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CEO Social Connections and Investment Efficiency: Evidence from a Large Language Model Approach

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Abstract: This paper investigates the influence of CEO social connections on corporate investment efficiency, with a focus on relationship-based governance mechanisms. Using a large language model (LLM) to quantify CEOs' social networks centrality, the study finds that CEOs with more extensive social networks are associated with higher investment efficiency. This positive effect is especially pronounced in resource-concentrated industries, such as monopolistic sectors, and under conditions of greater CEO reputational concern. The above analysis supports that an informal governance mechanism drives this effect: CEO networks centrality function as relational contracts that discourage external partners from recommending low-quality projects, thereby improving investment outcomes beyond traditional information-sharing channels. Overall, this study provides a novel perspective on CEO networks as informal governance tools, enriching the understanding of how social ties shape corporate decision-making and investment efficiency beyond conventional informational explanations.

1. Introduction

Social connections are inherently crucial in China, owing to the deep-rooted cultural emphasis on interpersonal relationships and their profound influence on both social and economic activities. This importance primarily stems from the concept of Guanxi, which refers to a network of personal relationships that facilitates the exchange of favors and resources. In a business and financial context, strong social connections can determine access to critical information, business opportunities, and even capital. For example, firms whose executives maintain close ties with government officials or bank managers may find it easier to secure loans or obtain favorable regulatory treatment. Therefore, investigating the role of social connections is not merely a sociological endeavor but also a critical lens for understanding the mechanisms driving China's unique economic landscape. This paper explores how these connections specifically shape corporate financial decisions and outcomes, an area where their impact is profound yet complex.

While the influence of CEO social networks on various corporate outcomes has been well-documented, their specific impact on corporate investment efficiency remains unexplored. Specifically, this study investigates whether CEOs' social networks influence a firm's investment efficiency, and if so, through what mechanisms does this relationship operate? This research gap is

particularly noteworthy given the paramount importance of investment efficiency in corporate finance and accounting theory. Investment efficiency, defined as the degree to which a firm allocates capital to projects that maximize shareholder value—avoiding both underinvestment in positive net present value (NPV) projects and overinvestment in negative NPV projects—is a core determinant of long-term firm value and economic growth [20,25]. Inefficient investment represents a direct agency cost and a misallocation of scarce economic resources. Therefore, understanding the channels that mitigate or exacerbate investment inefficiencies is a critical pursuit for both academia and practice. Investigating CEO social networks as one such channel is compelling because networks simultaneously provide access to unique resources and introduce potential biases. They can improve efficiency by reducing information asymmetry and providing valuable monitoring [24], yet they may also foster overconfidence, groupthink, or the pursuit of private benefits, leading to inefficient capital allocation.

This study uses data from Chinese listed firms –a context where interpersonal networks, or Guanxi, fundamentally shape corporate governance and resource allocation [3,28]. The Chinese setting is particularly suitable for this inquiry because its transitional economy exhibits significant variations in marketization, making investment efficiency a pressing concern and the role of informal CEO networks potentially more decisive than in mature markets [1]. To innovatively measure CEO connections, we apply a large language model (LLM) to analyze executive biographical texts, extracting and quantifying connections derived from educational affiliations, prior employment histories, concurrent board positions at other firms, and institutional backgrounds (e.g., military or government service) to construct a composite connection score. This computational approach offers a scalable, objective, and nuanced alternative to traditional survey-based or manually collected network measures, mitigating perception biases and enabling the analysis of large-scale executive data [13,15].

Using a final sample of 2,604 firm-year observations across 244 unique A-share listed companies from 2010 to 2025, we find robust evidence that well-connected CEOs are associated with significantly higher levels of investment efficiency, suggesting that such CEOs are more likely to undertake value-enhancing projects. This finding aligns with contracting theory, which posits that relationship networks serve as an informal governance mechanism: investors may be reluctant to reject a connected CEO's proposals for fear of losing access to the CEO's entire network of resources, thereby motivating the CEO to recommend higher-quality investments[8] . To partially account for the CEO's individual information advantage, we include firm-level controls—such as size, leverage, cash holdings, and growth potential—that capture key dimensions of a firm's information environment and resource profile. Our results remain consistent across multiple model specifications and after incorporating these controls along with firm and year fixed effects.

Our study makes several contributions. While prior literature establishes that CEO social connections enhance information access and resource acquisition [8,14], it predominantly emphasizes the informational and capital-access benefits of networks. A critical gap remains: how social ties translate into superior investment efficiency. This study advances relational governance theory by proposing that CEO networks function as informal disciplinary mechanisms. Specifically, external partners—fearing exclusion from the CEO's valuable resource pool—are incentivized to recommend higher-quality investments, thereby improving capital allocation. This relational governance channel differs from and complements existing information-advantage explanations, offering a novel perspective on how social capital mitigates agency costs and enhances corporate decision-making efficiency in relationship-based economies like China.

Second, we contribute to the corporate investment efficiency literature by identifying CEO social networks as a previously overlooked determinant of capital allocation decisions. While prior research has extensively documented how financial constraints, internal controls, and board monitoring

influence investment efficiency [2,4], the specific role of CEO personal connections remains unexplored. This oversight is particularly significant given the paramount importance of informal networks and Guanxi in Chinese business environments, where relational ties fundamentally shape resource access and economic transactions. By systematically analyzing how a CEO's alumni networks, prior employment affiliations, and political ties translate into more efficient investment decisions, we illuminate a critical yet neglected channel through which social capital mitigates information asymmetry and secures strategic resources. This investigation advances investment efficiency theory by demonstrating that personal relationships function not merely as supplementary governance mechanisms but as primary determinants of corporate capital allocation quality in relational economies.

Finally, we contribute to the measurement methodology of CEO social capital by proposing a novel approach that leverages large language models to extract a comprehensive, multi-dimensional index from unstructured biographical text. Unlike prior studies that rely on single-dimensional, manually collected proxies (e.g., alumni ties or specific employment histories), our LLM-based measure captures a holistic profile of CEO networks across diverse professional and personal relationships. This methodological advancement addresses a significant limitation in existing research: the systematic underestimation of social capital due to reliance on discrete, observable channels. By quantifying latent network resources inferred from narrative biographical data, we provide a more accurate and nuanced assessment of CEO social capital that is both scalable and replicable across large samples. This innovation enhances our ability to examine how social networks—operating through the relational governance mechanism proposed in this study—translate into measurably superior corporate investment outcomes.

2. Literature Review and Hypothesis Development

2.1 CEO Characteristics and Firm Behavior

A substantial stream of finance and accounting literature has established that a CEO's social network—often measured through specific channels such as shared educational backgrounds[5], employment histories, or regional ties—is a critical component of human capital. These connections provide access to superior information, business opportunities, and resources, which can enhance corporate decisions, including investment choices. For instance, CEOs with extensive and influential networks may prompt external partners (e.g., potential investors or project recommenders) to exercise greater caution when presenting low-quality investment proposals. The fear of losing access to the CEO's valuable resource network creates a self-disciplining effect, leading to a higher average quality of projects reaching the CEO and, consequently, potentially higher investment efficiency. However, existing research primarily relies on single-dimensional, observable network proxies (e.g., school ties) due to data availability constraints. This approach has significant limitations: it overlooks latent or hidden network resources that are not publicly disclosed and fails to capture the multifaceted nature of real-world networks, where executives simultaneously leverage educational, professional, institutional, and cross-industry ties [7].

The pervasive role of personal connections, or Guanxi, in China's business environment is a well-documented phenomenon in the literature, where such ties are recognized as a critical informal mechanism for securing resources, reducing transaction costs, and navigating institutional voids—particularly within the unique context of China's relationship-based economy and its politically embedded market system [21,28]. Prior empirical research has predominantly measured executive connections through narrowly defined, discrete channels such as shared alumni networks, employment history with government or regulatory bodies, or board interlocks [11]—an approach that may overlook the multifaceted and composite nature of an executive's actual social capital. To

address this limitation, our methodological contribution involves applying LLMs to analyze unstructured textual data from CEO biographies, enabling a more holistic and nuanced extraction of an individual's integrated social network from diverse relational cues mentioned in the narrative. This data-driven approach moves beyond single-dimensional proxies to generate a comprehensive connection metric, offering a significant methodological innovation that can be applied to other research contexts where social networks are inferred from qualitative profiles.

2.2 Hypothesis Development

CEO social networks act as a critical informal governance mechanism that disciplines external capital providers and enhances investment efficiency. In relational economies where formal institutions are underdeveloped, business transactions rely heavily on personal ties rather than arm's-length market mechanisms [27]. In such settings, a CEO's network represents valuable social capital that facilitates resource access and ensures cooperative behavior from connected partners [12]. When a CEO has strong social connections, external investors or business partners face heightened relational risks: rejecting a CEO's investment proposal or failing to cooperate may result in exclusion from the CEO's network and the loss of access to future private benefits[16,26] . This implicit threat serves as a disciplinary device, incentivizing network participants to carefully evaluate and support the CEO's projects, thereby reducing opportunistic behavior and enhancing the quality of resource allocation.

Consequently, CEOs with richer social ties are better positioned to secure higher-quality investment opportunities and foster commitment from key stakeholders, leading to improved corporate investment efficiency. This relational governance perspective contrasts with conventional views that emphasize information advantages; here, the network itself serves as an enforcement mechanism that aligns interests and mitigates agency conflicts within the relational ecosystem[10,17]. External partners, fearing exclusion from valuable network-derived resources (e.g., preferential contracts, political favors, or confidential information), are compelled to engage more constructively with the CEO's proposals. This results in more rigorous investment selection and execution, as partners strive to maintain their standing within the network. Thus, a CEO's social network does not merely expand information channels but actively shapes stakeholder behavior to promote disciplined, high-quality investment decisions. Based on the discussion above, we formulate our first hypothesis as follows.

H1: *All else equal, CEOs with greater social network centrality (as measured by LLM-based quantification) are associated with higher levels of corporate investment efficiency.*

The moderating effect of industry resource concentration reinforces the proposed relational governance mechanism, suggesting that the positive impact of CEO networks on investment efficiency is more pronounced in industries where critical resources are scarce and tightly controlled (e.g., energy, telecommunications, and licensed finance). In these sectors, access to essential inputs, regulatory approvals, or exclusive permits often depends on relational access rather than competitive markets [9,17]. A CEO's social connections in such environments carry higher "hostage value"[26], as external partners face severe consequences of exclusion: proposing low-quality investments and damaging the relationship may result in permanent cutoff from the scarce industry-specific resources controlled through the CEO's network. This heightened relational collateral intensifies the disciplinary pressure on capital providers to screen and recommend only high-value projects, thereby amplifying the positive effect of CEO networks on investment efficiency. In contrast, in competitive, resource-diffuse industries (e.g., retail or general manufacturing) where alternative partners and resources are readily available, network ties function more as channels for information exchange rather than as potent governance devices, thereby weakening the proposed effect. Thus, the stronger

positive association between CEO social networks and investment efficiency in regulated or concentrated industries reinforces the argument that networks serve as an informal governance mechanism—disciplining external partners through the threat of relational exclusion—rather than merely facilitating information flow. Consequently, we hypothesize as follows:

H2: *The positive association between CEO social network centrality and investment efficiency is stronger in resource-concentrated industries (e.g., monopolistic or oligopolistic sectors)*

We further predict that the governance effect of CEO social networks on investment efficiency is amplified when the CEO has a strong reputation for enforcing relational reciprocity—an attribute often observable in earlier career stages when reputation-building incentives are heightened. Reputation in relational networks acts as a credible commitment device: a CEO known for rewarding cooperation and punishing opportunism strengthens the perceived "collateral" value embedded in their network ties [6,18]. When external partners believe that the CEO has both the willingness and a track record of sanctioning those who deliver low-quality investments, the deterrent against suboptimal project recommendations becomes more effective. This is particularly salient in the early stages of a CEO's tenure, when reputational capital is being actively accumulated and relational enforcement actions are closely monitored within business circles [19]. In such periods, the CEO's network is not merely a static set of connections but a dynamic governance arena where the threat of exclusion is highly credible. Therefore, the stronger positive association between CEO networks and investment efficiency when CEOs have higher reputation concerns (e.g., during earlier career phases) reinforces the argument that networks operate as an informal disciplinary mechanism, leveraging relational reputation to secure higher-quality resource allocation. Consequently, we hypothesize as follows:

H3: *The positive association between CEO social network centrality and investment efficiency is stronger when CEOs face higher reputation-building incentives (e.g., during early career stages)*

3. Samples and Empirical Design

3.1 Measurement of CEO Social Network using LLMs

To overcome these limitations, we propose a novel methodology that leverages the inferential capability of LLMs to holistically assess CEO social capital from biographical data. We develop a scoring framework based on six dimensions derived from CEO resumes: (1) educational prestige, (2) elite corporate/institutional experience, (3) influence in professional associations, (4) political and governmental resources, (5) cross-industry network breadth, and (6) resource integration capability. Guided by structured prompts (see Appendix B), the LLM evaluates and scores each dimension, enabling the model to infer latent network resources not explicitly stated—akin to human reasoning. To anchor the scores and ensure comparative rigor, we provide the LLM with a benchmark resume exemplar and its predefined score. Addressing the LLM's tendency toward central clustering (e.g., scores concentrated in the 6– range), we employ an undersampling technique to ensure a balanced distribution across score ranges, thereby preventing our results from being driven by overrepresentation in any single segment. This method aims to generate a more comprehensive, multi-dimensional measure of CEO network strength for empirical analysis.

3.2 Sample Construction and Data

To empirically examine the relationship between CEO social capital and corporate investment efficiency, we construct a firm-year level sample using data from multiple sources. Our initial sample comprises all constituents of the CSI 300 Index—a major benchmark for the Chinese A-share market—spanning the period from 2010 to 2025. We measure corporate investment efficiency

following established methodologies in the finance literature [4,23]. Firm-level control variables (e.g., total assets, debt levels, operating cash flow, and Tobin's Q) are extracted from annual financial reports. CEO biographical data for social network scoring is manually collected from the management discussion sections and executive profiles within the same annual reports. To address the imbalance in score distribution—where LLM-generated social capital scores were initially clustered around 7–on our scale—we apply an undersampling technique. This process ensures that observations across all score ranges are proportionally represented, with each range accounting for approximately 10% of the final sample. Our initial merged sample contained 3,205 firm-year observations. After applying the undersampling adjustment and excluding observations with missing data for certain CSI 300 constituents, our final analytical sample consists of 2,604 firm-year observations encompassing 244 unique A-share listed companies.

3.3 Regression Models

The primary regression model to test our hypothesis is specified as follows:

$$InvestmentEfficiency_{it} = \alpha_0 + \alpha_1 \times CEO\_Network_{i,t} + \theta \times X_{it} + Firm\ Fixed\ Effect + Industry\ Fixed\ Effect + \epsilon_{it} \quad (1)$$

where i and t denote firm and year, respectively. The dependent variable, $InvestmentEfficiency_{it}$, is constructed based on the residual-based model introduced by [23] and widely applied in subsequent studies[2,4]. This model estimates a firm's expected level of investment, with inefficiency defined as the absolute deviation from this expectation. In this study, we multiply the absolute residual by –1, such that a higher value indicates greater investment efficiency and a lower value reflects higher inefficiency. The key independent variable, $CEO\_Network_{i,t}$, is a composite score derived from our LLM-based evaluation of the CEO's social capital across six dimensions: educational prestige, elite professional experience, associational influence, political resources, cross-industry ties, and resource integration capability (see Appendix B for scoring prompts). This measure captures both observable and latent network resources. The vector $X_{i,k,t}$ includes several firm-level control variables commonly used in investment efficiency research: Size (measured as the natural logarithm of total assets), Lev (the financial leverage ratio, defined as total debt divided by total assets), Cash (the ratio of cash and cash equivalents to total assets), and GrowthPotential (proxied by the market-to-book (M/B) ratio, calculated as the market value of equity divided by the book value of equity). These controls account for firm characteristics that may influence both investment behavior and a CEO's network, such as resource availability, risk profile, and growth opportunities [2,23]. The variable definitions can be found in Appendix A.

3.4 Descriptive Statistics

Table 1 presents the descriptive statistics for the key variables used in our analysis. The mean value of our dependent variable, InvestmentEfficiency (investment efficiency), is -0.04. The negative value arises because we multiply the absolute deviation measure of inefficiency by -1 for more intuitive interpretation: a higher (i.e., less negative) value indicates greater investment efficiency. Our primary variable of interest, CEO_Network (CEO social network score), has a mean of 0.55 and a standard deviation of 0.29, reflecting the balanced distribution achieved through the undersampling procedure that ensures proportional representation of observations across different score levels. Regarding firm characteristics, the average firm size (Size), measured as the natural logarithm of total assets, is 24.44. This value is notably higher than those in typical samples in broader literature[23], which is expected given that our sample consists of large CSI 300 constituent firms. The mean leverage ratio (Lev) is 0.48, indicating that sample firms finance approximately 48% of their assets with debt—a figure

consistent with prior studies of large listed Chinese companies [4]. The average market-to-book ratio (GrowthPotential) is 2.30, suggesting that the sample firms are generally perceived by the market to have valuable growth opportunities.

Table 1: Summary Statistics

Variable	Obs	Mean	STD	25%	50%	75%
InvEff	2,604	-0.04	0.06	-0.05	-0.02	-0.01
CEO-SN	2,604	0.55	0.29	0.30	0.55	0.80
CEOCareerConcern	2,604	0.30	0.30	0.10	0.20	0.33
HHI	2,603	0.21	0.18	0.10	0.16	0.25
Size	2,604	24.44	1.63	23.35	24.41	25.57
Lev	2,604	0.48	0.19	0.34	0.49	0.62
Cash	2,604	0.10	0.09	0.04	0.09	0.14
GrowthPotential	2,604	2.30	2.20	1.12	1.55	2.63

Table 2 presents the Pearson pairwise correlations among the main variables used in our regression analyses. The unconditional correlation matrix provides initial insights into the core relationships of our hypothesis. Most importantly, we observe a statistically significant positive correlation (0.106) between CEO_Network (the CEO social network score) and InvestmentEfficiency (investment efficiency). This preliminary finding is consistent with our core argument that CEOs with richer social capital have access to higher-quality information and opportunities, which can discipline potential investment partners and lead to more efficient investment outcomes. Furthermore, the correlation between CEO_Network and firm Size is positive (0.083), aligning with the intuitive notion that larger, more prominent firms tend to be led by CEOs with stronger and more extensive networks [7]. The correlations among control variables are as expected; for instance, firm size (Size) is positively correlated with leverage (Lev, 0.507), a common pattern in corporate finance literature where larger firms have greater debt capacity [22]. These initial, unadjusted correlations provide a supportive foundation for the more rigorous multivariate tests that follow.

Table 2: Correlation Analysis

ID	Variables	1	2	3	4	5	6
1	*InvEff*	1					
2	*CEO-SN*	0.106	1				
3	*Size*	0.144	0.083	1			
4	*Lev*	0.040	0.044	0.507	1		
5	*Cash*	-0.086	-0.032	-0.067	-0.256	1	
6	*GrowthPotential*	-0.050	-0.036	-0.409	-0.393	0.276	1

4. Empirical Results and Discussions

4.1 Main Empirical Results

Table 3 presents the main regression results examining the relationship between CEO social networks and corporate investment efficiency. Column (1) reports a baseline specification without control variables, where the coefficient on CEO_Network is 0.023 and statistically significant at the 1% level. This initial finding suggests a positive unconditional association between a CEO's social capital and investment efficiency. In Column (2), we introduce a set of standard firm-level control

variables, including size, leverage, cash holdings, and growth potential. The coefficient on CEO_Network remains positive and highly significant at 0.020, indicating that the relationship is robust to accounting for these fundamental firm characteristics. Finally, Column (3) incorporates both firm and year fixed effects to control for time-invariant firm heterogeneity and common macroeconomic shocks. The coefficient, while slightly reduced to 0.017, remains statistically significant at the 1% level. The consistency and significance of the CEO_Network coefficient across all three model specifications provide strong empirical support for our hypothesis that CEOs with more extensive and higher-quality social networks achieve greater investment efficiency [7].

The estimated relationship also has economic significance. Based on the coefficient from our most stringent model (Column 3), a 0.1 increase in the CEO_Network score (corresponding to one level in our scoring system) is associated with a 0.0017 increase in investment efficiency. Given that the scoring system ranges from 0 to 1 in 0.1 increments, a one full-level improvement in a CEO's network score (e.g., from 0.5 to 0.6) would increase investment efficiency by approximately 0.017. Relative to the sample mean of InvestmentEfficiency (-0.04), this translates to an improvement of about 6%. This magnitude is non-trivial and suggests that the quality of a CEO's social network is a significant contributor to firm-level capital allocation efficiency, comparable in importance to other well-studied governance and financial factors [2].

Table 3: Main Regression

Dep. Var.	***Investment Efficiency***		
Model	(1)	(2)	(3)
CEO-SN	**0.023*** **	**0.020*** **	**0.017*** **
	(0.004)	**(0.004)**	**(0.004)**
Size		0.007***	-0.005*
		(0.001)	(0.003)
Lev		-0.022***	-0.017
		(0.008)	(0.014)
Cash		-0.065***	-0.055***
		(0.014)	(0.016)
GrowthPotential		0.001	-0.002*
		(0.001)	(0.001)
Constant	Yes	Yes	Yes
Firm FE	No	No	Yes
Year FE	No	No	Yes
N	2604	2593	2584
adj. R-sq	0.011	0.037	0.162

4.2 Cross-Sectional Regression Results

To further examine whether the governance effect of CEO social networks drives our main result, we conduct cross-sectional tests based on CEO career concerns and industry resource concentration. Following prior literature [19], we measure CEO career concerns by the CEO's tenure stage, with high concern defined as the earlier phase of their career. Industry resource concentration is measured using the Herfindahl-Hirschman Index (HHI), where a higher HHI indicates a more concentrated, less competitive industry with scarcer critical resources and more valuable network access[9]. Table 4 presents the results of these moderated analyses. Columns (1) and (2) split the sample based on

CEO career concerns. The coefficient on CEO_Network is positive and highly significant (0.017) only in the high career concern subsample, supporting our hypothesis that reputational incentives amplify the governance effect. This suggests that when a CEO has stronger incentives to build and enforce their relational reputation, the disciplinary power of their network is more potent, leading to a stronger link between network strength and investment efficiency. Columns (3) and (4) split the sample by industry HHI. The effect of CEO_Network is positive and significant in both subsamples but is notably larger and more statistically significant (0.018) in high HHI (resource-concentrated) industries. This supports our prediction that industry resource concentration strengthens the governance mechanism, indicating that in industries where key resources are controlled by fewer firms, the threat of exclusion from a CEO's network carries greater consequences, thereby amplifying the positive effect of social ties on investment quality.

Table 4 Cross-Section Test

Dep. Var.	***Investment Efficiency***			
Sample	***Low Career Concern***	***High Career Concern***	***Low Industry HHI***	***High Industry HHI***
Model	(1)	(2)	(3)	(4)
CEO-SN	**0.007**	**0.017*****	**0.015****	**0.018*****
	(0.007)	**(0.005)**	**(0.006)**	**(0.006)**
Size	-0.014**	-0.001	-0.009**	-0.001
	(0.006)	(0.003)	(0.004)	(0.004)
Lev	0.021	-0.050***	0.006	-0.037
	(0.029)	(0.018)	(0.020)	(0.024)
Cash	-0.063**	-0.039**	-0.019	-0.103***
	(0.030)	(0.020)	(0.023)	(0.024)
Growth	0.001	-0.002*	-0.002	-0.001
	(0.002)	(0.001)	(0.001)	(0.001)
Constant	Yes	Yes	Yes	Yes
Firm FE	No	No	Yes	Yes
Year FE	No	No	Yes	Yes
N	1018	1529	1285	1286
adj. R-sq	0.212	0.192	0.157	0.203

The results across all four models in Table 4 provide convergent evidence that the positive relationship between CEO social networks and investment efficiency is likely driven by a governance or disciplinary mechanism, rather than solely by enhanced information access. The moderating roles of CEO career stage and industry structure are consistent with the theory that networks function as informal enforcement devices [6]. When a CEO has more at stake in maintaining a reputation for relational reciprocity, and when external partners are more dependent on accessing concentrated resources through the CEO's connections, the network's role in screening out poor investment proposals becomes more powerful. These findings complement and extend prior research that primarily links CEO networks to information advantages by highlighting the understudied governance channel through which social capital improves corporate resource allocation.

5. Conclusion

This study investigates the role of CEO social connections in corporate investment efficiency

within China's institutional context, where Guanxi networks are deeply embedded in business practices. Moving beyond conventional single-dimension measures (e.g., school ties or shared employment history), we introduce a novel, multi-dimensional measure of CEO social capital constructed from biographical data using an LLM. Our methodology addresses key limitations of prior research by capturing both observable and latent network resources across six dimensions and employing undersampling techniques to correct for LLM scoring bias, thereby offering a replicable framework for applying artificial intelligence (AI) in social network analysis. Empirically, we find that a stronger CEO social network is robustly associated with higher corporate investment efficiency. More importantly, cross-sectional tests reveal that this positive effect is significantly amplified in industries with high resource concentration and when CEOs face greater career reputation concerns—patterns that align with a relational governance mechanism rather than a pure information advantage channel. These findings complement and extend the existing literature, which has largely emphasized the informational benefits of networks [5], by highlighting how networks can serve as an informal disciplinary device: external partners are deterred from recommending poor investments due to the threat of exclusion from the CEO's valuable resource pool.

This study has several limitations that point to avenues for future research. First, while the LLM-based measure represents an improvement over traditional proxies, it remains an indirect assessment of social capital and may not fully capture the dynamic, qualitative aspects of network ties. Future studies could incorporate more direct data (e.g., board interlocks or professional event participation records) to validate and enrich our measure. Second, although we control for firm fixed effects and key financial variables, unobserved firm-level heterogeneity or time-varying governance factors may still influence both CEO network formation and investment outcomes. Third, our sample focuses on large, publicly listed Chinese firms (CSI 300 constituents); the findings may not be generalizable to smaller private firms or other institutional environments where network structures and enforcement mechanisms differ. Future research could examine whether the governance effect of CEO networks holds in different economic settings or for other types of corporate decisions (e.g., M&A performance or innovation strategy). Exploring how digital platforms and virtual professional networks are reshaping traditional guanxi-based governance also presents a promising research direction.

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Appendix A Variable Definition

Variable	Definition	Source
Investment Efficiency	Investment efficiency of firm i in year t; calculated as the absolute residual from Richardson (2006) model multiplied by –1 (higher value = greater efficiency)	Annual Reports
CEO_Network	Composite score of CEO social capital (0–1 scale) based on six dimensions: educational prestige, elite corporate/institutional experience, professional association influence, political resources, cross-industry network breadth, resource integration capability	CEO biographies and LLM Scoring
Size	Natural logarithm of total assets of firm i in year t	Annual Reports
Lev	Financial leverage ratio of firm i in year t; total debt divided by total assets	Annual Reports
Cash	Cash holdings ratio of firm i in year t; cash and cash equivalents divided by total assets	Annual Reports
Growth Potential	Growth potential of firm i in year t; market-to-book ratio (market value of equity divided by book value of equity)	Annual Reports
Industry Concentration	Herfindahl-Hirschman Index (HHI) of the industry; higher value indicates higher resource concentration	Annual Reports
CEO_Tenure	Indicator variable: 1 if CEO tenure ≤3 years (high reputational concerns), 0 otherwise	Annual Reports

Appendix B: Prompt

Based on the CEO's personal experience summary, comprehensively evaluate their Social Network Resource Level according to the dimensions below, with a score ranging from 1 to 10. Scoring Dimensions:

Dimension	**Evaluation Criteria**
(1) Educational Background	Whether they graduated from top-tier universities (e.g., Tsinghua, Peking, Fudan, Jiaotong, C9, Ivy League, G5, University of Tokyo, etc.)
(2) Experience at Prestigious Firms/Institutions	Whether they held executive or core roles in Fortune Global 500 companies, large state-owned enterprises, industry leaders, international organizations, or renowned law firms
(3) Influence in Associations/Organizations	Whether they serve as directors, committee members, advisors, or other key positions in industry associations, government advisory bodies, or professional societies
(4) Government-Business Resources	Whether they have a background in state-owned enterprises, government, or the public sector, or have deep connections and collaboration experience in policy-intensive fields
(5) Cross-Industry Network	Whether they hold high-level connections or board memberships across multiple industries (e.g., legal, energy, manufacturing, finance, technology, etc.)
(6) Resource Integration Ability	Whether they can leverage multiple identities or roles to integrate resources, connect different circles and fields, and create synergies (e.g., serving as multiple board members, executives, or advisors)

Scoring Benchmark Example:

- Example Person: Hu XX ; Education: Master's degree ;Career Experience: Lawyer, Partner at Law Firm, Independent Director of listed company; Current Role: Senior Partner at XX Law Firm, External Director of XX Institute, etc. ; Fields Involved: Legal, Energy, Manufacturing; Government-Business Resources: Has some experience interacting with SOEs and policy sectors
- Reference Score: 6 (Above average, with strong resource integration ability and cross-sector influence)

Output format example:

[PersonID, Score]