The policies include technological instruments such as the R&D of the core parts and the development of the EV prototypes. In addition, the governments are also concentrated on the EV promotion, purchase and regulations. So far, EV deployment has mostly been driven by policy. The major markets such as US. China, Nordic countries, and Korea have been evolved by the strong policy implementation.

This paper attempts to provide a review of international policy approaches that affect EV adoption. These reviews are organized as demand- and supply- factors, meaning characteristics of enhancing demand for EVs including policy incentives such as subsidies and exemption, stringency of environmental regulations, availability of battery charging infrastructure, etc. Supply-side factors include battery costs, driving range, and charging time. This study provides the effect of policies on development of EVs and explores the factors statistically that would potential influence diffusion of EVs and implications by comparing international and Korean experiences.

2. Methods of Analysis

With virtually zero emissions of end of pipe, EVs (and especially battery electric vehicles [BEVs]) are emerging as one of the most promising technology among all solutions being pursued today. The choice of focusing on BEVs is motivated by the fact that they are highlighted as one of the most attractive technology alternatives to Internal Combustion Engine Vehicles (ICEVs) in order to achieve fossil independence and a more energy efficient transport sector. Various ranges of policy instruments related to the promotion of EVs have been

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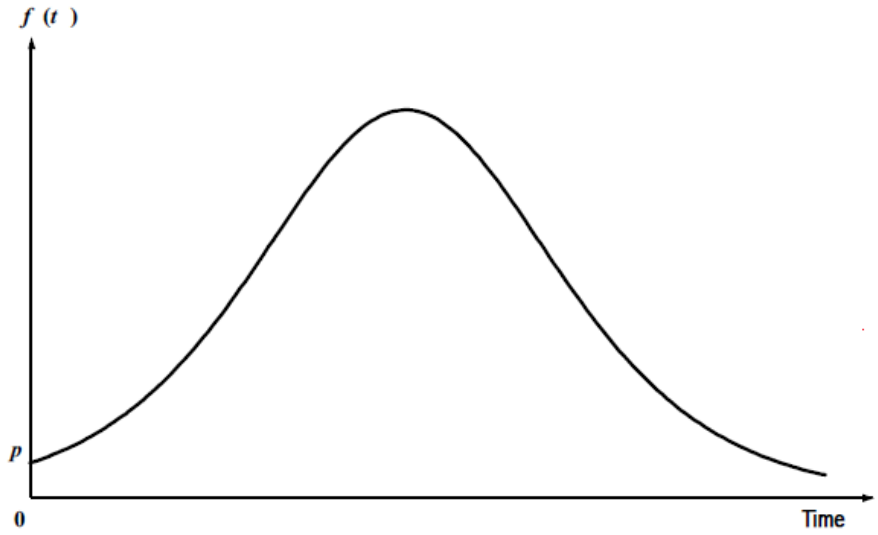
adopted in major global countries. China, Europe, Japan, United States, recently India, and Korea have spurred EV consumer demand through a combination of instruments including public procurement and investment plans, subsidies and other financial incentives addressing both EV purchase prices and charging infrastructure, fuel-economy standards and other policy measures, in particular including mandatory zero-emission vehicle (ZEV) standards. The primary focus of this paper is to take inspiration from existing policy experiences to indicate how to navigate the transition to mass market adoption of electric vehicles, while meeting economic and environmental sustainability requirements. In addition, this study compare policy approaches of Korea and other major countries.

To do so, we outlies the monetary and regulatory policy instruments that spur EV adoption in the perspectives of demand and supply. First, policy instruments are reviewed to provide market certainty and clear, strong signals to all stakeholders: consumers, vehicle and component manufacturers, including battery design researchers and manufacturers, electric vehicle supply equipment (EVSE) infrastructure suppliers. Second, the policy tools are compared to analyze how they encourage the transition to widespread adoption of electric vehicles in each regions. For example, we compare how financial incentives such as subsidy and tax exemption, and public mandatory standards affect rapid adoption of EVs in the countries

The approach we use to realize such goals is based on a stylized econometric diffusion model of EV with a time-series analysis. There exist various diffusion patterns including rapidly declining ones. Fourt and Woodlock (1960), in an early study, successfully described first purchases of grocery products by an exponential model. Moe and Fader (1998) proposed a joint segmentation model of consumers and products and applied it to the sales of music albums, which show rapidly declining diffusion patterns. From these studies we must recognize that the diffusion pattern of new product such as EVs, more precisely, the density function of adoption times, f (t), can take any pattern from S-shaped one to J-shaped one in a continuous manner as shown in Figure 1.

In EV diffusion rate analysis, we include prices and financial incentives, relative prices of fuels, government procurements, charging infrastructures, initiation periods of EVs, countries and regions, especially Nordic countries, and stringency of environmental standards.

Figure 1. A Continuous View of Diffusion Patterns



$$\text{EV shares} = f(\theta, x, p, \phi) + \epsilon, \quad (1)$$

where p is a vector of national and regional instruments related to EV price and financial incentives; x is a vector of relative prices of fossil fuels and electricity; θ is the diffusion of medium- and high-speed charging infrastructure; ϕ is a vector of other preferences and socio-economic characteristics, including initiation years, environmental standards, and etc. The preferences of a consumer are assumed to be affected by factors such as environmental awareness, geographical characteristics, the social network, and previous experiences. Additionally, ϵ is an error term containing random taste shocks and other features of vehicle demand; for example, expectations of future fuel prices, vehicle's second-hand market price, and the consumer's decision on when to buy a vehicle.

3. Results of Analysis

Major developments in China, the European Union, Japan, the United States, and Korea have been progressed. China, the European Union and India, which together account for roughly 60% of the global LDV market, proposed or implemented significant policy changes that are likely to accelerate the phase-in of electric cars and shape their deployment on a global scale. On the other hand, recent

announcements on the roll-back of federal regulations on the fuel economy of cars in the United States are expected to have a negative impact on the uptake of electric cars.

In EU, given that the current emissions level for a hybrid vehicle (HEV) with performance characteristics similar to the average European car is close to 80 gCO2/km (NEDC), the implication of this regulatory proposal is that low- and zero-emission vehicles will be necessary in the 2030 framework to meet the overall target.16 The proposed regulation outlines a vision that includes production shares of low- and zero-emission vehicles that reach 15% in 2025 and 30% or more in 2030. In China, annual mandatory minimum requirements on the number of NEV credits that need to be earned are set for car manufacturers. Credits can be earned either through producing or importing new energy cars or through the purchase of NEV credits from other manufacturers who have excess credits. The United States Environmental Protection Agency (EPA) announced a change in the GHG emissions standards for new light-duty vehicles sold in the United States between 2022 and 2025 (US Government Public Office, 2018). This decision results from a new determination following a mid-term evaluation of the standards, which was a regulatory requirement of the 2012 rule establishing the GHG emission standards for the 2017-25 period. In the mid-term review, the EPA examined a range of factors, such as the penetration of fuel efficient technologies, fuel price developments, vehicle electrification and consumer acceptance of efficient technologies.

The Korean government announced a “Green Car Roadmap” in 2010 with the vision of Korea becoming one of the four leaders worldwide in global green car power. This plan aimed to promote the green car industry and to increase rapidly the diffusion of EVs. Furthermore, a law, the “act on the promotion of development and diffusion of environmentally-friendly vehicles,” was legislated in Korea to expedite EV market penetration. As a part of this act, various incentives were offered to EV buyers to make these vehicles more attractive and competitive with ICEVs. Despite these efforts, only 11.7 thousand EVs had been sold by the end of 2016; this number was slightly over 13% of the government target.

4. Conclusion

In this study, we examine global policy approaches and the determinants of BEV adoption, with a focus on the EV diffusion. This study contributes with important

implications for policy makers aiming at promoting the transition towards a fossil independent vehicle fleet, where an increased BEV share is a highlighted solution. According to our results, the global policy instrument of public charging infrastructure has a significant and positive impact on the BEV adoption rate and it is also found to affect the BEV adoption to a higher degree in environmental policies. Furthermore, differences in the expansion of public charging infrastructure across regions could explain different diffusion rates of BEVs.