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The Impact of Informal Board Hierarchy on Corporate Debt Default Risk

Zixiang Yang

Department of Business, Nanjing Normal University, Nanjing, China

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Abstract: This paper employs a sample of non-financial listed companies on the Shanghai and Shenzhen A-share markets from 2008 to 2020 to empirically examine the impact of the informal hierarchy within the board of directors on corporate debt default risk. The results indicate that a clearer informal hierarchy in the board is associated with lower corporate debt default risk. Specifically, the informal hierarchy of the board influences debt default risk through two channels: the governance effect and the resource effect. The findings of this study provide insights for mitigating corporate debt default risk.

1. Introduction

The 20th National Congress of the Communist Party of China emphasized strengthening financial stability and guarding against systemic risks. Corporate debt default risk is a critical component, posing a major challenge to China's financial system. Since 2014, defaults by non-financial enterprises have risen significantly, including concerning trends in state-owned enterprises and high-rated bonds. Concurrently, profitability supporting debt servicing has declined, with over a thousand A-share listed firms reporting negative net profit growth annually from 2020 to 2022. This underscores the urgency of mitigating corporate default risk.

As the core governance body, the board of directors plays a vital role through decision-making, monitoring, and advising functions [1][2]. While effective board governance can reduce debt risk, existing research focuses mainly on formal mechanisms like independent directors. However, boards are collective decision-making bodies where formal structures may be insufficient. Scholars thus argue that informal governance mechanisms, particularly the informal hierarchy among directors, require attention.

Despite formal equality, differences in directors' capabilities and social capital establish an informal hierarchy, where high-status members influence others[3]. This hierarchy can enhance decision-making coordination, improve efficiency, and strengthen monitoring, positively affecting firm performance, M&A outcomes, and curbing misconduct. It may therefore be a key factor influencing debt default risk.

However, while the role of board informal hierarchy is recognized, its impact on debt default risk remains unexplored. Within China's relational and authority-oriented culture, this hierarchy may reduce default risk through two channels: a governance effect, improving oversight and constraining managerial self-interest; and a resource effect, where high-status directors leverage

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social capital to ease financing constraints and lower information asymmetry. Investigating this impact thus holds significant theoretical and practical importance.

2. Theory and hypotheses

2.1 Board Informal Hierarchy and Corporate Debt Risk

Debt default, defined as the failure to meet scheduled debt payments [4], can trigger financial distress. The board of directors, as the core governance body, plays a crucial role in managing this risk through decision-making and monitoring. However, a conflict exists between its formal egalitarian structure—characterized by one-person-one-vote and no formal superiors—and the need for efficient, coordinated decision-making amid director heterogeneity. This gap suggests informal rules, particularly an informal hierarchy among directors, are key to board functioning.

Based on power distance theory, an informal hierarchy enhances operational efficiency. High-status directors, deriving power from their capabilities and influence, are more willing to lead. The respect they garner guides others to align with them, motivating greater influence exertion. In China's high-power-distance context, this reduces challenges to high-status directors, minimizes conflict, and fosters cooperation. This establishes a clear division of labor, improving decision quality and efficiency in addressing default risk.

Simultaneously, relational contract theory explains how this hierarchy fosters cooperation. Directors spontaneously form an implicit hierarchy based on capability differences[3], rooted in social norms and mutual recognition. This builds trust-based relational contracts, facilitating constructive dialogue and increasing low-status directors' supportive participation and diligence. Their rational "compliance" (not blind obedience) aids consensus-building while preventing the board from becoming a rubber stamp, thereby reducing governance costs and non-constructive conflict.

From an agency perspective, debt default is endogenous, arising from conflicts between shareholders, managers, and creditors[1]. Shareholders may incentivize risky asset substitution or underinvestment, transferring risk to creditors, while managers may act opportunistically. An informal hierarchy mitigates these issues. It enhances the board's monitoring function, curbing managerial myopia and self-interest. High-status directors can also act as intermediaries to align stakeholder interests, making the board more cautious about high-risk decisions and ultimately reducing default risk.

Based on the above analysis, this paper proposes the following hypothesis:

Hypothesis 1: The greater the clarity of the board's informal hierarchy, the lower the corporate debt default risk.

2.2 The Mediating Role of Debt Agency Costs and Management Agency Costs

According to agency cost theory, the misalignment of interests between the principal and the agent in a transaction leads to losses for both parties, known as agency costs. These costs adversely affect a company's financial and capital management, further impair its future prospects, increase the risk of corporate debt default, and harm creditor interests. Board supervision serves as a crucial mechanism for mitigating conflicts of interest between shareholders and creditors, and between shareholders and management. Facilitated by an informal hierarchy, the board can more effectively execute its supervisory role and enhance operational efficiency. By alleviating conflicts between shareholders and creditors and reducing agency costs between shareholders and management, it ultimately lowers the risk of corporate debt default.

(1) Debt Agency Costs

The principal-agent conflict between shareholders and creditors generates three types of debt agency costs that increase default risk. A board's informal hierarchy can mitigate these costs through enhanced governance.

First, shareholders may prompt asset substitution (shifting to riskier projects) or underinvestment (rejecting positive-NPV projects), transferring wealth from creditors[1]. Creditors respond with higher interest rates or restrictive covenants, incurring costs that burden the firm and reduce investment efficiency. An informal hierarchy improves board oversight and advisory quality, aligning interests to curb such behaviors and lower these costs.

Second, creditors impose detailed covenants to protect their claims, leading to significant monitoring and bonding costs for the firm[4]. An effective informal hierarchy strengthens board supervision of management, improves disclosure quality, and reduces information asymmetry. High-status directors can also leverage networks to improve creditor communication, leading to more accurate risk assessment and less restrictive terms.

Third, covenants set accounting "red lines"; breaching them triggers a technical default. To avoid this, firms may engage in earnings management, while creditors may impose costly interventions. A clear informal hierarchy enhances the board's monitoring efficiency and earnings quality oversight, helping prevent technical defaults and their associated costs.

In summary, by improving supervision, information quality, and stakeholder alignment, a board's informal hierarchy helps mitigate all three categories of debt agency costs, thereby reducing corporate default risk.

(2) Management Agency Costs

Management's personal performance and compensation are often tied to firm size, fostering "empire-building" motives to expand via financing and control more resources. For managers, maximizing financing and investment without triggering default is optimal for personal gain, potentially sacrificing shareholder interests and increasing default risk. The board's core duty is to review management decisions to safeguard shareholder interests and firm development. Scientific and efficient decision-making relies on effective information integration. Thus, a clearer informal hierarchy enhances internal information integration and decision efficiency, reduces futile conflicts, and better enables the board to fulfill its functions. Moreover, greater hierarchy clarity lowers the likelihood of internal dissent, improving supervision of management's post-loan conduct, curbing motives to encroach on shareholder interests, and mitigating shareholder-management agency problems. It also leads to more reliable external disclosures, helping firms secure longer-term, lower-cost credit, thereby reducing default likelihood.

Based on the above analysis, this paper proposes the following hypotheses:

Hypothesis 2: The board's informal hierarchy reduces corporate debt default risk by decreasing shareholder-creditor agency costs.

Hypothesis 3: The board's informal hierarchy reduces corporate debt default risk by decreasing shareholder-management agency costs.

2.3 The Mediating Role of Financing Constraints

Digital finance mitigates corporate debt default risk by alleviating financing constraints through two primary mechanisms: lowering financing costs and broadening financing channels.

First, it reduces financing costs by leveraging big data and digital platforms to mitigate information asymmetry. By processing multi-dimensional structured and unstructured data from firms and supply chains, it enables efficient matching between borrowers and lenders. This lowers information search and transaction costs. For creditors, it improves risk assessment, reduces the misclassification of creditworthy firms, and enables more accurate pricing. Furthermore, digital

finance lowers service thresholds, accelerates credit approval, and intensifies competition in traditional banking, collectively reducing debt financing costs.

Second, digital finance broadens financing channels. It addresses the high costs and limited reach of traditional finance by employing information technology, offering diverse financing tools (e.g., supply chain finance) and extending services to a wider customer base. This expansion of accessible credit helps relieve financing constraints, thereby lowering the risk of debt default.

Hypothesis 4: The board's informal hierarchy reduces corporate debt default risk by alleviating financing constraints.

3. Data and methodology

3.1 Sample

This paper selects Chinese A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2008 to 2020 as the initial research sample. All required fundamental data are sourced from the China Stock Market & Accounting Research (CSMAR) database. Following common practices in prior research and the needs of this study, the following procedures were applied to the initial sample: (1) Excluding data from listed companies in the financial industry, as their data comparability with non-financial companies is poor. Data from the financial industry were removed according to the *Guidelines for Industry Classification of Listed Companies* issued by the China Securities Regulatory Commission (CSRC). (2) Removing data from ST and *ST listed companies. (3) Excluding observations with missing values for any variable. (4) To mitigate the adverse impact of outliers on the study's conclusions, all continuous variables were winsorized at the 1% and 99% levels. After applying these filters, the final dataset consists of an unbalanced panel of 26,764 firm-year observations from 3,501 listed companies. Data processing was performed using STATA 16.0 software.

3.2 Variable Definition

3.2.1 Dependent Variable: Debt Default Risk (EDF)

The debt default risk of listed companies is measured based on Merton's KMV model. Following the research of Deng et al. (2020), the corporate debt default risk (EDF) is inferred through the firm's distance to default (DD). The distance to default (DD) reflects the relationship between the market value of a firm's assets and its liabilities, indicating whether the firm's market value is sufficient to repay its debts and ensure normal operations. The closer the firm's asset value is to the default point, the higher the probability of default. The calculation of the distance to default (DD) is shown in Equation (1):

$$DD= [\ln(V/D)+(u-\sigma_V^2/2)]/(\sigma v \sqrt{T}) \quad (1)$$

Among them, “V” represents the market value of the firm's assets, which consists of the market value of debt (D) and the market value of equity (E), i.e., V=D+E. The market value of debt (D) is composed of current liabilities and non-current liabilities, calculated as Current Liabilities + 0.5×Non-Current Liabilities. “u” is the expected return on assets, assumed to be the firm's stock return from the previous year. “σ_v” is the volatility of the firm's asset value, which is derived from stock return volatility and debt volatility. Debt volatility “σ_D” is calculated as 0.05 + 0.25×σ_E, where “σ_E” is equity volatility. Furthermore, the volatility of the firm's asset value can be computed as: $\sigma_v=(E/V)\sigma_E+(D/V)(0.05+0.25\sigma_E)$. “T” is the debt maturity, set to 1 year. Substituting the above

calculations into the distance to default formula yields the distance to default, denoted as “DD”.

$$EDF=N(-DD) \tag{2}$$

In Equation (2), “N” represents the cumulative standard normal distribution function. A higher “EDF” value indicates a greater risk of corporate default.

3.2.2 Independent Variable: Board Informal Hierarchy (Gini)

The informal hierarchy of the board reflects status differences among its members in terms of professional background, social resources, and personal influence. Therefore, in theory, the relatively optimal method for measuring board informal hierarchy is to obtain relevant data through questionnaires. However, the most obvious drawback of this method is the need to obtain responses from every board member of the sample firms, making it costly and difficult to conduct large-sample studies, thus resulting in poor feasibility. To enable the measurement of board informal hierarchy for large-sample research, the common practice in most existing literature is to calculate it based on the principle of the Gini coefficient. The rationale of this method is that board members who hold more concurrent directorships in other companies have access to greater resources, possess higher influence and personal authority, and consequently receive more respect from other members within the board, resulting in a higher relative status. Although this method may not achieve the level of accuracy attainable through surveys, it can be widely applied to large-sample corporate research. Therefore, based on a comprehensive consideration and trade-off between accuracy and feasibility [5], and with reference to existing studies, this paper employs a measurement method based on the Gini coefficient to gauge board informal hierarchy. The calculation method is as follows:

$$YScore=S+BF+BO+BA+PFA+POL \tag{3}$$

$$Gini=2cov(YScore, RankYScore)/(BNum\times MeanYScore) \tag{4}$$

In Equation (1), YScore is the sum of each board member's number of external directorships and the score based on their professional background and appointment status. S represents the number of enterprises for which each board member serves as an external director; B_F, B_O, B_A, P_{FA}, and P_{OL} indicate whether each board member has a financial background, overseas background, academic background, holds a financial leadership position such as Chief Financial Officer (CFO) or chief accountant, or serves as board chair or general manager, respectively. These variables take a value of 1 if the condition is met, and 0 otherwise. In Equation (2), $Rank_{YScore}$ is the ranking of each board member's aforementioned composite score within the board; $Mean_{YScore}$ is the mean value of YScore; and BNum is the number of board members (also referred to as board size). Through the calculation of the Gini coefficient, the resulting Gini value in this study represents the clarity of the board's informal hierarchy. This value ranges between 0 and 1, with a higher value indicating greater disparity among board members in terms of professional background, social resources, personal prestige, and other aspects of status, thereby reflecting a clearer informal hierarchical structure.

3.2.3 Mediating Variables

(1) Debt Agency Cost (agency1)

In China, due to the relatively complex relationship between shareholders and creditors and the presence of information asymmetry, shareholders have opportunities to transfer risks to creditors. Typically, listed companies primarily obtain debt financing through three sources: bank loans,

commercial credit, and bond financing. Among these, banks are the main providers of debt financing for listed companies. Therefore, the cost of debt financing increases as the debt agency costs of listed companies rise, and the deterioration of the debt agency relationship may lead banks to adopt various measures to protect their own interests from infringement, such as raising loan thresholds, setting higher interest rate standards, and increasing the difficulty of loan approval.

Drawing on the research methods of Qin Ying and Ding Shuai, Zhou Kaitang et al., this study uses the interest expense ratio as a measure of the debt agency cost of listed companies. Debt Agency Cost (agency1) = Interest Expense Ratio = Interest Expense / Average of Total Long-term and Short-term Debt.

(2) Management Agency Cost (agency2)

Following the approach of Zhai Shuping et al. (2022), management agency cost is measured using the ratio of management expenses to main business revenue.

(3) Financing Constraints (WW)

In the literature, indicators for measuring financing constraints mainly include investment-cash flow sensitivity, the KZ index, and the WW index. Compared to the investment-cash flow sensitivity indicator, the theoretical foundation of the KZ index is more solid. However, TobinQ, which represents corporate investment opportunities in the composition of the KZ index, often involves significant measurement errors, reducing the accuracy of the KZ index in measuring financing constraints. In contrast, the WW index not only considers the financial characteristics of enterprises themselves but also takes into account the external industry characteristics in which they operate. This gives it broader economic significance, and the exclusion of TobinQ in its calculation further enhances its accuracy. Therefore, this study adopts the WW index to measure the financing constraint levels of enterprises in strategic emerging industries. The WW index is calculated as follows:

$$\lambda it=b1TLTDit+b2DIVPOSit+b3LNTAit+b4SGit+\ b5ISGit+b6CFit \quad (5)$$

In Equation (3), $TLTD_{it}$ is the ratio of long-term debt to total assets, $DIVPOS_{it}$ is a dummy variable that takes the value of 1 when dividends are paid, LNTAit is the natural logarithm of total assets, SG_{it} is the firm's sales growth rate, ISGit is the sales growth rate of the industry in which the firm operates, and CF_{it} is the ratio of cash flow to total assets. The coefficient vector b is provided by White and Wu (2006). A larger value of this index indicates a higher degree of financing constraints faced by the firm.

3.2.4. Control Variables

Drawing on relevant scholarly research, the following indicators are selected as control variables in this paper: firm size (Size), number of directors (Board), CEO duality (Dual), equity balance (Balance), cash flow ratio (Cashflow), operating revenue growth rate (Growth), firm age (Firmage), and the shareholding ratio of the largest shareholder (Top1).

3.3 Model

(1) Design of the Main Hypothesis Model. To investigate the impact of the board's informal hierarchy on corporate debt default risk, the paper constructs the following regression model for verification:

$$EDFit=\beta0+\beta1Giniit+\gamma CVsit+\sum jIndustryj+\sum tYeart+\varepsilon it \quad (6)$$

In this model, the explained (dependent) variable is debt default risk (EDF), the independent variable is the board's informal hierarchy (Gini), “CVs” represent the aforementioned control

variables, “Year” denotes year fixed effects, Industry denotes industry fixed effects, and “ε” is the random error term of the model. Additionally, the subscripts “i”, “t”, and “j” represent the firm, year, and industry, respectively.

(2) Model Design for Mediation Effect Testing. When testing the mediating roles of information disclosure quality and financing constraints, and referring to the three-step mediation effect test procedure proposed by Wen et al. (2004), the following three test models are constructed sequentially to verify the mechanism of the aforementioned mediating variables. The specific test models are as follows:

$$EDFit=\beta0+\beta1Giniit+\gamma CVsit+\sum jIndustryj+\sum tYeart+\varepsilon it \quad (7)$$

$$Mediatorit=\beta0+\beta1Giniit+\gamma CVsit+\sum jIndustryj+\sum tYeart+\varepsilon it \quad (8)$$

$$EDFit=\beta0+\beta1Giniit+\ Mediatorit\ +\gamma CVsit+\sum jIndustryj+\sum tYeart+\varepsilon it \quad (9)$$

In models (1) and (3), the explained variable is debt default risk (EDF), and the explanatory variable is the board's informal hierarchy (Gini). The Mediator in model (2) represents the mediating variables: debt agency cost (agency1), management agency cost (agency2), and financing constraints (WW). Furthermore, a Bootstrap test is conducted for the mediation effects, and the significance of the test results is automatically reported by the Stata analysis software.

4. Result

4.1 Descriptive Statistical Analysis

Table 1. Descriptive Statistical Analysis

Variable	N	Mean	Median	SD	Min	Max
EDF	26764	0.0170	0	0.101	0	0.798
Gini	26759	0.134	0.125	0.0620	0.0280	0.307
Size	26764	22.24	22.07	1.278	19.82	26.18
Board	26764	2.143	2.197	0.200	1.609	2.708
Dual	26764	0.238	0	0.426	0	1
Balance1	26763	0.343	0.253	0.287	0.00900	0.992
Cashflow	26764	0.0490	0.0470	0.0700	-0.156	0.248
Growth	26759	0.166	0.100	0.421	-0.572	2.708
FirmAge	26764	2.865	2.890	0.327	1.792	3.497
Top1	26764	0.344	0.323	0.149	0.0850	0.742

As shown in Table 1, the mean value of the explained variable, debt default risk (EDF), is 0.017, with a median of 0. This indicates that over half of the firms exhibit no default risk. However, its standard deviation reaches 0.101, and the maximum value is as high as 0.798, reflecting significant risk disparities among firms and the presence of extreme high-risk cases. The mean of the core explanatory variable, board informal hierarchy (Gini), is 0.134 (median 0.125), with a standard deviation of 0.062, suggesting a relatively balanced distribution. Among the control variables, the logarithm of firm size (Size) has a mean of 22.24 (standard deviation 1.278). The mean board size (Board) is 2.143 (approximately 8–9 members, standard deviation 0.200). CEO duality (Dual) accounts for 23.8% (mean 0.238). The mean equity balance (Balance1) is 0.343 (median 0.253, standard deviation 0.287, maximum 0.992), indicating substantial variation in balance of power among firms. The mean cash flow (Cashflow) is 0.049 (ranging from -0.156 to 0.248), reflecting overall financial health. The mean operating revenue growth rate (Growth) is 0.166, but its large

standard deviation of 0.421 (maximum 2.708) suggests volatile growth among some firms. The mean firm age (FirmAge) is 2.865 (approximately 17.5 years, standard deviation 0.327). The mean shareholding ratio of the largest shareholder (Top1) is 34.4% (median 32.3%, maximum 74.2%), highlighting the prevalence of concentrated ownership.

4.2 Main Hypothesis Testing

Table 2. Primary Hypothesis Regression

Variable	EDF
Gini	-0.034***
	(-3.41)
Size	0.017***
	(21.74)
Board	-0.012***
	(-3.44)
Dual	0.003**
	(2.07)
Balance1	-0.004
	(-1.58)
Cashflow	-0.059***
	(-6.76)
Growth	-0.005***
	(-3.46)
FirmAge	0.004**
	(1.97)
Top1	-0.024***
	(-4.53)
Constant	-0.352***
	(-19.93)
Year	Yes
Ind	Yes
VIF	1.05-1.85
N	26,753
R^2	0.118

The main hypothesis regression results are presented in Table 2. As can be seen from the regression results, the coefficient for board informal hierarchy (Gini) on debt default risk (EDF) is -0.034 and is significant at the 1% level. This indicates that, after controlling for the influence of other factors, a higher clarity of the board's informal hierarchy is associated with lower corporate debt default risk, thus supporting Hypothesis 1.

4.3 Mediation Effect Test

The regression results for the mediation effect test are presented in Table 3. The results in column (1) show that the correlation coefficient between board informal hierarchy and debt agency cost is significantly negative, indicating that greater clarity in the board's informal hierarchy leads to lower debt agency costs for the firm. The results in column (2) show that the coefficients for board informal hierarchy and debt agency cost are both significantly positive. The results in column (3)

show that the correlation coefficient between board informal hierarchy and management agency cost is significantly negative, indicating that greater clarity in the board's informal hierarchy leads to lower management agency costs for the firm. The results in column (4) show that the coefficients for board informal hierarchy and management agency cost are both significantly positive. The results in column (5) show that the correlation coefficient between board informal hierarchy and financing constraints is significantly negative, indicating that greater clarity in the board's informal hierarchy reduces financing constraints for the firm. The results in column (6) show that the coefficients for board informal hierarchy and financing constraints are both significantly positive. Furthermore, all Bootstrap tests pass (see Table 4), thereby confirming the mediation effects.

Table 3. Mediation Effect Regression

Variable	m1 agency1	m2 EDF	m3 agency2	m4 EDF	m5 WW	m6 EDF
agency1		0.029***				
		(2.86)				
agency2				0.011*		
				(1.73)		
WW						0.248***
						(9.37)
Gini	-0.009*	-0.037***	-0.016**	-0.034***	-0.010***	-0.036***
	(-1.75)	(-3.43)	(-2.46)	(-3.39)	(-2.85)	(-3.18)
Size	-0.001***	0.018***	-0.016***	0.017***	-0.048***	0.030***
	(-4.46)	(21.34)	(-45.17)	(21.33)	(-256.12)	(18.06)
Board	-0.001	-0.012***	-0.007***	-0.012***	-0.003***	-0.012***
	(-0.93)	(-3.22)	(-3.26)	(-3.42)	(-3.15)	(-3.01)
Dual	-0.000	0.003*	0.001	0.003**	-0.001***	0.003**
	(-0.47)	(1.88)	(0.78)	(2.06)	(-3.05)	(2.08)
Balance1	-0.004***	-0.005	0.004**	-0.004	-0.005***	-0.004
	(-3.51)	(-1.64)	(2.41)	(-1.60)	(-5.97)	(-1.23)
Cashflow	0.005	-0.063***	-0.094***	-0.058***	-0.160***	-0.023**
	(0.94)	(-6.66)	(-14.54)	(-6.62)	(-51.13)	(-2.16)
Growth	0.002***	-0.005***	-0.021***	-0.004***	-0.048***	0.007***
	(2.95)	(-3.33)	(-19.29)	(-3.23)	(-56.49)	(3.57)
FirmAge	0.005***	0.004*	-0.003**	0.004**	0.007***	0.002
	(4.81)	(1.79)	(-2.39)	(1.99)	(9.88)	(1.02)
Top1	-0.017***	-0.025***	-0.030***	-0.024***	-0.024***	-0.021***
	(-6.62)	(-4.38)	(-9.28)	(-4.45)	(-13.47)	(-3.52)
	(-4.36)	(-4.89)	(0.54)	(-4.74)	(-12.21)	(-4.97)
Constant	0.087***	-0.359***	0.474***	-0.348***	0.070***	-0.372***
	(12.67)	(-19.19)	(52.46)	(-18.99)	(15.25)	(-18.97)
N	24,964	24,964	26,753	26,753	23,396	23,396
R^2	0.040	0.121	0.312	0.118	0.845	0.129

Table 4. Bootstrap Test

Mediator Variable	Type of Effect	Coefficient	Std. Error	95%Confidence Interval(P)	95%Confidence Interval(BC)
agency1	Direct Effect	-0.03666	0.01083	[-0.05725,-0.01522]	[-0.05746,-0.01530]
	Indirect Effect	-0.00025	0.00017	[-0.00063,0.00003]	[-0.00073,-0.00002]
agency2	Direct Effect	-0.03385	0.01005	[-0.05389,-0.01386]	[-0.05390,-0.01447]
	Indirect Effect	-0.00018	0.00014	[-0.00049,0.00002]	[-0.00057,-0.00001]
WW	Direct Effect	-0.03642	0.01110	[-0.05792,-0.01508]	[-0.05798,-0.01530]
	Indirect Effect	-0.00238	0.00086	[-0.00398,-0.00072]	[-0.00411,-0.00080]

4.4 Endogeneity Tests

(1) Instrumental Variable Approach

Table 5. 2SLS

Variable	(1) First Gini	(2) Second EDF
IV1	10.056*** (177.76)	
Gini		-0.036*** (-3.65)
Constant	0.113*** (26.45)	-0.352*** (-19.63)
Kleibergen-Paap rk LM	5252.73	
Kleibergen-Paap rk Wald F	31598.75	
Controls	Yes	Yes
Year	Yes	Yes
Ind	Yes	Yes
N	25,787	25,787
R^2	0.831	0.119

The two-stage regression results based on the instrumental variable approach (Table 5) show that: in the first-stage regression, the estimated coefficient of the instrumental variable (IV1) on board informal hierarchy (Gini) is 10.056 and is highly significant at the 1% level (t = 177.76), while the model's goodness-of-fit reaches 0.831, confirming a strong correlation between the instrumental variable and the endogenous variable. In the second-stage regression, after controlling for control variables, year, and industry fixed effects, the coefficient of Gini on debt default risk (EDF) is -0.036 (t = -3.65, p < 0.01). Compared to the baseline regression coefficient (-0.034), its absolute value is larger while the significance remains consistent. This indicates that, after mitigating endogeneity bias, the suppressing effect of increased board informal hierarchy clarity on corporate default risk remains robust and even strengthens. Further statistical tests validate the effectiveness of the instrumental variable: the Kleibergen-Paap rk LM statistic of 5252.73 (p < 0.01) rejects the null hypothesis of "underidentification of instrumental variables," and the Kleibergen-Paap rk Wald F statistic of 31,598.75 far exceeds the Stock-Yogo test critical value of 16.38 for a 10% bias level, ruling out weak instrument concerns. In summary, the instrumental variable approach confirms a significant negative causal effect between board informal hierarchy (Gini) and corporate debt default risk (EDF).

(2) Heckman Two-Stage Model

Table 6. Heckman

First		Second	
	Gini_D		EDF
IV2	11.43***	Gini	-0.0301*
	(29.35)		(-1.74)
		IMR	0.0273**
			(2.45)
Constant	-1.539***	Constant	-0.339***
	(-29.13)		(-13.44)
Controls	Yes	Controls	Yes
Year	Yes	Year	Yes
Ind	Yes	Ind	Yes
N	26,690	N	26,690
Pseudo R2	0.0797	Wald chi2	1740.54***

As shown in Table 6, in the first stage, the coefficient of the instrumental variable (IV2) on the selection variable (Gini_D) is 11.43 and significant at the 1% level (t = 29.35). The pseudo R-squared of the Probit model is 0.0797, indicating strong explanatory power of the instrumental variable. In the second stage, after controlling for sample selection bias and including the inverse Mills ratio (IMR) in the regression, the coefficient of board informal hierarchy (Gini) on debt default risk (EDF) remains significant at -0.0301 (t = -1.74, p < 0.1). Moreover, the coefficient of IMR is significantly positive at 0.0273 (t = 2.45, p < 0.05), confirming the presence of sample selection bias. The overall model passes the Wald chi² test (1740.54***). After accounting for control variables, year, and industry effects, the conclusion indicates that even after correcting for

selection bias, the suppressing effect of board informal hierarchy clarity (Gini) on corporate default risk (EDF) remains valid.

(3) PSM-OLS

To address endogeneity concerns arising from sample self-selection (as shown in Table 7), this study employs Propensity Score Matching (PSM) to re-examine the main hypothesis. First, the board's informal hierarchy (Gini) is divided into two groups based on its median value. The group above the median is defined as the treatment group (assigned a value of 1), while the group below the median is defined as the control group (assigned a value of 0). Concurrently, firm size, board size, CEO duality, equity balance, cash flow ratio, operating revenue growth rate, firm age, and the shareholding ratio of the largest shareholder are selected as matching variables for debt default risk. A 1:1 nearest-neighbor matching approach is used for the matching, and regression is performed on the matched sample (results shown in Table 9). Furthermore, a 1:3 nearest-neighbor matching approach is applied for robustness checks. The coefficient for board informal hierarchy (Gini) on debt default risk (EDF) remained significantly negative at the 5% and 1% levels, respectively. This indicates that the findings of this study remain robust.

Table 7. PSM

Variable	(1) EDF	(2) EDF
Gini	-0.0224**	-0.033***
	(-2.16)	(-3.05)
Constant	-0.355***	-0.36***
	(-20.29)	(-18.29)
ATT	-1.69*	-2.03**
	(T-stat)	(T-stat)
Controls	Yes	Yes
Year	Yes	Yes
Ind	Yes	Yes
N	26,706	21997
R^2	0.126	0.115

4.5 Robustness Tests

(1) Replacing Independent Variables

After recalculating the board informal hierarchy by excluding independent directors, the regression results remain significant (as shown in Table 8). After controlling for variables such as firm size (Size), board characteristics (Board, Dual), ownership structure (Balance1, Top1), financial indicators (Cashflow, Growth), and firm age (FirmAge), and incorporating year and industry fixed effects, the regression coefficient of the core explanatory variable Gini_T on debt default risk (EDF) is -0.018, significant at the 5% level (t = -2.38). The sign of this coefficient is identical to that of the original Gini in the baseline regression (-0.034***), indicating that even after excluding the influence of independent directors, the inhibitory effect of increased clarity in the board's informal hierarchy on corporate debt default risk remains robust.

Table 8. Replacing Independent Variables

Variable	EDF
Gini_T	-0.018**
	(-2.38)
Size	0.017***
	(21.69)
Board	-0.012***
	(-3.21)
Dual	0.003**
	(2.02)
Balance1	-0.005*
	(-1.73)
Cashflow	-0.060***
	(-6.78)
Growth	-0.005***
	(-3.47)
FirmAge	0.004**
	(2.18)
Top1	-0.025***
	(-4.60)
Constant	-0.353***
	(-19.88)
Year	Yes
Ind	Yes
VIF	1.05-1.85
N	26,744
R^2	0.118

(2) Placebo Test

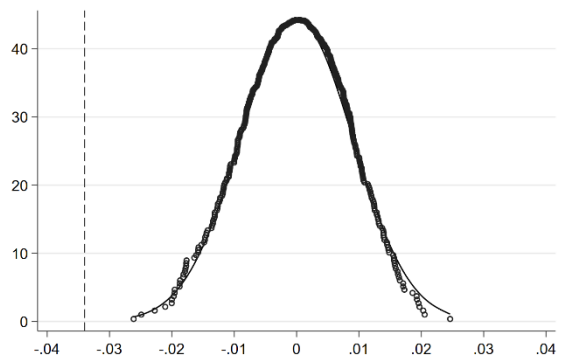

Figure 1. Plot of Spurious Estimated Coefficients

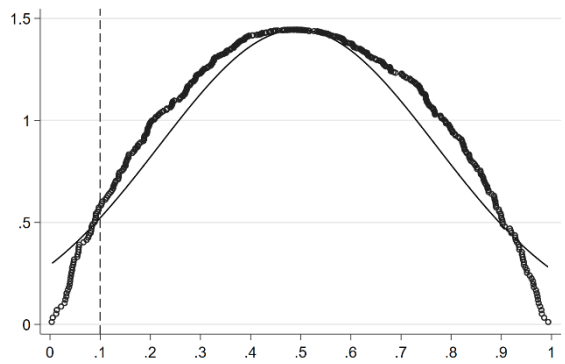

Figure 2. Plot of Spurious P-Values

By randomly generating 500 false treatment groups for board informal hierarchy and repeating the regressions, the mean of the coefficient distribution is -0.001 (close to zero), with a standard deviation of 0.009. The 95% confidence interval is [-0.018, 0.016], which fully includes zero (Figure 1). In contrast, the true Gini coefficient of -0.034 (from the baseline regression result) lies far outside the random coefficient distribution in the left tail ($p < 0.01$), significantly deviating from random treatment effects (Figure 2). This result rules out the possibility that unobserved confounding factors drive spurious regression outcomes, confirming that the negative impact of board informal hierarchy (Gini) on corporate debt default risk (EDF) is causal rather than a statistical artifact driven by random noise.

5. Conclusion

Due to differences in social network relationships and resource acquisition capabilities, an informal hierarchy tends to form among board members. Under the influence of this informal hierarchy, lower-ranking directors are more likely to support and agree with decisions made by higher-ranking directors, thereby influencing various corporate decisions. This study explores the impact of board informal hierarchy on corporate debt default risk. The results show that when the clarity of the board's informal hierarchy is high, it can reduce a firm's debt default risk by lowering debt agency costs and management agency costs, as well as alleviating financing constraints.

The implications of this study are as follows: First, a well-designed board composition can help firms obtain higher-quality credit resources and facilitate high-quality development. Second, when differences exist among board members in terms of social networks and resource acquisition capabilities, firms should fully leverage the governance and resource effects brought by such differences to support their growth.

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