Title

Green Innovation, Managerial Concern and Firm Performance: An Empirical Study

Abstract

Extant literature, while often suggesting a positive link between green innovation and firm performance, is inconclusive. Moreover, the possibly moderating role of management has not been sufficiently considered. Using a unique dataset sampling 188 manufacturing firms in China, we examine how managerial concern (for green issues) moderates the relationship between green innovation and firm performance. We find that green process innovation and green product innovation both significantly (positively) predict firm performance, when not considering managerial concern for the environment. Once including managerial concern, we observe that it compounds the positive effect of green process innovation on firm performance -- but not product innovation which no longer explains significant unique variance in firm performance. The findings hold various implications for future research and business policy.

Key words: green production innovation, green process innovation, managerial concern, firm performance.

1. Introduction

Adopting green practices is an important consideration for today's firms (Shu et al., 2016). Resource limitation, increasingly sophisticated consumers, societal pressures and regulatory policies are driving the need towards a more balanced approach to economic growth and environmental sustainability. China, in particular, home to 16 out of the world's top 20 most polluted cities (López, 2008; Dhakal, 2009), has seen many industries changing in order to adopt a 'green mindset' (Shu et al., 2016). Interest in *green innovation* and related concepts (e.g. eco-innovation, sustainable innovation, and environmental innovation) has also grown within the management literature over the past two decades (Schiederig et al., 2011). Green innovation is comprised of *product* and *process* innovation. It captures improvements in product design and manufacturing processes which save energy, reduce pollution, minimise waste and decrease a firm's negative impact on the environment (Woo et al., 2014; Chen et al., 2006; Chen, 2008; Dangelico and Pujari, 2010; Chang, 2011). In recent decades the empirical discourse exploring the relationship between sustainable development and firm performance has grown (Hall and Wagner, 2012); however the results remain inconclusive (Trumpp and Guenther, 2017; Lee and Min, 2015; Lee et al., 2016). The lack of an underpinning theoretical framework and difficulty accessing data are cited as barriers to further understanding the link between environmental issues and firm performance (Lee and Min, 2015; Trumpp and Guenther, 2017).

In addition to public and regulatory environmental policy, firms have myriad pressures to confront – e.g. from consumer and suppliers, to developing new markets and competitive advantage, to improving corporate image (Weng et al., 2015; Chen, 2008). Fundamentally, it remains unclear whether or when the pursuit of green innovation is likely to be profitable for a firm. Recent research highlights the extent to which green innovation can be ultimately transformed into firm performance is likely shaped by management (e.g. Przychodzen et al., 2016). However, there remains ambiguity around the impact of green innovation on firm performance. Much of extant research has either examined (solely) green *product* (Driessen et al., 2013; Albino et al., 2012), *or process* innovation (Tseng et al., 2013) – or otherwise considers green innovation broadly without delineating product and process innovation (Lee and Min, 2015; Aguilera and Ortiz, 2013). The lack of any general consensus let alone best practice as it relates to the role of green innovation in firm

performance indicates the need for future research. Based on the potential catalyzing role of management in green innovation (e.g. Przychoden et al., 2016; Testa et al., 2016) we suggest and examine whether the level of managerial environmental concern affects the relationship between green innovation (both product and process) and firm performance.

This study advances the conversation with an evidence-based examination of the relationship between green product and process innovation, firm performance, and the potential moderating role of managerial environmental concern, using a unique dataset of 188 Chinese manufacturing firms. Following a brief overview of the contemporary literature, the paper discusses the relevant concepts and hypotheses. The study's method is then described, after which the results are presented. The latter part of the paper discusses the findings and their relevance to business strategy practitioners and future research avenues.

2. Literature Review and Conceptual Development

Green Innovation and Firm Performance

Green innovation is comprised of green product innovation and green process innovation. Green *product* innovation is the production of a new product or service that inflicts no or reduced negative impact on the environment that the current or competing product (e.g. Wong, 2012). Green *process* innovation is the improvement of existing production processes and use of environmentally friendly technologies to produce goods and provide services that impose no or reduced negative impact on the environment (e.g. Wong, 2012). Firm performance, unless otherwise specified typically refers to a firm's financial and associated indicators – i.e. sales, ROI, market-share, stock market performance, and related intangibles.

Empirical research exploring the relationship between environmental performance and firm performance presents mixed findings (Lee and Min, 2015). A meta-analysis of 64 empirical studies published between 1978 and 2008 showed that 55% of the studies found a positive, 15% a negative, and 30% a null effect of environmental performance on firm performance (Horvathova, 2010). Studies focused specifically on green innovation (and related concepts e.g. eco-innovation, sustainable innovation, environmental innovation) also remain inconclusive. Some empirical research and

theoretical perspectives posit that green innovation has a negative effect on firm performance. Specifically, Driessen and colleagues (2013) found that green product innovation is associated with low financial performance. Aguilera and Ortiz (2013) observe that green innovative firms do not experience increased financial performance compared to non-green innovative firms. Other research (e.g. Liu et al., 2011) found that green innovation lead to an increase in costs. Recently a review of 63 studies published between 1991 and 2013 concludes that green product innovation improves firm performance (Dangelico, 2016); of those 63 studies only 3 even considered China – one of the most rapidly growing economies, with one of the largest environmental footprints.

Reflecting a more complex reality, a comprehensive study recently appearing in *Business Strategy and the Environment,* examined a sample of 2,181 firms and nine types of green process innovation – finding that only two of nine positively impact firm performance (Doran and Ryan, 2016). The findings of the above studies are in line with the traditional economics perspective that green innovation is costly and as such it often has a negative or null impact on firm performance (Palmer et al., 1995; Lee et al., 2016).

However the aforementioned fails to explain the various studies finding a positive effect (see Lee and Min, 2015). For example, investigating the Spanish FTSE4 Good IBEX index, Charlo and colleagues (2015) show that socially responsible firms obtain higher profits for the same level of risk. Similarly Fujii et al. (2013) found a positive relationship between the reduction of CO2 emissions and financial performance amongst Japanese manufacturing firms. Callan and Thomas (2009) conducted an extensive study whereby a positive relationship emerged between corporate social performance and corporate financial performance. Dangelico and Pontrandolfo (2015) examined product and process related environmental actions, ultimately finding a positive link between these actions and firm performance; however they also cite the importance and relevance of management throughout. Focusing on green innovation, Chen et al. (2006) show that the performance of green product and process innovation is positively correlated to competitive advantage. Dangelico and Pujari's (2010) review of the literature uncovered an array of benefits emerging from integration of environmental sustainability issues with product development and business

operations, including "increased efficiency in the use of resources, return on investment, increased sales, development of new markets, improved corporate image, product differentiation, and enhanced competitive advantage" (p. 480). The theoretical perspective that addresses this relationship is based on the Porter and Van der Linde (1995) hypothesis. The Porter Hypothesis relates the effects of environmental regulation on technological innovation and economic performance. It asserts that innovation offsets can occur, with technological change "partially or more than fully offset[ing] the costs of complying with environmental regulation" (Porter and van der Linde, 1995, p. 98). In essence: innovation offsets the costs of environmental initiatives due to the technological change it stimulates; this in turn has the potential to make firms more competitive (Thurow and Holt, 1997). Furthermore green product innovation leads to a more efficient use of raw materials, transforming waste into a useful resource and ultimately decreasing costs (Porter and van der Linde, 1995).

Managerial Environmental Concern

It is clear that evidence exists to support both sides of the argument on the impact of green innovation on firm performance. Given the ambiguity, a firm's engagement (or lack thereof) in green innovation is more a matter of managerial concern and decision-making than a matter of best practice or specified business policy. Research by Hahn and colleagues (2014) suggests, "a cognitive framing perspective offers a better understanding of managerial decision making on sustainability issues" (p. 482). Cognitive frames act as information filters wherein managers imbue ambiguous cues with meaning - which in turn results in them selecting and supporting particular strategic responses (Porac and Thomas, 2002; Weick, 1995). The role of management in the translation of green innovation into firm performance is not to be ignored (Przychodzen et al., 2016). The salience of any particular management concern – versus other competing stimuli and objectives – is a driving force of managerial attention and resources (e.g. Ocasio, 1997; Shepherd et al., 2017; Cho and Hambrick, 2006). We thus examine the environmental concern of management, given management's likely role as a catalyst. In particular, managers more concerned about *green issues* are apt to devote greater time/attention/support to such – potentially strengthening the likelihood of green innovation positively impacting firm performance (Bansal and Roth, 2000; Papagiannakis and Lioukas, 2012;

Papagiannakis et al., 2014).

Hypotheses

Following established convention in testing conditional (moderated) effects – to test the potentially moderating role of managerial environmental concern on the relationship between green innovation and form performance, it is necessary to first formally note the general relation (i.e. green innovation--firm performance). Yet, as previously discussed the impact of green innovation on firm performance remains ambiguous – and our research question is not about definitively settling the mixed main-effect results of prior research. Thus to proceed, based on the body of research indicating a positive relationship between green innovation and firm performance (Pujari, 2006; Gluch et al., 2009; Chiou et al., 2011; Chen et al., 2006), as a necessary step building to our primary hypothesis (H2) – we will formally posit a positive general main-effect.

Furthermore, distinguishing between *product* and *process* innovation is prudent. For example, Hall and Wagner (2012, p. 184) found "that only being a process innovator tends to positively influence environmental performance, whereas being purely a product innovator does not." Accordingly, we delineate green innovation into *product* and *process* innovation. Based on the body of extant research and meta-analysis findings (Lee and Min, 2015) as a starting point (to later test moderated effects), we formally delineate the following main-effects:

H1a: Green product innovation has a positive effect on firm performance.
H1b: Green process innovation has a positive effect on firm performance.

With regards to managerial concern, managerial concern for the environment has a positive impact of the adoption of environmental innovation strategies (Bansal, 2003; Eiadat, 2008; Qi et al., 2010; Testa et al., 2016), whereby it acts as a trigger for pursuit of green innovation. This in turn might enhance firm performance (Ar, 2012)[1].

[1] As such, and absent a theoretical basis for why a manager's concern/beliefs should directly impact firm performance, we do not hypothesize such a direct effect. Concurrently, following standard model comparison statistical analyses, in our regressions we model this possibility.

Furthermore Dangelico (2015) argues that considering environmental aspects from the beginning is a critical success factor for green product innovation development.

Thus it reasons that not only may managerial environmental concern be important in determining "*if*" a firm will pursue green innovation, but the degree of concern may shape (moderate) the coupling of green innovation and firm performance. Building on, and going beyond prior research that only considered product innovation (Ar 2012), we examine the potentially moderating role of managerial environmental concern in the second set of hypotheses:

H2a: Managerial environmental concern has a positive moderating effect on the relationship between green product innovation and firm performance.

H2b: Managerial environmental concern has a positive moderating effect on the relationship between green process innovation and firm performance.

The primary hypothesis (H2) and the overall model to be tested are illustrated below.

Insert Figure 1 here

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3. Method

Study Context

This study focuses on the Chinese manufacturing industry. Approximately one-third of world energy consumption and world CO2 emissions are due to the manufacturing industry (IEA, 2007). China, in particular, is the world's largest CO2 emitter (IEA, 2016), and home to 16 out of the world's top 20 most polluted cities (López, 2008; Dhakal, 2009). However in recent years a drive to adopt a 'green mindset' is emerging (Shu et al., 2016). The current legal environment compounds the relevance of this inquiry. Most acutely, in September 2016, China signed the Paris Climate Agreement. As such, our inquiry offers a timely examination of the way in which managerial environmental concern influences the link between green product/process innovation and firm performance, in the #1 manufacturing economy.

Data Collection

To test the hypotheses an original data collection – via a survey instrument –was designed. After piloting, the finalized instrument was sent to organizations facilitating data collection: the EU Chamber of Commerce in China; the China Chamber of Commerce of Metals and Chemicals; the Jiangsu Yancheng Science and Technology Bureau; the Sichuan Hong County Reform and Development Bureau. Through these organizations the survey was distributed to managers of Chinese manufacturing firms, and completed by the CEO/general manager, the production manager, the R&D manager or other TMT member. Of the 374 surveys distributed, 188 valid responses were returned, representing a response rate of 50.3%.

Sample Characteristics

Of the participating firms, 96.3% were SMEs and 93.6% were private firms. Sample characteristics are contained in Table 1.

Insert Table 1 here

Variable measurement

In this study the key variables are: green *product* innovation, green *process* innovation, managerial environmental concern, and firm performance. Each variable was operationalized based on multi-item scales from existing literature – as subsequently elaborated. In line with prior research, item responses were based on 5-point Likert scales, scored from 1 (strongly disagree) to 5 (strongly agree).

Green Product Innovation (Pt)

Numerous existing studies have developed scales related to green product innovation (Wong et al., 2012; Chen et al. 2006; Chen, 2008; Chiou et al., 2011). To develop valid measurements, the authors were guided by Chen and colleague's (2006; 2008) definition of green innovation which includes technology innovations linked to green product design, energy saving and pollution prevention. These studies informed the choice of items included in this research. In particular respondents were asked about the materials, design, reusability/recyclability, packaging, and labelling of new and existing products. Products using less energy, resources, and materials in the development and design phase were seen as more favourable (Chen, 2006; 2008). The ease of recycling the product at the end of its life, the use of non-toxic materials (Chiou, 2011) and the use environmentally friendly packaging (Wong, 2012) were other important considerations.

Green Process Innovation (Ps)

Operationalizing green process innovation required consideration of the hazardous emissions, energy use, and production operations during the manufacturing process (Wong et al., 2012; Chen et al. 2006; Chen, 2008; Chiou et al., 2011). Managers responded to questions about their respective firms' treatment of waste and emissions resulting from the production process (Chen et al. 2006; Chen, 2008). Energy consumption (Chiou, 2011), the use of cleaner technology and clean transportation methods throughout production and dispatch (Wong, 2012) were also components of the green process innovation variable.

Managerial Environmental Concern (MC)

Limited extant literature exists operationalizing managerial environmental concern. Following an extensive literature review, only three studies reference it (Ar, 2012;

Eiadat et al., 2008; Qi et al., 2010). After due consideration, this study adopted the four item scale of Eiadat and colleagues (2008), and consistent with Ar (2012). It reflects the relative salience of environmentally friendly innovation from a managerial perspective. In particular it considers the centrality of environmental innovation to firm strategy – as well as the perceived effectiveness and importance of environmental innovation for achieving strategic goals.

Firm Performance (FP)

Based on prior research (namely: Ar, 2012; Hassan et al., 2016; Chang and Fong, 2010; Suki, 2017), firm performance (FP) was operationalized based on 5 items covering: sales volume (FP_1), market share (FP_2), return on investment (FP_3) (Ar, 2012), firm image (FP_4) (Hassan et al., 2016) and customer satisfaction (FP_5) (Chang and Fong, 2010; Suki, 2017). To allow and account for some of the items being of more central to performance, total variable score was derived with multivariate factor analysis of the 5 items; specifically, each item was weighted according to its multivariate factor loading.

Control Variables

In this study, the following control variables included: firm size, age, and ownership structure. Firm size was operationalized according to number of employees (Marchi, 2012; Walker and Wan, 2012; Berrone et al., 2013; Huang and Li, 2015) and firm age by years since incorporation (Westman and Thorgren, 2016; Huang and Boateng, 2013; Ke, 2008; Tian and Estrin, 2008; Hess et al., 2008). Ownership structure was categorically coded, with fixed effects as a control.

The basis for including these controls was established on prior research and the following logic. Older and larger firms hold more experience and resources to develop environmental innovation strategy for better performance, thus it is important to control for such factors. Ownership structure was considered as current literature provides conflicting results as to its relevance to firm performance. Given that the study focuses on the Chinese manufacturing industry solely, a separate control for industry was not included.

4. Data Analysis and Results

Common method

As firm managers completed the survey, the potential for common method bias was considered. In terms of procedural controls, respondents completed the survey anonymously, and the items within the survey were easy to understand. Furthermore, different variables measuring disparate items were separated clearly across the survey. In terms of quantitatively assessing whether common method might none the less still be present, a Harman single-factor evaluated the potential existence of common method biases. The test resulted in a single-factor, chi square value of 843.897 (df = 152). Its degree of fit was substantially lower than that of the multi-factor measurement model 430.258 (df = 147) ($\Delta\chi^2$ (df=5)=413.639, P<0.01). Therefore the effect of common method biases is deemed acceptable.

Descriptive analysis

Table 2 provides descriptive statistics and variable intercorrelations.

Insert Table 2 here

Reliability and validity

A series of tests were run to check the reliability and validity of the valid responses. The coefficient of Cronbach's Alpha (a) and corrected item-total correlation (CITC) analyze reliability, whilst KMO & Bartlett's ball test evaluate validity. The results supported the reliability and validity of the scales (see Tables 5 and 6 in Exhibit Appendices for details).

Collinearity Tests & Hypotheses Testing

Before running hypothesis testing regressions, collinearity issues (Rong, 2005) and potential autocorrelation (Ma, 2002) were explored. When considering collinearity, it is necessary to conduct multicollinearity tests; essentially meaning that all control variables and independent variables are put into the model and the tolerance and variance inflation factor (VIF) of each variable is analyzed. Durbin-Watson's (D.W.) method is also adopted to test the sample data for residual independence. Analysis

results (see bottom of Table 3) show that the tolerance of all variables is above 0.1, and VIF is less than 4. These results suggest that a regression analysis is suitable. The D.W. value (1.911) approaches 2, thus it does not influence the accuracy of the t-test and F-test results.

Based on the conceptual research model, hierarchical regression analysis was employed in four steps – i.e. in four models. Model 1 contains only the control variables. Model 2 adds the green product and process innovation variables; Model 3 adds managerial concern; Model 4 adds the interactions between managerial concern green innovation.

Insert Table 3 here

In Model 1, firm age, size, and ownership structure have no discernable effects on firm performance. Once green product innovation and green process innovation are added in Model 2, the R^2 jumps to 0.311. As the parameter estimates show, both green innovation variables have a significant positive effect on firm performance. Individually both green product and process innovation are significant predictors of firm performance ($\beta = 0.342$ and 0.259 respectively, $p<.01$).

Model 3, as a precursor to the focal moderated model (Model 4), adds managerial concern for the environment. This serves as the baseline to allow subsequent observation of the *unique* variance incrementally explained by the interaction variables in Model 4. While not hypothesized and a bit beyond our immediate focus, the loss of predictive significance of product innovation in Model 3 is discussed at the end of this section.

Finally, Model 4 is the full model including two interactions: the *MC*-by-*process* and the *MC*-by-*product* interactions. In this model green *process* innovation has a significant positive impact on firm performance ($\beta = 0.147$, $P<0.1$) and the interaction between green *process* innovation and managerial concern is also significant ($\beta = 0.180$, $P<0.05$). Green *product* innovation, while showing a positive coefficient, does

not appear to significantly impact firm performance ($\beta = 0.088$, $P>0.1$); similarly, the interaction between green *product* innovation and managerial concern is not significant. This provides support for Hypothesis 2b, but not for Hypothesis 2a. It indicates that managerial concern plays a moderating role in relation to *process* innovation – in particular, compounding the positive relationship between green *process* innovation and firm performance.

This suggests an interesting, complex relation between innovation, managerial concern, and firm performance. To analyze this further we divide our sample of firms into two groups based on a mean split: those that are high (above average) in green product innovation and those that are low (below average). The supplemental analysis results (Table 4) indicate that within firms above the average in product innovation, a green product innovation does not significantly influence firm performance. This may be due to high-levels of product innovation increasing production costs, which offset revenue and related benefits.

Insert Table 4 here

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5. Implications and Conclusion

This paper examines green innovation, managerial concern, and firm performance. Specifically four hypotheses are tested. The results find that both green product and green process innovation have a positive main-effect on firm performance (H1a, H1b). Furthermore, in line with our central research questions and thesis, managerial concern has a positive moderating effect on the relationship between green *process* innovation and firm performance (H2b).

There are numerous contributions arising from this empirical study. The Chinese data provides a unique, yet timely, context for research of this nature. Furthermore, the study supports, extends, and clarifies existing research on the relationship between green innovation and firm performance. One of the ways this research differs from prior studies is by not just looking across firms overall – but by also parsing firms according to green product innovation into two groups (high versus low) and testing whether within the different groups, green product innovation has similar effects on

firm performance. The research findings show that green product innovation has a significant positive influence on firm performance within the subsample of firms below mean in it. This may be due diminishing returns at the high-end; in essence, it stands to be relatively easier and less expensive to increasing relatively low-levels green product innovation.

As a result of features of the external environment (e.g. government environmental protection laws and regulations), firms may be forced to conduct green product innovation. To achieve quick performance results in a short term, some firms may conduct low-level green product innovation. The overall, more stable positive relationship between green process innovation and firm performance (Models 2, 3, and 4) may be due to the possibility that in the long-term green process innovation is more conducive for sustainable development within a firm than green product innovation (Xie et al., 2015). Its benefits also appear to be more readily harnessed when managers perceive the managerial/strategic relevance of green. Considering the relatively greater control management has over its production processes (than end-products subject to more uncertain or more unstable consumer preferences/market acceptance), the finding makes sense – and is in line with the presented logic of managerial concern. It may be a bit more challenging for a firm to alter and improve its production (i.e. manufacturing) processes – thus requiring greater managerial concern – but if doing so, is likely to bear more stable fruit.

Implications for Strategy

The results suggest important implications for business strategy. Business managers should recognize that neither green product innovation nor green process innovation appears to undermine firm performance. On the contrary, both have a positive main-effect on firm performance. However engaging in innovation of any type carries an element of risk – with product innovation it is necessary to consider both the cost of inputs and the costs of conversion. Increasing low-level green product innovation appears to positively impact firm performance – yet positive returns to increased product innovation aren't observed within the upper half of green product innovators. Thus especially for firms facing potential cannibalization of existing product lines – or increasing costs to further green product development – managers would be wise to look at process innovation opportunities. Furthermore product innovation requires inputs from the environment and as such the firm's ability to convert product

innovation into firm performance is dependent on its access to resources.

Green process innovation appears to have a positive effect on firm performance at low, moderate, and high levels. It leads to an increase in the efficient use of inputs and/or increased efficiency in the conversion process. In comparison to green product innovation, it is less dependent on factors outside of the firm and so the firm ultimately has more control over this innovation type. An important outcome, from a strategy perspective, is the influence of managerial environmental concern. Managerial concern has a positive compounding effect on green process innovation's relationship on firm performance.

Thus, managers need to be aware of the importance of green innovation and open to engaging in green innovation practices. Corporate commitment to environmental issues centralizes this cause and in turn increases managerial environmental concern, which ultimately has a positive effect on firm performance (Pipatprapa et al., 2017). Our findings suggest that the environment should not be a decoupled afterthought or have negligible strategic significance. The relevance of managerial environmental concern increases the positive effect of innovation on performance. Thus, by making the environment a managerially relevant, salient concern, firms can promote green innovation as a means of achieving improved performance.

Implications for Policy

Green innovation practices are advantageous for both firms and the wider society. These practices ought to be encouraged by government bodies and policy makers. While green process innovation at all levels showed a positive effect on firm performance, this was not ubiquitously the case with green product innovation. Government policy may encourage green innovation either through progressive measures such as grants and rebates or punitive measures such as tariffs and quotas. Such actions increase the salience of green innovation in the minds of managers, thereby promoting managerial environmental concern. As previously mentioned, China recently signed the Paris Climate Agreement; this signals a commitment by the Chinese government to curb emissions and environmental pollution. Encouraging and supporting green innovation is an important part of reducing emissions – this research highlights that green product innovation may need more governmental support than

green process innovation as without greater external encouragement it may not be readily adopted by organisations given its negligible impact on firm performance above certain levels.

Limitations and Future Research

As with all studies there are also some limitations indicating opportunities for future research. Due to the lack of panel data, we cannot directly speak to the dynamic process of green innovative practices within firms. Secondly, although the sample is compelling, like prior studies it is circumscribed to a particular national context – in this case, China. Furthermore considering the sheer volume of manufacturing firms in China a sample of 188 is relatively minuscule. Future research involving other contexts, alternative data sources, or that tracks firms and their innovation activities over time would be useful. This study focused solely on Chinese manufacturing firms, future studies could continue to take an even more fine-grained look at specific industries and explore how green innovations' relevance can be shaped by specific industries. Finally, future research can further open the black box of how managerial environmental concern, and associated cognition and action, shape the coupling between green innovation, strategic behavior, and strategic outcomes such as firm performance.

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Table 1 Description of Firms

Variable	Item	Frequency	Frequency (%)
Respondents Managerial Position	CEO/general manager	17	9.0%
	Legal person	24	12.8%
	R&D manager	24	12.8%
	Production manager	19	10.1%
	Marketing manager	56	29.8%
	Other	48	25.5%
Ownership Structure	State owned or State holding company	4	2.1%
	Private company	176	93.6%
	Joint venture	5	2.7%
	Wholly foreign owned company	2	1.1%
	Other	1	0.5%
Firm Age	≤3 years	17	9.0%
	3～5 years	28	14.9%
	5～10 years	68	36.2%
	10～15 years	43	22.9%
	15～20 years	11	5.9%
	≥20 years	21	11.2%
Firm Size	≤100 persons	107	56.9%
	101～500 persons	74	39.4%
	≥500 persons	7	3.7%

Table 2 Descriptive Analysis

	Mean	St. dev.	Firm Age	Firm Size	MC	Pt	Ps	FP
Firm Age	3.35	1.366						
Firm Size	1.47	.570	.289**					
MC	4.412	.640	-.012	.150*				
Pt	4.371	.569	.016	.167*	.710**			
Ps	4.266	.577	-.031	.166*	.620**	.705**		
FP	4.055	.593	-.087	.072	.612**	.516**	.481**	

*P<0.1,** P<0.05,*** P<0.01. Ownership structure was categorical and is not shown here.

Table 3 Regression Analysis (Pt, Ps, MC, FP)

Variable	**Firm performance**			
	Model 1	Model 2	Model 3	Model 4
Firm Age	-.118	-.081	-.075	-.093
Firm Size	.105	.002	-.013	-.008
Green Product Innovation (Pt)		.342***	.107	.088
Green Process Innovation (Ps)		.259***	.137*	.147*
Managerial Concern (MC)			**.456*** **	**.517*** **
MC* Pt				-.044
MC* Ps				**.180** **
R^2	.021	.311	.410	.429
adjusted R^2	.005	.292	.390	.404
F value	1.301	16.454***	20.946***	16.817***
VIF	1.000～1.092	1.011～1.868	1.017～2.408	1.022～2.515
Tolerance	.916～.1.000	.535～.989	.415～.983	.398～.978
D.W.				1.911

Note: All the regression coefficients were standardized; * P<0.1, ** P<0.05, *** P<0.01. Fixed ownership structure effects were insignificant and are not shown here.

Table 4 Supplemental Mean-Split Regression Analysis: The Effect of Green Product Innovation on Firm Performance (within below vs above average product innovation firms)

DV = Firm Performance	Model 5 (bottom-half Pt firms)	Model 6 (top-half Pt firms)
Process Innovation	.132	.269**
Product Innovation	.240*	
		.074
R^2	.098	.100
adjusted R^2	.072	.083
F value	3.848**	6.143***

Note: All regression coefficients standardized; * P<0.1, ** P<0.05, *** P<0.01.
Given insignificance of controls, for simplicity simple results shown here.

EXHIBIT – Reliability and Validity Analysis Details

The below tables provide the results of tests run to test the reliability and validity of the valid responses. The results supported the reliability and validity of the scales. The coefficient of Cronbach's Alpha of every measurement item excluding itself and every variable overall, is greater than 0.7; the CITC of each measurement item is above 0.5, supporting scales reliability. The KMO values of all variables are greater than 0.7, and Bartlett's ball test is significant, supporting scale validity.

Table 5 Reliability Analysis

Variable	Measurement Items	CITC	Cronbach's Alpha excluding item	Cronbach's Alpha
Green Product Innovation	Pt1	.591	.765	.800
	Pt2	.687	.737	
	Pt3	.660	.745	
	Pt4	.527	.823	
	Pt5	.617	.754	
Green Process Innovation	Ps1	.606	.803	.831
	Ps2	.677	.789	
	Ps3	.569	.815	
	Ps4	.690	.780	
	Ps5	.640	.796	
Mgr. Concern	MC1	.787	.939	.934
	MC2	.869	.907	
	MC3	.869	.909	
	MC4	.878	.903	
Firm Performance	FP1	.746	.840	.876
	FP2	.777	.832	
	FP3	.747	.840	
	FP4	.667	.860	
	FP5	.613	.871	

Table 6 Validity Analysis

Variable		Pt	Ps	MC	FP
KMO value		.826	.825	.863	.796
Bartlett's ball test	Approx. chi square	338.074	341.970	672.071	540.526
	Degree of freedom	10	10	6	10
	Significance	.000	.000	.000	.000