Formal control and social control in green product innovation: An empirical research in China

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Abstract

With the growing ecological concern and increasing environmental consciousness of our society, an increasing number of firms start to adopt green product innovation (GPI) for sustainable success. Although the existing literature has scrutinized the implementation of GPI, the investigation about what are drivers of this underlying practice is limited. To address the gap, this study sheds light on the relationship between control mechanisms, i.e. formal control and social control, and GPI, and explore the nature between two mechanisms. Using a sample from 239 senior managers and directors in Chinese manufacturing industry, we test the hypotheses through moderated structural equations modelling (MSEM). The research findings indicate that both formal control and social control have significant and positive impacts on GPI, but they need to be applied as substitutions. Drawing on institutional theory, we suggest practitioners apply formal control or social control individually because simultaneously adopting both mechanisms may bring negative impact on GPI. Besides, we also suggest managers and directors enhance their awareness of GPI because it positively influences firms' financial performance and social performance under the empirical evidence.

Keywords: Green product innovation; financial performance; social performance

1. Introduction

Considering the environmental protection with the new product innovation, many researchers and practitioners pay more attention on green product innovation (GPI). GPI adopts a systematic procedure to design processes and product, which triggers innovation in an environmental conscious way (Lenox et al.1996). There existing a number of literature discussing the implement and impacts of GPI, while the research about the antecedents of GPI is rarely investigated. Knowledge without the drivers of GPI may not comprehensive enough to picture how GPI facilitates firm performance.

To fill the gap, this study integrates the perspective from institutional theory with GPI and explore how do control mechanism, regarded as an important tool to benefit alliance participants from goal congruence and preference convergence (Geringer and Hebert, 1989), influence GPI as antecedence. In line with institutional theory, the formal

structure in firm's organization is influenced by the institutional environment in a great extent. In another word, green-oriented firms which underlie eco-friendly culture, usually legitimize their organization to promote technical efficiency and guide social behaviour. In the view of the control mechanism is structural arrangement to regulate partners' behaviour (Fryxell et al, 2002), the establishment of the mechanism should be consistent with firms' green institutional environment, then influence GPI through corresponding legitimization. Surprisingly, few empirical researches have been done to support the its impact on GPI. Therefore, the first research question is to instigate whether the adoption of control mechanism can positively influence firm's GPI.

According to Wong et al (2012), GPI has a great influence on firms' competitive advantage and green new product success. A rational interpretation is green innovation promotes the development of firm's environmental management (Guoyou et al, 2013), so that generate more business opportunities than competitors. A growing literature has contributed to the knowledge of GPI and firm's performance in different aspects. In this paper, we focus on the association of GPI with financial performance and social performance. Due to the inconclusive result about whether GPI strengthens or weakens firm's financial performance, the paper tests their relation based on empirical evident. Besides, social performance is another important performance factor to be examined, that is, to evaluate the influence of GPI on firms' ability to translate institution's mission into practice effectively and be corresponded to the main social value. But the research of social performance has been under-examined empirically in the literature (Short et al, 2016). So, the second research purpose is to investigate the influence of GPI on firm's financial performance and social performance.

In order to answer those two research questions, a theoretically model has been proposed to describe the relationships among two control mechanisms, GPI and firm's financial performance and social performance. The model is tested by using empirical data from 239 senior managers and directors in Chinese manufacturing firm with rational measurement scales. Based on the empirical result, we provide both theoretical and practical implications. On the one hand, insufficient existing research discuss the antecedent of GPI, and we make contributions on GPI literature from inter-organizational control mechanism by identifying how formal control and social control as the driver to improve GPI. Meanwhile, we also extend the knowledge about the nature between formal control and social control by testing their interaction effect. On the other hand, due to the negative effect to GPI is found when operate both control mechanisms at the same time, practitioners are suggested to applying either formal control or social control to enhance GPI. Moreover, more focus on GPI should be paid as it improves firm's financial and social performance.

The study is organised as follows: Section 2 includes the review of the literature and development of the research model. Section 3 explains the research methodology and data collection. Section 4 presents the analysis and the model results. Finally, the discussion, the conclusion and the recommendations for future research are presented in Section 5.

2. Theoretical Model and Hypotheses Development

2.1 Green production innovation and social mechanism

According to Grønhaug and Kaufmann (1988), new product innovation is increasingly recognized as the main factor for sustaining firm's competitive advantage. From internal aspect, new product innovation brings advanced knowledge, capacities, resources and technologies for firms, from external aspect, customer's need or firm's expectation can be meet by new function and design (Reguia, 2014). Since environmental issue is

recognized as a serious, worldwide public concern, customers gradually start to value the product from its impact on the environment. Meanwhile, firms from both developed countries and developing countries have begun to merge environmental concerns in product innovation, i.e. green product innovation (GPI). This research adopts Chen et al. (2006) definition of GPI: "*product innovation that is related to environmental innovation, including the innovation in product that is involved in energy-saving, pollution-prevention, waste recycling, no toxicity, or green product designs*". Therefore, comparing to traditional product innovation, GPI involves additional environmental requirements in the design process, relevant regulation and rules are formulated to protect the ecosystem from raw materials and energy consumption, waste generation, health and safety risk, and ecological degradation (Hundal, 2000). For achieving that, new green technologies are developed and put into use in a new product. As a result, GPI contributes to firm's sustainable competitive advantage from developing eco-friendly technology, knowledge-base, capacities, as well as satisfying the customer's demand for the eco-friendly product.

It is essential on the notion for firms to realize that appropriate adoption of control mechanism has an important influence on GPI. Control mechanisms are firms' safeguards to govern intergenerational exchange, that enhances supplier's commitment through supplier investments, relational norms and explicit contracts. (Jap and Ganesan, 2000). For green-oriented firms, control mechanisms influence the transaction expenditures, cooperation expenditures, and partners' initiative to participate in green innovative activities (Li et al, 2010).

Das and Teng (2001) contend that formal control and social control are two basic and essential mechanisms in the alliance. Specifically, formal control is defined as the formal and written contract to explicitly regulates alliances' responsibilities and obligations (Abdi and Aulakh, 2012), and set of detailed instructions, regulations, rules and standardized work procedures are created to reduce the detriment of uncertainty (Youngdahl et al, 2003). Unlike formal control that relies on established rules or regulation to reach an agreement, social control tends to promote cooperation by informal activities. Social exchange has a substantial influence on inter-firm cooperation. Internal social activities are channels of organizational learning for staff, which develop firm's knowledge base, and inspire new ideas about green innovation (Mohr and Sengupta, 2002). Also, the relations between focal firm and suppliers, or focal firm and customer are also positively influenced by social control (Tachizawa and Wong, 2015).

It is reasonable to explain the positive roles of formal control and social control on GPI through the lens of institutional theory. A note by Scott (2008) claimed, institutional theory emphasizes that institutions are highly resilient social structure, which helps to achieve "*rule like frameworks, rational myths and knowledge legitimated*". From this perspective, the organization is made up of different institutional elements, rules, norms or beliefs, which influenced by external environment or internal interaction. Meanwhile, those organizational rules and norms influence firm's social behaviour. With more regulations and laws proposed for concerning environmental protection, companies not only undertake external pressure but spontaneously pay more attention to environmental protection while developing a new product, thus the influence their social behaviour. Based on institutional theory, the way to pursue green product innovation can be described as "*coercive, normative and mimetic*" (Martínez-Ferrero and García-Sánchez, 2017; DiMaggio and Powell, 1983). Formal control is an approach to accomplish "coercive and normative" through the establishment of rules and regulations with the corresponding penalty. On the other

side, social control is greatly influenced by social environment, with the general growth of people's environmental awareness and the increasing emphasis on environmental protection of corporate culture, social control enables firms to follow the mainstream value and study from successful green-orient firms. Therefore, the following hypotheses are proposed:

H1: Formal control is positively associated with green product innovation.
H2: Social control is positively associated with green product innovation.

Clearly that social mechanisms are closely relevant to the firms' organizational coordination, structural sustain and regulation, and discrete network consolidation (Grandori and Soda, 1995). Many academics have attempted to answer the question - Should formal control and social control be adopted simultaneously as complementary or separately as a substitution? (Li et al, 2010). In the case of Chinese green-oriented firms, adopting single control mechanism at one time might a better option to promote GPI. On the formal control side, the establishment of contractual governance builds legal system to regulate the firms' behaviour and to influence their performance, for example, some focal firms have specific requirement about the amount for exhaust gas and discharged sewage for their suppliers, for ensuring the product development and manufacturing do not cause damage to the ecosystem. When social control is applied at the same time, the increasing trust among partners might be a challenge for firms because some negotiations take place to avoid punishment from formal control. On the social control side, Chinese society attaches great importance to relations (i.e. Guanxi) as it reduces the transaction costs (Abdi and Aulakh, 2012). The social control provides opportunities for knowledge exchange through interaction and communication, and this mechanism contributes to building trust among buyers and suppliers (Li et al., 2010). Based on common corporate culture and cognitive of the importance of environmental protection, firms are more likely to have appropriate behaviours on GPI. However, evidence shows that formal control weakens communication efficiency because it forces the agreement of intricate commitments, regulations and obligations, thus negatively affect the relationship between partners and causing higher transaction fees (Mayer and Teece, 2008). So only to implement formal control and social control as substitution can positively influence GPI. Thus, hypothesis 3 is proposed as follow:

H3: The use of formal and social control mechanisms will function as substitutes in explaining green product innovation.

2.2 Green product innovation and firm performance
In the literature of GPI, whether it promotes or weakens firm's financial performance has been subject to considerable debate. Some traditional economic research claimed that any environmental innovation brings extra economic burden and additional cost such as higher expenditure from expensive environmental techniques, and other compulsory environment commitment, which is detrimental to firm's financial performance (Stefan and Paul, 2008; Li, 2014). However, more evidence show that GPI is an important strategy to enhance firms' profitability in the long-term (Chen et al., 2006). GPI not only help to explore new technologies and green business to gain economic benefit, but also exploit existing resources in a sustainable way to reduce the emission of dangerous substances (Andersen, 2010; Zhang and Walton, 2017). Due to the external and internal convention and regulation about environmental protection, it is unavoidable to invest an amount of expenditure for green product's R&D, however, the

financial return from the investment is significant and sustainable (Sezen and Çankaya, 2013). Particularly, the green-orient product innovation usually adopts novel technologies to meet customers' needs, thus customers tends to purchase the products which would not cause the burden on the environment, so as to increase sales of the product brings a more stable profit to the firms.

According to Cooper (2017), social performance represents firms' behaviour to the social value when transfer mission into practice, it represents corporate socially responsible to solve social issues, e.g. environmental issue. Compared to firms that only pursue monetary profit, eco-oriented firms take responsibility to concern and involve into the environmental issue and pay attention to environmental profits (Ghisetti and Pontoni, 2015; Nasi et al., 1997). In addition, Ranganathan (1998) proposes four key elements of social performance and highlighted the importance of GPI influence the social performance. Firstly, employment practices: GPI not only require producing eco-friendly products, but also has a strict standard for their working environment, which ensure workers' safety and protect them from polluted or toxic pollution during production. Secondly, community relations: though reducing waste of resources and damage to the environment, firms take their society responsibility by obeying international or internal regulation and convention about environmental protection, so that contributes to build an eco-friendly community (Chen et al, 2006). Thirdly, ethical sourcing, under the constraint of lack of laws, it is a moral issue whether or not to destroy the ecological environment in order to pursue corporate interests. GPI provided a win-win idea to solve this ethical issue by innovating new product with little harm to the ecosystem (Chang, 2011). Fourthly, social impact of product, except from meeting customers' demand for functionality like other traditional products, green products also have the ability to meet people's psychological needs for ecological protection (Pujari, 2006). If firms still conduct conventional product development instead of GPI, they are not able to take the social responsible for environmental protection, which will cause a serious problem in the future (Lin, 2013). Hence, we proposed the following hypotheses:

H4: Green Product Innovation will be positively associated with financial performance.
H5: Green Product Innovation will be positively associated with social performance.

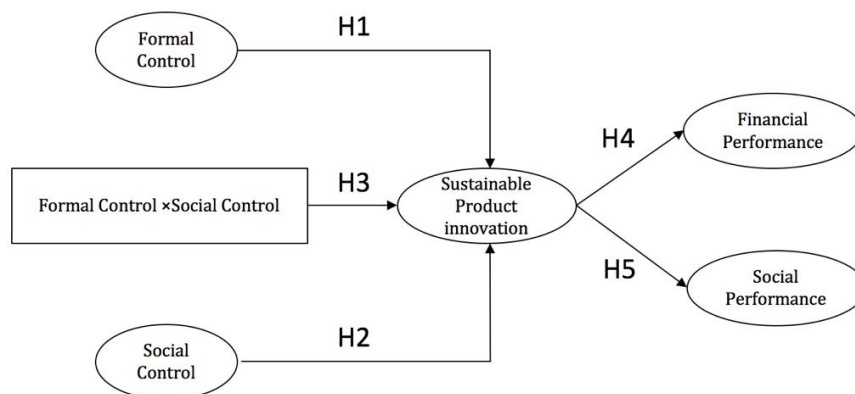Figure 1 shows our proposed theoretical model.

Figure 1. Theoretical Model

3. Methodology

3.1 Data Collection

To examine the theoretical model of this study, a sample of manufacturing companies was collected from China. To ensure the content validity, we organize an expert panel, which consists of three experienced practitioners and three OM researchers, to preliminarily review the questionnaire items for measuring our proposed constructs. As the focus of this study, green production innovation is a resource demanding practices. Enterprises with limited resource therefore might not fit the scope of this study. Three sample filter conditions were considered in this study, namely targeted firm size, targeted industries and job position. Specifically, the qualified respondents should be middle-level manager or higher in a manufacturing company with more than 150 employees. Because our targeted respondents are the Chinese managers, the English questionnaire was translated to Chinese through a backward translation method (Brislin, 1980). We hired a Chinese market company to collect the data via an online questionnaire platform. Overall, we obtained 239 valid responses representing their individual company. Moreover, a chi-square (X^2) test was adopted to examine the non-response bias. The insignificant result indicates that there is no difference between the early-response group and late-response group in terms of firm size (X^2=3.913, df=2, p=0.344) and the annual revenue (X^2=5.803, df =3, p=0.122) at the level of 0.1. Therefore, we can conclude that non-response bias is not a threat to this research.

As this study collected the data through single informant of each company, common method bias might be a potential problem (Podsakoff et al., 2003). To assess the common method bias, we conducted the well-known Harman's one-factor test. Five distinct factors were identified in the exploratory factor analysis (EFA). However, the first factor in the EFA only accounted for 15.682% of the total variance, which was not the majority of the total variance (i.e. 63.38%). We also adopted the confirmatory factor analysis (CFA) to reinforce the results of common method bias test. Twenty-four question items in our studies were formed as a single factor. The poor model fit (X^2/df = 7.269, CFI = 0.702, IFI=0.704, GFI=0.680 and RMSEA = 0.115) for the single factor model indicates the CMB problem is not a concern in this research.

3.2. Reliability and Validity of the Constructs

Before testing the theoretical model, EFA and CFA were applied to examine the reliability of all proposed constructs in this study. First, EFA was performed through the principal component analysis for each construct with the corresponding indicators. Our results in the EFA showed that the five factors solutions, with all factor loadings greater than the threshold value of 0.5 (Netemeyer et al., 2003). Therefore, the unidimensionality was first confirmed. The CFA with good model fit indices for the five factors solutions also support the unidimensionality. Moreover, to check the construct reliability of the five factors generated from the EFA, composite reliability (p_c) was also calculated. As shown in Table 1, all five p_c were greater than 0.809, exceeding the minimum recommended value of 0.7. Therefore, we can conclude that the measurement adopted in this study are reliable.

This study applied CFA to examine the convergent and discriminant validity (O'Leary-Kelly and Vokurka, 1998). Due to the significant factor loadings in the CFA model, which all greater than 0.70 (with t-value greater than 2.0), the convergent validity was supported. The good model fit of CFA also provide evidences for the convergent validity (CFI=0.973, IFI=0.973, NNFI=0.969 and GFI=0.901). Moreover, as suggested by Hair (2006), the root mean square error of approximation (RMSEA) and the value of X^2/df were checked. With RMSEA=0.035 and X^2/df=1.296, the indicators

were less than the threshold of 0.1 and 5 respectively. Overall, the model fit indices we obtained all indicate an excellent fit for the measurement model. Moreover, to assess the discriminant validity, this study adopted the average variance extracted (AVE) and inter-construct correlations comparison method. To achieve discriminant validity, Chin (1998) suggests, the square root of AVE for each construct should be greater than its correlations with other constructs. In our study, all five constructs' square root of AVE are greater than their correlations with other constructs, which means that the discriminant validity is confirmed.

4. Analysis and result

In order to test of theoretical model, a moderated structural equation modelling (MSEM) technique was adopted. In compare with the moderated regression analysis, MSEM is more appropriate, as all the variables in our study were latent. Moreover, MSEM is helpful to address the limitations of moderated regression analysis, such as the loss of statistical power as the reliability decrease (Aiken and West, 1991) and estimated coefficient bias (Ping, 1995). Following Cortina et al. (2001) and Conway et al. (2016), we composed the moderated structural model through a three-step procedure. First, all the question items for the social control (S_{xn}, n = [1, 5]) and formal control were standardized (S_{zm}, m = [1, 5]). Then, we computed the interaction as follow:

$$(1) \quad xz = \sum_1^5 S_{xn} * \sum_1^5 S_{zm}$$

Third, we fix the measurement properties, including the path coefficient (λ_{xz}) and random measurement error (θ_{xz}) for interaction terms xz in our structural model as follow:

$$(2) \quad \lambda_{xz} = \sum_1^5 \lambda_{xn} * \sum_1^5 \lambda_{zm}$$

Where λ_{xn} represents the path coefficients from the construct (i.e. social control) to its items S_{xn}, n = [1,5];

λ_{zm} represents the path coefficient from the latent construct formal control to its indicators S_{zm}, n = [1,5].

We calculated the random measurement error for interaction term xz as follow:

$$\theta_{xz} = (\sum_1^5 \lambda_{xn})^2 * Var(x) * \sum_1^5 \theta_{zm} + (\sum_1^5 \lambda_{zm})^2 * Var(z) * \sum_1^5 \theta_{xn} + \sum_1^5 \lambda_{xn}$$
$$* \sum_1^5 \lambda_{zm}$$

Where θ_{xn} and θ_{zm} represents the random the random measurement errors for indicators S_{xn} and S_{zm} respectively.

We also obtained good model fit indices for the MSEM fit (X^2/df = 1.445, CFI = 0.969, IFI=0.965, GFI=0.886 and RMSEA = 0.043). In H1, we hypothesize that the formal control is positively associated with the green product innovation. The result indicates the positive impact of formal control on green product innovation is not significant (p = 0.205 > 0.05). Therefore, H1 is not supported in our study. In H2, we predicted that the social control will be positively associated with the green production innovation. Interestingly, we find that the impact is negative and significant ($p < 0.05$). Therefore,

H2 is also rejected. Then we considered whether the social control and formal control functioned as substitutes or complements in improving the green production innovation. The effect of interaction term created in our moderated structural model is positive and significant ($\beta = 0.83$, $p<0.01$). This indicates that formal control and social control mechanism function as complements, thus supporting H3. To reinforce the findings in MSEM regarding the effect of our interaction term, we conduct a simple slope analysis to plot the interaction effect. The effect of social control turned to be positive when formal control is high. In other words, the formal control mechanism dampens the negative relationship between social control and green product innovation. Moreover, we also find that social control strengthens the positive relationship between formal control and green product innovation. In summary, the interaction effect between formal control and social control was functioned as complement in explaining the green product innovation. In H4 and H5, we expected the green product innovation is positively associated with social performance and financial performance. The positive effects of green product innovation on financial performance ($\beta = 0.76$, $p<0.01$) and social performance ($\beta = 0.70$, $p<0.01$) are both significant. Therefore, our results provide support H4 and H5.

5. Conclusion

Given the environmental impact of product innovation, organizations recognise that GPI can play an important role in firm performance. In order to improve the performance of GPI, how to perform its antecedents, i.e. control mechanisms are examined in this research. Significant and positive results for the direct effects of formal control and social control on GPI are found. Our research result of MSEM shows that the interaction effect of formal control and social control is negative, which means adopting both mechanisms simultaneously may weaken the positive effect on GPI. Moreover, significant results are also found in the positive effects of GPI on financial performance and social performance.

This study makes three main contributions. Firstly, most prior studies widely recognized the importance of GPI, while only a few studies pay attention on its antecedents, and this study contributes to the GPI literature by further investigating the influence of control mechanisms as drivers to develop GPI. Secondly, by identifying the interaction between control mechanisms and GPI, the research findings contribute to the control mechanism literature from the perspective of institutional theory. Although formal control and social control has been identified to improve GPI, how to implement those two mechanisms remains untested. Based on the empirical analysis, this study indicates that two control mechanisms should be implemented as a substitution for achieving better GPI, as simultaneously applying formal control and social control may bring a negative effect on GPI. Thirdly, this research demonstrates the positive influence of GPI on both financial performance and social performance, which respond to the call of Berrone et al (2013) for a more sophisticated theorizing and tests in the area of operations management. So, the practitioners should understand the important role of GPI in improving the firm performance.

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8

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