International Entrepreneurship and Management Journal (2024) 20:631–661
https://doi.org/10.1007/s11365-023-00886-x

The impact of equity pledge on inefficient investment: a perspective from family entrepreneurship

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Accepted: 8 August 2023 / Published online: 1 September 2023

Abstract
As an efficient and convenient financing method, equity pledges may have a heterogeneous impact on the inefficient investment of family firms. In order to verify this point, this paper takes A-share listed family enterprises from 2010 to 2021 as a research sample. It conducts an empirical test on the impact of equity pledges on inefficient investment in family firms by constructing a panel regression model. The results show that equity pledges can inhibit the inefficient investment of family firms. The social-emotional wealth factor weakens the encroachment effect of the controlling shareholder's equity pledge on the enterprise and shows a specific governance effect. Further research found that the inhibitory effect of equity pledges on the inefficient investment of family firms is only significant in over-investment. It is more effective when a family firm employs a general manager through internal promotion than other means. In addition, when a family firm is run by one generation in control, this inhibitory effect can also be enhanced due to its more vital socioemotional wealth for the family firms. Our research can provide crucial theoretical guidance and decision-making reference for preventing and controlling the operational risks of real enterprises in developing countries. At the same time, this research can also provide a way for developed countries to understand China's economic operation.

Keywords Equity pledge · Family firms · Inefficient investment · Over-investment · Socioemotional wealth

Introduction

As an essential national economy formed under the background of China's reform and opening up, family firms are different from state-owned enterprises and private enterprises. They are fully market-oriented economies. In terms of financing constraints and market competition, state-owned enterprises with a state-owned nature and background face greater challenges. They will more fully participate

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in the survival of the fittest in the market. However, equity pledge, as a low-cost and high-efficiency financing method (Anderson & Puleo, 2020; Huang et al., 2022), has been supported institutionally by the *Measures on Stock Pledge and Repo Transactions and Registration and Clearing* issued in China in 2013 and has benefited from the subsequent bullish market in 2014 and 2015 when its business scale has shown explosive growth. Pledge transactions in China are more common and relatively large than stock markets in other countries (Zhou et al., 2021). In 2020, the entire capital market almost entered a state where "all stocks are pledged." According to Wind data, at the end of 2020, more than 3400 companies in the A-share market had pledged equity, and more than 40% of the pledged stocks originate from the controlling shareholders of the enterprises. More than 20% of the shareholders have pledged up to 50%. 9.75% equity of the entire A-share market has been involved in the pledge, with a market value of up to 6 trillion yuan. Meanwhile, by the end of 2020, more than 80% of the pledged shares came from large shareholders of the family firms, and the total number of pledged shares reached more than 440 billion, accounting for about 70% of that of pledged shares in the A-share market. The scale of equity pledges with such a high value in family firms again exposes their financing constraints and the strong demand for funds. The particular equity pledge situation of Chinese family enterprises provides an excellent scenario for our empirical research to study the relationship between equity pledges and inefficient investment. This is why we choose Chinese family firms as the sample of the empirical experiment.

Equity pledge is a low-cost financing behavior, but the motivation for large shareholders to have equity pledges is not simply out of financing. Singh (2018a, b) believes that large shareholders may use equity pledges for operating listed companies and improve their valuation. On the other hand, according to Chen et al. (2007), Wang and Chou (2018), large shareholders pledge shares to tunnel list companies. In other words, controlling shareholders in financial distress will use equity pledges to seek private benefits of control, which can be supported by cases such as Sichuan Mingxing Electric Power Co., Ltd., and Hongyi "Corporations-in-grade." It can be seen that the motivation of large shareholders to pledge equity is not simply to finance listed companies. However, in most cases, it is carried out to maximize their interests.

The performance whitewashing behavior of controlling shareholders under equity pledge strengthens the information asymmetry between investors and management, and investors lack benign monitoring and evaluation of management, which triggers moral hazard of management and leads to inefficient investment. On the other hand, under-investment is manifested as the abandonment of projects with positive expected net present value, which increases the volatility of financial returns. Excessive investment will cause the enterprise financial difficulties (Zhang, 2022). Excessive investment often places too much emphasis on expansion scale and development speed, ignoring the control of corporate risks, thereby

increasing the company's financial risk. Driven by equity pledges, whether inefficient investment behavior will affect corporate risk-taking has become a concern.

The research on the impact of equity pledges on investment efficiency has shown that the equity pledge of large shareholders worsens inefficient investment. It is worth noting that there is evident divergence among scholars in further classifying inefficient investment into over-investment and under-investment. Different conclusions are drawn through theoretical and substantive analysis on how the equity pledge influences over-investment or under-investment. Several major points of view are as follows. Dou et al. (2019) believe that controlling shareholders' equity pledges will significantly increase inefficient investment. This view is supported by Wang and Chou (2018), who finds that a high proportion of large shareholders' equity pledge will radically reduce enterprise investment efficiency. Conversely, by classifying inefficient investment into over-investment and under-investment, Diamond et al. (2022) see the two mechanisms of intensified financing constraints and weakened corporate governance as the cause for under-investment, but no apparent correlation with over-investment.

This paper contributes to the literature in several ways. First, only a few studies have focused solely on family firms and investment efficiency in the existing literature. Research objects of investment efficiency mainly concern listed companies or state-owned enterprises (Huang et al., 2022). At present, a small amount of research on the investment efficiency of family firms is based on the analysis of corporate governance, ownership structure, internal control, and other management characteristics (Ho et al., 2020; Jiang & Kim, 2020; Chen et al., 2021). However, studies have yet to be undertaken to explore the investment efficiency of family firms from the perspective of external behavior. This research gap makes studying equity pledges and inefficient investment in family firms more valuable. Second, this paper starts with the social-emotional wealth theory (SEW). Unlike previous studies, this paper pays more attention to the potential benefits of SEW. This paper takes family firms that have emerged under the degree of market liberalization in recent years as the research object and reveal the impact of equity pledges on the investment efficiency of family firms through the unique social and emotional wealth characteristics of family firms. Contribute to universality. Finally, this paper analyzes the impact of equity pledges on enterprise investment efficiency and the specific impact mechanism, i.e., the separation of two rights, the second generation's inheritance, and the types of general manager's promotion has different moderating effects.

The remainder of this paper is structured as follows. Section "Literature review" provides an in-depth review of the relevant literature. Section "Background and hypotheses" proposes research hypotheses. Section "Empirical Design and Data" presents the methodology and data sources. Section "Results" discusses the research results. Section "Conclusions" contains the conclusions. Finally, Section "Policy implications" proposes corresponding policy implications based on the research conclusions.

Literature review

Equity pledge

Research on equity pledges has focused on their economic consequences in recent years. Studies have shown that equity pledges will expand the leverage effect of control rights, and as the proportion of equity pledges increases, the agency problem will be aggravated (Chauhan et al., 2021; Zhou et al., 2021). The behavior of the equity pledge will affect the weakening incentive effect and strengthen the encroachment effect of the company's value. After the major shareholders carry out equity pledge financing, there will be risks of transfer of control rights and leverage risks (Li et al., 2022). The equity pledge will also lead to the separation of the two rights. The severe separation of the control right and the cash flow right provides convenience for the shareholders to obtain the benefits of the control right. When shareholders face severe financial constraints, it is easier to seize funds from listed companies. Even under solid external supervision or internal checks and balances, this behavior of taking funds still exists. The higher the proportion of equity pledges, the greater the risk the company faces, and the more likely conflicts between shareholders will be intensified. Shareholders will have the motivation of risk aversion and "hollowing out" in order to maintain control after the equity pledge (Anderson & Puleo, 2020).

Equity pledge and inefficient investment

The problem of inefficient investment of enterprises has always been a concern for scholars. Enterprise inefficiency investment has two results: under-investment and over-investment (Khediri, 2021; Xu et al., 2023). Based on the theory of information asymmetry, the internal and external information of the company is asymmetric. When there is a financing constraint problem due to the high cost of external financing, major shareholders choose the financing method of equity pledge, which may cause the company to miss good investment opportunities and cause insufficient investment. According to the agency theory, management may expand investment by considering its interests and investing in projects whose internal rate of return is lower than the cost of capital, resulting in excessive investment (Rehman et al., 2021). When a company has a large amount of debt, compared with the fixed income of creditors, shareholders' income is more variable. When the investment project succeeds, it can obtain excess income; they only bear fixed risks when it fails. Therefore, shareholders are more inclined to invest in high-risk and high-return projects. When the equity concentration is high, the main reason for over-investment is the information asymmetry between shareholders and creditors. Li et al. (2021) reveal that controlling shareholder's equity pledge aggravates the over-investment and exacerbates the under-investment of enterprises. Moreover, Chu (2011) points out that under the controlling shareholders' equity investment, the deepening of the long-term interest inconsistency between controlling and minority shareholders of listed companies has led to over-investment. In terms of under-investment, as noted by Morellec (2004), if other

shareholders and creditors predict the "tunneling" behavior of the controlling shareholder, they will also require a high rate of return on capital, which leads to the rise of financing cost and further causes under-investment due to financing constraints.

In terms of over-investment, Johnson et al. (2000) claims that private gain from the controlling power is the intrinsic cause of inefficient investment. In the study conducted by Masulis et al. (2009), controlling shareholders may neglect the economic evaluation of the project for their utility and interfere with the listed companies' investment in projects in which they gain synergistic benefits by investing or purchasing personal assets at a higher price than the market average, or conducting dilutive mergers and acquisitions and inefficient investment, which eventually leads to over-investment. Controlling shareholders with information advantages are likelier to expand their investment scale and choose riskier investments. Rehman et al. (2021) find that politically connected firms in the Indian banking sector lead to significant inefficiencies in over-investment.

The above research shows that the equity pledge and the risk of transfer of control rights may drive the behavior of large shareholders to become more active and rational and more negative and irrational. For the two seemingly contradictory conclusions, it is necessary to sort out the reasons for the different conclusions.

Family firms equity pledge and inefficient investment

Family firms, as the essential national economy formed under China's reform and opening up, differ from state-owned ones and generally small and medium-sized private enterprises. First of all, family firms are the economy under complete marketization. Family firms face greater challenges than state-owned enterprises in terms of financing constraints and market competition, especially those with a strong background. They thus will be more fully involved in the market evolution (Calabrò et al., 2019). Besides, in a country with a rich accumulation of "family culture," a family firm is a socio-economic entity integrating features of both "enterprises" and "parents." Strategically, family firms have more affective endowment than small and medium-sized private enterprises, and the first-generation members of the family firms have a strong desire for their business that represents the glory of the family to be carried forward and passed on. Therefore, family firms' behavioral decision-making and development positioning are more inclined to be based on long-term interests (Martínez-Romero et al., 2020). As a particular economic entity, a family firm will inevitably make a difference in the decision-making of the equity pledge behavior of the controlling shareholder and the non-family firm controlling shareholder (Wang et al., 2022).

Kelleci et al. (2019) argue that the choice of professional managers as CEOs in family firms can significantly inhibit inefficient investment through the implementation of equity incentives, which encourage managers to evaluate investment opportunities more carefully, significantly reduce overinvestment and alleviate underinvestment. In addition, equity incentives promote the inhibition of inefficient investment caused by agency problems and information asymmetry. Other scholars have conducted relevant studies on the collusion among shareholders, family excess control, the preference of

family board seat allocation, allocation of family control rights, selection of family firms executives, agency relationships, and political connections (Gao et al., 2019; Cheng et al., 2020; Amin & Liu, 2020; Kanadlı et al., 2020; Purkayastha et al., 2022).

Overall, mixed research results regarding the relationship between equity pledges and inefficient investment have been obtained. Differences in the characteristics of control rights will lead to different operational and financial behaviors of large shareholders (Amin & Liu, 2020). Furthermore, different characteristics of control rights, such as the way to obtain control rights, the degree of separation of control rights, and cash flow rights, will all have an impact. The separation of rights under the equity pledge will directly aggravate the conflict of interests between major, minor, and medium shareholders and stimulate agency conflicts (Anderson & Puleo, 2020). In addition, according to the actual phenomenon, it can be seen that the number of private enterprises with equity pledges is much more than that of state-owned enterprises, which is related to the financing characteristics of private enterprises (Zhou et al., 2021). And most of the private enterprises with equity pledges are family enterprises. Moreover, the existing research has yet to research the investment efficiency of family enterprises from external behavior. The research in this paper fills up the research gap here. Based on this, two points can be the focus of attention: the characteristics of corporate control rights and the equity pledge of listed family companies. Therefore, this paper conducts a systematic empirical study on the relationship between family business equity pledges and inefficient investment.

Background and hypotheses

Inefficient investment is not conducive to the long-term development of enterprises and will damage company values. When the shareholders' equity is relatively concentrated, large shareholders with decisive control have a stronger motive to seek private benefits of control (PBC), which expropriates the interests of minority shareholders and creditors and thus results in the second agency problem (Singh, 2018a, b; Liu & Tian, 2021). Claessens et al. (2002) have worked on the relationship between company values and the degree of separation of control rights and cash-flow rights and have found that company values are positively correlated with cash-flow rights of controlling shareholders and negatively correlated with the degree of separation of two rights, i.e., the greater the degree of separation, the smaller the company values. According to Jensen (1993), when large shareholders have absolute decision-making power, they tend to invest in riskier projects for higher returns and carry out acquisitions with a high premium, thus encroaching on the rights and minority interests and resulting in over-investment. However, the under-investment is caused by inappropriate behavior in that large shareholder's tunnel assets of listed companies through related party transactions and thus lead to a shortage of internal funds.

It is acknowledged that the higher the proportion of equity pledges, the greater the degree of separation of two rights and the stronger the motive of controlling shareholders who pledge equity to occupy the company. The higher the proportion of major shareholders' equity pledges, the more serious the agency

problems caused by separating two rights. Therefore, large shareholders' equity pledge intensifies the separation of cash-flow rights and control rights, which further amplifies the encroachment effect of major shareholders on the company, minority shareholders, and creditors, and exacerbates inefficient investment. When large shareholders encroach on the interests of minority shareholders and creditors through investment in high-risk and high-yield projects, acquisitions with high yield and high premium, and large-scale business expansion (Gu et al., 2022), over-investment will occur in listed companies. On the other hand, when major shareholders directly encroach on the interests of other stakeholders through the activities such as directly occupying companies' internal non-operating funds, conducting related party transactions and interest transfer, and other forms of encroachment, it will lead to under-investment (Wang et al., 2020). However, in the family firms' equity pledge studied in this paper, controlling shareholders pursue not only economic interests but also non-economic goals, which will affect the final decision of shareholders to seek private benefits of control. Berrone et al. (2012) draw our attention to socioemotional wealth (SEW), which is the intermingling of psychological or emotional factors possessed by family members. These factors cannot directly influence business performance but will affect it through the acts or strategies applied to companies.

Based on the analysis above, this paper argues that the unique factor of socioemotional wealth in family firms will lead to different economic consequences of family firms' equity pledges. First, the socioemotional wealth of family firms will lessen the encroachment effect caused by the separation of two rights under the equity pledge. The effective endowment of controlling shareholders to family firms will also promote controlling shareholders to have a more intensive demand of preventing risks of losing control and inhibit the over-investment through reducing the investment in high-risk and high-yield projects, acquisitions of high premium projects and other related financial activities. Meanwhile, it will lessen shareholders' encroachment by capital occupation, thereby alleviating insufficient investment. Second, the socioemotional wealth arouses more attention from controlling shareholders of family firms and thus facilitates controlling shareholders to prevent risks of losing control under the equity pledge. Shareholders tend to avoid risks and reduce the investment scale while operating businesses in case of investment failure. This triggers a decline in stock prices and causes the loss of control of family firms. Therefore, the impact of controlling shareholders' equity pledges on family firms will present the governance effect concerning the inhibition of inefficient investment. Accordingly, this paper states the first two assumptions as follows:

Hypothesis 1 (H1) *Controlling shareholders' equity pledge inhibits the inefficient investment of family firms, and the higher the proportion of equity pledge, the greater the inhibition of inefficient investment.*

Hypothesis 2 (H2) *The separation of control rights and ownership caused by controlling shareholders' equity pledge on family firms weakens the encroachment effect.*

Intergenerational inheritance is a long-term process. A complete inter-generational inheritance begins with the second generation participating in managing family firms. It ends with the first generation completely withdrawing from the operation of the family firms. To be more rigorously defined, successful family firm inheritance includes the transfer of ownership and management rights and the inheritance of implicit knowledge, such as entrepreneurship and individual social network. In recent years, it has become a characteristic of family firms for family members, especially the first-generation entrepreneurs, who are the actual controllers of the family firms, to have a particular expectation that the family firms can be smoothly transferred from themselves to the second generation, thrive or even expand its scale under the management of the second generation. Family firms in China have experienced rapid development under the operation of first-generation entrepreneurs. Entrepreneurs usually have their unique management style and business philosophy and form a distinctive corporate culture of family firms, which is the essential difference between family and non-family firms. Demsetz and Lehn (1985) report that first-generation entrepreneurs add value to their businesses through acquired expertise, long-term and total equity, and non-economic association with enterprises, such as reputation and emotional connection. It is also observed that the company led by the first generation has better operating performance than any other companies, especially those run by other family members. Hence, the influence of first-generation entrepreneurs on the family firms differentiates from that of other family members. The first-generation entrepreneurs of family firms have developed a keen insight into the market, strong decision-making ability, and their pursuit of the emotional wealth of the enterprise under the influence of the traditional family culture. That is why first-generation entrepreneurs can make comprehensive business decisions that concern the family firms' long-term development by their own or family needs in business management to satisfy the demand for adequate endowment within the family. It has been demonstrated by Jensen (1993) that first-generation entrepreneurs have more outstanding capabilities and motivations to supervise business management. Their business skills can effectively reduce the information asymmetry between the management of companies and the board of directors, thus reducing the inefficient investment of the board of directors. Other scholars have reached similar conclusions and believe that the entrepreneurial chairman of the first generation triggers fewer agency problems and exerts stronger governance effects than the non-entrepreneurial chairman. While first-generation entrepreneurs actively participate in the company's management, family firms perform well.

To summarize the analysis above, when first-generation entrepreneurs operate family firms, their investment in the family firms will inevitably have a different impact. Family control is a symbol of family firms. According to the socioemotional wealth theory, family firms will utilize sufficient control over the enterprise to strike a balance between its interests and the goals of enterprises set both in the long-term and short-term. In an investigation into family firms, Chu (2011) claims that family firms face development obstacles due to financial constraints. Family firms need more debt or equity financing to break the growth dilemma. All these financing behaviors increase the control risk of family firms. For those family firms that care about their controlling power, family control preferences

make it possible to give up high growth rates at the cost of dilution control. Several authors have considered the moderating effect on the protection behavior of the socioemotional wealth of the family firms aroused by external resources, entrepreneurial experience, and other factors (Boellis et al., 2016; Gomez-Mejia et al., 2018). Because first-generation entrepreneurs are affected by the inseparability of investment risk, equipped with long-term sustainable business philosophy and the pursuit of the reputation and emotions of the family firms. It can be further inferred that first-generation entrepreneurs will use their abilities to keep abreast of market change to avoid the risk of inefficient investment under the equity pledge. Moreover, in the meantime, supervise managers more frequently to avoid the negligent behavior of the board of directors as much as possible and prevent the transfer of family firms' control under the equity pledge. Thus, this paper proposes the following research hypotheses:

Hypothesis 3 (H3) *The role of equity pledges in inhibiting the inefficient investment is stronger when the family firms has not completed its succession and the first-generation entrepreneurs are involved in the actual management of the business.*

The degree to which family firms pursue socioemotional wealth and its impact on behavioral decision-making is not only related to the controlling shareholders but also influenced by the implementation of the internal operation of family firms. Decisions made by the family firms' core executives affect the family firms' development. However, as family firms in China have completed their start-up period, large family firms during the growth period are required to introduce external professional managers to manage the enterprises more professionally in the inheritance process. The expertise of external professional managers can meet the demands of standardized management of family firms management standardization. Whether general managers can weigh the advantages and disadvantages of economic and non-economic goals, as well as shareholders of family firms, in decision-making depends on the willingness of the general manager to pursue socioemotional wealth. Further analysis shows that the behavior decision of the general manager is affected by factors such as personal work experience, working period, academic background, the size of the family firms' equity incentive, and gender. Among numerous factors, this paper argues that the work experience of general managers has an essential impact on their willingness to pursue socioemotional wealth. Especially in the entrepreneurial period of family firms, employees with senior-level seniority usually develop deep friendships with family firm controllers. These employees can be classmates, friends, and brothers of family controllers. Although they have no direct kinship, they have become "members of the family" of the family controller to some extent. Such executives also bear profound feelings for family firms, and thus they will also pursue socioemotional wealth for family firms. Therefore, an internally promoted general manager of a family firm has a more profound and special affection for businesses than a professional manager employed outside the family firm. Moreover, the pursuit of socioemotional wealth by internally promoted general managers is unmatched by professional managers as outsiders.

Whether the socioemotional wealth of family firms ultimately affects the corporate investment behavior under the equity pledge or not and to what extent it will affect the corporate investment activities are both influenced by the preference of the general manager as the core executive for socioemotional wealth. The difference in the degree of internalization of general managers fundamentally determines whether they can be aligned with family shareholders and are willing to pursue socioemotional wealth, thus reducing inefficient investment. Based on the above analysis, this paper predicts:

Hypothesis 4 (H4) *Internal promotion of general managers in family firms enhances the inhibition of controlling shareholders' equity pledge on inefficient investment.*

Figure 1 shows the comprehensive research framework of the above studies.

Empirical design and data

Empirical design and models

In order to study the impact of the controlling shareholders' equity pledge on the inefficient investment of family firms and test whether **H1** is valid, this paper designs the corresponding empirical model as follows. Considering the endogeneity and the period for the impact of the equity pledge on the investment efficiency of enterprises, this paper draws on the empirical strategy of Purkayastha et al. (2022), performs a one-period lag treatment on the main variables in the regression, and constructs the following panel regression model:

$$\begin{aligned} Ieffi_{it} = {} & \beta_0 + \beta_1 Pled_{i,t-1} + \beta_2 Size_{i,t-1} + \beta_3 Lev_{i,t-1} + \beta_4 Roa_{i,t-1} + \beta_5 Top_{i,t-1} \\ & + \beta_6 Age_{i,t-1} + \beta_7 Ppe_{i,t-1} + \beta_8 Growth_{i,t-1} + \beta_9 Mgr_{i,t-1} \\ & + \beta_{10} Instr_{i,t-1} + \beta_{11} Dual_{i,t-1} + \beta_{12} Ddr_{i,t-1} + \eta_i + \lambda_t + \varepsilon_{it} \end{aligned} \quad (1)$$

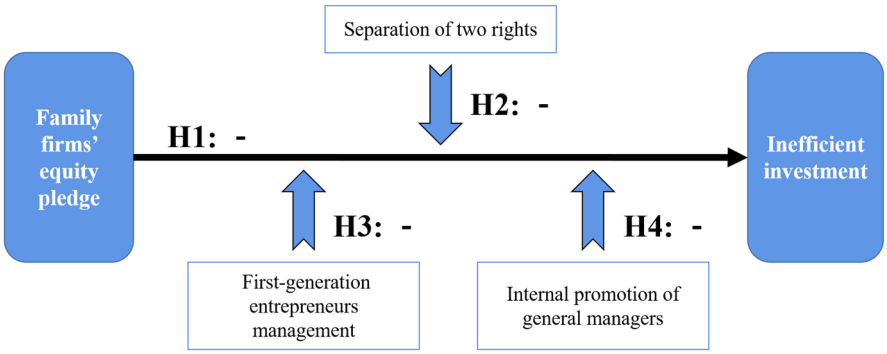

Fig. 1 Research framework. Note: "-" means negative impact

$$\begin{aligned} Ieffi_{it} = {} & \beta_0 + \beta_1 Ple_{i,t-1} + \beta_2 Size_{i,t-1} + \beta_3 Lev_{i,t-1} + \beta_4 Roa_{i,t-1} + \beta_5 Top_{i,t-1} \\ & + \beta_6 Age_{i,t-1} + \beta_7 Ppe_{i,t-1} + \beta_8 Growth_{i,t-1} + \beta_9 Mgr_{i,t-1} \\ & + \beta_{10} Instr_{i,t-1} + \beta_{11} Dual_{i,t-1} + \beta_{12} Ddr_{i,t-1} + \eta_i + \lambda_t + \varepsilon_{it} \end{aligned} \tag{2}$$

where, i indexes the firm and t indexes the year. *Ieffi* is dependent variables, i.e., inefficient investment. *Pled* and *Ple* are equity pledge dummy variables and equity pledge rate respectively. *Size* is firm's assets. *Lev* is firm's liabilities to assets ratio. *Roa* is firm's return on assets. *Top* is firm's ownership concentration. *Age* is firm's age. *Ppe* is firm's asset tangibility. *Growth* is firm's development capacity. *Mgr* is firm's management shareholding ratio. *Instr* is the institutional shareholding ratio. *Dual* is a dummy variable for the concurrent role of chairman and general manager of the firm. *Ddr* is the proportion of shares held by independent directors. η and λ are industry and year effect respectively. ε is a random error term.

Because the equity pledge leads to the separation of the controlling shareholders' cash-flow rights (ownership) and control rights, according to previous studies, the separation of two rights will lead to the encroachment effect of major shareholders on the company and eventually lead to the inefficient investment of the enterprise. While this paper argues that family firms, because of their unique pursuit of non-economic objectives, even if the control rights of controlling shareholders are more significant than their cash-flow rights due to the equity pledges, the encroachment effect will not show because shareholders of family firms value their family control rights based on the socioemotional wealth. Instead, these shareholders will be more risk-averse in their investment decision-making because they are concerned about the potential risks of losing control under the equity pledge to reduce the inefficient investment and avoid a negative impact on the capital market, which will lead to the loss of control. Therefore, the following Eqs. (3) and (4) are constructed by adding the interaction terms of the degree of the separation of two powers (*Cs*) of controlling shareholders and the equity pledge to Eqs. (1) and (2) to test the mechanism of equity pledge affecting inefficient investment in family firms. In which cs, the degree of separation of two rights, is replaced by two measures, including a dummy indicator (*Cs*0) and an absolute indicator (*Cs*1) for the separation of two rights. Also, based on the characteristics of *Cs*1 and *Ple* both in the interaction terms, the estimated coefficients are demeaned in order to cope with the estimation error. Suppose β_3 in Eqs. (3) and (4) pass the significance test, and the coefficients are negative. In that case, it indicates that the separation of two rights due to controlling shareholders' equity pledges in family firms will inhibit the efficiency of corporate investment rather than the inefficient investment caused by the encroachment effect, and **H2** is verified.

$$\begin{aligned} Ieffi_{it} = {} & \beta_0 + \beta_1 Pled_{i,t-1} + \beta_2 Cs_{i,t-1} + \beta_3 Cs_{i,t-1} * Pled_{i,t-1} + \beta_4 Size_{i,t-1} \\ & + \beta_5 Lev_{i,t-1} + \beta_6 Roa_{i,t-1} + \beta_7 Top_{i,t-1} + \beta_8 Age_{i,t-1} + \beta_9 Ppe_{i,t-1} + \beta_{10} Growth_{i,t-1} \\ & + \beta_{11} Mgr_{i,t-1} + \beta_{12} Instr_{i,t-1} + \beta_{13} Dual_{i,t-1} + \beta_{14} Ddr_{i,t-1} + \eta_i + \lambda_t + \varepsilon_{it} \end{aligned} \tag{3}$$

$$Ieffi_{it} = \beta_0 + \beta_1 Ple_{i,t-1} + \beta_2 Cs_{i,t-1} + \beta_3 Cs_{i,t-1} * Ple_{i,t-1} + \beta_4 Size_{i,t-1} + \beta_5 Lev_{i,t-1} + \beta_6 Roa_{i,t-1} + \beta_7 Top_{i,t-1} + \beta_8 Age_{i,t-1} + \beta_9 Ppe_{i,t-1} + \beta_{10} Growth_{i,t-1} + \beta_{11} Mgr_{i,t-1} + \beta_{12} Instr_{i,t-1} + \beta_{13} Dual_{i,t-1} + \beta_{14} Ddr_{i,t-1} + \eta_i + \lambda_t + \varepsilon_{it} \quad (4)$$

Next, to test the moderating effect of second-generation entrepreneurs' inheritance of family firms on the impact of equity pledges on inefficient investment, and since the nature of the moderator variable of second-generation inheritance is a dichotomous variable, this paper applies grouping regression. Based on Eq. (1) and (2), regression was performed respectively on the non-inheritance group, in which the first-generation entrepreneurs control the operation of family firms, and the inheritance group, in which other generations except for the first control the operation. Suppose the regression coefficient β_1 of the equity pledge indicator in the non-inheritance group is negative, while that in the heritage group is insignificant or less significant. In that case, it can be inferred that the first-generation entrepreneurs' actual control has a more substantial effect on equity pledge to inhibit inefficient investment, and the **H3** of this paper is verified.

Finally, in order to test the moderating effect exerted by the promotion mode of general managers on the impact of equity pledges on the inefficient investment of family firms, based on Eqs. (1) and (2), the corresponding grouping regression is conducted according to the source of hiring general managers of family firms, namely internal promotion or external employment. If the general manager is promoted internally, that is, $Pceo = 1$, the coefficient of equity pledge and non-efficient investment is significantly negative, and when the general manager is hired from the outside, that is, $Pceo = 0$, the relationship between equity pledge and inefficient investment is not apparent. It shows that the general managers of the family firms who are promoted internally compared with those who are externally hired improve the inhibition of inefficient investment, and **H4** is verified.

Variables

Dependent variables. Inefficient investment (*Ieffi*) as a response variable includes under-investment (*Under*) and over-investment (*Over*). The relationship between them is: inefficient investment refers to the behavior that the actual investment expenditure of the enterprise is inconsistent with the optimal investment level. Abandoning projects with positive net present value when sufficient resources exist in the firm results in under-investment, and committing firm resources to projects with negative net present value results in over-investment. This paper explores investment inefficiency through the residuals of Richardson (2006)'s investment efficiency model. The specific model is as follows:

$$Invest_{it} = \alpha_0 + \alpha_1 Growth_{i,t-1} + \alpha_2 Cash_{i,t-1} + \alpha_3 Age_{i,t-1} + \alpha_4 Size_{i,t-1} + \alpha_5 Return_{i,t-1} + \alpha_6 Invest_{i,t-1} + \eta_i + \lambda_t + \varepsilon_{it} \quad (5)$$

where, *Invest* is a dependent variable that represents the actual amount of new investment of the enterprise. The total investment of enterprises can be divided into new investment, which includes expectations investing and extra expectations investing (over-investment and under-investment) and maintenance investment according to the use of investment, with the following relationship equation: Total investment-maintenance investment = new investment = expectations investing + extra expectations investing; New investment = cash paid for building fixed assets, intangible assets and other long-term assets - cash recovered from disposal of fixed assets, intangible assets, and other long-term assets. Therefore, in this paper, capital expenditure *Invest* = (cash paid for the purchase and construction of fixed assets, intangible assets and other long-term assets + net cash paid for the acquisition of subsidiaries and other business units-net cash recovered from the disposal of subsidiaries and other business units) / total assets at the end of the previous year.

In addition, *Growth* represents the development capacity of the enterprise, expressed as the growth rate of operating revenue; *Cash* represents the cash holdings of the enterprise, measured by monetary funds, net short-term investments, total liabilities and total assets in balance sheet; *Age* represents the age of the company and is calculated on the listing date; *Size* represents the size of a listed company, measured by total assets in the balance sheet; *Return* represents the annual return of stocks in the capital market and is replaced by the annual is replaced by the annual return on equity considering the reinvestment of cash dividends; η_i and λ_t represent dummy variables of Industry and Year respectively.

Independent variables Equity pledge, as an explanatory variable, is measured by two methods. (1) Equity pledge dummy variable (*Pled*). Whether the controlling shareholder's equity pledge exists in the family enterprise at the end of the year indicates whether the controlling shareholder of the family enterprise has pledged the equity in that year. *Pled*=1 if the controlling shareholder's equity pledge exists in the company at the end of year *t* and 0 otherwise (DeJong et al., 2020). (2) Equity pledge rate (*Ple*). The continuous variable equity pledge rate of the controlling shareholder's equity pledge reflects the degree of equity pledge of the controlling shareholder in that year, and is measured by the ratio of the number of shares pledged by the controlling shareholder to their own total shareholdings at the end of year *t* (Bhatia et al., 2019).

Moderator variables With the current background that family firms in China are gradually entering the handover to next generations, this paper discusses the moderating effect of equity pledge on the investment efficiency of family firms from two perspectives including whether family firms are inherited by second-generation entrepreneurs or not and how general managers are promoted within family firms.

1. Inter-generational inheritance (*Entr*). According to previous studies, inter-generational inheritance is a process that begins with the second generation participating in the management of the family enterprise and ends with the second generation eventually becoming the actual controller of the family enterprise and gaining full decision-making power. Churchill and Hatten (1997) divided the inter-generational inheritance

into four stages according to the degree of transfer of power: owner-managed business, training and development of the new generation, a partnership between the generations, and transfer of power. Xu et al. (2022) defined a company with second-generation involvement as a company where a second-generation member, who is the actual controller of the company, is appointed as the chief executive officer (CEO) or chairman or director. This paper draws on the definition of Xu et al. (2022) and designs the regulatory variable about inter-generational inheritance since the research object of this paper is controlling shareholders of family firms, and the research concerns the economic consequences of controlling shareholders' equity pledge behavior. It is also due to the inevitable influence on controlling shareholders' decision-making by inter-generational inheritance as an essential stage in the development of family firms. *Entr*=1 when the first generation of family firms serves as the CEO or the general manager, i.e., the actual control of family firms is still in the hands of the first generation, and the succession has not been completed, and 0 otherwise.

2. General manager promotion method (*Pceo*). Referring to Du et al. (2022), *Pceo* = 1 when the general manager of family firms is promoted internally and 0 when hired from the outside.

Control variables This paper mainly considers factors affecting the investment efficiency of enterprises from the aspects of corporate governance characteristics and corporate financial characteristics. Appropriate control variables are selected to enhance the validity of the empirical results. A set of control variables in terms of corporate governance characteristics include the logarithm of the natural logarithm of total assets (*Size*), year of the listing of corporations (*Age*), ownership concentration (*Top*), namely the shareholding ratio of the largest shareholder; Management shareholding ratio, institutional shareholding ratio, executive duality and other multidimensional measurement indicators. Control variables also include corporate growth (*Growth*) that affects the development of corporations, i.e., (operating revenue of current period–operating revenue of prior period) / operating revenue of prior period; liabilities to assets ratio (*Lev*), i.e., total liabilities / total assets of the enterprise; return on assets (*Roa*), i.e., net profit/ total assets, and other variables as indicators in terms of corporate financial characteristics (Anderson & Puleo, 2020) . Asset Tangibility (*Ppe*) = (Inventory Net Value + Fixed Assets Net Value) / Total Assets at the Beginning of the Period. The management shareholding ratio (*Mgr*) is measured by the management's share of the listed company's shares in the company's total shares. Institutional shareholding ratio (*Instr*) refers to the shareholding ratio of institutional investors. Two-in-one (*Dual*) is 1 if both the chairman and the general manager serve concurrently, and 0 if not. The proportion of shares held by independent directors (*Ddr*) refers to the proportion of shares held by independent directors to the total share capital. Considering the endogeneity issues, this paper treats the main variables in the regressions with a one-period lag. The detailed definitions of these variables are in Table 1.

It can be concluded from Table 1 that the maximum value of *Ieffi* is 4.930, indicating that some enterprises have relatively high inefficient investment, and the average value is -0.329, indicating that the degree of inefficient investment in most sample enterprises is not severe. The mean value of *Over* is 0.857, and the maximum

Table 1 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Ieffi	15170	-0.329	1.339	-3.992	4.930
Over	6041	0.857	1.457	0.008	10.365
Under	9129	1.058	1.016	0.012	4.317
Pled	24065	0.603	0.489	0	1
Ple	12903	0.177	0.255	0	1
*Cs*0	24065	0.504	0.500	0	1
*Cs*1	23441	0.126	0.195	0	0.781
Entr	24065	0.906	0.291	0	1
Pceo	24065	0.856	0.351	0	1
Size	23675	21.707	1.086	19.213	24.934
Lev	23675	0.379	0.205	0.044	0.960
Roa	23675	0.040	0.084	-0.417	0.220
Top	23664	0.324	0.140	0.087	0.720
Age	20642	1.725	0.922	0	3.219
Ppe	23675	0.182	0.131	0.002	0.566
Growth	23227	0.004	0.010	-0.008	0.077
Mgr	22712	0.232	0.276	0	1.120
Instr	23587	0.354	0.247	0.001	0.892
Dual	24065	0.409	0.492	0	1
Ddr	14710	0.379	0.052	0.333	0.571

value is 10.365, indicating that the proportion of over-invested sample enterprises in the whole sample is relatively low. The mean value of *Under* is 1.058, and the maximum is 4.317, indicating that the sample companies with an insufficient investment account for a relatively high proportion of the total sample. The mean value of *Pled* is 0.603, indicating that the sample companies with equity pledges account for a relatively high proportion of the total sample, which is more in line with the actual situation in the Chinese market. The Pearson correlation coefficient calculates the correlation among dependent, independent, and moderator variables, and the results are shown in Table 2. It can be seen from Table 2 that the correlation of these variables is significant at the 10% level, and the selected nine variables are suitable for inclusion in the model. Also, the variance inflation factor (VIF) values of all independent variables are less than 10. Therefore, there is no significant multicollinear relationship among all independent variables in this paper, and the data studied are suitable for regression analysis.

Data sources

This paper takes the data of A-share listed family firms from 2010 to 2021 as samples because large shareholders' equity pledge has gradually begun to form a scale since 2010. Thus the impact of the equity pledge behavior of shareholders on listed companies is representative. Cleaner data from 2010 is selected as the beginning of

Table 2 Correlation Analysis

	Ieffi	*Over*	*Under*	*Pled*	*Ple*	*Cs*0	*Cs*1	*Entr*	*Pceo*
Ieffi	1								
Over	0.938***	1							
Under	-0.999***	0.054***	1						
Pled	-0.038***	0.023*	0.042***	1					
Ple	-0.058***	0.023*	0.056***	0.158***	1				
*Cs*0	-0.044***	0.067***	0.117***	-0.002	0.030***	1			
*Cs*1	-0.111***	0.048***	0.112***	-0.031***	0.033***	0.628***	1		
Entr	0.007	0.040***	0.014	0.014**	0.006	0.071***	0.076***	1	
Pceo	0.096***	-0.130***	-0.148***	-0.082***	-0.028***	-0.074***	-0.093***	-0.019***	1
VIF				1.010	1.00	1.710	1.720	1.010	1.010
1/VIF				0.993	0.999	0.584	0.582	0.991	0.991

the sampling period when considering that the share-trading reform implemented in China in 2005 requires a long transition time. The data of family businesses has been updated to 2021, so this paper chooses 2021 as the cut-off year of the research scope. The sample selection follows the following principles: (1) Exclude companies with ST stock in the sampling period; (2) Eliminate the abnormal or missing financial data; (3) In order to avoid the possible impact of extreme outliers on the regression results, this paper winsorize all continuous variables at 1% and 99%. This paper uses Stata16.0 for data processing and statistical analysis based on the above sample selection criteria. It analyzes the equity pledge observation data of 24065 A-share listed family enterprises selected from the CSMAR database.

Results

Benchmark result

Table 3 presents the empirical test results on the impact of controlling shareholders' equity pledges of listed family firms on investment efficiency. It can be noticed that both the equity pledge dummy variable (*Pled*) and controlling shareholders' equity pledge rate (*Ple*) facilitate the inhibition of inefficient investment of enterprises. However, when inefficient investment is divided explicitly into over-investment and under-investment, the controlling shareholders' equity pledge in family firms shows an apparent negative correlation with over-investment (*Over*), and the significance levels of equity pledge dummy variable (*Pled*) and equity pledge rate (*Ple*) are both 1%. On the other hand, neither equity pledge dummy variable (*Pled*) nor equity pledge rate (*Ple*) is significant on under-investment (*Under*). As shown in the above descriptive statistical analysis, under-investment is less evident in family firms than over-investment, and there are hardly any family firms with severe under-investment. However, the empirical results still show that the listed family firms with controlling shareholders' equity pledges can effectively inhibit their inefficient

Table 3 Benchmark Estimate Results

Variable	*Ieffi* (1)	*Ieffi* (2)	*Over* (3)	*Under* (4)	*Over* (5)	*Under* (6)
Pled	-0.251***		0.086	0.247***		
	(0.041)		(0.063)	(0.051)		
Ple		-0.327***			-0.193**	-0.178*
		(0.090)			(0.042)	(0.095)
Size	-0.522***	-0.623***	-0.524***	-0.129**	-0.564***	-0.152**
	(0.040)	(0.055)	(0.067)	(0.051)	(0.100)	(0.071)
Lev	-0.257	-0.495**	-0.128	-1.077***	-0.173	-1.182***
	(0.157)	(0.208)	(0.269)	(0.187)	(0.368)	(0.247)
Roa	0.228	0.581**	0.042	0.153	-0.469	0.175
	(0.238)	(0.293)	(0.372)	(0.290)	(0.477)	(0.361)
Top	-0.849***	-1.246***	-0.848**	-1.181***	-1.196*	-1.527***
	(0.275)	(0.371)	(0.417)	(0.362)	(0.625)	(0.475)
Age	-0.336***	-0.220***	-0.386***	-0.269***	-0.381***	-0.485***
	(0.044)	(0.064)	(0.063)	(0.065)	(0.100)	(0.091)
Ppe	-0.941***	-1.428***	-0.329	-0.091	-0.469	-0.309
	(0.219)	(0.299)	(0.339)	(0.277)	(0.497)	(0.368)
Growth	-7.468***	-6.333***	-9.135***	-3.315	8.797***	-0.863
	(1.748)	(2.154)	(3.016)	(2.036)	(3.813)	(2.474)
Mgr	-0.017	-0.203	-0.424**	-0.006	-0.403	-0.060
	(0.135)	(0.180)	(0.208)	(0.175)	(0.300)	(0.222)
Instr	-0.112	-0.100	0.248	0.660***	0.917**	0.868***
	(0.168)	(0.226)	(0.256)	(0.215)	(0.370)	(0.285)
Dual	0.049	0.013	0.092	-0.005	0.083	0.069
	(0.047)	(0.061)	(0.076)	(0.057)	(0.102)	(0.075)
Ddr	0.006	0.114	0.277	0.742	0.657	0.064
	(0.455)	(0.604)	(0.749)	(0.549)	(1.068)	(0.715)
Industry Effect	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES
R^2	0.034	0.045	0.109	0.029	0.107	0.039
N	9259	6187	3949	5310	2600	3587

*** means statistical significance at 1% level, ** means significance at 5% level, * Statistical means significance at 10% level, and the corresponding standard error is shown in parentheses

investment. Equity pledge has a positive effect on family firms which is different from that of non-family firms.

Furthermore, from the perspective of control variables, the coefficients of *Size* and inefficient investment *Over* and *Under* are -0.524 and -0.129 respectively (see columns (3) and (4) in Table 3), both of which are significant at the level of 1%, which indicates that the larger the family enterprise, the more effective its management of enterprise investment efficiency compared with smaller family firms, the more mature its investment decisions, which is in accordance with the reality. At

the same time, this result is the same as Hou et al. (2021), which further supports our point of view. Most of the family firms in China originated from the reform and opening-up in the 1980s, when a group of entrepreneurs who work hard and accumulated experience at the grassroots. This batch of family firms usually starts from scratch, grows from small companies to large ones with enough abilities and capital to expand their sizes, and even become multinational companies formed by globalization around 2021. Therefore, small-scale companies' investment demand is greater than large-scale companies. The management and corporate governance of large-scale family firms enable them to have more scientific control over the efficiency of enterprise investment. Thus the level of inefficient investment in large-scale family firms is lower. From the above empirical results, **H1** in this paper has been verified. It can be concluded that the listed family firms with the controlling shareholder's equity pledge will inhibit its inefficient investment as the proportion of the controlling shareholder's equity pledge increases, the stronger the effect of inhibiting the over-investment of the family firms.

Mechanism and test of inefficient investment in family firms

Table 4 illustrates the impact of the separation of two rights on the controlling shareholders' equity pledge of family firms and the efficiency of enterprise investment. The regression results show that the regression coefficients of the interaction terms are both negative under the condition of over-investment (*Pled*Cs*0 and *Ple*Cs*0 in columns (3) and (4), *Pled*Cs*1 and *Ple*Cs*1 in columns (7) and (8)), regardless of the separation of two rights dummy variable (*Cs*0) or the degree of the separation of two powers (*Cs*1), and they have passed the significance test at the level of 10% respectively. This explains that under the family firms' equity pledge, the separation of control rights and cash-flow rights caused by the equity pledge is inconsistent with previous studies, which argue that separating two rights will lead to an encroachment effect. The impact of equity pledge on the investment efficiency of the family enterprise is affected by the special nature of the family itself, namely the influence exerted by the socioemotional factors. When control rights and cash-flow rights are separated, controlling shareholders will make decisions based on the stable operation of the enterprise and hold a risk-averse attitude in investment out of their preference for the control of family firms. According to the regression results, **H2** in this paper has been verified.

Moderating effect of second generation inheritance

Based on the attributes of the actual controller of the family firms, the samples are divided into the non-inheritance group, with the first-generation entrepreneur having actual control of the family firms as the chairman or general manager, and the inheritance group in which the second or third generation has already become the chairman or general manager. The regression results of the two groups are presented as follows. First, by comparing the regression coefficients of equity pledge indicators in columns (1) and (2) of Tables 5 and 6, it is found that the regression coefficients

Table 4 Mechanism Test

Variable	*Ieffi* (1)	*Ieffi* (2)	*Over* (3)	*Over* (4)	*Ieffi* (5)	*Ieffi* (6)	*Over* (7)	*Over* (8)
Pled	-0.344***		0.050		-0.307***		0.011	
	(0.052)		(0.081)		(0.047)		(0.071)	
Ple		0.388***		0.470***		0.410***		0.443***
		(0.106)		(0.181)		(0.093)		(0.161)
*Cs*0	-0.069	0.182**	-0.113	0.096				
	(0.082)	(0.087)	(0.115)	(0.125)				
*Pled***Cs*0	0.218***		-0.079*					
	(0.075)		(0.005)					
*Cs*1					-0.289	0.352	-0.853**	0.278
					(0.254)	(0.260)	(0.425)	(0.417)
*Pled***Cs*1					0.436		-0.886**	
					(0.312)		(0.464)	
*Ple***Cs*0		-0.134*		-0.686**				
		(0.085)		(0.278)				
*Ple***Cs*1						-0.856*		-3.577***
						(0.481)		(1.075)
Size	0.522***	0.623***	0.530***	0.572***	0.524***	0.623***	0.546***	0.560***
	(0.040)	(0.055)	(0.067)	(0.100)	(0.040)	(0.056)	(0.067)	(0.101)
Lev	-0.270*	-0.499**	-0.136	-0.195	-0.255	-0.497**	-0.137	0.262
	(0.157)	(0.208)	(0.269)	(0.368)	(0.158)	(0.209)	(0.268)	(0.371)
Roa	0.222	0.579**	0.051	0.465	0.217	0.551*	0.095	0.471
	(0.238)	(0.293)	(0.372)	(0.476)	(0.240)	(0.295)	(0.370)	(0.478)
Top	-0.880***	-1.279***	-0.828**	-1.124*	-0.816***	-1.211***	-0.813*	-1.198*
	(0.275)	(0.371)	(0.418)	(0.625)	(0.277)	(0.373)	(0.417)	(0.629)
Age	-0.333***	-0.220***	-0.389***	-0.384***	-0.330***	-0.215***	-0.386***	-0.385***
	(0.044)	(0.064)	(0.063)	(0.100)	(0.044)	(0.065)	(0.063)	(0.101)
Ppe	-0.944***	-1.423***	-0.330	-0.449	-0.960***	-1.432***	-0.328	-0.390
	(0.219)	(0.299)	(0.340)	(0.496)	(0.220)	(0.300)	(0.338)	(0.498)
Growth	-7.487***	-6.314***	-8.144***	-9.737***	-7.553***	-6.257***	-6.528***	-8.571***
	(1.747)	(2.154)	(3.019)	(3.812)	(1.752)	(2.163)	(3.011)	(3.816)
Mgr	-0.023	-0.190	0.409*	0.358	-0.006	-0.190	0.445**	0.350
	(0.135)	(0.180)	(0.209)	(0.300)	(0.135)	(0.180)	(0.209)	(0.302)
Instr	0.151	0.170	0.273	0.955**	0.095	-0.104	0.319	1.034***
	(0.170)	(0.229)	(0.257)	(0.373)	(0.169)	(0.229)	(0.256)	(0.376)
Dual	0.047	0.015	0.093	0.064	0.054	0.019	0.089	0.055
	(0.047)	(0.061)	(0.076)	(0.102)	(0.047)	(0.061)	(0.075)	(0.102)
Ddr	0.007	0.121	0.294	0.518	0.018	0.130	0.249	0.662
	(0.455)	(0.604)	(0.750)	(1.068)	(0.457)	(0.607)	(0.745)	(1.069)
Industry Effect	YES	YES	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.035	0.046	0.110	0.111	0.035	0.046	0.115	0.114
N	9259	6187	3949	2600	9187	6150	3927	2587

*** means statistical significance at 1% level, ** means significance at 5% level, * Statistical means significance at 10% level, and the corresponding standard error is shown in parentheses

of both equity pledge dummy variables and equity pledge rate variables are only significant in the non-inheritance group. Their coefficients are -0.270 and -0.329, respectively, and are significant at 1%. It suggests that equity pledge is more likely to inhibit inefficient investment when the first-generation entrepreneurs control the family firms.

After dividing inefficient investment into over-investment and under-investment according to its specific manifestations, the equity pledge indicator only significantly inhibits over-investment. The corresponding regression coefficient of the equity pledge indicator in the non-inheritance group is significant and is not significant in the

Table 5 Estimated Results for the Uninherited Group

Variable	*Ieffi* (1)	*Ieffi* (2)	*Over* (3)	*Under* (4)	*Over* (5)	*Under* (6)
Pled	-0.270***		-0.088**	-0.262***		
	(0.045)		(0.049)	(0.058)		
Ple		-0.329***			-0.319**	-0.108
		(0.090)			(0.161)	(0.107)
Size	-0.545***	-0.669***	-0.491***	-0.121**	-0.591***	-0.110
	(0.044)	(0.061)	(0.074)	(0.057)	(0.111)	(0.079)
Lev	-0.268	-0.610***	-0.047	-1.213***	-0.489	-1.187***
	(0.175)	(0.231)	(0.305)	(0.209)	(0.421)	(0.274)
Roa	0.150	0.438	0.052	0.200	0.412	0.054
	(0.266)	(0.331)	(0.424)	(0.325)	(0.552)	(0.410)
Top	-0.720**	-1.060**	-0.838*	-0.891**	-0.704	-1.097**
	(0.313)	(0.417)	(0.498)	(0.405)	(0.721)	(0.541)
Age	-0.382***	-0.312***	-0.336***	-0.213***	-0.373***	-0.427***
	(0.049)	(0.071)	(0.071)	(0.073)	(0.112)	(0.099)
Ppe	-1.124***	-1.748***	-0.475	-0.022	-0.837	-0.298
	(0.243)	(0.330)	(0.372)	(0.310)	(0.551)	(0.414)
Growth	-4.317**	-1.509	-10.116***	-2.946	-11.157***	-0.408
	(2.007)	(2.452)	(3.589)	(2.280)	(4.458)	(2.750)
Mgr	-0.009	-0.215	-0.485**	-0.133	-0.375	-0.062
	(0.146)	(0.195)	(0.233)	(0.188)	(0.331)	(0.242)
Instr	0.083	-0.049	0.868***	0.556**	1.112***	0.852***
	(0.187)	(0.249)	(0.296)	(0.236)	(0.416)	(0.315)
Dual	0.019	0.003	0.103	0.028	0.100	0.055
	(0.052)	(0.068)	(0.085)	(0.064)	(0.114)	(0.084)
Ddr	0.052	0.298	0.142	-0.582	0.363	0.020
	(0.501)	(0.665)	(0.818)	(0.607)	(1.161)	(0.792)
Industry Effect	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES
R^2	0.036	0.048	0.067	0.027	0.072	0.033
N	7953	5353	3399	4554	2255	3098

*** means statistical significance at 1% level, ** means significance at 5% level, * Statistical means significance at 10% level, and the corresponding standard error is shown in parentheses

Table 6 Estimated Results for the Inherited Group

Variable	*Ieffi* (1)	*Ieffi* (2)	*Over* (3)	*Under* (4)	*Over* (5)	*Under* (6)
Pled	-0.159		-0.021	0.203		
	(0.104)		(0.156)	(0.131)		
Ple		0.677***			-0.563	-0.686**
		(0.222)			(0.350)	(0.274)
Size	-0.473***	-0.512***	-0.862***	-0.117	-1.141***	-0.279
	(0.114)	(0.167)	(0.171)	(0.151)	(0.247)	(0.218)
Lev	-0.680	-0.381	-0.075	-0.987*	-1.595*	-1.749**
	(0.440)	(0.639)	(0.641)	(0.553)	(0.807)	(0.752)
Roa	0.123	-0.239	0.794	-1.180	-2.256*	-0.122
	(0.652)	(0.840)	(0.863)	(0.842)	(1.236)	(1.031)
Top	0.861	0.565	0.468	-2.051*	-0.696	-2.862*
	(0.746)	(1.122)	(0.794)	(1.161)	(1.152)	(1.485)
Age	-0.249**	0.184	-0.422***	-0.421**	-0.626***	-0.816***
	(0.119)	(0.201)	(0.147)	(0.202)	(0.232)	(0.314)
Ppe	-0.319	-1.168	-0.277	-0.102	-0.456	-1.132
	(0.643)	(0.906)	(0.913)	(0.827)	(1.144)	(1.121)
Growth	-8.896***	-9.341***	-12.382***	7.427	11.676***	5.555
	(4.166)	(5.165)	(5.587)	(6.183)	(6.500)	(7.220)
Mgr	0.427	1.026	1.438**	0.889	3.724***	0.162
	(0.475)	(0.687)	(0.567)	(0.776)	(1.047)	(1.007)
Instr	-0.258	0.646	-0.470	1.162	1.027	0.788
	(0.491)	(0.777)	(0.570)	(0.727)	(0.856)	(1.051)
Dual	0.380***	0.382**	0.344**	0.197	0.415*	0.193
	(0.129)	(0.177)	(0.173)	(0.164)	(0.227)	(0.214)
Ddr	0.063	0.439	1.244	0.759	-1.044	-1.347
	(1.361)	(1.775)	(1.897)	(1.716)	(2.281)	(2.227)
Industry Effect	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES
R^2	0.067	0.096	0.659	0.055	0.724	0.097
N	1306	834	550	756	345	489

*** means statistical significance at 1% level, ** means significance at 5% level, * Statistical means significance at 10% level, and the corresponding standard error is shown in parentheses

inheritance group. Thus, equity pledge mainly inhibits inefficient investment of family firms by specifically restraining over-investment. Our results echo the research by Xu et al. (2022) on the impact of family succession on R&D in family firms. The empirical results prove that first-generation entrepreneurs have particular expectations out of their vigorous pursuit of affective endowment and the reputation of family firms that the family firms can be smoothly transferred from themselves to the second generation (Gomez-Mejia et al., 2018), thrive or even expand its scale under the management of the second generation, which reduces the desire of the first-generation entrepreneurs

to invest inefficiently and intensifies the awareness of avoiding the transfer of control power. It can be concluded that controlling shareholders' equity pledge has a particular governance effect on family firms.

In addition, there is a significant negative correlation between control variable *Size* and inefficient investment index *Ieffi* and *Over*, both of which are highly significant at the 1% level. It may attribute to the period of maturity and recession after companies have developed to a certain scale. These companies are usually equipped with a more professional management system; thus, large-scale family firms improve the inhibition of inefficient investment. The empirical test results illustrate that when the first generation controls family firms, the controlling shareholder's equity pledge intensifies the impact of the equity pledge on inefficient investment due to the pursuit of adequate endowment and the reputation of family firms. Overall, the first-generation entrepreneurs of family firms exert a regulatory effect on the relationship between equity pledges and the inefficient investment of the enterprise. **H3** in this paper is tested.

Moderating effect of promotion mode of the general manager

The promotion mode of the general manager, i.e., whether the manager is promoted internally or hired from outside, indirectly affects the impact of controlling shareholders' equity pledges on inefficient investment in family firms due to differences in socioemotional wealth to the business. The regression samples are grouped and tested according to the promotion mode of the general manager of family firms. Tables 7 and 8 show the results of internal promotion and external employment, respectively. First, comparing the empirical results in columns (1) and (2) in Table 7 with those in columns (1) and (2) in Table 8, it can be found that controlling shareholders' equity pledge in the internal promotion group has a significant inhibitory effect on inefficient investment in family firms, with coefficients of -0.230 and -0.210 for the equity pledge dummy variable and equity pledge rate, respectively. Both are significant at the 1% level. In contrast, the correlation coefficient of the equity pledge indicator on inefficient investment in the external employment group is not significant. The empirical test results show that the promotion mode of general managers does have a moderating effect on the relationship between controlling shareholders' equity pledges and inefficient investment in family firms. Specifically, internally promoted general managers, compared with externally employed ones, weaken the encroachment effect of socioemotional wealth on the separation of the two rights due to a certain degree of internalization as pan-family members. This conclusion verifies that in Chinese society, Gomez-Mejia et al. (2007) theory of SEW within the family, which is generally applicable in Western society, is also valid.

In terms of further differentiating inefficient investment into over-investment and under-investment, according to the regression results in columns (3) and (5) of Table 7, the coefficients of equity pledge dummy variable and equity pledge rate and over-investment are -0.044 and -0.162 respectively, which are significant at the level of 5%. However, the relationship between equity pledge indicators and under-investment is not significant. In addition, the results in Table 8 show that controlling

Table 7 Estimated Results for the Internal Promotion Group

Variable	*Ieffi* (1)	*Ieffi* (2)	*Over* (3)	*Under* (4)	*Over* (5)	*Under* (6)
Pled	-0.230***		-0.044**	0.209***		
	(0.042)		(0.015)	(0.057)		
Ple		-0.210***			-0.162**	-0.112
		(0.087)			(0.075)	(0.110)
Size	-0.511***	-0.587***	-0.473***	-0.243***	-0.458***	-0.270***
	(0.046)	(0.063)	(0.068)	(0.066)	(0.102)	(0.087)
Lev	-0.256	-0.518**	-0.328	-1.298***	-0.037	-1.471***
	(0.175)	(0.228)	(0.270)	(0.220)	(0.365)	(0.287)
Roa	0.140	0.182	0.194	0.310	0.173	0.119
	(0.261)	(0.319)	(0.372)	(0.341)	(0.464)	(0.420)
Top	-0.807**	-0.820*	-0.763*	-0.810*	-1.542**	-0.883
	(0.315)	(0.419)	(0.427)	(0.454)	(0.633)	(0.578)
Age	-0.321***	-0.216***	-0.279***	-0.303***	-0.266***	-0.463***
	(0.046)	(0.068)	(0.061)	(0.073)	(0.097)	(0.101)
Ppe	-0.870***	-1.210***	-0.228	-0.179	-0.173	-0.026
	(0.239)	(0.325)	(0.330)	(0.332)	(0.495)	(0.428)
Growth	-3.332	-4.491*	-3.535***	-4.596*	-7.950***	-0.844
	(2.039)	(2.510)	(1.146)	(2.474)	(3.817)	(3.066)
Mgr	0.011	0.120	0.404*	0.071	0.542*	0.023
	(0.148)	(0.199)	(0.209)	(0.206)	(0.302)	(0.260)
Instr	0.114	0.203	0.350	0.505**	0.904**	0.744**
	(0.183)	(0.244)	(0.253)	(0.252)	(0.352)	(0.331)
Dual	0.059	0.059	0.063	0.039	-0.116	-0.023
	(0.053)	(0.069)	(0.079)	(0.068)	(0.106)	(0.091)
Ddr	0.339	0.426	0.119	0.582	0.425	0.104
	(0.498)	(0.656)	(0.753)	(0.651)	(1.050)	(0.834)
Industry Effect	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES
R^2	0.028	0.036	0.089	0.029	0.118	0.038
N	7955	5271	3530	4425	2292	2979

*** means statistical significance at 1% level, ** means significance at 5% level, * Statistical means significance at 10% level, and the corresponding standard error is shown in parentheses

shareholders' equity pledges of family firms in the "internal promotion group" can inhibit over-investment but has no noticeable impact on under-investment, which is consistent with the test results of equity pledge and inefficient investment in the regression of the primary model. Finally, the regression results in columns (3)-(6) of the "external employment group" in Table 8 show that the regression coefficient of the equity pledge indicator is not significant in terms of inefficient investment, over-investment, and under-investment.

Table 8 Estimated Results for the External Employment Group

Variable	*Ieffi* (1)	*Ieffi* (2)	*Over* (3)	*Under* (4)	*Over* (5)	*Under* (6)
Pled	-0.304*		0.420	0.420***		
	(0.157)		(0.386)	(0.149)		
Ple		-0.994***			2.021**	-0.401
		(0.283)			(0.803)	(0.263)
Size	-0.462***	-0.368**	-0.247	-0.209*	-0.782	-0.031
	(0.129)	(0.172)	(0.410)	(0.125)	(0.572)	(0.172)
Lev	-0.650	-1.454**	-1.223	-0.480	-1.502	-0.831
	(0.519)	(0.689)	(1.421)	(0.482)	(1.826)	(0.649)
Roa	0.114	0.643	0.939	0.270	0.400	0.755
	(0.781)	(0.981)	(1.858)	(0.751)	(2.317)	(0.986)
Top	-1.230	-2.418**	-1.173	-1.852**	-4.239	-3.493***
	(0.917)	(1.215)	(2.141)	(0.887)	(2.822)	(1.246)
Age	-0.333	0.131	-0.539	-0.246	-0.411	-0.949**
	(0.232)	(0.332)	(0.476)	(0.280)	(0.674)	(0.400)
Ppe	-1.142	-1.017	-2.231	-0.833	-2.938	-0.857
	(0.773)	(1.073)	(2.256)	(0.713)	(2.840)	(1.018)
Growth	10.028**	8.870	5.700***	-1.043	7.489**	-2.921
	(4.355)	(5.422)	(2.685)	(4.378)	(3.693)	(5.619)
Mgr	-0.840	-1.481	-0.113	-1.025	-0.249	-1.338
	(0.834)	(1.014)	(1.925)	(0.773)	(2.806)	(0.922)
Instr	0.714	0.427	0.564	1.696***	0.389	2.222**
	(0.639)	(0.858)	(1.589)	(0.619)	(2.296)	(0.875)
Dual	0.048	0.287	0.220	0.054	0.372	-0.164
	(0.212)	(0.275)	(0.500)	(0.197)	(0.703)	(0.260)
Ddr	0.057	0.127	2.379	2.297	3.329	3.243
	(1.551)	(2.252)	(3.674)	(1.457)	(6.428)	(2.072)
Industry Effect	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES
R^2	0.033	0.063	0.142	0.052	0.212	0.079
N	1304	916	419	885	308	608

*** means statistical significance at 1% level, ** means significance at 5% level, * Statistical means significance at 10% level, and the corresponding standard error is shown in parentheses

Based on the above analysis, general managers employed through internal promotion in family firms, compared with ones hired from outside, are more conducive to reducing the inefficient investment in family firms since managers promoted internally have a more effective endowment, a more profound sense of belonging to family firms and a certain pursuit of socioemotional wealth.

Robustness tests

In order to enhance the reliability of the research results, make the research conclusions of this paper more convincing, and take into account the possible impact of endogenous problems in the research on the experimental results. In this paper, the robustness test is carried out by changing the test method. The Heckman two-stage method is mainly used to solve the problem of sample selection bias. The steps of the Heckman two-stage method we adopted are as follows. In the first step, we

Table 9 Robustness Tests

Variable	*Ieffi* (1)	*Ieffi* (2)	*Over* (3)	*Over* (4)	*Under* (5)	*Under* (6)
Pled	-0.425***		-1.462***		-0.881***	
	(0.115)		(0.544)		(0.224)	
Ple		-0.642**		-1.765*		-0.038
		(0.285)		(0.935)		(0.277)
Size	0.964***	1.110***	5.237***	4.580***	0.658***	0.865***
	(0.079)	(0.154)	(1.435)	(1.170)	(0.163)	(0.276)
Lev	-2.593***	-3.018***	-10.909***	-9.347***	-0.571	0.238
	(0.349)	(0.645)	(3.275)	(2.731)	(0.364)	(0.439)
Roa	-1.023**	-1.642*	-6.231**	-4.070	-1.050	-1.397
	(0.494)	(0.953)	(2.929)	(2.542)	(0.754)	(0.989)
Top	0.777**	0.754	0.900	1.115	1.520**	1.485*
	(0.326)	(0.579)	(1.423)	(1.500)	(0.692)	(0.851)
Age	-0.277***	-0.223	-3.796***	-3.795***	-2.449***	-2.500***
	(0.100)	(0.179)	(1.141)	(1.087)	(0.542)	(0.676)
Ppe	-0.714***	-0.507	-2.866*	-1.686	-0.539	-0.917*
	(0.242)	(0.437)	(1.490)	(1.334)	(0.394)	(0.538)
Growth	-9.043**	-12.909*	-0.101	-5.650	-0.323	-1.629
	(3.963)	(7.071)	(22.476)	(21.551)	(3.395)	(6.874)
Mgr	-0.237	-0.152	-1.951*	-1.425	-0.211	-0.202
	(0.174)	(0.315)	(1.015)	(0.941)	(0.301)	(0.385)
Instr	-0.771***	-0.996**	-0.047	-0.878	-1.193**	-1.040
	(0.234)	(0.430)	(0.930)	(0.958)	(0.568)	(0.674)
Dual	0.063	0.091	0.173	0.105	0.075	0.064
	(0.067)	(0.123)	(0.348)	(0.344)	(0.115)	(0.148)
Ddr	1.187**	1.669	2.856	3.441	0.550	0.443
	(0.583)	(1.086)	(3.019)	(3.091)	(0.963)	(1.229)
IMR	3.091***	4.557***	12.086***	9.741***	4.358***	4.576***
	(0.533)	(1.182)	(3.495)	(2.669)	(1.112)	(1.374)
Industry Effect	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES
N	12075	7514	12075	7514	12075	7514

*** means statistical significance at 1% level, ** means significance at 5% level, * Statistical means significance at 10% level, and the corresponding standard error is shown in parentheses

estimate using a random sample of all firms. And use the estimated results to calculate the value of the inverse Mills ratio. In the second step, we use the selected sample observation value and the calculated inverse Mills ratio value as a parameter to be estimated to estimate the above model and obtain the estimated coefficient of the independent variable. Similarly, the regressions are conducted on inefficient investment. Further analysis is carried out by differentiating inefficient investment into and concerning the research design, which simultaneously uses the equity pledge dummy variable and equity pledge rate.

Columns (3) and (4) in Table 9 reveal that the coefficients of the inverse Mills ratio (*IMR*) are all significant at the 1% level. This finding indicates that the sample distribution bias of equity pledge does exist, and thus it is necessary to take the possible estimation bias caused by the sample itself into account. Regarding the regression results of the impact of equity pledge on corporate investment efficiency, the data from the table shows that the correlation coefficients of the equity pledge dummy variable (*Pled*), the equity pledge continuous variable (*Ple*) and inefficient investment (*Ieffi*) are -0.425 and -0.642, respectively, and both are significantly negative at the 1% level, indicating that controlling shareholders' equity pledge can inhibit inefficient investment, which is in line with previous studies. Moreover, when further differentiating inefficient investment into *Over* and *Under*, columns (3)-(6) from Table 9 reveal that equity pledge only inhibits over-investment. The coefficients of over-investment and the equity pledge dummy variable (*Pled*) and the equity pledge rate *Ple* are -1.462 and -1.765, respectively, and both are significant at the 10% level, while the relationship between equity pledge and *Under* is insignificant, which is consistent with the aforementioned empirical structure of the main regression model. Related symbols, such as the main control variables *Size* and *Ppe*, and corresponding significance levels are almost identical to the significance levels reported in the empirical regression of the primary model regression, and the regression results of the remaining control variables are also consistent. Therefore, these results support the conclusion that controlling shareholders' equity pledge in firms improves the inhibition of inefficient investment.

Conclusions

This paper explores the impact of controlling shareholders' equity pledges on the inefficient investment of family firms based on the socioemotional wealth theory and distinguishes two dimensions of inefficient investment, which are over-investment and under-investment, for specific analysis. The A-share family firms with equity pledges from 2010 to 2021 are selected as the research subjects, and the following conclusions are drawn by combining theoretical analysis and empirical tests:

First, controlling shareholders' equity pledges of family firms can inhibit the inefficient investment of enterprises, and it is only significant under the condition of over-investment. Compared with previous studies, this paper finds that controlling shareholders pursue not only economic interests in family enterprises but also non-economic goals, affecting shareholders' final decision-making on seeking control rights for private interests. Equity pledge reduces the encroachment effect of

large shareholders who seek socioemotional wealth in the family firms when control rights and cash-flow rights are separated.

Second, compared with the second generation, when first-generation entrepreneurs control family firms, controlling shareholders' equity pledges has a more apparent inhibiting effect on inefficient investment in family firms, which is similar to the research conclusions of other scholars. As entrepreneurs of family firms, namely the first-generation entrepreneurs, compared with the second or third-generation, they have a richer affective endowment and more profound emotional attachment to the enterprise, reputation, and corporate culture because they have experienced the challenging start-up period of family firms. However, based on the socio-emotional wealth theory, this paper finds that family businesses will use their sufficient control over the business to weigh their interests and the long-term and short-term goals of the business.

Third, compared with general managers hired from outside, ones directly promoted within family firms have a positive moderating effect on the relationship between controlling shareholders' equity pledges and inefficient investment in family firms. The pursuit of socioemotional wealth and the affective endowment to family firms of internally promoted general managers are unmatched by professional managers as outsiders. The above findings fill the gap in the research on equity pledge and investment efficiency of family firms from the perspective of external behavior.

Policy implications

This research has important implications as stated below.

First, affected by economic globalization and COVID-19, government departments need to formulate more standardized and reasonable pledge management methods for the equity pledge business at the regulatory level. At the same time, strengthen the construction of information disclosure systems to avoid the impact of changes in the external environment. Let equity pledges play an influential governance role in family enterprises to reduce the risk of equity pledge business. It is suggested that information disclosure can be enhanced from the specific use of pledged funds to facilitate the supervision by managers and accurate judgment of the shareholders' investment intentions by investors who can invest in family firms more rationally.

Second, considering the maximization of interests and long-term development of family businesses, family businesses should start cultivating their own internal talents and establish a sound internal management system. From the research conclusion of this paper, it can be seen that the equity pledge of the controlling shareholder of listed family enterprises has an obvious inhibitory effect on the non-investment efficiency of the enterprise, and the equity pledge shows a certain governance effect. And the governance effect is more obvious when the family business chooses the internally promoted general manager. It can be seen that internally promoted general managers and family members have a more consistent objective function, which can effectively alleviate the first type of principal-agent problem between shareholders and management. Cultivating the emotion between the management and the family

business, corporate culture identity, etc. can gradually internalize the professional managers with professional management knowledge and ability, so as to reduce the business decisions made out of self-interest motives in the operation of the family business . At the same time, the board of directors should fully fulfill the responsibility and obligation to limit the opportunistic behavior of the management, and play the role of "supervisor" within the company.

Third, investors should view equity pledge behavior objectively to improve their investment benefits. Equity pledge has left investors with a negative impact and a repulsive attitude toward companies whose large shareholders have pledged equity because of frequent blowouts of large shareholders' equity pledge that existed in 2020. Investors should have a comprehensive understanding of the impact of equity pledges on companies, as there are positive aspects of equity pledges. For investors, the listed companies with equity pledges should not be excluded but treated differently to increase their investment returns.

Finally, securities traders with equity pledge-related businesses should set a more reasonable and risk-controlled pledge ratio for the pledgor according to the nature of their enterprises to increase the efficiency of capital market financing and their business income. Meanwhile, it helps improve the efficiency of risk management by focusing the risk of equity pledge on capital occupation within the family firms. Securities traders can increase the equity pledge ratio of family firms according to their state of operation, which raises interest income while enhancing the quality of the business through more effective risk management measures.

There are still some deficiencies in this paper that need to be further improved in follow-up research, mainly reflected in the following: Considering the inconsistency of the existing research conclusions on the efficiency of equity pledges on corporate investment, some scholars have proposed that equity pledges will lead to excessive investment in enterprises, It will also lead to an insufficient investment of enterprises, but some scholars believe that equity pledge only affects over-investment or only under-investment. In the follow-up, starting from the fundamental reasons for forming different conclusions, more in-depth research on the inefficiency of family businesses can be carried out.

Funding This work was supported by The Fundamental Research Funds for the Central Universities [Grant Numbers: CXJJ-2023-430].

Data availability Readers can request it from corresponding author if they have a reasonable reason.

Declarations

Conflict of interests The authors have no relevant financial or non-financial interests to disclose.

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