A key stakeholder-based financial subsidy stimulation for Chinese EV industrialization: A system dynamics simulation

Chao Lu [a], Hu-Chen Liu [a], Jie Tao [b], Ke Rong [c,*], Ying-Che Hsieh [d]

[a] School of Management, Shanghai University, 200444 Shanghai, China
[b] Business School, University of Shanghai for Science and Technology, 200093 Shanghai, China
[c] Institute of Economics, Tsinghua University, 100084 Beijing, China
[d] Institute of Technology Management, National Tsing Hua University, 30013 Hsinchu, Taiwan

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ABSTRACT

Successful policy-making for an emerging industry relies on two key factors: adopting a scientific perspective and accurately forecasting the policy's potential effects. By combining Mitchell's score-based approach and expert grading method, this paper identifies the key stakeholders of the Chinese electric vehicle (EV) industry, and proposes a key stakeholder-based policy research framework (G-MIC: Government — Manufacturers, Infrastructure, Consumers). Furthermore, a system dynamics (SD) model is outlined, focusing on financial subsidy (FS) policy and the three groups of programs that are set to simulate level of FS, FS allocation, and the demand for realizing the CAO (Civilian Auto Ownership) goal of the Chinese EV industry by 2020. The findings reveal that the following show that a key stakeholder perspective is a better approach to policy research; the SD model constructed under the G-MIC framework extends the methodology of SD; and a "bottom-up" policy-making path is more likely to improve policy outcomes.

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1. Introduction

Financial subsidy is a direct policy instrument used to stimulate innovation, unlike indirect networking or coordination support (Junichi and Okamuro, 2011). For an emerging industry, which often rises with new technology and market uncertainty, as well as a weak industrial system (Rong et al., 2013), FS can play an important role during the nurturing process. An R&D subsidy significantly increases the probability that a firm in the manufacturing and service sectors applies for patents (Adam B. and Le, 2015; Dang and Motohashi, 2015), so as to help the firm to secure its core technology (Yao et al., 2015) and competitive strength. In addition, a price (or consumer) subsidy is beneficial in reducing the burden on potential consumers, so as to create demand and achieve commercialization. Thus, FS could be used in the whole process of public RD&D (research and development, and demonstration, including basic R&D and technology RD&D), marketization (market demonstration, commercialization), and market penetration (market accumulation, diffusion) along with the innovation chain (Grubb, 2004). In addition, as FS is closely related to the total financial revenue of one country or region, it is important to design a proper policy program under the constraint of the financial budget, including a sustainable subsidy scale and a scientific subsidy allocation (Lu, 2014).

Fortunately, the theory of stakeholder could be well equipped to solve such policy problems (Vedung, 2008; Aurich-Beerheide et al., 2015; Loi, 2016), for its expertise in tackling unstructured issues like policy-making, along with engaging in dialogue with stakeholders, could improve our understanding of a problem and help find its potential solutions (Cuppen, 2012). Choices that require multiple stakeholders to balance conflicting objectives are among today's most controversial decisions (Gregory and Keeney, 1994), and are especially apparent during the innovation process. The general shift towards a polycentric understanding of policy-making requires the involvement of stakeholders as active participants in the policy process at different levels of societal organization (Pahl-Wostl, 2002). However, as all the individuals and groups that could affect the achievement of an organization's objectives, or could be affected by this achievement, are "stakeholders" (Freeman, 1984), who should take the responsibility to carry out company governance? All of the stakeholders or just the key ones? Moreover, as many scholars are focusing on conceptual analysis or qualitative research (case studies included), there remains a gap in the literature regarding related policy simulation and forecasting from the perspective of stakeholders, especially concerning emerging industries.

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* Corresponding author at: Institute of Economics, Tsinghua University, 100084 Beijing, China.
E-mail addresses: 06luchao@163.com (C. Lu), huchenliu@foxmail.com (H.-C. Liu), taojie@usst.edu.cn (J. Tao), r@tsinghua.edu.cn (K. Rong), ych@mx.nthu.edu.tw (Y.-C. Hsieh).

Apart from the theoretical angle, we also find similar evidence in industry practice: as one of the seven strategic emerging industries in China, the electric vehicle (EV) industry is greatly supported by governments, with FS being the main policy instrument. However, there is still a long way for the Chinese EV industry to go before achieving large-scale commercialization and international competitiveness. For example, the "Ten Cities, Ten Thousand Vehicles" large-scale demonstration project initiated by Chinese central government failed to achieve its anticipated target by quite a large extent when the program came to an end in 2012. What's more, by the end of October 2015, China had only promoted a total of 284,500 new-energy vehicles (see Fig. 1), which is less than 60% of the 500,000 target set by the *Energy-saving and New-energy Vehicle Industry Development Plan (2012–2020)*. Moreover, when comparing this with the policy of the new-energy automotive industry (Lu et al., 2014a) of some other developed countries (USA, Japan, Germany etc.), two critical deficiencies can be identified: the inadequate level of accumulative policy support and the inappropriate policy resource allocation (Lu, 2014). Thus, the reasons why policy instruments did not receive their corresponding return are identified: emerging industry is facing challenges as to how to motivate different stakeholders to achieve collaborative innovation with the help of a significant incentive and a scientific allocation of scarce policy resources. What's more, the EV industry is also listed as a key area of development according to the latest "Made in China 2025" plan, and will be continually supported by government investments in the thirteenth five-year period (2016–2020). There is an urgent demand for research on FS stimulation on Chinese EV industrialization, so as to help guarantee a positive outcome for the policy.

Learning from both the literature and industry issues above, the study of emerging industry's policy design from the perspective of stakeholders is an area that has so far been largely overlooked. This paper will focus on FS, the widely used innovation policy instrument, to carry out quantitative stakeholder-based policy research, using a simulation methodology and taking the Chinese EV industry as an example. The purpose of this paper is to explore this from a scientific policy research perspective and construct an SD model to simulate potential policy effects, so as to support the creation of a successful policy.

This paper is structured as follows: the next section will review literature on the theories of stakeholder and innovation policy, as well as policy simulation methodologies. This is followed by the identification of key stakeholders and the construction of a research framework in the third section. The fourth section will propose a policy simulation model of financial subsidy stimulation for EV industrialization in China. This is followed in the fifth section by a simulation and scenario analysis of the level of financial subsidy support and optimization of resource allocation among different key stakeholders, as well as a discussion of policy demand in realizing China's EV CAO goal proposed in "Energy-saving and New-energy Vehicle Industry Development Plan" (2012–2020). The theoretical and practical contributions of this paper will be discussed in the concluding section, as well as an explanation of future research directions.

2. Literature review

China's EV industry is a prime example of an emerging industry innovation, which has received a large number of financial subsidies from both central and local governments in recent years. However, the obvious gap between market performance and government anticipation reflects a certain degree of imbalance between different stakeholders. Therefore, literature on stakeholder theory, innovation policy, and policy simulation will now be reviewed.

2.1. Stakeholder theory

Stakeholder theory was conceived and developed to challenge the ideas of traditional shareholder theory—a view that shareholders or stockholders are the owners of the company, and the firm has a binding fiduciary duty to put their needs first, to increase value for them. It was mainly adopted to analyze company governance, corporate social responsibility, hostile takeovers, and other issues at the corporate or organizational level (Freeman, 1984; Alkhafaji, 1989; Freeman and Evan, 1990; Mitchell et al., 1997; Li and Wang, 2007). Later, the stakeholder theory has been widely used in such fields as public policy (Roberts and Bradley, 1991; Riege and Lindsay, 2006; Cairns et al., 2016; Dunn, 2015; Spyridaki et al., 2016), industrial policy (Koontz, 2005; Dubbeling et al., 2010; Monterrosa et al., 2015), policy evaluation (Vedung, 2008; Parkes, 2012; Gatta and Marcucci, 2016), and institution design (Doh and Guay, 2006; Macário et al., 2016) etc. In fact, during the era of open governance as opposed to traditional management (Bovaird, 2005a), policy-making has seen a general polycentric shift, which requires the involvement of stakeholders as active participants in the policy-making process at different levels of societal organization (Pahl-Wostl, 2002; Qi et al., 2013; De Marchi et al., 2016). A stakeholder-based policy process can facilitate the efforts of government policy-makers and non-government stakeholders to articulate their policy desires and to encourage the adoption and acceptance of particular environmental policies (Altman and etkus, 1994; Gregory and Wellman, 2001; Pahl-Wostl, 2002; Fox et al., 2013).

Nevertheless, an important issue emerges when we subject stakeholder theory to policy-related analysis; that is, how many or which kinds of stakeholders should be taken into consideration, bearing in mind it is impossible to involve them all. Some scholars hold the view that staff, customers, suppliers, shareholders, and representatives from the community and company should jointly govern the company (Evan and Freeman, 1993; Blair, 1995; Keith, 1998), while other scholars support a different view that it is enough for only some important stakeholders to take this responsibility (Itami and Roehl, 1991; O'Conner, 2003; Lu et al., 2014b). The dispute about the theory of stakeholder governance continues.

However, when we return to the rigorous definition of corporate governance, due to the excessive dispersion of control, the view of the "all stakeholders" based governance structure not only lowers the
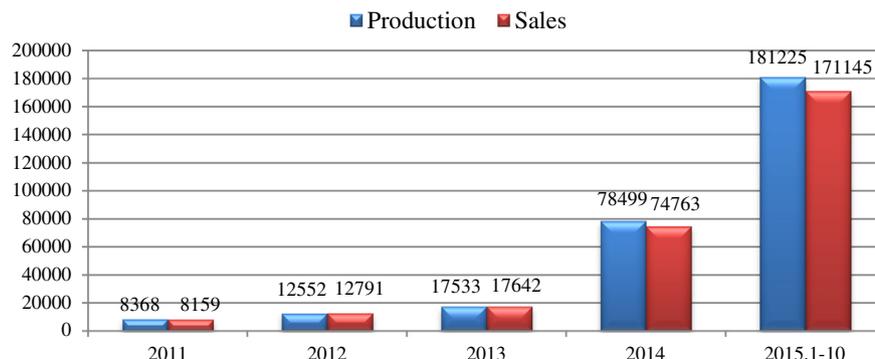

Fig. 1. Production and sales numbers of China's new-energy vehicles. Source: China Association of Automobile Manufacturers, http://www.caam.org.cn/.