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# Local implementation for green-manufacturing technology diffusion policy in China: from the user firms' perspectives

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ABSTRACT

In recent years, China has started to change its growth strategy to a more sustainable model in response to the limits-to-growth dilemma. Specifically, the national policy advocates to promote the use of green-manufacturing technologies through demonstration projects, and to incentivize Chinese manufacturers to adopt these green-technologies that are also encouraged by local governments. These green technologies can increase the economic gains of manufacturers by reducing costs on energy consumption and shift away from selling low-margin products. However, the local authorities often encounter obstacles when implementing policies for promoting these technologies among manufacturing firms. This paper explores the factors that affect the decision-making of user firms throughout the policy implementation process. Based on the econometric analysis of the survey for China's electric motors upgrading project in Guangdong Province, this study shows that three key factors are helpful in the local government's effort to implement the national project, i.e. manufacturers' awareness, the understanding of the energy-efficiency technology, and the long-term macroeconomic benefits. In addition, encouraging the participation of financial institutions is especially useful for local governments to convince small-and-medium sized firms. These findings are beneficial for local implementation of green-manufacturing technology diffusion policies in China and have worldwide policy implication as well.



## 1. Introduction

Today, China is recognized as the manufacturing hub of the world. However, it is facing great challenges when traditional "high growth high resource-consumption" growth model is no longer sustainable. China is trying to promote the new growth model "medium growth rate with high resource efficiency" (Lu et al., 2013). The pursuit of energy efficiency is a critical element of the Chinese Government's new economic strategy. In China, the manufacturing sector accounts for 42.64% of GDP and 68% of total energy consumption in 2013 (DES, 2013). During policy-setting meetings of the Chinese State Council, in 2009, a decision has been made to reduce the amount of carbon dioxide ($CO_2$) emissions per GDP unit by 40–45% and set the goal of increasing the proportion of non-fossil fuels in primary energy consumption in China to around 15% by 2020 (Chen, 2009). "US–China Joint Announcement on Climate Change" was signed in Beijing on November 12, 2014, in which China has committed to cap the $CO_2$ emissions by 2030 or even earlier. The commitment to the share of alternative energy consumption to around 20%, by the same deadline, has also been made (Office of the Press Secretary, 2014).

To achieve these goals, Chinese government has launched a series of national-level policies. In particular, one of the policies aims to incentivize and encourage Chinese manufacturers to adopt green-manufacturing technologies, in order to take advantage of the energy conservation attribute of these technologies, which can help to reduce the carbon emissions of Chinese manufacturers and facilitate saving costs from energy consumption reduction. Besides government agencies, the successful diffusion of these green-technologies also needs the collaborative efforts from non-legislative entities such as user-firms, suppliers, service providers, financial institutions, and other related organizations, when helping to fulfill the twofold policy goals of both achieving major energy-saving and emission-reduction. While these efforts can help to address market failure issues associated with carbon

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emissions, they are also facing various challenges. These efforts do not contribute to economic growth directly and may even have damping effects – the initial investment on green-technologies is considerable, and it also needs a period of time for manufacturers to get the pay-back (Chan et al., 1995). In order to cope with these issues, government agencies need to intervene.

In early 2013, China's Ministry of Industry and Information Technology (MIIT) and General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) of the People's Republic of China (ESCUD, 2013) launched the "National Project on Energy Saving through Upgrading Electric Motors (2013–2015)" (hereafter referred to as EMU Project) which aims to improve manufacturing competitiveness and reduce production costs from energy-saving and improving products' quality (Feng, 2013). Energy consumption of motors in industrial sector accounts for 75% of the yearly electricity consumption of motors in China and more than 95% of these motors are inefficient models (Zhou et al., 2015b). This national project is intended to upgrade the current low efficiency models with a new line of motors built with servo technology, which is a more advanced and mature line that helps manufacturers to produce their goods at peak efficiency. The willingness to adopt this new technology is rather vague due to the aforementioned economic costs and considerable pay-back period. Hence, a government-led initiative is necessary for the technology dissemination, which may ultimately contribute to China's long-term goal of capping the carbon emission by 2030.

The implementation of this national project is led by the MIIT with local governments as the frontline forces, and it faces a variety of challenges. First, this national project has multiple policy objectives so that it is difficult to align the interests of all stakeholders, when aiming to not only improve energy efficiency in an aggregate level but also to enhance manufacturing competitiveness of individual firms (Zhou et al., 2015b). Second, the role of government for policy implementations needs to be better defined, as government agencies are used to mandatory policy measures traditionally; however in recent years they realize that market-oriented policies should play a more critical role to leverage the participation of market players and intensive resources. In addition, policymakers and implementers should focus more on the willingness of potential user-firms. In these cases, it is vital to create innovative implementation measures for local governments to address and satisfy user-firms' demands so that more firms can adopt these green-technologies. The review of previous researches shows that there are limited inquiries into this issue, particularly in China. In addition, even fewer literature has conducted quantitative methods (World Bank Group, 2015; Section 2.1). This paper attempts to fill these gaps.

This paper, therefore, seeks to identify the drivers and barriers of user-firms compliance with the national green-manufacturing policy, and to find out effective measures to facilitate successful policy implementation or the diffusion to diverse manufacturing firms when concerned with both large firms and small-and-medium sized enterprises (SMEs). The authors refer the drivers and barriers as the implementation factors of policies in this paper. The research framework is shown in Fig. 1, which will answer the following research questions:

- R1: What are the factors that affect the user firms' decision to comply with the national EMU project?
- R2: What are the differences of responses between large firms and SMEs towards policy implementation?
- R3: What are the differences between the attitudes of the firms that have adopted EMU technology, those testing EMU technology, and those that remain hesitant about policy implementation?

To answer these questions, a survey has been conducted and questionnaires have been distributed to a selected group of manufacturers in Dongguan City (see Section 3). The analysis of the Dongguan demonstration project is particularly interesting, as Dongguan is carefully chosen by the MIIT to provide valuable information for future policy implementation. Dongguan is a city in Guangdong Province where 35% of the motors for injection molding machines in China are located. The experience in Dongguan may give insights to the further implementation of the national EMU project which is expected to produce annual net energy-savings of 80 billion kWh of electricity, equivalent to 7.3% of annual energy consumption in China (see Appendix).

Statistical factor analysis and regression analysis are utilized to analyze the survey responses and to validate the initial research framework. In the framework, four implementation factors are identified. Awareness and understanding of the energy-efficient technology on the firm-level is a critical part of any industrial policy involving an upgrade (Macey and Brown, 1990; Harborne

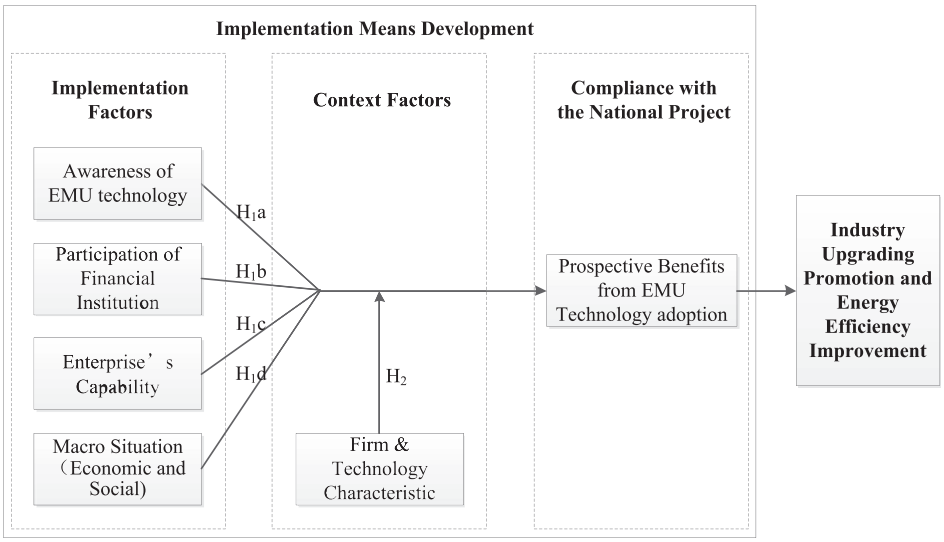


**Fig. 1.** Initial research framework.

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