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Non-family shareholder governance and green innovation of family firms: A socio-emotional wealth theory perspective

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ABSTRACT

We draw on socio-emotional wealth (SEW) theory to investigate the influence of non-family shareholder governance (NFSG) on green innovation in family firms. We find that non-family shareholder holding has no significant impact on green innovation, but the directors appointed by non-family shareholders (NFSDAs) significantly promote the implementation of green innovation strategies in family firms. The underlying mechanisms are characterized by NFSG bringing valuable resources and promoting the firm reputation, which further facilitates green innovation. The effect of NFSG is more pronounced for entrepreneurial family firms and family firms located in high institutional efficiency areas. The green professional backgrounds of NFSDAs and having excess NFSDAs also effectively promote green innovation. Finally, green innovation promotes the long-term orientation of family firms. Through this study, we draw on SEW theory to enrich research on NFSG and green innovation in family firms. Our findings can help family firms achieve a solid basis for long-term orientation.

1. Introduction

With the increasing severity of climate change, environmental protection has become a major challenge facing humankind. As a micro subject unit of economy and society, enterprises need to start with their own strategies to deal with the crisis brought by environmental changes. In many strategic decisions of enterprises, green innovation strategy is one of the most significant ways that firms can achieve sustainable and long-term development (Calabrò, Vecchiarini, Gast, Campopiano, & Kraus, 2019). Unlike traditional innovation activities, green innovation enables companies to obtain a competitive advantage while protecting the environment (Quan, Ke, Qian, & Zhang, 2023). An extensive number of previous studies examine green innovation activities (Berrone, Cruz, Gómez-Mejía, & Larraza-Kintana, 2010; Berrone, Fosfuri, Gelabert, & Gómez-Mejía, 2013; Quan et al., 2023). However, an important but unanswered question is how family firms practice their green innovation strategies.

Among many types of enterprises, family firms not only account for a large proportion of the firms in the global economy but also play a key role in economic development (Du, Ma, & Li, 2022; Jiang, Shi, & Zheng, 2020). For example, >30% of U.S. listed firms in the Standard & Poor's 500 are either controlled or managed by families (Anderson & Reeb, 2003; De Massis, Ding, Kotlar, & Wu, 2018). On the one hand, the family firm is embedded in the background of the environmental protection era. It needs to respond to the human development trend of environmental protection by implementing the green innovation strategy. On the other hand, the goal of the family firm is to establish a sustainable foundation (Du et al., 2022). The green innovation strategy can help the business to enhance its core competitiveness (Quan et al., 2023), thus helping the long-term development of the family firm. Therefore, it is vital to help family firms implement green innovation strategies and thus, at the same time, achieve social and economic sustainability.

Socio-emotional wealth (SEW) refers to the non-economic benefits that the family obtains from the family firm by virtue of its identity as owner, decision-maker and manager. SEW is the primary reference point for family firms when they make strategic decisions (Berrone et al., 2010; Gómez-Mejía, Haynes, Núñez-Nickel, Kathyrn, & Moyano-Fuentes, 2007). Furthermore, SEW can be divided into the restricted SEW with a focus on short-term non-economic interests and the extended SEW with a focus on the compatibility of the interests between the controlling families and external stakeholders (Miller & Le Breton-Miller, 2014). Although both types of SEW have an impact on the

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strategic decisions of family firms (Calabrò et al., 2019; Du et al., 2022), family firms will be more willing to harm the interests of external stakeholders to protect SEW when facing risks (Gómez-Mejía et al., 2007). This makes family firms tend to be conservative (Gómez-Mejía, Cruz, & Berrone, 2011), thus making it difficult to promote the implementation of the green innovation strategy effectively.

Shareholders are the main body of corporate decision-making, which makes corporate risk decision-making first depend on shareholders' risk attitude (Habib & Hasan, 2017). As the family shareholders may be biased in the process of balancing the two types of SEWs, it is the key to help the family firms implement the green innovation strategy to straighten out the relationship between the two types of SEWs with the help of non-family shareholders.

The coexistence of family shareholders and non-family shareholders is common in family firms (Li, 2018). With the increase in the importance of non-family shareholders, it is particularly important to pay attention to what role non-family shareholders play in the risk decision-making of family firms (Du et al., 2022; Fattoum, Guedri, & Delmar, 2020; Li, 2018; Sacristán-Navarro, Cabeza-García, & Gómez-Ansón, 2015). Departing from previous research on non-family shareholders mainly focusing on ownership structure (Gómez-Mejía et al., 2011; Li, 2018; Sacristán-Navarro et al., 2015), we refer to Du et al. (2022) to define the concept of non-family shareholder governance (NFSG) from two aspects: shareholder holding and the directors appointed by the shareholders, because non-family shareholders can participate in corporate governance through general meetings (*e.g.*, as shareholders holding) and/or board participation (*e.g.*, as appointed directors) at the same time.

Under the situation that non-family shareholders can participate in corporate governance by shareholder holdings and appointed directors, they can not only avoid the controlling families from paying too much attention to the restricted SEW but also can strengthen the controlling families' attention to the extended SEW (Du et al., 2022), thus overcoming the family dilemma of balancing two kinds of SEW when facing green innovation strategy. It should be noted that the concept of the directors appointed by non-family shareholders (NFSDAs) is different from that of non-family directors. NFSDAs are the person non-family shareholders trust most or the person who can best represent their interests (Du et al., 2022; Villalonga & Amit, 2009); non-family directors who are not appointed by non-family shareholders do not need to reflect the interests of non-family shareholders (Anderson & Reeb, 2004; Rosecká & Machek, 2022). Therefore, we pay attention to the influence of NFSDAs on green innovation strategy, thus providing a theoretical basis for testing the role of non-family shareholder governance.

Previous studies mainly focus on the corporate innovation or green awareness of family firms in developed economies, such as the U.S. and European countries (Berrone et al., 2010; Chrisman & Patel, 2012; Gómez-Mejía, Campbell, & Martin, 2014). We extend the literature by exploring the relationship between non-family shareholder governance and green innovation in China. China provides an ideal setting in which to investigate the relationship between non-shareholder governance and green innovation for the following reasons. Firstly, family firms play an increasingly important role in China's economic development. Prior research documents that family firms represent over 50% of the private economy among listed companies in China (Jiang et al., 2020). Furthermore, the PricewaterhouseCoopers' Survey of Global Family Businesses in 2021-China Report highlights that, even amidst the COVID-19 pandemic, Chinese family firms demonstrate superior growth in sales turnover compared to the global average (PwC, 2021). These findings indicate the growing prominence of family firms within China's economy and their increasingly significant role in the global economic landscape. Secondly, family firms, particularly those with diverse property rights capital (*e.g.*, non-family shareholders), play a critical role in China's economic transformation and upgrading (Arregle, Hitt, & Mari, 2019; Chua, Chrisman, Steier, & Rau, 2012). Understanding the effects of different property rights on family firms could also have policy implications for China's mixed-ownership reform (Du et al., 2022). Finally, the rapid economic development of the emerging economies represented by China in the past decades has been accompanied by substantial environmental costs (To, Ha, Nguyen, & Vo, 2019; Wang & Li, 1999). Recognizing these severe environmental issues, the Chinese government has proposed a series of environmental regulations to encourage green practices (Quan et al., 2023). Therefore, in the context of China, focusing on the impact of non-family shareholders on the green innovation strategies of family firms can provide not only a better understanding of the role of heterogeneous property rights capital in the transformation and upgrading of emerging economies but also in-depth insights into corporate green innovation decisions and practices.

Based on data from listed family firms during the 2011 to 2020 research period, we find that non-family shareholder holding has no significant impact on green innovation but that NFSDAs, representing an effective form of NFSG, can more effectively promote family firms' green innovation strategies. The underlying mechanism is that NFSG can not only prevent the controlling families from paying too much attention to the restricted SEW to exert the resource effect but also strengthen the controlling families' attention to the extended SEW to exert the reputation effect, thus promoting the green innovation of family firms.

Our cross-section tests show that NFSG plays a more significant role in the promotion of green innovation strategies for entrepreneurial family firms and family firms located in high institutional efficiency areas. Further research based on NFSG reveals its dynamic effect on green innovation. The green professional backgrounds of NFSDAs and having excess NFSDAs can more effectively promote family firms' green innovation strategies. In addition, both restricted and extended SEW can promote green innovation *via* NFSG. We further find that green innovation has a real impact on the value of family firms. Specifically, green innovation can promote the long-term orientation of family firms, and NFSG can further strengthen the relationship between green innovation and long-term orientation.

We conduct a series of tests to mitigate endogeneity concerns. First, to address the potential endogeneity arising from the unobserved and time-varying difference between family firms with NFSDAs (the experimental group) and family firms without NFSDAs (the control group), we implement the propensity score matching (PSM) method. Doing so helps us control fundamental differences between these two groups. Our baseline results remain the same based on the matched sample. Second, to address the mutual causality concern arising from changes in the external environment that may affect NFSG and green innovation simultaneously, we implement an instrumental variable (IV) approach to re-estimate our baseline model. Our results continue to hold. Third, to alleviate the sample self-selection bias arising from the possibility that a director appointed by non-family shareholders may not be randomly selected, we re-test our hypothesis using the Heckman two-stage regression model. Fourth, to address the potential endogeneity arising from missing variables, we use firm fixed effects regression to re-test our hypothesis. Fifth, to address the potential endogeneity arising from unobservable variables, we follow Oster (2019) and use coefficient stability analysis to re-estimate our test. Sixth, considering that NFSG may be endogenously determined, we refer to Cheng, Lee, and Shevlin (2016) and use the lagged value of the independent variables and control variables to re-estimate our model. Seventh, potential errors in measures must also be considered. Thus, we use alternative measures of the key variables to ensure the robustness of our baseline results. Our baseline results remain the same. Our baseline results remain robust after excluding the service industry with few green patents. Finally, we change the criteria of the large family shareholders and find that the regression results are consistent with the basic results.

We make the following three contributions. First, we provide a basis for how family firms can promote green innovation strategies by balancing different types of SEW. Previous studies find family firms difficult to effectively balance restricted SEW and extended SEW when facing risks, which leads to conservative strategic decisions (Gómez-

Mejía et al., 2007; Gómez-Mejía et al., 2011). We find that non-family shareholder governance can help family firms to achieve an effective balance between restricted SEW and extended SEW, thus helping family firms to implement the green innovation strategy. It not only responds to the call for more research on how various types of SEW affect the green innovation strategies of family firms (Calabrò et al., 2019) but also provides new ideas for family firms to promote green innovations.

Second, studies mainly define the concept of NFSG in terms of ownership structure (Fattoum et al., 2020; Li, 2018; Sacristán-Navarro et al., 2015). In this study, we verify the rationality and effectiveness of NFSG in two dimensions, ownership structure and board participation, thus responding to the call for increased research attention on NFSG (Du et al., 2022). Furthermore, we analyze how the characteristics of appointed directors affect family firms' green innovation strategies from different perspectives, thus extending research on NFSG and family firm strategies.

Finally, our findings can be used as a reference for family firms in other emerging markets to effectively improve green innovation. Our findings show that NFSG can help family firms better promote green innovation strategy implementation. Therefore, one strategy for family firms in emerging economies aiming to improve their green innovation could be to actively seek non-family shareholders to engage in the corporate governance of their firms.

The remainder of this paper is structured as follows. Section 2 describes the literature review and hypothesis development. Section 3 details the sample selection and research design. Section 4 presents the main findings and a series of robustness tests. Section 5 presents mechanism tests and additional tests. Finally, Section 6 concludes the study.

2. Literature review and hypothesis development

2.1. Literature review

2.1.1. NFSG

"NFSG" refers to non-family shareholders participating in the corporate governance of family firms through ownership structure (shareholder holding) and board participation (appointed directors) (Du et al., 2022). Few studies focus directly on NFSG. Du et al. (2022) find that NFSG can help family firms improve corporate risk-taking. Thus, following Du, Ma and Li (2022), we review the literature on NFSG from the dimensions of ownership structure and board participation.

Regarding ownership structure, non-family shareholders may have a negative effect on corporate value due to their higher voting rights (Fattoum et al., 2020; Sacristán-Navarro et al., 2015). Nonetheless, non-family shareholders can also have more positive effects on family firm business decisions (Carney & Child, 2012). For example, Gómez-Mejía et al. (2011) find that institutional investors can offer family firms key information and abundant resources. At the same time, non-family shareholders can enhance CEO turn-over-performance sensitivity (Li, 2018) and the level of corporate risk-taking (Du et al., 2022). Additionally, the higher ownership of the dominant family relative to other non-family shareholders can prompt family owners to adopt family logic (Xu, Chen, & Wu, 2019).

Regarding the board of directors, studies show that most non-family directors of the board not only have a good educational background but also demonstrate good professional skills (Blumentritt, Keyt, & Astrachan, 2010; Miller & Le Breton-Miller, 2014). These characteristics help family firms build a more efficient management team and create more economic value (Déniz-Déniz, Cabrera-Suárez, Martín-Santana, & Josefa, 2018, 2020). In particular, independent directors, as an important internal governance mechanism, can restrain the entrenchment of family directors and improve the performance of family firms (Anderson & Reeb, 2004; Bammens, Voordeckers, & Van, 2011; Miller & Le Breton-Miller, 2006). Meanwhile, three types of conflict arise in family firms: conflict between family and non-family members, conflict among family members (*i.e.*, family conflict), and conflict among non-family members (Rosecká & Machek, 2022). In addition, bifurcation bias within family firms arises from different treatment, such that controlling families typically treat family members better than their non-family counterparts (Verbeke & Kano, 2012). The unequal treatment of non-family directors and directors within the family firm can easily lead to bifurcation bias, which is not conducive to the long-term development of family firms (Verbeke & Kano, 2012; Jennings, Dempsey, & James, 2018).

2.1.2. Green innovation in family firms

Green innovation is defined as "hardware and software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management" (Chen, Lai, & Wen, 2006, p. 333). Therefore, green innovation contains two key attributes: innovation and green environmental protection.

From the perspective of family firm innovation, studies generally find that family firms demonstrate a lower willingness to innovate than non-family firms (Block, Hansen, & Steinmetz, 2022; Duran, Kammerlander, Essen, & Zellweger, 2016). According to the SEW theory, family firms usually regard profit and SEW loss as primary reference points for making decisions that can avoid or reduce the loss of SEW (Berrone, Cruz, & Gómez-Mejía, 2012; Gómez-Mejía et al., 2007). Due to the high risk and uncertainty of innovation strategies, strong resource commitment and long investment periods are required to obtain innovation results, which requires family firms to obtain more external funds, resources, and appropriate talents (Anderson & Reeb, 2004). This may weaken family control and thus threaten SEW. To avoid the potential loss of SEW, the decision-makers of family firms tend to be conservative (Gómez-Mejía et al., 2007), which ultimately weakens family firms' willingness to innovate (Chrisman & Patel, 2012; Gómez-Mejía et al., 2014). However, the literature indicates that factors such as the long-term investment horizon of the controlling families and the low communication cost among family members may cause family firms to show strong decision-making ability in innovation activities (Diaz-Moriana, Clinton, Kammerlander, Lumpkin, & Craig, 2020).

In addition, with the development of SEW theory, the dimension of SEW has been continuously expanded. According to Miller and Le Breton-Miller (2014), SEW can be categorized as either restricted or extended SEW. Controlling families' emphasis on different types of SEW may have a differentiated impact on innovation (Calabrò et al., 2019). In addition, Block et al. (2022) find that both the innovation input and output of family firms are lower than that of non-family firms.

From the perspective of the green nature of family firms, research focuses on the differences between family firms and non-family firms in terms of environmental protection. Compared with non-family firms, family firms show more positive environmental awareness and environmental performance for the sake of preserving SEW, such as family reputation and control rights (Berrone et al., 2010). Family firms also have a stronger ability to improve innovation levels and performance through environmental strategies (Craig & Dibrell, 2006). Furthermore, in the process of implementing green innovation strategies, family firms pay more attention to internal stakeholders, such as shareholders, executives, and employees. In contrast, non-family firms focus more on external stakeholders, such as consumers, suppliers, and competitors (Huang, Ding, & Kao, 2009). Environmental protection is a long-term oriented non-intermittent commitment behaviour (Aragón-Correa & Sharma, 2003; Hart, 1995), which is intrinsically consistent with the long-term orientation of family firms (Le Breton-Miller & Miller, 2011; Miller & Le Breton-Miller, 2011). Meanwhile, following legitimacy theory, families whose firms' operations contribute to environmental destruction or that demonstrate negative attitudes toward environmental protection lose social legitimacy; as a result, they often face damage to their status, reputation, and image, which is not conducive to the long-term development of their family firms (Berrone et al., 2010;

Gómez-Mejía et al., 2007).

2.1.3. Literature summary

With research focusing on the differences between family firms and non-family firms in green environmental protection decision-making and innovation strategy, the heterogeneity of family firms is ignored (Arregle et al., 2019; Chua et al., 2012). That is, insufficient research attention is paid to family firms' underlying motivation to implement a green innovation strategy. Family firms often face the dual pressure of innovation and environmental protection when developing their green innovation strategy. Nonetheless, research mainly focuses on the innovation strategies of family firms and ignores the attribute characteristics of green environmental protection (Berrone et al., 2010; Chrisman & Patel, 2012). In addition, studies investigate the economic consequences of non-family ownership structure and board participation separately, thus ignoring that they are both dimensions of NFSG that operate simultaneously. Therefore, we focus on the influence of NFSG on green innovation strategy in consideration of both ownership structure and board participation. Doing so not only allows for a fresh and more profound understanding of the determinants of family firms' green innovation strategies but also helps advance research on the consequences of NFSG.

2.2. The connection between SEW theory and NFSG

SEW theory is an important theoretical basis for family firm research (Berrone et al., 2012; Gómez-Mejía et al., 2007). According to SEW theory, non-economic gains and losses are often taken as the standard in the process of strategic decision-making by controlling families (Gómez-Mejía et al., 2011; Gómez-Mejía, Patel, & Zellweger, 2018). Previous studies have divided SEW into restricted SEW with the core of maintaining family control and extended SEW with the core of realizing intergenerational inheritance, which fully reflects the heterogeneous characteristics of SEW (Miller & Le Breton-Miller, 2014; Miroshnychenko, De Massis, Miller, & Barontini, 2021).

Because the family firm attaches importance to two types of SEW, which leads the family firm to face the dual goals of maintaining family control and achieving intergenerational inheritance, the controlling family may have a positive attitude toward non-family shareholder governance, or it may exclude non-family shareholder governance (Gómez-Mejía et al., 2007; Miller & Le Breton-Miller, 2014; Swab, Sherlock, Markin, & Dibrell, 2020). In this situation, whether non-family shareholder governance (non-family shareholder holding and NFSDAs) can balance restricted SEW and extended SEW is the key to promoting the implementation of strategic decision-making of family firms (Du et al., 2022; Du, Ma, Li, & Ma, 2023).

2.3. Hypothesis development

As mentioned above, non-family shareholder governance needs to balance the two types of SEW to promote the implementation of strategic decisions. Therefore, we combine the specific characteristics of green innovation strategy to analyze how non-family shareholder governance plays a role.

The green innovation strategy contains the dual attributes of green and innovation (Quan et al., 2023). Regarding innovation attributes, innovation activities need a lot of sustained resources (Berrone et al., 2010; He & Tian, 2013; Oltra, 2008). The key to implementing an innovation strategy is whether non-family shareholder governance can provide sufficient resources for innovation activities. In terms of green attributes, paying attention to environmental protection can enhance the reputation of enterprises and help to enhance the long-term development orientation of enterprises (Begum et al., 2022), which is in line with the long-term investment horizon emphasized by family firms (Le Breton-Miller & Miller, 2011; Miller & Le Breton-Miller, 2011). Thus, the recourse effect and reputation effect by non-family shareholder governance are crucial underlying mechanisms to promote the green innovation strategy of family enterprises.

Therefore, we take SEW theory as the theoretical basis and analyze the influence of non-family shareholder governance on the green innovation of family firms from the two dimensions of restricted SEW and extended SEW, combining the two underlying influence mechanisms of resource effect and reputation effect.

Analysis of resource effect based on non-family shareholder governance: the innovative nature of green innovation is typically riskier and requires better knowledge and greater financial commitment than other green practices of enterprises, and it usually only yields rewards over the long term (Ahuja, Lampert, & Tandon, 2008; Berrone et al., 2010; Quan et al., 2023). However, given the severe external financing constraints faced by family firms (Chan, Dang, & Yan, 2012), controlling families tend to build internal capital markets through excess control (Amit, Ding, Villalonga, & Zhang, 2015; Villalonga & Amit, 2009), which fails to provide stable and sustained capital investment for green innovation strategy in the long term and also strengthens controlling families' excessive protection of restricted SEW. A family firm's emphasis on restricted SEW can strengthen its control requirements, leading to the rejection of external capital (Gómez-Mejía et al., 2011) and thus strengthening its financing constraints.

In fact, NFSG cannot change the nature of the family firm (Du et al., 2022; Li, 2018). However, it can effectively alleviate the controlling family's excessive emphasis on restricted SEW, thus exerting the resource effect to facilitate the family firm's green innovation strategy implementation.

Regarding the ownership structure in NFSG, the entry of non-family shareholders can transmit the signal of ownership structure adjustment and the opening up of the controlling family to other stakeholders to gain the recognition of external stakeholders and alleviate the financing constraints faced by the family firm (Croce & Martí, 2017). It can also reduce the motivation of the controlling family to maintain excessive control as well as avoid their overprotection of restricted SEW (Fattoum et al., 2020), thus promoting the rational allocation of enterprise resources and alleviating the financing constraints that come with green innovation strategy implementation.

Regarding board participation in NFSG, NFSDAs can not only enhance management's vision and weaken management's short-sighted behaviour but also prevent family directors who attach too much importance to the protection of restricted SEW from entrenching the interests of non-family directors (Déniz-Déniz et al., 2018, 2020). Meanwhile, NFSDAs can weaken the bifurcation bias within a family firm, which can also bring more external resources to alleviate the financing constraints faced by the family firm in the process of green innovation strategy implementation (Ciravegna, Kano, Rattalino, & Verbeke, 2020). As the financing constraints of a family firm ease, the controlling families may even become more willing to invest in green innovation strategies to enhance the firm's long-term orientation and achieve an everlasting foundation.

Analysis of reputation effect based on non-family shareholder governance: the green awareness characteristic of a green innovation strategy is consistent with the long-term orientation and long investment horizon characteristic of family firms (Le Breton-Miller & Miller, 2011; Miller & Le Breton-Miller, 2011). It is internally consistent with extended SEW, which focuses on guiding the long-term direction of decision-makers, so as to help the family firm to realize the intergenerational inheritance (Miller & Le Breton-Miller, 2005; Miller & Le Breton-Miller, 2014). For the long-term development of family firms and to realize intergenerational inheritance, controlling families cherish and attach great importance to family reputation (Allen, Qian, & Qian, 2005; Park & Luo, 2001; Xu, Yuan, Jiang, & Chan, 2015).

When family firms show a positive attitude toward environmental protection, they can often protect their families' status, reputation, and image (Berrone et al., 2010). Therefore, whether NFSG can strengthen controlling families' protection of extended SEW to exert the reputation

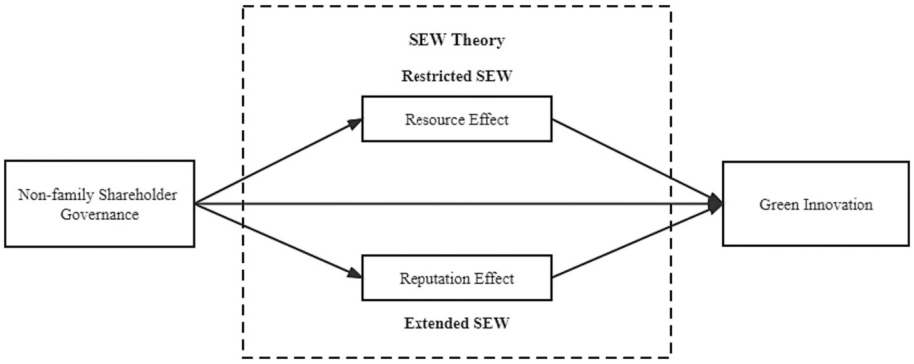

Fig. 1. The logical framework diagram.

effect and thus enhance their emphasis on the long-term development of their family firm is key to promoting green innovation strategy implementation.

Regarding the ownership structure in NFSG, non-family shareholders can limit the struggle caused by a high degree of family ownership (Schulze, Lubatkin, & Dino, 2003) and help family firms realize the importance of protecting their reputation. When family firms realize the importance of reputation, they will pay more attention to protecting their extended SEW and actively implement their green innovation strategy. Additionally, the participation of non-family shareholders urges family shareholders to maintain a long-term cooperative relationship with them to uphold the family's reputation (Miller & Le Breton-Miller, 2005). Therefore, family firms pay more attention to their extended SEW than the loss of restricted SEW caused by the dilution of controlling families' rights (Miller & Le Breton-Miller, 2014), thus urging family firms to focus more on green innovation strategy implementation.

Regarding board participation in NFSG, NFSDAs can introduce excellent external human resources to family firms (Anderson & Reeb, 2004), thus bringing advanced management experience to family firms. These excellent external directors make controlling families more aware of the importance of protecting extended SEW by maintaining family and corporate reputation, thus encouraging family firms to invest resources in green innovation strategies to facilitate their long-term development. In addition, family firms' emphasis on extended SEW can encourage them to further refrain from favouring family employees, thus reducing the bifurcation bias to maintain the reputation of family firms (Ciravegna et al., 2020; Kano, Ciravegna, & Rattalino, 2021). Therefore, NFSG can generate a reputation effect to prompt family firms' attention to extended SEW. Thus, family firms with clear inheritance inevitably increase their investment in green innovation activities to realize long-term orientation.

Based on the above analysis, NFSG can prevent controlling families from paying too much attention to restricted SEW, thus exerting the resource effect to alleviate the financing constraints faced by family firms and encouraging their green innovation strategy implementation. NFSG also can strengthen the protection of extended SEW, thereby exerting a reputation effect. This, in turn, enhances the importance of long-term firm development to the controlling families, thus promoting their green innovation strategy implementation. Fig. 1 is the logical framework diagram of the hypothesis. Therefore, we propose the following hypothesis:

Hypothesis 1. NFSG is positively correlated with the green innovation of family firms.

3. Sample selection and research design

3.1. Sample and data

Our sample selection starts with all A-share firms listed on the Shanghai and Shenzhen stock exchanges between 2011 and 2020. We use 2011 as the starting year because the China Securities Regulatory Commission issued a new edition of the "Standards for Information Disclosure Content and Format of Companies Offering Securities to the Public" in 2012. As annual reports generally provide comparative data over the same period of the previous year, we include data from 2011. We exclude financial and insurance firms, as these firms use different accounting standards (Du et al., 2022; Jiang et al., 2020).

An enterprise is considered a family firm if the largest shareholder is an individual or a family, if its shareholding ratio is above 5%, and if at least one family member participates in the management or control of the enterprise. There are at least three reasons that we define shareholders holding >5% as large shareholders. First, the family firm is controlled by the major shareholders of the family. Previous studies usually regard shareholders holding >5% as large shareholders (Edmans, 2014). Second, the *Securities Law of China* stipulates that "when an investor holds or holds 5% of the issued voting shares of a listed company together with others through agreements or other arrangements, it needs to make a report and announcement." Thirdly, the previous studies on non-family shareholder governance usually take 5% as the criteria when defining a family firm (Du et al., 2022, 2023). To ensure the robustness of the conclusion, we also take 10% as the threshold of large shareholders.

We mainly obtain relevant information about NFSG in family firms from the annual reports of family firms. In addition, considering that the controlling families may appoint indirect relatives to safeguard their interests, and the information of these indirect relatives is usually difficult to obtain through official channels such as the annual report, we search for this information through alternative channels such as websites, news and newspapers, to avoid ignoring the influence of these family members.

Other relevant data mainly come from the China Stock Market and Accounting Research database and the China Research Database Services (CNRDS) platform. Our final sample consists of 2510 firm-year observations. It is worth noting that our sample only includes all the family firms that meet our research requirement rather than the whole Chinese listed firms (they are not our research focus). Our sample size is comparable with previous studies on non-family shareholder governance (Du et al., 2022, 2023). To avoid the estimation bias of outliers, we winsorize all of the continuous variables of our study at the 1st and 99th percentiles.

3.2. Measures

3.2.1. Dependent variable

A green innovation strategy is an enterprise's activities to reduce environmental pollution and create new market opportunities through technological and product innovation (Ioannou & Serafeim, 2012). Green innovation is a key factor in coordinating economic growth and environmental protection and a strategic choice for enterprises to enhance their green competitiveness (Quan et al., 2023). Compared with R&D investment or environmental protection investment expenditure, the patent data applied by enterprises are relatively objective and can more truly reflect enterprises' current green innovation activities (Kesidou & Wu, 2020). We therefore use the number of green invention patents as a proxy for green innovation (Berrone et al., 2013; Li et al., 2017; Quan et al., 2023).

Patent data are downloaded from the CNRDS platform. We use the number of green patent applications as a proxy variable for green innovation. On the CNRDS platform, green patents are classified as invention patents and utility model patents. An invention patent typically requires more commitment and advanced management skills to develop than a utility model patent (Quan et al., 2023). Thus, we use the number of green invention patents as a proxy for green innovation. To summarize, green innovation (*GI*) equals the logarithm of 1 plus the number of green invention patents.

3.2.2. Independent variables

Following Du et al. (2022, 2023), we measure NFSG in two dimensions: ownership structure and board participation. We measure non-family ownership structure (*NS*) by the ratio of non-family shareholders. We use the ratio of NFSDAs to measure the board participation of non-family shareholders (*NB*).

3.2.2.1. Non-family ownership structure. First, we manually review the annual reports of the family firms to obtain the names and shareholding ratios of the top 10 shareholders. Second, we refer to relevant research on shareholder classification (Boubakri, Cosset, & Saffar, 2013) and divide the top 10 shareholder shareholders of a family firm into family shareholders and non-family shareholders. Finally, we calculate the sum of the non-family shareholding ratio in the top 10 shareholders as the proxy variable of non-family ownership structure (*NS*).

3.2.2.2. Board participation of non-family shareholders. To measure the board participation of non-family shareholders, we must rely on the concept of NFSDAs. NFSDAs are non-family shareholders appointed to serve as the directors of family firms (Du et al., 2022, 2023). We review the annual reports of the sampled family firms and manually collect the number of NFSDAs. Cross-checking the data yields consistent samples, thus demonstrating the data's consistency, reliability, and robustness. In line with Du et al. (2022, 2023), we further match non-family shareholders with NFSDAs.

If a non-family shareholder is a non-family member and serves as a company director, this indicates that that shareholder appoints a director. This is in line with the *Company Law of China* that stipulates "shareholders who individually or collectively hold more than 3% of the company's shares have the right to nominate directors".

Suppose a non-family shareholder is a legal person shareholder. In that case, the director of a listed company who is concurrently a director in a legal person shareholder's company is the director appointed by non-family shareholders. Non-family shareholders include natural person shareholders and legal person shareholders (Du et al., 2022, 2023). Since a legal person shareholder cannot directly serve as or appoint a director, it is necessary to judge whether the director is concurrently employed in the company where the shareholder works (Jiang & Kim, 2020). Finally, we use the ratio of NFSDAs to the number of board members as the proxy variable for the board participation of non-family shareholders (*NB*).

3.2.3. Control variables

We mainly control the relevant variables that can trigger corporate green innovation from corporate characteristics and corporate governance (Anderson & Reeb, 2004; Jiang et al., 2020; Le Breton-Miller, Miller, & Lester, 2011; Opler, Pinkowitz, Stulz, & Williamson, 1999; Villalonga & Amit, 2006). From the perspective of corporate characteristics, we control corporate size (*Size*), firm leverage (*Lev*), listing age (*Age*), corporate performance (*ROE*), and cash holding (*CF*). From the perspective of corporate governance, we control board size (*Board*), independent directors (*Indep*), CEO duality (*Dual*), ownership balance (*Balance*), and managerial ownership (*Mshare*). In addition, year-fixed effects (*Year*) and industry-fixed effects (*Industry*) are included in the study. The definitions of all of the variables used in this study are provided in Appendix A.

3.3. Model specification

We establish Model (1) to test the influence of NFSG on green innovation. A significant and positive value of α_1 would imply that NFSG can improve green innovation, thus verifying Hypothesis 1.

$$GI_{it} = \alpha_0 + \alpha_1 NFSG_{it} + \sum \alpha_i Control_{it} + Year + Industry + \varepsilon \quad (1)$$

where *GI* is green innovation; *NFSG* is non-family shareholder governance, including *NS* and *NB*; and *Control* indicates the control variables.

3.4. Descriptive statistics

The descriptive statistics of the key variables are shown in Panel A of Table 1. The mean and standard deviation of *GI* are 0.540 and 0.848, respectively. These values indicate that different family firms differ in

Table 1
Descriptive statistics.

Panel A

Variable	*N*	*Mean*	*Median*	*SD*	*Max*	*Min*
GI	2510	0.540	0	0.848	3.296	0
NS	2510	0.146	0.133	0.089	0.544	0.018
NB	2510	0.069	0	0.122	0.500	0
Size	2510	21.970	21.910	0.994	26.210	19.520
Lev	2510	0.370	0.368	0.177	0.945	0.031
Growth	2510	0.160	0.114	0.353	4.806	−0.624
Age	2510	2.740	2.773	0.378	3.555	1.386
ROE	2510	0.072	0.074	0.113	0.442	−1.112
CF	2510	0.050	0.046	0.068	0.258	−0.200
Board	2510	2.097	2.197	0.188	2.708	1.609
Indep	2510	0.375	0.333	0.051	0.600	0.308
Dual	2510	0.366	0	0.482	1	0
Balance	2510	0.474	0.356	0.442	2.961	0.018
Mshare	2510	0.185	0.087	0.203	0.705	0
Confucius	2510	3.066	3.664	1.469	4.762	0

Panel B

Category	*Criteria*	*N*	*Proportion*
Industry	*Heavy pollution*	742	29.56%
	Non-Heavy pollution	1768	70.44%
Region	*Southeast & Bohai Sea*	1830	72.91%
	Others	680	29.09%

Note: *GI* represents green innovation; *NS* represents non-family ownership; *NB* represents NFSDAs; *Size* represents corporate size; *Lev* represents firm leverage; *Growth* represents the growth rate of sales revenue; *Age* represents firm listing age; *ROE* represents accounting performance; *CF* represents cash holding level; *Board* represents board size; *Indep* represents the proportion of independent directors on the board; *Dual* represents CEO duality; *Balance* represents ownership balance degree; and *Mshare* represents managerial ownership.

Table 2
Regression results of NFSG and green innovation.

Variable	(1)	(2)
NS	0.161	
	(0.91)	
NB		0.330***
		(2.60)
Size	0.263***	0.267***
	(11.32)	(11.46)
Lev	0.145	0.139
	(1.33)	(1.28)
Growth	−0.041	−0.042
	(−0.99)	(−1.02)
Age	−0.086*	−0.091*
	(−1.73)	(−1.82)
ROE	0.573***	0.569***
	(3.49)	(3.47)
CF	−0.460*	−0.436*
	(−1.85)	(−1.75)
Board	−0.010	−0.029
	(−0.10)	(−0.27)
Indep	−0.857**	−0.873**
	(−2.22)	(−2.27)
Dual	0.042	0.044
	(1.30)	(1.35)
Balance	0.090**	0.100***
	(2.38)	(2.73)
Mshare	−0.045	−0.082
	(−0.59)	(−1.06)
Year	Yes	Yes
Industry	Yes	Yes
Cons	−5.273***	−5.296***
	(−8.97)	(−9.04)
N	2510	2510
R2	0.253	0.255

Note: This table implies the regression results for *NFSG* and green innovation. Column (1) presents the regression results for *NS* and *GI*. Column (2) presents the regression results for *NB* and *GI*. The t-statistic is shown in parentheses. * $p <$ 0.10, ** $p < 0.05$, and *** $p < 0.01$.

their degree of green innovation and show a large gap between the maximum value (3.296) and the minimum value (0). This further indicates a gap in family firms' recognition of green innovation strategies during the sample period. The median of green innovation during the sample period is 0, which is lower than the average level of green innovation (0.540) during the sample period. This indicates that the green innovation level of most family firms is below the average level. The mean of *NS* is 0.146,[1] indicating that the average shareholding ratio of non-family shareholders exceeds 10%, and the conditions for appointing directors are met (Du et al., 2022). The average value of *NB* (0.069) is lower than that of *NS* (0.146), indicating that non-family shareholders face the "same shares but different rights" dilemma. The descriptive statistics of the other variables are consistent with relevant studies (Du et al., 2022; Jiang et al., 2020).

Panel B of Table 1 presents family firm distribution across industries and regions. Since we focus on the green innovation strategy of family firms, we thus first classify the sample family firms according to the degree of industry pollution. From Panel B of Table 1, we can find that the sample size of family firms in heavily polluted industries is 742, accounting for 29.56%. The sample size of family firms in non-heavy pollution industries is 1768, accounting for 70.44%. Following Amit et al. (2015), we divide the Chinese mainland into six regions: the Southeast Region, the Bohai Sea Ring Region, the Central Region, the Northeast Region, the Southwest Region, and the Northwest Region. The sample size of family firms in the southeast and Bohai Sea Ring region is 1830, accounting for 72.91%. The sample size of family firms in the Central, Northeast, Southwest and Northwest regions is 680, accounting for 27.09%.

[1] It should be noted that the average value of shareholding ratio of non-family shareholders is 0.146, which is the average value of the sum of the shareholding ratio of non-family shareholders in the top ten largest shareholders, and the shareholding ratio of the single non-family shareholder does not exceed the shareholdings of the controlling families in the sample family firms.

4. Empirical results

4.1. Baseline regression results

Table 2 shows the regression results for NFSG and green innovation. Column (1) presents that although the coefficient of *NS* is positive, it is not significant, indicating that it is hard for non-family shareholders to promote family firms' green innovation solely through ownership. The coefficient of *NB* in Column (2) is positive and statistically significant, which indicates that NFSDA can help family firms implement green innovation strategies. Therefore, Hypothesis 1 is supported.

However, it is hard for non-family shareholders to play a governance role only through ownership structure. When they appoint directors to engage in the corporate governance of family firms, they can facilitate green innovation strategy implementation. Thus, only when non-family shareholders actually participate in corporate governance by appointing directors can they exert substantial influence. That is, NFSDAs serve as a more effective means for non-family shareholders to engage in corporate governance.

To sum up, we believe that, compared with non-family shareholders holding, NFSDAs can not only effectively ease the controlling families' over-emphasis on the restricted SEW, thus exerting the resource effect, but also strengthen the controlling families' protection of the extended SEW, thus exerting the reputation effect. As a result, this helps balance the restricted SEW and the extended SEW and further promotes the implementation of the green innovation strategy.

4.2. Endogeneity issues

4.2.1. PSM method

We adopt the PSM method to eliminate the endogeneity that may be caused by self-selection. Family firms with NFSDAs are assigned to the experimental group. In turn, family firms without NFSDAs are assigned to the control group. We select the control variables, including *Size*, *Lev*, *Growth*, *Age*, *CF*, *Board*, *Indep*, and *Mshare*, as the matching variables and adopt the one-to-one no-return matching method.

Table 3 presents the results of the PSM balance test. Before PSM, the mean values of the matching variables demonstrate a significant difference between the experimental and control groups. In contrast, after

Table 3
Balance test of PSM.

Variable	Sample	Mean (Experimental)	Mean (Control)	*t*-test
Size	Unmatched	21.810	22.037	−5.29***
	Matched	21.811	21.825	−0.28
Lev	Unmatched	0.344	0.382	−4.84***
	Matched	0.344	0.352	−0.81
Growth	Unmatched	0.190	0.146	2.86***
	Matched	0.190	0.189	0.06
Age	Unmatched	2.708	2.754	−2.77***
	Matched	2.709	2.711	−0.13
CF	Unmatched	0.045	0.052	−2.25**
	Matched	0.045	0.048	−0.94
Board	Unmatched	2.126	2.085	5.01***
	Matched	2.126	2.133	−0.80
Indep	Unmatched	0.373	0.376	−1.65*
	Matched	0.373	0.373	−0.25
Mshare	Unmatched	0.238	0.162	8.66***
	Matched	0.238	0.236	0.14

Note: This table indicates the balance test of PSM. The numbers in brackets are *t*-statistics. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

PSM, the mean values of the matching variables no longer demonstrate a significant difference between the experimental and control groups. Thus, the PSM balance test is supported. Meanwhile, Column (1) of Table 4 presents the results of the PSM regression. The coefficient of *NB* is positive and significant, implying that the conclusion is robust.

4.2.2. IV method

To avert the endogeneity caused by mutual causality and missing variables, we adopt the IV method. In terms of the IV, we follow Jin, Li, and Liang (2023) and take the number of Confucian temples in the Ming and Qing Dynasties in the area where the family firm is located as the IV. The ethical thoughts behind the Confucius temples can affect the configuration of the family firm's board of directors (Jin et al., 2023). Specifically, the more ethical thoughts a region has, the more its code of conduct is accepted by the social customs of the region (Akerlof, 1980), which makes the controlling families more inclined to maintain the unity of the family and then hold an exclusive attitude toward the non-family members. However, the number of Confucius temples in a region reflects historical events, which have little to do with the corporate governance of modern enterprises. Thus, the IV meets the exogenous and correlation requirements of this study.

We present the descriptive statistics of IV in Panel A of Table 1. Columns (2) and (3) of Table 4 present the regression results. As shown in Column (2), in the first-stage IV regression, *Confucius* is negatively correlated with *NB* at the 5% level. This implies that there is no "weak IV" problem. Furthermore, it implies that in areas with strong traditional Confucian culture, family firms are more likely to exclude non-family shareholders, reflecting the influence of traditional Confucian culture on the corporate governance of family firms. At the same time, Kleibergen-Paap rk LM statistics are significant at the level of 1%, indicating that there is no problem of insufficient recognition; Cragg-Donald Wald F statistic is higher than the critical value of Stock-Yogo weak instrumental variable identification F test at 10% significance level, indicating that there is no weak instrumental variable problem. As shown in Column (3), in the second-stage IV regression, the coefficient of *NB* is significantly positive at the 5% level. This implies that NFSG significantly improves the level of green innovation, indicating that our conclusion is robust.

4.2.3. Heckman two-step regression method

To solve the problem of sample self-selection, we use the Heckman two-stage regression method. In the first-stage regression, we estimate Model (2) by probit regression. In Model (2), we take whether the family firm has a director appointed by non-family shareholders (*NBDum*) as the dependent variable, and we regress the IV (*Confucius*) and the control variables. The control variables used in Model (2) are the same as those used in Model (1).

$$Probit(NBDum_{it}) = \beta_0 + \beta_1 Confucius_{it} + \beta_i \sum Control_{it} + Year + Industry + \varepsilon \quad (2)$$

We obtain the inverse Mills ratio (*IMR*) through Model (2) and then add *IMR* as a control variable to Model (1) for the second-stage regression. Columns (1) and (2) of Table 5 present the results of the Heckman two-stage model. As shown in Column (1), the coefficient of *Confucius* is negative and statistically significant, indicating that there is no weak IV problem. As shown in Column (2), the coefficient of *IMR* is not significant, indicating that there is no serious self-selection effect. After controlling *IMR*, the coefficient of *NB* is positive and statistically significant, implying that our results are not affected by the self-selection problem.

4.2.4. Firm fixed effects regression

Firm fixed effects can be used to capture the differences between individuals that do not change with time to overcome the problem of missing variables to a certain extent. As such, we use firm fixed effects to avoid the endogeneity that may be caused by the missing variables. Column (3) of Table 5 presents the regression results for firm fixed effects. The coefficient of *NB* is positive and significant at the 10% level, indicating that the problem of missing variables does not affect our conclusion.

4.2.5. Coefficient stability analysis

Oster (2019) proves that when a model may have unobservable missing variables, the estimator $\beta^* = \beta^*(R_{max}, \delta)$ can be used to obtain consistent estimates of the true coefficients. This estimator needs to set two parameters: δ and R_{max}. δ is the selection proportionality, which measures the strength of the correlation between the observable variable and the variable of interest compared with the correlation between the unobservable omitted variable and the variable of interest. R_{max} indicates that if the unobservable omitted variable is the maximum, the goodness-of-fit of the regression equation can be determined. Oster (2019) sorts and tests the results in the literature using random simulations. Referring to Oster (2019) and Satyanath, Voigtländer, and Voth (2017), we take the following steps to test the robustness of the empirical results. First, δ is set to -1 and R_{max} to 0.632, according to similar literature (Du et al., 2022). If $\beta^* = \beta^*(R_{max}, \delta)$ falls within the 95% confidence interval of the estimated parameters, the result is robust. Second, the R_{max} value method is the same as that used in the first step, and the value of δ is calculated to make $\beta = 0$. If the value of δ is greater than or equal to 1 or <0 (when the value of δ is <0, the coefficient adjusted by deviation should be greater than the coefficient of the previous regression, which proves the robustness of the result), the result is

Table 4
PSM and IV test results.

Variable	(1)	(2)	(3)
NB	0.287*		0.227**
	(1.88)		(2.23)
Confucius		−0.003**	
		(−2.17)	
Control	Yes	Yes	Yes
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Cons	−6.633***	0.076	−5.290***
	(−7.41)	(0.94)	(−17.46)
Kleibergen-Paap rk LM statistic	–	16.101** (0.032)	
Cragg-Donald Wald F statistic	–	16.146	
N	1305	2510	2510
R2	0.285	0.118	0.253

Note: This table shows the regression results for the PSM and IV tests: Column (1) shows the results of the PSM test; Columns (2) and (3) show the results of the IV test. The t-statistic is shown in parentheses. * p < 0.10, ** p < 0.05, and *** p < 0.01.

Table 5
Heckman and firm fixed effects test results.

Variable	(1)	(2)	(3)
NB		0.347***	0.226*
		(2.61)	(1.81)
Confucius	−0.002**		
	(−2.37)		
IMR		−0.783***	
		(−2.78)	
Control	Yes	Yes	Yes
Year	Yes	Yes	Yes
Industry	Yes	Yes	No
Firm	No	No	Yes
Cons	−2.566**	−3.206***	−7.494***
	(−2.41)	(−3.37)	(−7.97)
N	2510	2510	2510
R2 / Pseudo R2	0.069	0.263	0.145

Note: This table shows the regression results for the Heckman and firm fixed effects tests: Columns (1) and (2) present the results of the Heckman two-stage test, and Column (3) presents the results of firm fixed effects. The t-statistic is shown in parentheses. * p < 0.10, ** p < 0.05, and *** p < 0.01.

robust.

Table 6 presents the results of the coefficient stability analysis. As can be seen from row (1), $\beta^*(R_{max}, \delta) = -0.266$, which falls within the 95% confidence interval of the estimated parameters, indicating that the robustness test has been passed. As shown in row (2), $\delta = -1.054$ is <0 and indicates that the robustness test has been passed. Therefore, the key variables are not omitted.

4.3. Other robustness tests

4.3.1. Variable lag regression

In view of the lagging nature of corporate innovation, especially patent applications (He & Tian, 2013). Meanwhile, firms' internal governance may be endogenously determined (Cheng et al., 2016). As such, we lag the independent variables and control variables by one period. We use this method because endogenous explanatory variables are related to their lag variables, but lag variables are not related to current disturbance terms. If lag variables can significantly affect the explained variables, then no serious endogeneity exists. As shown in Column (1) of Table 7, the coefficient of *NB* is positive and significant at the 10% level, which is consistent with the baseline regression results and indicates that the conclusion is robust.

4.3.2. Alternative measures of variables

We change the methods used to measure the independent and dependent variables to ensure the robustness of our baseline results. For the independent variable, we use the dummy variable to measure *NB*. *NB* is recorded as 1 when non-family shareholders appoint directors, and 0 otherwise. For the dependent variable, we use the sum of the number of utility model patent applications and the number of invention patents to measure green innovation. As shown in Columns (2) and (3) of Table 7, the coefficients of *NB* are significant and positive. Therefore, the results remain robust after changing the methods used to measure key variables.

4.3.3. Elimination of service industry sample

We use the number of green patents to measure green innovation. However, the patent level of family firms in the service industry may not be too high, which may lead to under-estimate our baseline results. In order to ensure the robustness of the research conclusions, we eliminate the family firms in the service industry and conduct regression analysis again. As shown in Columns (4) of Table 7, the coefficients of *NB* are significant and positive. Therefore, the results remain robust after excluding the service industry sample.

4.3.4. The measure of changing family large shareholder

We change the criteria for judging the family's large shareholders. Specifically, considering that the *Company Law of China* stipulates that the shareholders holding >10% of the company's shares have the right to request the board of directors (Jiang & Kim, 2020), we take 10% as the criterion to judge the family large shareholder. As is shown in Column (5) of Table 7, the coefficients of *NB* are significant and positive. Therefore, the results remain robust after changing the criteria of large family shareholders.

Table 6
Coefficient stability analysis results.

Method	Judgment Standard	Actual Calculation Result	Whether It Passes or Not
(1)	$\beta^*(R_{max}, \delta) \in [-0.494, -0.038]$	$\beta^*(R_{max}, \delta) = -0.266$	Pass
(2)	$\delta \geq 1$ or $\delta < 0$	$\delta = -1.054$	Pass

Note: This table shows the regression results for the coefficient stability analysis: Line (1), δ test; Line (2), $\beta^*(R_{max}, \delta)$ test.

Table 7
Other robustness test results.

Variable	(1)	(2)	(3)	(4)	(5)
NB	0.231*	0.087**	0.443***	0.289**	0.354***
	(1.79)	(2.56)	(2.92)	(1.99)	(2.56)
Control	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Cons	−4.826***	−5.252***	−6.932***	−5.698***	−5.704***
	(−7.51)	(−8.99)	(−9.83)	(−8.35)	(−9.03)
N	2259	2510	2510	1980	2371
R2	0.251	0.255	0.329	0.238	0.249

Note: This table shows the regression results for other robustness tests. Column (1) presents the regression result for lagging the independent variables and control variables, Column (2) presents the regression result for changing the independent variable (*NB*), Column (3) presents the regression result for changing the dependent variable (*GI*), Column (4) presents the regression result for excluding service industry samples, and Column (5) presents the regression result for changing the criteria of family large shareholders. The t-statistic is shown in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

5. Underlying mechanisms and additional tests

5.1. Underlying mechanism test

Drawing on SEW theory, NFSG prevents controlling families from focusing too much on restricted SEW, thus exerting a resource effect to ease their financing constraints and encouraging their green innovation strategy implementation. It also protects extended SEW, thus exerting a reputation effect to increase the controlling families' focus on both the long-term development of the family firm and environmental protection, as well as to encourage their green innovation strategy implementation. We use indirect methods, namely the resource and reputation effects, to measure restricted and extended SEW. Although external investors can alleviate these financing constraints, they can also threaten the restricted SEW of family firms (Gómez-Mejía et al., 2011), which is at the core of family control. Therefore, family firms reject external investors, thereby worsening their financing constraints. In terms of extended SEW, family firms seeking to achieve an everlasting foundation focus more on corporate and family reputation and actively fulfil their social responsibilities (Berrone et al., 2010).

In the measurement of the resource effect, we use investment-cash flow sensitivity to measure the financing constraints. We refer to Custódio and Metzger (2014) and establish Model (3):

$$Inv_{i,t+1} = \theta_0 + \theta_1 NB_{it} + \theta_2 CF_{it} + \theta_3 NB_{it}{}^* CF_{it} + \sum \theta_i Control_{it} + Year + Industry + \varepsilon \quad (3)$$

In Model (3), *Inv* represents the investment level of the enterprise, measured by the ratio of capital expenditure to total assets (Custódio & Metzger, 2014). *CF* is measured by the ratio of net operating cash flows to total assets. Meanwhile, we refer to the relevant literature on measuring financing constraints and control for some of the variables that affect financing constraints (Beatty, Scott, & Weber, 2010; Custódio & Metzger, 2014; Hoshi, Kashyap, & Scharfstein, 1991), namely *Size*, *Lev*, *Growth*, *Age*, *ROE*, *Nwc* (the ratio of net working capital to total assets), *Capex* (the ratio of capital investment to total assets), *Board*, *Indep*, *Dual*, *Balance*, and *Mshare* (managerial ownership). *NB*CF* is the core variable of Model (3). If the coefficient (θ_3) of *NB*CF* is negative and statistically significant, it indicates that marital role reversal reduces the financing constraints faced by family firms. Column (1) of Table 8 presents the regression results of the resource effect mechanism test. The coefficient of *NB*CF* is negative and statistically significant, indicating that NFSG reduces family firms' financing constraints. This result supports the resource effect mechanism.

Given that media coverage is an important source of information for corporate stakeholders when evaluating the reputation of companies

Table 8
Results of the underlying mechanism test.

Variable	*Resource effect*	*Reputation effect*
	(1)	(2)
NB	0.005	0.323**
	(0.78)	(2.25)
*NB*CF*	−0.210**	
	(−2.33)	
Control	Yes	Yes
Year	Yes	Yes
Industry	Yes	Yes
Cons	−0.023	−4.479***
	(−0.74)	(−6.71)
N	2168	2482
R2	0.416	0.336

Note: This table shows the regression results for the underlying mechanism test. Column (1) is used to test the resource effect, and Column (2) is used to test the reputation effect. Meanwhile, as for the resource effect, the coefficient of *NB*CF* needs to be tested; as for the reputation effect, the coefficient of *NB* needs to be tested. The t-statistic is shown in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

(Fombrun & Shanley, 1990), we measure the reputation effect by the number of non-negative media reports. Based on the research of Milbourn (2003) and Francis, Huang, Rajgopal, and Zhang (2008), we use the logarithm of the number of positive news reports about the company in newspapers and online sources in a given year (*Rep*). The higher the value of *Rep*, the better the company's reputation. If a good reputation strengthens the positive effect of marital role reversal on philanthropy, the reputation effect mechanism is established. Column (2) of Table 8 presents the regression results of the reputation effect mechanism test. The coefficient of *Rep* is positive and statistically significant, indicating that a good corporate reputation strengthens the positive effect of NFSG on green innovation. This result supports the reputation effect mechanism.

5.2. Situational factors

Although NFSG can significantly improve the green innovation of family firms, its influence on green innovation is not homogeneous. The relationship between NFSG and green innovation can also be influenced by internal and external situational factors. Therefore, we select the family-oriented approach (reflecting a family firm's own attribute factors), heavy-pollution industry (reflecting a family firm's industry attributes), and institutional efficiency (reflecting a family firm's macro-environmental attributes) as situational factors. These situational factors can urge the NFSG to make certain adjustments when balancing the relationship between restricted SEW and extended SEW to exert the resource effect and reputation effect to a greater extent and thus better help the family firms to promote the green innovation strategy. We then observe whether NFSG can have heterogeneous influences on green innovation under the effect of different situational factors.

5.2.1. The types of family firms

Two types of family firms exist in China. The first type is the entrepreneurial family firm, which the controlling family founds. The second type is the non-entrepreneurial family firm, which is a firm that transforms from a non-family firm into a family firm through mergers and acquisitions and various other means (Du et al., 2022; Villalonga & Amit, 2010). As the two types of family firms become so in different ways, their goals also tend to differ. Entrepreneurial family firms pay more attention to the long-term interests of the enterprise. In contrast, non-entrepreneurial family firms have a short history of development, which leads them to pay more attention to the establishment of family authority and the short-term goals of the enterprise (Villalonga & Amit, 2010). For entrepreneurial family firms, against the realistic background of the controlling families paying more attention to long-term orientation, the positive effect of NFSG can be strengthened to promote the firms' green innovation strategy implementation. For non-entrepreneurial family firms, the controlling families have a low degree of recognition of the firm and focus on the safety of the firm's assets. In particular, non-family shareholders make family firms pay more attention to family control, which results in the controlling families making more conservative decisions. Thus, NFSG cannot have a positive effect on the family firms' green innovation strategies. Therefore, we believe that NFSG can improve the green innovation level of entrepreneurial family firms.

To verify the above analysis, we use the family style of a family firm as the standard. In the regression, entrepreneurial family firms are equal to 1, and non-entrepreneurial family firms are equal to 0. As shown in Column (1) of Table 9, *NB* can promote the green innovation of entrepreneurial family firms. As shown in Column (2) of Table 9, *NB* has no significant effect on the green innovation of non-entrepreneurial family firms. Therefore, NFSG can effectively improve the green innovation of entrepreneurial family firms but not of non-entrepreneurial family firms.

5.2.2. Heavy-pollution industries

Ecological environmental problems arise as a result of production methods and lifestyle. In terms of production methods, all kinds of enterprises, including family firms, especially heavy-pollution firms, have crucial responsibilities. Heavy-pollution firms are not only a crucial driving force for China's rapid economic development but are also the main producers of environmental pollution. Therefore, enterprises in heavy-pollution industries should implement green innovation strategies. The characteristics of large investment, slow effect, and high risk in heavy-pollution industries mean that family firms cannot gain direct profit in the short term. Family firms need to invest a lot of resources to upgrade their environmental protection facilities, which greatly increases their operating costs and thus reduces the willingness and enthusiasm of enterprises to invest in environmental protection (Orsato, 2006). NFSG can effectively exert the resource effect and reputation effect, thus increasing family firms' access to funds for upgrading their environmental protection facilities (thus helping them improve their level of green innovation) and helping controlling families uphold their family reputation. We believe that NFSG can also help improve the green innovation level of family firms in heavy-pollution industries.

We define heavy-pollution industries according to the *Environmental Information Disclosure Guide of Listed Companies* (*Draft for Comments*) issued by the Chinese government. They include 16 industries, such as thermal power, steel, and cement industries. When a family firm belongs to a heavy-pollution industry, *HP* equals 1; when a family firm does not belong to a heavy-pollution industry, *HP* equals 0. As shown in Column (3) of Table 9, *NB* can promote the green innovation of family firms in heavy-pollution industries. Meanwhile, as shown in Column (4), *NB* can also promote the green innovation of family firms in non-heavy-pollution industries. Therefore, regardless of whether a family firm belongs to a heavy-pollution industry, NFSG can effectively facilitate the firm's green innovation strategy implementation. This further demonstrates the important role of NFSG in improving family firms' green innovation levels across all industries.

5.2.3. Institutional efficiency

China is still in the process of economic transition, and as such, the degree of market development differs significantly across the country's regions (Amit et al., 2015). In areas with high institutional efficiency, the government can provide more efficient and transparent public services, enterprises can obtain resources more conveniently, market competition mechanisms are more efficient, and restraint mechanisms (*e.g.*, property rights protection and the legal system) are stronger (Amit et al., 2015; Beck, Demirgü-Kunt, & Maksimovic, 2005). Therefore, a perfect institutional environment can further strengthen the resource and reputation effect of NFSG, thus helping family firms implement

Table 9
Situational factor analysis results.

Variable	*FS*		*HP*		*IE*	
	(1)	(2)	(3)	(4)	(5)	(6)
NB	0.267**	0.457	0.451**	0.331**	0.476***	−0.206
	(2.01)	(1.12)	(2.09)	(2.18)	(2.98)	(−1.09)
Control	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Cons	−5.842***	−4.333***	−1.881**	−6.871***	−7.110***	−2.428***
	(−7.97)	(−4.32)	(−2.10)	(−9.95)	(−9.21)	(−2.73)
N	2015	495	742	1768	1830	680
R2	0.266	0.293	0.170	0.310	0.273	0.300

Note: This table shows the regression results for the situational factors. Columns (1) and (2) are the regression results for family style as the situational factor, Columns (3) and (4) are the regression results for heavy pollution industry as the situational factor, and Columns (5) and (6) are the regression results for institutional efficiency as the situational factor. The t-statistic is shown in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

green innovation strategies. In contrast, areas with an imperfect institutional environment, imperfect market systems, excessive government intervention, and the lack of fair and effective legal systems can hinder NFSG from playing a positive role, thus making it difficult to impact family firms' green innovation strategies positively. Therefore, we believe that NFSG can improve the green innovation level of family firms in areas with perfect institutional environments.

We follow Amit et al. (2015) and Du et al. (2022) and use the World Bank's *Report on the Government Governance, Investment Environment and Harmonious Society: China's 120 City Competitiveness*. This report covers six regions of mainland China: the Southeast Region, the Bohai Sea Ring Region, the Central Region, the Northeast Region, the Southwest Region, and the Northwest Region. In the first two regions, institutional efficiency is higher and is thus recorded as 1. In the other regions, institutional efficiency is lower and is thus recorded as 0. As shown in Column (5) of Table 9, when a family firm is located in an area with high institutional efficiency, *NB* can promote green innovation. However, as shown in Column (6), *NB* has no significant effect on green innovation when a family firm is located in an area with low institutional efficiency.

5.3. Additional analyses

Although Du et al. (2022) study the influence of NFSDAs, they still mainly focus on the non-family ownership structure and do not conduct an in-depth analysis of the characteristics of NFSDAs (*e.g.*, the dynamic effect, excess NFSDAs, and the specific expertise of directors). Therefore, we conduct further research on the specific characteristics of NFSDAs to provide more diversified and sufficient evidence for verifying the value of NFSDAs.

5.3.1. Influence of NFSG characteristics

5.3.1.1. Dynamic effect: from the perspective of the policy shock. We find that against the realistic background of vigorously developing China's mixed-ownership economy, NFSG can exert the resource and reputation effect to improve green innovation. In fact, the support of China's government for the mixed ownership economy demonstrates dynamic change, namely a gradual strengthening trend. Therefore, in the context of the increasing development of the mixed ownership economy in China, the impact that NFSG can have on the green innovation of family firms requires further exploration. Therefore, we further study the dynamic impact of NFSG on the green innovation of family firms after the strengthening of the mixed ownership reform in China. In 2015, the Chinese State Council announced that they would further strengthen the development of the mixed ownership economy going forward and promote mutual learning and promotion as well as the common development of all varieties of ownership capital. Thus, to reflect the strengthening of the mixed ownership reform in China, we adopt 2015 as the initial sample year. As using capital with different property rights to activate enterprise vitality has become crucial to achieving economic transformation in China (Arregle et al., 2019; Du et al., 2022), the promulgation of this policy provides a standard against which we can test the dynamic effect of NFSG on the green innovation of family firms.

We use *Policy* to measure the event in which mixed ownership reform is promoted more vigorously. *Policy* equals 1 for sample periods starting in 2015 and beyond, and 0 otherwise. The interaction of NFSG with mixed ownership reform in the setting of higher reform intensity allows for the dynamic effect of NFSG on the green innovation of family firms to be further elucidated. Column (1) of Table 10 presents the regression results. The coefficient of *NB*Policy* is 0.457, and it is positively correlated with *GI* at the 10% level. This indicates that once mixed ownership reform is promoted more vigorously, NFSG can help family firms further enhance their level of green innovation. (See Table 10.)

5.3.1.2. Influence of excess NFSDAs. The regression results show that non-family shareholders appointing directors is more effective for promoting green innovation in family firms than the non-family ownership structure. However, the descriptive statistics indicate that non-family shareholders hold the same number of shares as family shareholders but have different rights. Therefore, under the equivalence logic of ownership and control rights, there remains room for improvement in promoting the green innovation level of family firms *via* NFSDAs. In other words, under the inequivalence logic of ownership and control

Table 10
Extended analysis results: characteristics of the appointed directors.

Variable	(1)	(2)	(3)
NB	0.120		
	(0.83)		
Policy	0.117*		
	(1.65)		
*NB*Policy*	0.457*		
	(1.85)		
Over-NB		0.080**	
		(2.06)	
NB-EP			1.329**
			(2.22)
Control	Yes	Yes	Yes
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Cons	−5.243***	−5.325***	−5.250***
	(−8.91)	(−9.07)	(−8.96)
N	2510	2510	2510
R2	0.256	0.254	0.255

Note: This table shows the regression results for the extended analysis section on NFSG characteristics. Specifically, Column (1) uses the specific policy as a shock to test the impact of the dynamic effect. Column (2) tests the impact of excess NFSDs on green innovation. Column (3) tests the impact of the green expertise of NFSDA on the relationship between NFSG and green innovation. The t-statistic is shown in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

rights, this dilemma can be solved by further considering excess NFSDAs. In fact, having excess NFSDAs means that non-family shareholders can exert more influence on the strategies of family firms so as to better safeguard their own interests (Villalonga & Amit, 2009). We thus change the original reciprocal logic of ownership and control rights (Grossman & Hart, 1986; Hart & Moore, 1990) and observe the governance effect of excess NFSDAs.

We use *NF* and *NB* to measure excess NFSDAs. Specifically, when the value of *NB* exceeds the value of *NF*, this indicates the phenomenon of excess appointed directors. Thus, *Over-NB* is recorded as 1, and 0 otherwise. As shown in Column (2) of Table 10, the coefficient of *Over-NB* is positive and significant, implying that excess appointed directors can promote family firms' green innovation. Therefore, an excess appointed director is a key and effective way for non-family shareholders to engage in the governance of family firms.

5.3.1.3. Influence of NFSDAs' green backgrounds. Directors with relevant experience and expertise may be better at providing and monitoring resources (Hillman & Dalziel, 2003). Meanwhile, studies show that experienced directors can greatly assist in making effective corporate decisions (Adams, Akyol, & Verwijmeren, 2018; Feng & Xiao, 2022). According to the upper echelons theory, the different characteristics of managers can affect the business decisions of enterprises to varying degrees (Hambrick, 2007; Hambrick & Mason, 1984). Schoar and Zuo (2017) also find that management skills are gradually formed over managers' personal life and career, with professional experience, in particular, influencing their idiosyncratic cognitive structure, value orientation, and even decision-making mode. Therefore, we believe that whether NFSDAs have expertise in green environmental protection can directly affect the green innovation strategies of family firms.

We isolate the number of NFSDAs with green professional backgrounds, such as environmental protection engineering (*DG*), and calculate the ratio of *DG* to *Board* (*NB-EP*) as a proxy for the level of green professional experience. As shown in Column (3) of Table 10, the coefficient of *NB-EP* is significant and positive at the 5% level. This indicates that NFSDAs with green expertise can further enhance green innovation strategies in family firms. Therefore, the professional expertise of NFSDAs should be included in the criteria for testing the effectiveness of NFSG.

5.3.2. Effect of controlling families: from the perspective of SEW

A family nature of a family firm makes it possible for two kinds of SEW to guide strategic decisions for a family firm directly (Du et al., 2022). Although we mainly discuss the influence of NSFG on green innovation strategy based on two kinds of SEW in theoretical analysis, we have not directly tested the role of two kinds of SEW. Therefore, we try to quantify the two types of SEW further to analyze their impact on the relationship between NSFG and green innovation.

Referring to existing research (Anderson & Reeb, 2003; Du et al., 2022), we use family ownership and intergenerational inheritance to measure restricted SEW and extended SEW, respectively. For restricted SEW, when the value of family ownership exceeds its own median, *FC* equals 1, and 0 otherwise. For extended SEW, when the descendant of the controlling family serves as the chairman or CEO, *SC* equals 1, and 0 otherwise. The regression results are shown in Table 11. Regarding the influence of restricted SEW, Columns (1) and (2) show that in the sample group with higher family ownership ($FC = 1$), the correlation between *NB* and *GI* is positive and significant at the 5% level. In the sample group with lower family ownership ($FC = 0$), *NB* has no significant influence on *GI*. Regarding the impact of extended SEW, Columns (3) and (4) show that *NB* has no significant impact on *GI* in the sample group with intergenerational succession ($SC = 1$), and the correlation between *NB* and *GI* is positive and significant at the 1% level in the sample group without intergenerational succession ($SC = 0$).

For restricted SEW, the family attribute of family firm makes non-family shareholders not threaten the position of the controlling family. In contrast, the controlling family can make use of the abundant resources brought by non-family shareholders from the external capital market (Arregle et al., 2019). Therefore, with the support of the controlling family, non-family shareholders can better play their own governance role, thus helping family firms optimize their strategic decisions, including those related to green innovation. For extended SEW, because family firms aim to achieve intergenerational inheritance smoothly, it needs to be recognized by stakeholders within the business, including non-family shareholders (Sharma, Chrisman, & Chua, 2003; Zellweger, Nason, & Nordqvist, 2012). Especially in the stage where intergenerational inheritance has not been realized, entrepreneurs pay more attention to coordinating the interests between non-family shareholders and family shareholders, thus creating a good environment for realizing intergenerational inheritance (Zhu & Kang, 2021).

Overall, SEW (including restricted and extended SEW) can further optimize the relationship between NFSG and green innovation. Controlling families should hold an open and supportive attitude toward NFSG to facilitate green innovation strategy implementation in their firms.

Table 11
Extended analysis results: effect of controlling families from the perspective of SEW.

Variable	(1)	(2)	(3)	(4)
NB	0.423**	0.185	−0.205	0.421***
	(2.38)	(0.99)	(−0.82)	(2.90)
Control	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Cons	−5.439***	−4.824***	−2.527**	−6.616***
	(−6.58)	(−5.38)	(−2.38)	(−9.24)
N	1211	1299	717	1793
R2	0.248	0.287	0.282	0.288

Note: This table presents the regression results for the extended analysis of the influence of the controlling families from the perspective of SEW. Columns (1) and (2) test the impact of restricted SEW (family ownership) on the relationship between NFSG and green innovation, whereas Columns (3) and (4) test the impact of extended SEW (intergenerational succession) on the relationship between NFSG and green innovation. The t-statistic is shown in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

5.3.3. Economic consequence analysis of long-term orientation

For family firms, improving their long-term orientation is the key goal and a crucial topic of academic research (Lumpkin, Brigham, & Moss, 2010; Sharma, Salvato, & Reay, 2014). Studies generally argue that family firms have a higher level of long-term orientation than non-family firms (Gómez-Mejía et al., 2007). Controlling families with long-term orientation prefer long-term strategies, thus realizing a long-term vision (Gentry et al., 2016). Can green innovation thus enhance the long-term orientation of family firms? In the case of different levels of NFSG, does green innovation have heterogeneous influences on long-term orientation? These questions require examination. Therefore, we analyze the long-term orientation as the economic consequence. First, we test the impact of green innovation on long-term orientation. Secondly, we divide NFSDAs into sub-groups according to the median of NFSDAs and observe the influence of green innovation on long-term orientation differentiation in the context of heterogeneous NFSDAs.

Research on the definition of long-term orientation does not offer a unified viewpoint or mature measurement method. Long-term orientation reflects the tendency to prioritize the long-term meaning and influence of decisions and actions, and thus such decisions and actions will often only produce results after a long period of time (Miller & Le Breton-Miller, 2005). In turn, controlling families pay more attention to the impact of strategic decisions on long-term performance. Therefore, measuring long-term orientation by long-term performance can reflect the definition of long-term orientation to some extent; that is, family

firms with long-term orientation prefer long-term strategies when making decisions to realize their long-term vision (Gentry et al., 2016; Hoffmann, Wulf, & Stubner, 2016; Memili, Fang, Koc, Yildirim-Oktem, & Sonmez, 2018). Specifically, we use the average return on total assets of the next three periods as the proxy variable of long-term orientation (*LO*). At the same time, taking the median of *NB* as the standard, we test whether green innovation at different levels of NFSG has different effects on long-term orientation. Specifically, we construct Model (4):

$$LO_{i,t+1\sim t+3} = \rho_0 + \rho_1 GI_{it} + \sum \rho_i Control_{it} + Year + Industry + \varepsilon \quad (4)$$

In Model (4), $LO_{i,t+1\sim t+3}$ represents the average return on total assets in the next three periods. *Control* represents the control variable, which is consistent with Model (1). If the coefficient (ρ_1) of *GI* is positive and statistically significant, green innovation can significantly improve the long-term orientation of family firms. When the level of NFSG is high (*High-NB*), if the coefficient (ρ_1) of *GI* is positive and statistically significant, NFSG can strengthen the positive effect of green innovation on the long-term orientation of family firms. The regression results are shown in Table 12. As shown in Column (1), the correlation between *GI* and *LO* is positive at the 10% level of significance, indicating that green innovation can effectively enhance the long-term orientation of family firms. As shown in Column (2), when NFSG is high, *GI* is positively correlated with *LO* at the 10% level of significance. As shown in Column (3), there is no significant correlation between *GI* and *LO* when NFSG is low. These results show that the positive impact of green innovation on the long-term orientation of family firms is more significant at higher levels of NFSG. To advance their long-term orientation, family firms should fully leverage non-family shareholders' positive role in promoting green innovation.

Table 12
Extended analysis results: economic consequence analysis of long-term orientation.

Variable	(1) *LO*	(2) *High-NB*	(3) *Low-NB*
GI	0.003*	0.004*	0.002
	(1.85)	(1.83)	(1.30)
Control	Yes	Yes	Yes
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Cons	0.098**	0.186**	0.070
	(2.53)	(2.12)	(1.59)
N	1757	562	1195
R2	0.355	0.274	0.422

Note: This table presents the regression results for the extended analysis of the long-term orientation. Column (1) tests the impact of green innovation on long-term orientation. Columns (2) and (3) test the impact of NFSG on the relationship between green innovation and long-term orientation. The t-statistic is shown in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

6. Conclusions and implications

Green innovation strategy implementation is of great significance to promoting the long-term orientation of family firms and helping them achieve everlasting foundation. We use the SEW theory to explore the impact of NFSG on the green innovation strategies of family firms. Compared with non-family shareholder holding, NFSDAs can help family firms implement their green innovation strategies by exerting the resource and reputation effects. For entrepreneurial and family firms located in high institutional efficiency areas, NFSG plays a more significant role in promoting green innovation. We further test the characteristics of NFSG. NFSDAs with green professional backgrounds and having excess NFSDAs can effectively promote the implementation of green innovation strategy in family firms. Finally, NFSG can strengthen the positive effect of green innovation on long-term orientation.

Our findings provide important theoretical and practical insights. First, we draw on SEW as the research framework to deepen our understanding of the green innovation strategies of family firms and respond to the call of Calabrò et al. (2019) to combine different types of SEW to investigate the green innovation activities of family firms. Second, we respond to the calls of Li (2018) and Du et al. (2022) to attach importance to the study of NFSG and find that NFSDAs serve as a more effective form of NFSG. Third, our findings not only provide evidence for the effectiveness and rationality of NFSDAs but also indicate that the non-family shareholders resist the self-interest behaviour of the controlling family by amplifying the control rights. Fourth, we find that the industry expertise of NFSDAs can also play a positive role in the green innovation of family firms. This finding once again confirms the conclusion of Hillman and Dalziel (2003) that directors with relevant industry experience can provide valuable resources for enterprises. Finally, we measure different types of SEW through indirect and direct methods, thus providing a new perspective on the measurement of SEW.

Interpretation of our findings may have the following caveats, possibly offering future research opportunities. First, there is not a natural shock in our setting to allow us to establish causality. We thus utilize a series of robustness tests to mitigate endogeneity issues to the positive correlation between non-firm family shareholder governance and green innovation. Second, we explore the effectiveness of NFSG in China, and our findings may not be fully applicable to other contexts. Future studies could explore the role of NFSG within the institutional environments of different countries. In addition, although we use indirect methods (*i.e.*, the resource and reputation effects) and direct methods (*i.e.*, family ownership and intergenerational inheritance) to measure restricted and extended SEW, these methods still cannot fully cover the rich connotation of SEW. Thus, future research could further explore how to measure SEW more accurately using large-sample empirical testing methods.

CRediT authorship contribution statement

Shanzhong Du: Conceptualization, Original Draft, Formal Analysis, Software, Investigation, Methodology, Data Curation, Funding Acquisition, and Review & Editing.

June Cao: Conceptualization, Validation, Original Draft, Supervision, Resources, Investigation, Methodology, Writing-Review & Editing, Funding Acquisition, and Project Administration.

Declaration of Competing Interest

We certify that all authors have approved the final version of the manuscript being submitted. We warrant that the article is our original work, hasn't received prior publication and isn't under consideration for publication elsewhere.

We certify that there's no financial or personal interest that could affect the work reported in this paper.

Data availability

Data will be made available on request.

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Table A
Definitions of variables.

Variable	Detailed definition
GI	the logarithm of one plus the number of green invention patents.
NS	the sum of non-family shareholding ratio in the top ten shareholders
NB	the board participation of non-family shareholders
Size	the logarithm of total assets
Lev	the ratio of debt to assets
Growth	the growth rate of sales revenue
Age	the logarithm of the firm's listing years
ROE	return on equity
CF	the ratio of liquid assets to the book value of total assets net of liquid assets
Board	the logarithm of the number of directors
Indep	the proportion of independent directors
Dual	if the chairman and the CEO are the same person, the score is 1; otherwise, the score is 0
Balance	the ratio of the sum of the holdings of the second to fifth largest shareholders to the holdings of the first largest shareholder
Mshare	the ratio of managerial ownership
Confucius	the number of Confucius temples in the Ming and Qing dynasties in the area where a family firm is located
Nwc	the ratio of net working capital to total assets
Capex	the ratio of capital investment to total assets
Rep	the logarithm of the number of positive news reports about the company in newspapers and online sources in a given year
FS	entrepreneurial family firms are equal to 1, and non-entrepreneurial family firms are equal to 0
HP	when a family firm belongs to a heavy-pollution industry, *HP* equals 1, and 0 otherwise.
IE	institutional efficiency is higher and is thus recorded as 1; institutional efficiency is lower and is thus recorded as 0.
Policy	*Policy* equals 1 for sample periods starting in 2015 and beyond, and 0 otherwise
Over-NB	when the value of NB exceeds the value of NF, *Over-NB* is recorded as 1, and 0 otherwise
NB-EP	the number of NFSDAs with green professional backgrounds
FC	when the value of family ownership exceeds its own median, *FC* equals 1, and 0 otherwise
SC	when the descendant of the controlling family serves as the chairman or CEO, *SC* equals 1, and 0 otherwise
LO	the average return on total assets in the next three periods

Table B
Abbreviation table.

Abbreviation	Full name
SEW	socio-emotional wealth
NFSG	non-family shareholder governance
NFSDAs	the directors appointed by non-family shareholders
R&D	research and development
CSMAR	China Stock Market and Accounting Research
CNRDS	China Research Database Services
PSM	Propensity Score Matching
IV	Instrumental Variable

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