The Effect of Design and Implementation of Auto Recall System on Innovation Performance of Automobile Enterprises

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ABSTRACT: Auto recall system is a major institutional design to eliminate defective cars and guarantee product safety. Technology innovation is an important means for enterprises to improve safety of vehicles. The establishment of auto recall system exerts a profound impact on technology innovations. Based on questionnaire survey of automobile industry, this paper uses structural equation model to make an empirical research on the effects of auto recall system on technology innovations of China’s automobile industry. Research results demonstrate that the design and implementation of auto recall system have a significant positive effect on product innovation performance of automobile enterprises, and government regulation uses system design and implementation to affect product innovations. Meanwhile, auto recall system implementation and government regulation have a significant positive effect on process innovation performance of automobile enterprises, while auto recall system design has no direct and significant effect.

1 INSTRUCTION

In recent years, with the rapid development of China’s economy, automobile production and sales have increased steadily. According to statistics, China saw production of 23,722,900 and sales of 23,491,900 automobiles in 2014, with a year-on-year increase of 7.3% and 6.9% respectively. China has ranked first in both production and sales for the sixth consecutive year. However, China has weaker capacity for research and development (R&D) and technology innovations than developed countries, and there is a lack of high technology with intellectual property right (IPR). Compared with international standard, China lags far behind. Meanwhile, as cars gradually become a part of consumers’ daily life, defective auto products also give rise to personal and property safety risks.

General Administration of Quality Supervision (AQSIQ), together with the National Development and Reform Commission, the Ministry of Commerce and the General Administration of Customs, jointly issued Provisions on the Administration of Recall of Defective Auto Products (No.60 Order of General Administration) in March 12, 2014, when management system for recall of defective auto products has been established and come into effect, in order to guarantee auto product safety through intensified market supervision. In the same year, some supportive documents were released to ensure institutional normalization of auto recalls, including Administrative Measures for Investigation and Identification of Defective Auto Products, Supervision and Administrative Measures for Inspecting and Testing of Defective Auto Products and Notice of Administrating Relevant Record Information for Submitting Defective Auto Products Recalls. The State Council promulgated Regulation on the Administration of Recall of Defective Auto Products (No.626 Order) in October 22, 2012, when auto recall system evolved into administrative regulation from departmental rule, further strengthening the supervision and management of recall of defective auto products. AQSIQ officially released Implementation Measures for Regulation on the Administration of Recall of Defective Auto Products (No.176 Order), further improving China’s auto recall system.

The establishment and improvement of auto recall system provide an opportunity for auto-makers to eliminate defects and improve technology in the form of laws and regulations. Up to December 31, 2014, there have been 854 recalls of automobiles in China. Specifically, 478 design defects concerning 11,060,000 vehicles, 373 manufacturing defects concerning 8,630,000 vehicles and 3 logo defects concerning 70,000 vehicles have been improved by auto-makers. For automobile industry, technology innovations and auto recall system have enhanced security level internally and externally. Furthermore, China has given great impetus to independent innovation strategy in automobile industry. In this context, the presented research is of great significance to promote technology innovations in
China’s automobile industry and improve the auto recall system.

2 THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

As product recall has an increasingly close relationship with technological innovation, the role of recall system in technology innovations has attracted widespread attention. Murthy et al. (2008) pointed out in research that large-scale recalls provided an opportunity for manufacturers to develop new products or improve existing products. Levinthal and James (1993) demonstrated that large-scale recalls, as a catalyst for improving product reliability that is difficult to cope with due to huge cost, made enterprises and their suppliers focus on researching how to deal with product defects. Sriram and Sinha (2011) indicated that enterprises learned more from recalls with accumulative recall experience, hence reducing the possibility of defects and improving product quality. It is thus evident that auto recall system plays an important role in technology innovations of enterprises, but the available studies fail to reveal the specific effects.

Technology innovation is a commercial process of practically applying new concepts of technology through R&D and combinations of technology so as to generate economic and social benefits. Hopkins and Brynjolfsson (2010) argued in their research that technology innovation performance comprised all outcomes from initial R&D to patents and release of new products. According to different research objectives and perspectives, there are different measures of technology innovation performance in existing studies. Oslo Manual, an international innovation survey guide, divides technology innovation performance into product and process innovation performance, and other studies classify technology innovation performance into economic and social benefits, or technology and management performance. Even so, most empirical studies still choose product and process innovation performance as major measurement indexes of enterprise technology innovations. This paper combines features of China’s automobile enterprises to evaluate technology innovation performance from product and process innovation performance respectively. The former is mainly concerned with such measurement indexes as improved automotive technology, enhanced automobile safety level and increased automotive reliability. The latter is mainly about such measurement indexes as reduced production costs and shortened production cycle of automobiles.

(1) Auto recall system design and technology innovation performance of enterprises

Auto recall system is established mainly for defective auto products in the market. The legal reason for recalls lies in security issues of production batch. Automobile enterprises are the responsibility subjects and actors of recalls. There are voluntary and mandatory auto recalls. Davidson and Worrell (1992) argued enterprises that make technology improvements in recall products can more effectively reduce the adverse effects arising from recalls than those who are willing to replace products and refund at the purchasing price of products. Haunschild and Yhee(2004) further pointed out automobile enterprises can learn more technical expertise from voluntary recalls than mandatory ones. In addition, under the auto recall system, some automobile enterprises have turned their focus from cost to product safety and quality. Based on the above analysis, the following describes the presented research hypotheses and alternative hypotheses:

H1a: Auto recall system design exerts positive effects on product innovation performance of enterprises

H1b: Auto recall system design exerts positive effects on process innovation performance of enterprises

(2) Auto recall system implementation and technology innovation performance of enterprises

In the implementation of auto recall system, automobile enterprises make technology improvements and innovations in defective automobiles based on technological capabilities and resources accumulated from existing research, which stimulates technology learning. To eliminate defects of recalled vehicles, automobile enterprises will expand the scope of technology learning through which can greatly increase automotive reliability and reduce future recalls. At the same time, recall experience will lay a foundation for improving technical performance of automobiles in the future. In case of high sharing degree of auto parts, automobile enterprises can apply the knowledge acquired from the recall of a product type to other types of the product lines, thereby increasing the reliability of related auto products (Kalaignanam et al. 2013). Based on the above analysis, the following describes the presented research hypotheses and alternative hypotheses:

H2a: Auto recall system implementation exerts positive effects on product innovation performance of enterprises

H2b: Auto recall system implementation exerts positive effects on process innovation performance of enterprises

(3) Mediating role of government regulation

Government regulation is a way to carry on transactions between consumers and enterprises or between enterprises. Under government regulation, consumers and enterprises with different market
forces can more effectively make external dealings. Therefore, it is imperative to regulate auto recalls. However, according to the Regulatory Capture Theory, there exists a possibility that regulatory agencies of auto recalls may be captured by automobile enterprises in the process of regulation. To avoid this possibility, there is a need for effective supervision of regulatory agencies. In fact, the system arrangement that a principal also serves as a supervisor is superior to the one that an external party is a supervisor, because the latter is also motivated by supervisions of the external party. That is to say, there exists a problem that supervisors need to be supervised. Based on the above analysis, the presented research hypotheses and alternative hypotheses are described as follows:

H3a: Government regulation exerts positive effects on auto recall system design

H3b: Government regulation exerts positive effects on auto recall system implementation

China’s auto recalls is in the charge of government departments which are responsible for executive decisions, policy formulation and planning making, and technical support institutions implement centralized regulation model for recalls under the leadership of competent departments. The technical support institutions for recall administration are responsible for information gathering and analysis of defective automobiles, research and judgment of defect technology, technical supervision of recall process and technology evaluation of recall effects. Open and multi-source information of defective automobiles provides essential clues for automobile enterprises to make technology innovations. Auto recall regulators and automobile enterprises carry out investigations as well as technology research and judgment of defective automobiles, hence promoting tacit knowledge dissemination of technology innovations among automobile enterprises. Auto recall effect evaluation is conducive to ensuring the feasibility of technology innovation schemes for eliminating defects so that technological innovations are further marketed. Based on the above analysis, the presented research hypotheses and alternative hypotheses are described as follows:

H4a: Government regulation exerts positive effects on product innovation performance of enterprises

H4b: Government regulation exerts positive effects on process innovation performance of enterprises

Auto recall system design, implementation and government regulation altogether constitute the framework of auto recall system. Auto recall system design is the prerequisite and foundation for system implementation and government regulation, while government regulation accompanies the whole process of auto recalls and guarantees the smooth implementation of auto recall system. However, the design and implementation of auto recall system do not mean that enterprises must make technology innovations. Government regulation is not only an important guarantee for successful technology innovations under auto recall system, but drives enterprises to make technology innovations by pooling innovative resources with a view to removing defects. It is thus clear that government regulation has a close relationship with auto recall system design and implementation, namely the former affects technology innovation performance through the latter. Based on the above analysis, the presented research hypotheses and alternative hypotheses are described as follows:

H5a: Government regulation acts as an intermediary between system design and product and process innovation performance

H5b: Government regulation acts as an intermediary between system implementation and product and process innovation performance

3 RESEARCH DESIGN

3.1 Research capital and data acquisition

To ensure validity of research data, automobile enterprises once recalled cars are chosen as research objects. Questionnaires are mainly issued to relevant staff responsible for auto recalls. There are 117 questionnaires issued via e-mail and on site, and 74 valid questionnaires are collected with a validity rate of 63.25%.

Descriptive statistics of sample features suggest that research sample contains 27 state-owned enterprises, accounting for 36.49%; 12 private enterprises, accounting for 16.22%; 13 foreign-funded enterprises, accounting for 17.57%; and 22 joint ventures, accounting for 39.19%. There are 29 enterprises with self-owned brands (39.19%), 9 with joint-venture brands (12.16%), 28 with imported brands (37.84%), 2 with joint-venture and imported brands (2.70%), 4 with self-owned and joint-venture brands (5.41%) and 2 with self-owned, joint-venture and imported brands (5.41%).

3.2 Variable measurements

Independent variables. Research on related literature both at home and abroad is still at its infancy in terms of auto recall system design, implementation and government regulation. There is no systematic well-developed scale that can be directly used, and related research is only found in a part of literature. This paper uses existing research results of Pelkmans et al. (2014) and Kalra et al. (2009) for reference to develop measurement indexes of auto recall system design, implementation and government regulation by combining system practice
and characteristics. There are three indexes for system design, including improving auto recall laws and regulations, appropriate penalties of auto recalls and scientific procedures for defect investigation, while there are two indexes for system implementation, including timely information release of auto recalls as well as auto recalls and implement standards. Government regulation is concerned with the validity of auto recall regulation.

Dependent variables. There have been well-developed scales that can be used in terms of product and process innovation performance. This research uses Oslo Manual and existing research results of Lee and Berente (2013) and Singh and Khamba (2014) for reference to develop a scale for product and process innovation performance. Product innovation performance is mainly concerned with such indexes as improved automotive technology, enhanced automobile safety level, increased automotive reliability, improved comfort and prolonged service life. Taking full consideration into production characteristics of automobile industry, process innovation performance mainly includes such indexes as reduced production costs and shortened production cycle of automobiles.

4 RESEARCH RESULTS

4.1 Reliability and validity

The original data is scales in the form of questionnaires, testing the reliability of variable value in different dimensions respectively. CITC-value of all dimensions (SD, SE, PP and TP) is greater than 0.4 and consistency alpha coefficient is greater than 0.75, which indicates that reliability test is passed and internal consistency is good. Validity test based on CFA shows that standardized coefficients are larger than 0.5 which are significant when p<0.001. Collectively, research sample meets the validity requirements of establishing SEM.

4.2 Structural equation model analysis

An analysis is made based on CALIS module of SAS system. The objective function value upon optimization operation is 0.2480, benchmark model function value is 1.9746, corresponding Chi-square value is 544.9782, concomitant probability is less than 0.0001, GFI (AGFI) upon adjustment is 0.3626, Parsimonious GFI is 0.1830, RMSEA estimator is 0.3469, ECVI estimator is 0.3443 and Bentler-Bonett NFI is 0.8744. Subsequently, covariance structures are employed to make an analysis and maximum likelihood is used to evaluate, and Graph 2 shows the calculation results of structural equation.

System design has some positive influences on product innovation performance with a standardized regression coefficient of 0.2091, but exerts no significant influences on process innovation performance. System implementation has a significant effect on product and process innovation performance, with a standardized regression coefficient of 0.2318 and 0.1265 respectively, which demonstrates that the system implementation has a greater influence on product innovation performance than on process innovation performance. Government regulation exerts a significant influence on system design and implementation, with a standardized regression coefficient of 0.8569 and 0.4777 respectively, which indicates that the influence on system design is greater than that on system implementation.

<table>
<thead>
<tr>
<th>Paths</th>
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<th>S.E.</th>
<th>t-value</th>
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<td>0.1106</td>
<td>1.8901</td>
</tr>
<tr>
<td>H1b</td>
<td>0.0566</td>
<td>0.1150</td>
<td>0.4922</td>
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<tr>
<td>H2a</td>
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<td>H2b</td>
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<td>0.0160</td>
<td>53.5875</td>
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<tr>
<td>H3b</td>
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Besides, government regulation has no significant effects on product innovation performance and a relatively significant effect on process innovation performance, while it has significant influences on system design and implementation. That is to say, government regulation uses system design and implementation to affect product and process innovation performance. In conclusion, we get results that provide support for theoretical hypotheses through a statistic analysis of questionnaire data and a structural equation test of research hypotheses.

5 PREFERENCES, SYMBOLS AND UNITS

Consistency of style is very important. Note the spacing, punctuation and caps in all the examples below.

This research chooses auto recall enterprises as a research sample and develops auto recall system and a technology innovation scale. Empirical research is conducted on the effects of China’s auto recall system on technology innovation of automobile enterprises. Furthermore, we test the mediating effects of government regulation on auto recall system design and implementation, and the following describes major research conclusions:

Effects of auto recall system on product innovation performance. Both the design and implementation of auto recall system have a significant positive effect on product innovation performance, while government regulation shows no signs of direct and significant effects. This indicates...
that the design and implementation of China’s auto recall system play an important role in product innovation, because China’s automobile enterprises improve design defects of recalled vehicles mainly through a technology improvement or innovation. For automobile enterprises, to remove defects is to make product innovations. Unlike traditional product innovations, product innovations under auto recall system attach more importance to product safety. Due to the constraint of auto recall system, making product innovations to handle safety defects tends to be more efficient and innovative effect is more obvious. Besides, the setup of procedures such as risks evaluation of auto product defects and effect evaluation of auto recalls further promotes product innovations.

Effects of auto recall system on process innovation performance. Auto recall system implementation and government regulation have significant positive effects on process innovation performance, while auto recall system design exerts no direct and significant effects. This suggests that the effects of auto recall system on process innovation performance are mainly in system implementation and government regulation, and system design has limited direct effects on process innovation which remains to be further improved. Automobile enterprises address manufacturing defects mainly through improvements or innovations in process technology with a view to eliminating safety concerns in manufacturing. Meanwhile, such process innovation effects may arise as increased production efficiency and saving raw materials.

Mediating effects of government regulation, government regulation exerts significant positive effects on process innovation, but shows no signs of direct and significant effects on product innovation. On the other hand, government regulation has significant effects on the design and implementation of auto recall system and auto recall system has significant positive effects on product innovation, which means that government regulation acts as an intermediary between auto recall system and technology innovation of enterprises, and affects product innovations through system design and implementation. That is to say, government regulation on auto recall system should be further strengthened to promote technology innovations of automobile enterprises.

6 ACKNOWLEDGMENTS

This work was financially supported by The National Soft Science Research Program titled Research of Defective Auto Product Recall System Oriented to Technology Innovations (No. 2014GXS4B065).

REFERENCES