

TOWARD A GREENER CAR FUTURE: THEORY AND EVIDENCE FROM CHINA'S FUEL EFFICIENCY POLICY MIX

Yan Lu, School of Public Policy & Management, Tsinghua University, Phone +86 15652791278, E-mail: luyaninthu@hotmail.com

Yang Yu, Institute for Interdisciplinary Information Sciences, Tsinghua University, Phone +86 18513112656, E-mail: yangyu1@tsinghua.edu.cn

Overview

It is unclear how the automotive sector responds to the policy mix of the Corporate Average Fuel Efficiency (CAFE) and Attributed-Based Fuel-Efficiency Standards (ABFES). Currently, most countries only select one policy instrument from those two options to regulate their car market. But China simultaneously implements both the CAFE and ABFES since 2012. Examining the market dynamics when both CAFE and ABFES are implemented is not just important for Chinese market but also useful for the design of an attribute-based CAFE, which currently raises a broad debate in many countries.

Existing studies have discussed the distortion of incentive caused by the loopholes of ABFES, which allow car producers to manipulate the curb weight rather than improving the efficiency for meeting the enforced standards. Although evidences suggest that CAFE have improved the environmental performance of American automotive sector, but the economic inefficiency of CAFE also has been broadly critised. In contrast to the companies under the ABFES, whose strategies mainly target at strategically manipulating each car model's features, companies under the CAFE pay attention at the marketing strategies for deciding the car-model profiles. Once CAFE and ABFES are simultaneously implemented, companies need to simultaneously consider car features and model marketing to adapt the attributed CAFE.

In this research, we first construct an economic mathematical model to analyze the central implications of such occasion, characterize the deadweight loss caused by attribute-basing with the consideration of CAFC, and predict in which policy mix attribute-basing may be efficient than its basic scenario. After that, through the examination of China's 2004–2017 domestic vehicle models, we have found that the decision making of enterprise varies under different policy intensity. A significantly curb weight manipulation has been observed with a number of vehicle models bunching on the targets-preferred end of each weight class when policy intensity is high. Also, a subtle but efficient amelioration takes place when CAFC has been introduced.

Our work differs from past research regarding this topic in two important ways. First, we focus on the policy mix instead of single policy instrument and try to make practical policy advice, especially for Chinese policymakers. Second, other empirical researchers have emphasized testing the existence of manipulation but ignored its theoretical basis. Therefore, we are trying to construct an analytical and predicting model.

The paper is organised as follows: after the introduction, the second section consists of a brief overview about the fuel-economy based regulation practice in China and a review of relevant important literatures. The third section measures the policy mix impacts from a theoretical point of view. In section four we look for evidence from China's empirical data and present our results by comparing them with other researchers and theoretical predictions. In the final section, potential policy implications are raised.

Data

We collected relevant data (curb weight, transmission type, horsepower etc.) of China's car models from January 2005 to January 2018 which across the fuel efficiency standard Phase I,II,III and IV through the database of MII (Ministry of Industry and Information) Technology and other public accessed industry research reports. The data cover all types of passenger cars sold in China's automobile market during this period.

Methods

Theoretical model (follow Ito, K., & Saltee, J. M. (2014)) Without CAFC (Before 2012), suppose one firm produces $j = 1, 2, 3 \dots J$ models, the standard σ is depend on the car model attributes a_j . firm can choose the price p_j , fuel efficiency g_j and the attributes a_j . q_j is the quantity sold of model j , which is a function of g_j, p_j, a_j for every model in this market. c_j is the marinal cost of model j . $Q \equiv \sum_{j \in J} q_j$ is the total sales in this market. θ is the CAFC level determined by government.

$$\begin{aligned} \max_{g_j, p_j, a_j} \pi &= \sum_{j \in J} (p_j - c_j) q_j \\ \text{s.t. } g_j &\leq \sigma(a_j) \text{ for } j \in J \end{aligned}$$

When with CAFC (after 2012):

$$\begin{aligned} \max_{g_j, p_j, a_j} \pi &= \sum_{j \in J} (p_j - c_j) q_j \\ \text{s.t. } g_j &\leq \sigma(a_j) \text{ for } j \in J \\ \text{and } \sum_{j \in J} \frac{q_j}{Q} g_j &\leq \theta \end{aligned}$$

When $\theta \neq \sum_{j \in J} \frac{q_j}{Q} \sigma(a_j)$, the constraints faced by one firm with CAFC is not identical. Then we can use Lagrangean method to discuss the difference of shadow price and the actions choosed by those firms of how they respond the CAFC strategically.

For the empirical approach, we use bunching and cross sectional techniques to discuss the differences of distortion and the production choice route to compliance with regulations before and after CAFC.

Results

First, theoretically, the welfare of attribute-based regulation scenario will be improved when CAFC has been introduced. When the method for calculating CAFC changes, different scenarios are presented with different potential implications.

Second, consistent with other studies, a remarkably manipulation of curb weight has been observed with different patterns at different time.

Third, a subtle but definite change for car manufacturers to compliance with the regulations have been proved when CAFC is introduced.

Conclusions

For attribute-based regulation, it doesn't always fail to provide an incentive compatible strategy for car enterprises to make car greener. By introducing CAFC, welfare will be improved to a certain extent through correct the distortion both theoretically and practically. We need a better policy mix in this type of regulation to get better policy impacts.

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