Environmental Regulation on Enterprises' Green Innovation Performance

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Environmental regulation has a positive impact on energy-intensive enterprises' environmental innovation prospective, stakeholder pressure, and innovation capability, respectively. In turn, this has a significant impact on enterprises' green innovation performance. Stakeholder pressure and green innovation capability to play an important role between environmental regulation and green innovation performance. It is better to promote enterprises' green innovation prospective and innovation ability through environmental regulation to promote stakeholder pressure, in turn, that improve enterprises' innovation performance. It is important to leverage these influencing factors to promote green innovation performance to achieve a carbon turning point.

environmental regulation green innovation performance energy-intensive enterprise

1. Introduction

Green innovation means maximizing the economic output from innovation and minimizing environmental pollutant emissions. The green innovation performance of energy-intensive enterprises is conducive to promoting China's innovation-driven strategy and green and low-carbon economy, reducing environmental pollution, ecological destruction, and resource waste, and achieving harmonious and sustainable development of the social economy and environment. Many companies have an environmental goal of producing recyclable packaging and energy-saving products such as green low-carbon products to mitigate climate change and carbon neutrality. Previous research stated that Chinese firms' green technology innovation could be influenced by environmental regulations [1][2][3]. However, Kneller and Manderson proposed that the influence of environmental regulation on green technology innovation has an incomplete effect [4]. With stricter environmental regulations and carbon neutrality, regulation costs for energy-intensive enterprises increase. The stricter environmental regulation promotes green innovation performance in energy-intensive enterprises, but the influence paths and mechanisms of environmental regulation and green innovation performance need further analysis. Moreover, environmental innovation attitude and capability positively affected corporate green innovation, and green innovation led to positive environmental low-carbon performance [5]. Jiang et al. revealed internal and external prospective factors of corporate green innovation, such as institutional and stakeholder pressure [6].

Considering the green innovation performance of energy-intensive enterprises is still insufficient [7], the TPB model demonstrated that it could be used to reach individual adoption. However, there is a lack of study on whether the TPB model predicts green innovation performance at the company level. The TPB model proposed by Ajzen extends the theory of reasoned action, and previous researchers extended the TPB model in individual innovation

adoption [8][9]; however, there is limited research on how environmental regulations affect the firm's green innovation performance through the revised TPB model [7].

1.1. Environmental Regulation

Environmental regulation is the regulation that the government uses to restrain enterprises through administrative laws and regulations, market mechanisms, and environmental protection propaganda. Environmental regulation has an objective and goal of attributes and environmental regulation functions to protect the ecological environment with formal and informal regulation [10]. Liu pointed out that environmental regulation means the government can restrict enterprises' pollution behavior, improve the environment, and promote the coordinated development of the industrial economy and environmental protection by establishing a legal system [11]. Tong et al. proposed that the government restrains the pollution behavior of firms by issuing administrative systems, using market mechanisms, and giving play to the public [12]. Shen et al. pointed out that China has shifted from administrative and command-based regulation to market-based environmental regulation, which has effectively supplemented administrative and command-based environmental regulation [13]. Command-based regulations primarily include administrative regulations, local laws, and environmental protection laws and regulations [14]. The administrative regulations primarily have fines for pollutants exceeding the standard and the concentration control of environmental pollutants issued by the environmental protection law [8]. Market-based environmental regulation primarily refers to carbon taxes, carbon emission trading, waste disposal taxes, and other policies guided by market economic incentives [15][16][17]. With the diversification of environmental regulation subjects, informal environmental regulations have emerged, including the government, industry associations, and other subjects. It involves public participation and has the attribute of information [18].

1.2. Green Innovation Performance

Innovation is the generation, acceptance, and implementation of new products, processes, or services. Innovation can drive the force of corporate performance and competitive advantage, societal and technological progress, and economic growth. Porter suggested that technological innovation can improve the productivity of an organization, which leads to the value of an organization's competitive advantage [19]. Damanpour and Evan proposed innovation, including product, process, and organizational innovation aspects [20]. The organization of economic and cooperative development (OECD) defined technological innovation to include new products and processes [21]. Green technology innovations are categorized as technology, product design, the production process, and management functions. Green technology innovation comprises energy resource minimization, materials reduction, and pollution prevention during production [22]. Green technology innovation includes modifying an existing new product design to reduce the negative impact on the environment [23].

Green innovation can be understood as green or environmental technology innovation, etc. It follows that green technology innovation is one of the leading forces driving green low-carbon green economic growth. Existing studies have explored the driving factors of green innovation from different perspectives. It is primarily divided into the theoretical perspectives of Schumpeter, institutional innovation, and the national innovation system, as well as

the theoretical perspectives of enterprises' sustainability management [24]. Existing studies are helpful to understand the influencing factors of green innovation, which can be summarized as follows: Environmental policy-oriented institutional factors [25], corporate internal governance factors, stakeholder factors, and innovation capabilities [26]. Due to the large consumption of steel and glass, electricity, water, and coal, fossil fuels have released excessive greenhouse gases that have caused global warming.

Energy-intensive enterprises' green innovation can lead to the value of corporate competitive advantage and increase corporate value. Energy-intensive enterprises' eco-friendly product and process innovations can minimize the enterprise firm's waste and improve energy efficiency through recycling and reuse, while also improving the firm's economic and social performance by reducing waste and costs [27][28]. Recent research proposes that green innovation can drive environmental performance, and environmental performance relies on the value of eco-friendly materials, environmental procedures, new product development, and the inclusion of environmental sustainability concerns in corporate activities and product innovation [29].

Green innovation performance can be understood as green innovation efficiency or performance, which refers to the ratio of enterprises' input to output in green technology innovation and is an important indicator to measure green technology innovation. The higher the efficiency of green innovation, the better the match between resource factor input, innovation factor input, and green performance output. There have been abundant achievements in the evaluation of green innovation efficiency, and most literature uses stochastic frontier analysis (SFA) and data enveloping analysis (DEA) to measure green innovation performance [9][25].

2. Environmental Regulation on Enterprises' Green Innovation Performance

2.1. Environmental Innovation Prospective Effect

Serious environmental impacts and climate change threaten future generations' survival. Following this agenda, more and more countries' governments are beginning to propose environmental regulations to ameliorate environmental externalization, causing traditional profit maximization-driven businesses to shift to more sustainable businesses. Environmental regulations influence business decisions to make greener choices and produce green products and processes. For example, environmental regulations can affect the business management's environmental perception and decisions [30]. Environmental regulations push firms to focus on environmental issues [31], and firms can benefit and be exempted from paying fines [1]. To survive under stringent environmental regulations, firms need to adapt and act according to these regulations [28]. However, the firm's environmental innovation adaptation relies on the behavioral innovation perspective of green innovation [24]. Previous studies highlight the significance of an environmental attitude to pro-environmental action [32][33][34]. Though firms are the major concern and priority of the government to enforce environmental regulation, this is not limited to the firm only. Environmental regulation pressure can cultivate awareness among individuals and society, causing more environmentalists to establish helpful environmental norms and culture. Moreover, Milfont et al.'s study on national

identity revealed the importance of environmental attitude and superordinate environmental identity in the result of pro-environmental actions [35].

Environmental regulations aiming to prevent environmental degradation from worsening further, when strictly enforced, would impact the firm's profitability due to the high environmental costs, thus influencing the firm's managers' innovation perspectives. Milfont et al. pointed out the importance of an environmental attitude to pro-environmental behaviors and environmental regulation to a positive environmental innovation perspective at the individual level [35]. López-Gamero et al. focused on firms affected by environmental law or regulation, IPCC, meaning participant firms were all from polluting backgrounds; the result might not apply to other industries [30].

When enterprise managers believe that green innovation can increase their advantage and sales or market share, their energy-saving technology or cleaner production technology can reduce environmental pollution and avoid government penalties [7]. The company can also receive tax incentives or technology research subsidies, which will generate a positive environmental innovation perspective and cause a driving force from expected performance. The positive environmental innovation perspective of the firm managers toward green innovation activity due to environmental regulation and the influence of other stakeholder pressure drives green innovation development and improves green innovation performance. Green product and process innovation include producing less polluting material, and this refers to adopting new environmental production methods that save energy, reduce emissions, reduce waste, and use fewer polluting materials. Prior studies indicate that green innovation improves firm organizational performance in terms of financial and non-financial criteria such as profits, return on assets and sales, market share [7][36], and sustainable performance in economic, environmental, and social aspects [28][37]. Green innovation performance can improve competitive advantages and firm value [38]. Firms are more aware of environmental issues and proactively drive green innovation and improve green innovation performance. Kitsis and Chen found that top management's environmental commitment positively affects the firm's engagement in green operations.

2.2. Stakeholder Pressures' Effect

Prior studies examined whether environmental regulations are linked to stakeholder pressure, and many studies have focused on the relationship between environmental regulation and environmental behavior [39] and the relationship between stakeholder pressure and environmental practice and innovation [40][41][42]. Studies have indicated that government pressure is critical to stimulating environmental behavior [43][44]. Even though environmental regulation pressure is generally referred to as the most significant stakeholder pressure due to stricter environmental regulation, Kawai et al. found no significant relationship between regulatory and societal pressure on environmental practice [42]. In their studies, Kitsis and Chen excluded the influence of government regulation pressure and non-government organization environmental demand [40]. Generally, when exploring the relationship between environmental regulation and stakeholder pressure, the role of government is critical. The government wants to solve the environmental issue and promote economic growth.

With the diversification of regulations and subjects, market-based environmental regulation enforces the environmental regulation followed by a series of environmental costs such as carbon emission trading and taxes or subsidies to attract cooperation. In addition, the emergence of informal regulations, such as news media disclosure, would impact each stakeholder's interest in providing subsidies to firms and maximize their innovation motivation, due to the high level of strict environmental regulation and the amount of environmental damage cost. Thus, investors would pressure the firm not to go against environmental regulations to avoid losing a significant profit to penalties and tax payments [1][2]. As more regulations and enforcement create environmental awareness among society, consumers, competitors, and suppliers tend to adopt better environmental behavior to support the government's environmental goal [45][46]. The government is enforcing environmental regulations in line with the carbon turning point and carbon neutrality proposed by the Chinese government, hence focusing on stakeholder pressure perceived by the firm under the influence of environmental regulations.

A stakeholder is a group of institutions with a conflict of interest with the firm, such as the government, society, consumers, an environmental protection agency, shareholders or investors, employees, suppliers, and even competitors, and they can affect and be affected by the firm's decision [47][48]. Environmental regulation or a carbon trading system can cause stakeholders to change their environmental preservation perception. When stakeholders perceive environmental preservation, their innovation perspective tends to be more positive. Therefore, stakeholder pressure perceived by firms can influence firms to consider environmental issues and develop environmental innovation [39]. The firm will tend to make stakeholder priority the business objective to maximize stakeholders' profit and welfare or to fulfil stakeholder demand for new environmental regulations by engaging in environmental behavior, causing them to form a more positive innovation perspective toward environmental practice. Stakeholders are important to keep the firm consistently in existence, and stakeholder pressure can affect firm decision-making [43].

Various research has mentioned the critical role of stakeholder pressure on firms as a driver of environmental behavior due to the relationship between stakeholders and the firm, causing them to be able to affect and also be affected by the firm's decision [47], so when this stakeholder has environmental awareness about an environmental issue, they can influence the firm to have a more positive environmental innovation perspective. Kawai et al. explored the relationship between stakeholder pressure and green innovation in Japanese multinational companies in North America and Europe. The results indicated that market stakeholder pressure drives environmental behavior implementation and green innovation activity [42]. Kitsis and Chen found that stakeholder pressure positively affected top management commitment to green operations of 206 US firms. However, studies have not included the influence of government regulatory pressure and pressure from NGOs [40]. Nishitani et al. posited that government and final consumer pressure effectively influenced firms to implement environmental management control systems in Vietnam [44]. As observed, prior studies have examined the critical role of stakeholder pressure in different industries and countries, but the result has not been consistent.

Stakeholder pressure can enhance firm's green innovation capability, especially under the influence of government regulatory pressure. Previous research has focused on the relationship between environmental regulation pressure from the government and its effect on technology innovation and green innovation performance [1][49][50].

Stakeholders can affect firms' decisions, and stakeholders are essential to maintaining the consistent sustainable development of the firm. Hence, how the firm manages pressure from these stakeholders, such as the government, investors, the local community, customers, suppliers, employees, and even competitors, is critical for firm growth and sustainable development. Due to the diversification of environmental regulations, from basic administrative regulations to market-based environmental regulations, any obligation of environmental law will result in fines and penalties for environmental damage. This increases the firm's cost of production and damages the reputation of the firm in public, ultimately decreasing profitability [48][51][52][53]. Green technology innovation is the solution for the firm to contribute to realizing the government's environmental goal while affecting the long-term development of the firm [54]. Evidence can be obtained from Ouyang et al. that in the long term, government regulatory pressure improves industry innovation in China [49]. Fang et al. also indicated that the national specially monitored firm program improved the innovation of those firms supervised under the program [50]. Moreover, Cai et al. pointed out direct regulatory pressure as significantly enhancing the green technology innovation of Chinese heavy-polluting industries, and the result is more significant when the companies are state-owned [1]. Stakeholder pressure can affect green innovation [55]. Shahzad et al. found that stakeholder pressure positively affects the knowledge management process and green innovation. Furthermore, the green innovation of the firm can be improved following the expansion of the firm's green innovation capability [56]. However, research regarding the effect of stakeholder pressure on firm's green innovation capability is still limited compared to research regarding government stakeholders' regulatory pressure and its impact on the green innovation capability of the firm [57]. In addition, Kawai et al. found that regulatory pressure and societal pressure have no significant effect on the environmental practices and green innovation of Japanese multinational companies based in North America and Europe [42]. This difference in findings prompts this study to fill the research gap by focusing on stakeholder pressure from the government, suppliers, investors, consumers, employees, and competitors and their effects on firm's green innovation capability and green innovation in enterprise firms in China.

2.3. Green Innovation Capability's Effect

While environmental regulations solves the environmental problem and burdens firms with additional costs to adopt specific technology or pay fines [49], developing green innovation seems to be the only solution to stringent environmental regulation [1]. This phenomenon is observed in the increasing number of patents following the introduction of environmental regulations [2]. The high production cost and government subsidies encourage firm-level low-carbon green innovation development, causing firms to proactively innovate new green products or processes that save energy, reduce pollutants, and reduce waste [1][2]. However, the development of green innovation depends on the firm's green innovation capability, such as resources available and specific technology requirements and knowledge [58]. Green innovation capability refers to the strong ability to carry out innovation strategy and development, including the resources available, innovation knowledge, and ability. Therefore, aside from resource availability, innovation knowledge from external sources is equally important for the firm's green innovation capability and ensures successful green innovation development. When the firm engages with learning knowledge, especially from external sources, it is recognized as an absorptive capability, which initially refers to utilizing knowledge learned from external sources and applying this knowledge within the firm [59].

Another important contribution of their study is that they posited that absorptive capability is accumulative, and prior-accumulated knowledge facilitates the further accumulation of knowledge. This ability to exploit external knowledge enhances the firm's innovative capabilities. Similarly, Lichtenthaler and Lichtenthaler also referred to absorptive capability as exploring external knowledge while realizing the significance of internal knowledge [60]. Tu et al. defined absorptive capability as the organizational mechanism that helps firms to identify, communicate, and assimilate relevant external and internal expertise [61]. Absorptive capability is essential to ensure the firm can scan, acquire, and utilize helpful information from external and internal environments that improve its green innovation capability through product and process innovation development.

Environmental regulation stimulates environmental awareness, increases the consideration of environmental behaviors in the business environment, and drives innovation development within the industry. Incentivized by stricter environmental regulations, the firm would innovate the production process or development of a new green product. With prior knowledge, the firm may seek knowledge from the external environment that would enable it to implement innovation within the firm effectively. Therefore, environmental regulations improve green innovation capability when the firm acquires valuable knowledge of technology, management, and operation from external stakeholders such as suppliers, consumers, the government, the local community, and competitors and internally from employees and collaborators that facilitate the firm's green innovation capability. Prior studies fundamentally understand the relationship between environmental regulation and green innovation capability. However, the data primarily focus on secondary data and use city or province data for research. Even though secondary data provide more precise and accurate information, these data are unable to analyze the mechanism at the micro level, especially for energy-intensive firms. Firms might develop innovation for reasons other than environmental regulation enforcement. One possible reason is other stakeholders' pressure that drives the firm's innovation, which the study examines further.

Environmental innovation capability is critical to realizing the green innovation performance, and green innovation performance development is the financial and technological barrier. The lack of technology and managerial capability might lead to failure in implementing green process, and green procurement. Hence, it can be understood that better green innovation capability indicates that the firm has better green innovation performance. Even though green innovation capability can lead to the success or failure of green innovation in the firm, green innovation capability is subject to change over time. This is because green innovation is a long-term investment project that allows the firm to improve its green innovation capability through organizational learning, resource reallocation, and intensive employee training. Past studies examining the effect of green innovation capability on green innovation performance have shown that dynamic innovative capabilities, opportunity-recognizing innovative capability, and opportunity-capitalizing capability positively correlated with a hotel's eco-innovation [62]. Innovation capability also mediated the relationship between two types of leadership and green procurement in the UAE public sector [63].

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