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Customer concentration, firm R&D investment and moderation effects

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ABSTRACT

Building on resource dependence theory (RDT) and attention-based view (ABV), this research examines the impact of customer concentration on firm R&D investment and the conditional factors. We argue a firm with heavy reliance on a high number of major customers will have a lower level of R&D investment due to loss of discretion in decision-making and increase of operational risks. Moreover, the external factors, competitive intensity, intellectual property right (IPR) protection, and the internal factor, the firm's management myopia, will exacerbate the negative effect. Findings from a large sample of A-share listed firms in Chinese stock markets 2008–2017 (14,203 firm-year observations) support our hypotheses. This research adds to the customer concentration studies and RDT literature by uncovering a dark side of firms' concentrated customer base and the situational factors that strengthen this effect. It also marks an early empirical analysis of ABV-based prediction.

1. Introduction

With increasing specialization, modularity, and dynamic competition in B2B markets (Griffith et al., 2017), close supplier-customer relationships are seen as one of the key resources for both parties to achieve sustainable competitive advantage (Chang et al., 2014; Santouridis & Veraki, 2017). To ensure preferred partnership status, supplier companies often allocate a disproportionate amount of resources to managing and maintaining relationships with major customers (Chang et al., 2010), causing many B2B firms to have a concentrated customer base. Customer concentration (hereafter CC) is defined as the structural distribution of revenue from the firm's major customers, reflecting the degree of how much a firm relies on its major customers (Dhaliwal et al., 2016; Patatoukas, 2012).

As a key stakeholder (Zhong et al., 2021), customers (and the degree of a firm's CC) can have a profound impact on a firm's resource allocation. This includes R&D investment, which is another important strategy representing the degree of investment in and commitment to R&D for sustainable development and competitive advantage. R&D investment is crucial for firms to build long-term competitive advantages for superior performance (Alam et al., 2019; Díaz-Díaz et al., 2022). Previous studies have explored the antecedents of a firm's R&D efforts including external environmental factors, such as institutional factors (Bradley et al., 2017; Brown et al., 2013; Judge et al., 2015; Xiao, 2013), market environment (Artés, 2009; Fang et al., 2014; Hsu et al., 2014), as well as internal organizational factors, such as organizational resource endowment (Alessandri & Pattit, 2014; Revilla & Fernández, 2012) and corporate governance (Ahn et al., 2017; Baranchuk et al., 2014; Ferreira et al., 2014). An interesting question emerges: How does CC impact a firm's R&D investment? For example, ZG (SHE stock code 300414), a major provider of 5G lightning protection equipment that serves world-famous telecom equipment manufacturers, such as Ericsson, ZTE, Nokia, Samsung, and HUAWEI, disclosed in its annual report (http://www.cninfo.com.cn/new/disclosure/stock?stockCode=300414&orgId=9900023935&sjstsBond=false#latestAnnouncement) that while there was an increase of sales to its top five customers from 58.18 % to 73.99 % out of total revenues during 2017–2019, its R&D expenditure against total assets fell from 2.46 % to 1.77 %.

The literature has examined the influence of CC on a range of firm decisions, for example, financial costing (Campello & Gao, 2017), capital structure decisions (Banerjee et al., 2008; Chu, 2012), earnings

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management (Raman & Shahrur, 2008), tax avoidance (Huang et al., 2016), public disclosure (Crawford et al., 2020), and financial performance (Irvine et al., 2016; Patatoukas, 2012). As a "double-edged sword", on the one hand, CC releases a dangerous signal of the firm's operation risk because the firm will face significant losses if a major customer decides to seek alternative suppliers or exit the relationship (Dhaliwal et al., 2016; Irvine et al., 2016). On the other hand, it is also seen as a positive indicator of economies of scale and operational efficiency in analyst reports, management forecasts and even IPO prospectuses (Ak & Patatoukas, 2016; Patatoukas, 2012).

Despite past advancements in knowledge, there are still at least three gaps in the literature. First, prior studies have focused disproportionately on CC's impact on a firm's financial decisions, largely ignoring its effect on R&D investment, which is critical to a firm's innovation and success (Brown et al., 2009). Although a small amount of recent research has explored the relationship between CC and firm innovation, for example, innovation performance (Pan et al., 2020), green innovation performance (Huang et al., 2023), and sustainable innovation performance (Zhong et al., 2020) (see the summary in Table 1), its effect on firm R&D investment has been missing. How firms decide on their R&D investment when they have a concentrated customer base is a key phenomenon of interest, because it is a major strategy that can influence their advantage, innovation performance and beyond (Brown et al., 2017).

Second, while firm R&D investment and innovation carry risks, very little is known about how CC will influence firm decisions on R&D investment through the lens of operational risks. Prior studies give attention to external environmental factors such as the institutional environment (Chen et al., 2024), cultural environment (Shao et al., 2013), and technological change (Nambisan et al., 2018), as well as internal organizational elements like CEO traits (Chen et al., 2023), corporate governance (Jia et al., 2019) and other aspects discussing the impact of operational risks on firms' innovation decisions. But they do not offer guidance on how the dependence on key customers can impact firm resources for R&D given these risks.

Third, the literature offers no knowledge of whether or not (and if so, how) situational factors influence the CC's effect on a firm's R&D investment, such as the roles of environments and internal management attention (Ocasio, 1997). Hence, we know little of the underlying mechanism of how environmental and cognitive factors affect the relationship between CC and a firm's R&D decision.

Drawing on resource dependence theory (RDT) (Pfeffer & Salancik, 1978) and attention-based view (ABV) (Ocasio, 1997), we investigate the effect of CC on firm R&D investment, and explore boundary conditions by considering three factors: industrial (i.e., competitive intensity) (Voss & Voss, 2008), institutional (i.e., intellectual property right, hereafter IPR) protection (Huang et al., 2017) and cognitive (i.e., management myopia) (Zhong et al., 2021). We propose that (1) when heavily reliant on a small number of customers, firms' decision-making power and autonomy in resource allocation are significantly influenced by the needs and power of these customers, thereby exposing them to high operational risks, which ultimately limits their R&D investments, and (2) the competitive intensity, IPR protection and management myopia reinforce the negative impact of CC on firm R&D investment. We employ a proprietary panel dataset of the 14,203 annual observations of China's A-share public listed firms from 2008 to 2017 to test our hypotheses.

Our research seeks to contribute to the literature in four ways. First, it adds to the CC literature by exploring its effect on firm R&D investment, a decision critical for firms' long-term competitive advantages and sustainable growth (Porter, 1992). Prior studies have surprisingly overlooked its potential influence on firm strategic decisions of R&D investment. Our research addresses this important issue by seeing CC as an important factor that presents resource dependence on major customer firms (Zhong et al., 2021), expanding our knowledge of how this resource dependence can cast a heavy cost on firm R&D investment.

Second, this study contributes to this diversified stream of literature by revealing the operational risks of CC in influencing firm innovative efforts. Existing studies have explored how operational risk affects the firm innovation behavior from the aspects of the institutional environment (Chen et al., 2024), cultural environment (Shao et al., 2013), technological change (Nambisan et al., 2018), CEO characteristics (Chen et al., 2023), and corporate governance (Jia et al., 2019). Few studies have examined the relationship between CC and firm R&D investment from the angle of operational risk. Our study sheds light on this critical area, revealing how reliance on a small number of customers can increase operational risks and reduce firm investment in R&D. We argue when firms make asset-specific investments to meet the needs of major customers, a large number of conversion costs will be generated, thus increasing the firm operational risks. The conversion costs and unilateral sunk costs caused by CC far outweigh the benefits of economies of scale, thus inhibiting firms from investing in innovation.

Third, it enriches the RDT literature by exploring the conditions of how firms' dependence on external resources influences a key strategic decision, namely CC's impact on a firm's R&D investment. We identify and test three external and internal factors (competitive intensity, IPR protection and management myopia) that moderate the CC-R&D investment association. Considering these factors offers a more nuanced view of the relationship between CC and firm R&D investment (Hillman et al., 2009; Wry et al., 2013), which also extends the insights of RDT.

Fourth, this research also expands the ABV literature by empirically testing this theory. Although ABV literature is growing to apply the perspective of organizational and managerial attention to explore the cognitive basis for strategy formulation (Stea et al., 2015), it largely relies on the textual analyses of the letter to shareholders (hereafter LTS) (Ocasio, 2011), which carry inherent bias and lack of operationalization (Leung et al., 2015; Merkl-Davies & Brennan, 2011; Zhong et al., 2021). As a consequence, it runs short of quantified analyses to confirm developed predictions (Ocasio et al., 2018). Our research not only considers factors in the role of managerial myopia drawing on ABV (Nikolov, 2018; Zhong et al., 2021) but undertakes a long-awaited statistically empirical study to put this ABV-based relationship into quantitative tests, forming one of the first efforts to statistically valid proof of ABV.

2. Theoretical background and hypotheses

2.1. Antecedents to R&D investment

R&D investment requires a strong financial commitment. It has the following characteristics (Hall et al., 2016). First, it is of high risk. R&D investment is riddled with high sunk costs, long return cycles, and a high uncertainty of output. Second, the costs generated by R&D investments are irreversible, including purchases of specialized equipment and materials for experiments and the payment of researchers' salaries. Third, R&D activities are usually regarded as business secrets that have information asymmetry with external entities. R&D investment is valuable for supplier firms to deliver goods and/or services to their customers. The literature has documented antecedents to firm R&D investment from two complementary perspectives that emphasize internal and external factors. The first perspective focuses on the impact of internal organizational factors, such as firm boundaries (Bena & Li, 2014), strategy (Patel & Chrisman, 2014), firm size (Revilla & Fernández, 2012), organizational slack (Alessandri & Pattit, 2014), ownership structure (Ferreira et al., 2014; Lopez Iturriaga & López-Millán, 2017), CEO characteristics (Ahn et al., 2017; Barker & Mueller, 2002), and management compensation (Baranchuk et al., 2014). The second perspective focuses on the impact of external environmental factors, such as the institutional environment and market environment. Institutional factors include legal shareholder protection (e.g., Brown et al., 2013; McLean et al., 2012), labor law (e.g., Acharya et al., 2013, 2014), IPR protection (e.g., Brown et al., 2017; Chen & Puttitanun, 2005), and

Table 1
Literature review on customer concentration and firm innovation.

Author & Year	Data & Method	Theory	Key Findings	Other
Gentry & Shen (2013)	U.S. manufacturing firms from 1979 to 2005	Agency theory	Managers tend to cut R&D expenses when they are under pressure to meet analyst forecasts, especially when they face an increase in employment risk after missing the forecasts.	
Shao et al. (2013)	68,329 firm-years from 44 countries	Not mentioned	Firms in individualistic countries invest more in R&D but not in capital expenditure and cash, suggesting that individualistic values are associated with risk taking.	Mechanism: Firms' risk-taking
Krolikowski & Yuan (2017)	U.S. firms from 1980 to 2005 Tobit model	1. Transaction cost economics 2. Resource dependence theory 3. Theory of incomplete contracts	1. High CC promotes suppliers' R & D intensity and innovation. 2. Strong customer bargaining power hinders suppliers' R&D intensity and innovation.	Mechanisms: 1. relationship-specific investment 2. industry competitiveness 3. suppliers' financing constraints
Nambisan et al. (2018)		Not mention	Digital platforms are enabling entrepreneurship and innovation and by changing the underlying operational risks.	
Jia et al. (2019)	Chinese A-share listed companies from 2000 to 2012	Agency theory	Higher quality public governance enhances the capabilities of corporate governance tools and further reduces agency risk in innovation.	
Zhou et al. (2019)	Chinese A-share listed companies from 2012 to 2016 Hausman Test	1. Stakeholder theory 2. Information asymmetry 3. Expectation theory	1. All other things being equal, customer concentration has a negative impact on the corporate innovation capabilities of listed companies. 2. All other things being equal, there is a threshold effect of financing constraint between the innovation capability of listed companies and customer concentration. The impact of customer concentration on innovation capability varies with the level of financing constraint. 3. All other things being equal, the correlation between customer concentration and innovation capability of listed companies is different as managers' expectations on the future of companies being different. Optimistic expectations are more conducive to the increase of investment in innovation capability, as well as the reduction of customer concentration.	Moderators: 1. Financing constraint 2. Managers' expectations
Harrison et al. (2020)	3,000 CEOs' personality traits	Upper echelons research	CEOs' observed levels of conscientiousness, neuroticism, and extraversion have important consequences for the perceived riskiness of the firm, as reflected in stock volatility.	
Pan et al. (2020)	Chinese A-share listed companies from 2006 to 2015 OLS model	Transaction cost theory	1. Suppliers with higher customer concentrations produce fewer patents and invention patents. 2. The effect is more pronounced in firms with lower business diversification and in firms that have lower stability in their major customers.	Moderators: 1. Business diversification 2. Major customer stability
Zhong et al. (2020)	Chinese A-share listed companies from 2009 to 2017 OLS model	Not mentioned	1. There is an inverted U-shaped relationship between customer concentration and enterprise innovations. 2. There is a high positive correlation between customer concentration and enterprise innovations under high economic policy uncertainty. 3. There is an inverted U relationship between customer concentration and enterprise innovations under low economic policy uncertainty.	Moderator: Economic policy uncertainty
Wen et al. (2021)	Chinese A-share listed companies from 2010 to 2015 OLS model	Not mentioned	1. Customer concentration is negatively associated with supplier CSR performance. 2. The negative relation is more pronounced in suppliers without foreign customers or foreign investors, suppliers that are non-state-owned, and suppliers operating in poor legal environments. 3. Reduced demand of disclosure from customers and limited awareness of CSR are potential mechanisms through which customer concentration negatively affects CSR performance.	Moderators: 1. foreign customers or foreign investors 2. ownership nature 3. legal environments Mechanisms: 1. the demand of disclosure from customers 2. limited awareness of CSR
Chen et al. (2023)	21,754 firm-year observations from 1970 to 2016 in BoardEx	1. Developmental psychology research 2. Imprinting theory	Firms' risk-taking mediates the negative relationship between a CEO's pre-career exposure to religion and the firm's innovation.	Moderator: Board Composition Mediator: Firms' risk-taking
Huang et al. (2023)	Chinese listed firms from 2006 to 2018 GMM model	1. Resource-based view 2. Legitimacy and institutional pressure view	1. Customer concentration has a positive impact on a firm's green innovation. 2. Compared to non-state-owned enterprises, the relationship between customer concentration and green innovation is more pronounced in SOEs. 3. The impact of customer concentration on green innovation is more pronounced in high-level marketization regions. 4. The positive relationship between customer concentration and green innovation is more pronounced after the promulgation of the new Chinese Environmental Protection Law.	Moderators: 1. ownership nature 2. marketization degree 3. China's new Environmental Protection Law' promulgation
Chen et al. (2024)	Chinese A-share listed companies from 2008 to 2020	Not mentioned	Personal data protection system (PDPS) improves innovation quantity by reducing financial constraints and risks.	

(*continued on next page*)

Table 1 (*continued*)

Author & Year	Data & Method	Theory	Key Findings	Other
This paper	Chinese A-share listed companies from 2008 to 2017 OLS model	1. Resource dependence theory 2. Attention-based view	1. Customer concentration is negatively associated with firm R&D investment. 2. Competitive intensity strengthens the negative effect of customer concentration on corporate R&D investment. 3. IPR protection strengthens the negative impact of customer concentration on corporate R&D investment. 4. Management myopia strengthens the negative impact of customer concentration on corporate R&D investment.	Moderators: 1. Competitive intensity 2. IPR protection 3. Management myopia Mechanisms: 1. Power imbalance in the transaction relationship 2. Firm operational risks

public policy (e.g., Becker, 2015; Crespi et al., 2016; Zúñiga-Vicente et al., 2014). Research also investigates the impact of the market environment, such as market structure (Artés, 2009; Matsumura et al., 2013), financial development (Hsu et al., 2014; Maskus et al., 2012), and stock liquidity (Fang et al., 2014; Wen et al., 2018). Despite these useful studies, the existing literature mainly discusses the antecedents to R&D investment from the perspective of the supply side, neglecting the demand-side factors (i.e., customers).

2.2. Operational risks and innovation

Risk management is one of the most concerned topics for innovation scholars (Wu & Wu, 2014). Compared to strategic risks, operational risks arise from people, processes and tangible assets that can affect the efficiency of a firm's day-to-day operations (Meulbroek, 2008) and key decisions. Existing research mainly focuses on identifying variables that affect operational risk, such as financial risk management (Kim & Xu, 2024; Yang & Birge, 2018), supply chain management (Gao et al., 2019; Osadchiy et al., 2016), financial leverage (Kouvelis et al., 2018; Luo & Shang, 2015), corporate governance (Benaroch & Chernobai, 2017; Chernobai et al., 2011). Recently, two research streams have paid attention to the importance of how to prevent and attenuate operational risks in a firm's innovation effort. Specifically, one stream of prior scholarship has highlighted the importance of external environmental factors. For example, Nambisan et al. (2018) emphasized that digital platforms enhance firm entrepreneurship and innovation by lowering operational risks. The second stream has examined the internal organizational factors. For example, Jia et al. (2019) found that improved corporate governance tools play an important role in reducing agency risk for innovation. Surprisingly, little work has examined the role of customers, strategically key for firm success, in managing the operational risks associated with firm innovation. Consequently, this study seeks to examine CC's impact on firm R&D investment from the perspective of operational risks to fill this gap.

2.3. CC and its effect

As one of the most important assets of a firm, customers can have a profound impact on a firm's investment decisions (e.g., R&D investment). The relationship between suppliers and customers has aroused extensive attention in both theoretical and practical circles. For example, to prevent and control various risks caused by CC, the China Securities Regulatory Commission (hereafter CSRC) has successively issued a series of laws and regulations to strengthen the risk supervision of major customers of listed companies.

Existing studies have explored the influence of CC on various aspects of firms' behavior and financial decisions, such as financing cost (Campello & Gao, 2017), capital structure decision (Banerjee et al., 2008; Chu, 2012), mergers and acquisitions (Ahern & Harford, 2014; Fee & Thomas, 2004), tax avoidance (Huang et al., 2016), and public disclosure (Crawford et al., 2020). They have identified different mechanisms such as the power imbalance view (Dhaliwal et al., 2016; Fabbri & Klapper, 2016) and operational efficiency view (Irvine et al., 2016; Patatoukas, 2012). The former emphasizes the dynamic nature of the relationship on the aspects of power and competition between a firm and its customers, whereas the latter focuses on the social capital generated by trading partnerships under the principle of embeddedness.

Recent studies have explored the relationship between CC and firm innovation outcomes, for example, innovation performance (Pan et al., 2020), green innovation performance (Huang et al., 2023), sustainable innovation performance (Zhong et al., 2020) (see Table 1 for a summary). However, they have overlooked the influence of CC on firm R&D investment—a key strategic decision that shapes a firm's ability to create and develop knowledge, determine its innovation trajectory, and drive new product development, which in turn affects customer appeal (Mackelprang et al., 2015). This capability forms the foundation for long-term competitive advantage and success (Brown et al., 2017). Due to high risk, irreversibility, and significant information asymmetry, R&D investment can pose direct risks for suppliers. Highly uncertain R&D projects can make external financial institutions and investors, such as banks and stock markets, reluctant to fund them. Thus, internal financing emerged as a major determinant of R&D investment (Czarnitzki & Hottenrott, 2011). However, we know little about whether CC can influence a firm's R&D investment. The only exception is Krolikowski and Yuan (2017). However, their treatment that separates CC from customer bargaining power appears to be endogenic, because, according to RDT, a high level of CC attributes major customers with a greater degree of bargaining power; isolating them ignores the power imbalance arising from the resource-dependence relationship. As a result, we seek to close this gap by focusing on CC's effect on firm R&D investment. Given its significance as one of the most valuable assets, firms tend to allocate substantial resources towards cultivating strong, enduring, and close relationships with major customers in order to sustain their competitive advantage (Santouridis & Veraki, 2017). Consequently, within-firm CC tends to exhibit greater stability with reduced variation. Building upon this premise, our study aims to investigate inter-firm CC and its influence on R&D investment instead of tracking individual firms' changes in CC and their subsequent effects.

2.4. Theoretical framework

The theoretical framework of this paper mainly follows two theories: RDT and ABV. RDT focuses on resource acquisition in organizations and the way organizations respond to environmental constraints. Its core proposition is that the survival of an organization depends on its ability to obtain critical resources from the external environment and to reduce the uncertainty of the resources required, and that organizations will try various tactics to restructure their dependencies (Pfeffer & Salancik, 1978). Hence, firms are subject to the influence of the actions and strategies of external actors (Pfeffer & Salancik, 1978), including their major customers. Power and dependence are the cornerstones of RDT (Pfeffer & Salancik, 1978). Based on Emerson's (1962) approach to power dependence, scholars further identified two different theoretical dimensions of resource dependence, namely "power imbalance" and "interdependence" (Gulati & Sytch, 2007). Thus, the central proposition of RDT is that to reduce the uncertainty associated with dependence on another firm's resources, a firm will attempt to restructure its resource dependence with various tactics (Pfeffer & Salancik, 1978). According to RDT, the resource-dependence relationship with a small number of customers leads to an asymmetric power structure among business partners. When heavily relying on a small number of customers, firms therefore may change their behaviors to meet the needs of large customers to reduce the uncertainty of the transaction relationship, including their R&D investment decisions. In addition, the power imbalance increases the likelihood that major customers will engage in opportunistic behavior, increases the firms' operational risk, which also affects their R&D investment. Thus, we predict that CC has negative impact on firm R&D investment by aggravating the power imbalance and increasing the operational risk of the firm.

RDT further recognizes that the role of firms' resource dependence is constrained by external environmental factors (Hillman et al., 2009). Since the uncertainty of the external environment reduces the firm's ability to control the flow of resources, when the external environment changes, it will also affect the resources dependence relationship between firms and their major customers and bring adaptation problems to the decision maker (Pfeffer & Salancik, 1978). Previous studies have pointed out that external environmental factors such as institutional and industrial environments have an important impact on resource advantages and strategic choices of firms (Porter, 1991), and may influence firms to adopt different strategies associated with risks and uncertainty activities (Acemoglu & Akcigit, 2012; Auh & Menguc, 2005).

We echo the call of Pfeffer and Salancik (2003) "for more research examining the RDT boundary conditions", and further consider the moderating roles of external environmental and internal cognitive factors, which are competitive intensity (Voss & Voss, 2008), IPR protection (Huang et al., 2017) and management myopia (Zhong et al., 2021), on the relationship between CC and firm R&D investment.

According to RDT, competitive intensity and IPR protection are important because these two external environmental parameters may influence firms' dependence on external resources including their key customers (Heirati et al., 2016). Competitive intensity, defined as the number of competitors within a given industry, is a critical factor in the marketplace (Jaworski & Kohli, 1993). A high degree of competition intensity can increase resource constraints, competitor hostility, and the lack of opportunities for future growth. Research based on RDT shows that firms operating in highly competitive markets are more likely to cooperate closely with trading partners (Fynes et al., 2005) as a strategic response to environmental uncertainty and inter-firm dependence. In addition, firms are subject to the influence of the institutional environment (Peng & Heath, 1996; Peng et al., 2008). IPR is a key institutional scheme in shaping firms' interaction with their partners and reliance on resources (Covin & Miller, 2014; Meyer & Peng, 2016). It affects not only the speed and performance of innovation (Lerner, 2009) but also firms' strategic response to managing dependencies (Telg et al., 2023).

Further, although RDT was originally developed to explain resource exchange to manage uncertainty in the external environment, this understanding has been expanding over the past decades to be used in combination with other theories to explain relationships within the organization (Medcof, 2001). RDT posits that a firm's dependency and its responses are based on perceptions of resource availability, which are formed through management attention and interpretation (Pfeffer & Salancik, 1978). ABV, built on Simon (1947)'s research on bounded rationality, provides valuable insights into how individual cognitive characteristics of management can influence firms' dependence on external resources (Hambrick & Mason, 1984; Ocasio, 1997). To pursue the profit expectation of the firm under shareholder pressure and financial pressure, management myopia is a common phenomenon in the investment decision-making process of the firm (Barton & Wiseman, 2014). It describes the extent to which the management's attention is present-oriented and reflects the bounded rationality of decision-makers (Lechner et al., 2020). Management myopia influences how managers perceive situations and their relevant decision-making (Kaplan, 2011), which may include resource allocation for R&D under the situation of high CC.

In summary, we extend the existing research and incorporate the industrial environment (competitive intensity), institutional environment (IPR protection) and cognitive mechanisms (management myopia) into the theoretical frame. We posit that the competitive intensity, IPR protection and management myopia reinforce the negative impact of CC on firms' R&D investment by decreasing the suppliers' discretion in R&D decision-making and increasing their operational risks, which provides a comprehensive understanding of how CC impacts a firm's R&D investment under the boundary mechanisms of external and internal factors.

2.5. Hypothesis development

2.5.1. CC and firm R&D investment

Following RDT, we propose that a high degree of CC will reduce the firm's R&D investment. First, high CC exacerbates the power imbalance in the transaction relationship, thus inhibiting the firms' configuration of innovation resources. Specifically, the resource-dependence relationship creates an asymmetric power structure with major customers, resulting in the dependent firm's decision-making and resource allocation being heavily influenced by the demands and power of these key customers (Heide & John, 1990). For firms with high CC, the future purchasing behavior of major customers is uncertain, leading to increased business uncertainty (Hillman et al., 2009; Sutton et al., 2021). Therefore, to mitigate this uncertainty, firms need to adapt their behavior to align with those customers' interests (Hillman et al., 2009; Pfeffer & Salancik, 1978). In other words, firms will be more motivated to stabilize the relationship by allocating scarce resources to their major customers and maintaining a durable relationship with them, so as to reduce the likelihood of major customers seeking alternative suppliers or even exiting the relationship (Elking et al., 2017). To retain major customers as valuable resources, firms must consider their needs in key decisions, sometimes even sacrificing their own autonomy (Johnsen et al., 2020). For example, firms often undertake price concessions, have more deliveries of small quantities, customize their products, and provide extra marketing and technical support (Irvine et al., 2016), take on more inventory, and expand trade credits to satisfy their main customer (Fabbri & Klapper, 2016). Consequently, firms may lose some of their ability to allocate sufficient resources to innovation activities, which can lead to a reduction in R&D investment.

Second, high CC also heightens a firm's operational risks, thereby reducing its likelihood of investing in R&D. To meet the specific needs of major customers, firms devote plenty of resources to engage in relationship-specific investments (Kwak & Kim, 2020). Thus, although major customers contribute to the supplier's stable sales and enhance operational efficiency (Irvine et al., 2016; Patatoukas, 2012), they can also be high-cost customers. The costs associated with increased CC are mainly borne by supplier firms, while their major customers bargain away many benefits with their powerful position. Past research has shown that the benefits accrued from CC are not sufficient to offset their costs (Saboo et al., 2016). The more a firm invests in a particular relationship, the higher the conversion costs and unilateral sunk costs, and the more exposed it is to different types of operational risks (Gu et al., 2017). When considering R&D investments, firms with higher CC tend to adopt cautious investment strategies, thus reducing their willingness to invest in R&D. Therefore, we propose the following:

H1. CC is negatively associated with firm R&D investment

2.5.2. Moderation effect of competitive intensity

As a key factor reflecting market dynamics, competitive intensity influences how firms utilize their organizational resources to align with the external environment and mitigate the negative impacts of market competition by formulating and implementing appropriate strategic actions. Thus, competitive intensity can influence how firms allocate resources and their cooperative behavior (Lumpkin & Dess, 2001). Competitive intensity may affect the power balance of a firm and its customers, and ultimately their behaviors in transactions (Andrevski & Ferrier, 2019). We predict that competitive intensity worsens the negative impact of CC on a firm's R&D investment.

First, competitive intensity can strengthen the power imbalance between the firm and its major customers. It manifests as resource limitations, strong competitors, a shortage of alternative products/services, and price competition (O'Cass & Weerawardena, 2010; Tsai & Yang, 2013). Firms with high CC have to implement more customer-centered strategies and devote disproportionate resources to managing and maintaining existing customers (Banker et al., 1996; Das et al., 2000). Consequently, a high level of competition intensity will further tilt the power imbalance towards the firm's major customers, further restricting its autonomy in resource allocation. Therefore, competitive intensity worsens the negative impact of CC on firms' R&D investment by further reducing firms' discretion in decision-making, which ultimately limits a firm's R&D investment, as argued in H1.

Second, fierce market competition increases the risk that the major customers engage in opportunistic behaviors, thereby heightening the firm's operational risks. For example, customers in a highly competitive market enjoy greater relative market power (Appiah-Adu & Singh, 1998) and can switch to other suppliers more easily. Firms will be subjected to the constraints of competitive environments and, as a result, become more dependent on their major customers (Clemente & Roulet, 2015). Therefore, competitive intensity heightens the operational risks faced by firms with high CC and compels them to adopt a more defensive approach to resource allocation, ultimately reducing their willingness to invest in R&D. Hence, we propose:

H2. Competitive intensity strengthens the negative impact of CC on firm R&D investment

2.5.3. Moderation effect of IPR protection

A prominent institutional factor (Peng et al., 2017), the IPR regime plays a vital role in the formation and implementation of firms' strategies (Scott, 1995). IPR refers to measures that allow inventors to exercise a monopoly over the use of IPRs for a limited period of time (Krammer, 2018). We propose that strong IPR protection strengthens the negative impact of CC on R&D investment.

Innovation driven by improvements in IPR, such as new product development or patents, can shift the balance of power in favor of firms, making major customers more cautious. Innovation may enable a firm to attract more new customers and even enter new markets. However, this will be considered a threat to its major customers' power advantage. Therefore, they may pressure the firm and undermine its autonomy in controlling valuable resources (Chen & Miller, 2007). For example, in the Japanese manufacturing industry, a supplier of a *keiretsu* is prohibited from cooperating with members of other *keiretsus* (Sakai, 2003). With stronger IPR protection, firms that heavily rely on a small number of customers may ease this pressure by engaging less in R&D to stabilize the relationships with the buyers. Based on this, we propose:

H3. IPR protection strengthens the negative impact of CC on firm R&D investment

2.5.4. Moderation effect of management myopia

According to ABV, how organizations distribute their decision-makers' attention defines firm behavior (Ocasio, 1997). Managers' attention is a valuable and scarce resource in an organization because different issues and tasks compete for the limited attention of decision-makers (Cyert & March 1963). The distribution of attention by key decision-makers significantly affects the decision and outcome of the firm (Cho & Hambrick, 2006; Ocasio, 1997), including firm R&D investment decisions. Myopia, in management literature, refers to a form of cognitive deficits or biases exhibited by managers (Levinthal & March 1993; Ridge et al., 2014). As a cognitive bias characterized by systematic deviations from rational norms due to cognitive shortcuts (Zhang & Cueto, 2017), management myopia affects the speed (Eggers & Kaplan, 2009) and scope (Narayanan et al., 2011) of a firm's behaviors. Levinthal and March (1993) initially divided management myopia into temporal and spatial myopia. Specifically, temporal myopia emphasizes "the attention tendency to sacrifice long-term goals to meet short-term goals"; spatial myopia, on the other hand, reflects "the attention tendency to ignore unfamiliar areas". Temporal myopia can induce management to prioritize near-term results at the expense of long-term value (Shi et al., 2020); spatial myopia only allows management to respond to visible cues and familiar domains (Downing et al., 2019; Shepherd et al., 2017). In this paper, we focus on temporal myopia, viewing management myopia as management's attention tendency to prioritize investments that improve short-term returns at the expense of long-term investments, following prior research (Souder et al., 2016).

Existing studies have primarily explored the core concept of management myopia in terms of its antecedents and outcomes. Some studies have focused on its drivers, for instance, company culture (Laverty, 2004), executive compensation and financial incentive structures (Thanassoulis & Somekh, 2016), social network structure (Opper & Burt, 2021) and the pressure of capital market (Tong & Zhang, 2024). Others have explored its outcomes, including finance performance (AlGhazali et al., 2023; Eklund & Mannor, 2021), innovation performance (Li & Wu, 2023; Liu, 2022), firm efficiency (Arianpoor et al., 2023; Tunyi et al., 2024), and corporate social responsibility (Chatjuthamard et al., 2024; Lu et al., 2024). However, few studies have considered the impact of management myopia in the context of CC and firm R&D investment.

Prior studies have shown that temporal attention of management has an important impact on a firm's strategic behavior and results (Lin et al., 2019; Souder & Bromiley, 2012), which involves a trade-off between short-term and long-term goals. For instance, investing in a promising long-term project may reduce the likelihood that existing resources will be invested in short-term goals. Thus, according to ABV, we propose that management myopia exacerbates the negative effect of CC on a firm's R&D investment.

First, myopic managers' pursuit of short-term profits reinforces the sense of legitimacy of their attention to the benefits from CC and further guides them to match the firm's resources with its major customers' existing needs, ultimately curtailing R&D investment. Previous research has documented top managers' obsession with achieving short-term profitability goals, even sacrificing long-term shareholder value (Schuster et al., 2020; Souder et al., 2016; Thanassoulis, 2013). As managers become more myopic, their attention will match their firms' existing resources with perceived opportunities that are more consistent with the pursuit of short-term profits, rather than making long-term investments that do not produce immediate significant benefits (Bushee, 1998; Wahal & McConnell, 2000). Hence, managerial myopia leads firms to prioritize their major customers in terms of attention and resource allocation (Chen & Miller, 2007), undermining their autonomy in controlling valuable resources and ultimately reducing R&D investment.

Second, managers encounter trade-offs between long-term and uncertain investments in R&D, and between short-term and certain benefits by cutting R&D spending (Chen et al., 2015). Driven by short-term profits, development activities led by myopic management tend to be tailored to the unique needs of specific customers, focusing on the customization of existing products or services. This approach prioritizes immediate gains over the development of new and diversified products or services for other customers or markets (Yli-Renko & Janakiraman, 2008). Consequently, it hinders growth outside of these specific relationships and increases switching costs and the risk of opportunism for customers. In short, management myopia strengthens the negative impact of CC on R&D investment by increasing the operational risk of firms. Hence, we propose:

H4. Management myopia strengthens the negative impact of CC on firm R&D investment

3. Research methodology

3.1. Data collection

Our sample consists of all of the Chinese A-share listed companies in the Shanghai and Shenzhen Stock Exchanges from 2008 to 2017. The initial sample consists of 24,273 firm-year observations from 3,395 listed companies. We used several sample selection criteria. First, we obtained the data of A-share listed firms and their top five customer firms from the China Stock Market and Accounting Research (CSMAR) database (https://us.gtadata.com/) and the R&D intensity data are from the Wind Economic Database. Second, we excluded firms in the financial services industry, which follow different accounting rules and regulations (Pindado et al., 2015), based on the industry categorization of *The Guidance on Industry Classification of Listed Companies (2012 Revision),* and firms that suffer from financial losses in two consecutive fiscal years named Special Treatment firms cap by the CSRC (Chu et al., 2011). Third, (Pindado et al., 2015) also eliminated observations with insufficient financial information or outliers to construct our variables, ultimately resulting in a sample of 14,203 firm-year observations from 2,779 listed companies. To eliminate the potential bias effect caused by extreme values, all continuous variables are winsorized at the 1st and 99th percentiles.

3.2. Measures

3.2.1. Dependent variable

As one of the most commonly used indexes to measure the *R&D investment* of a firm (Eroglu & Hofer, 2014), R&D intensity can accurately reflect the relative amount of resources that firms devote to knowledge creation and development (Schildt et al., 2012); in addition, R&D intensity is a more accurate measure of a firm's ability to take risks than R&D expenditure (Bromiley et al., 2017). Following prior research (Tian & Wang, 2014), we calculated *R&D investment* as a proportion of R&D expenditures to total assets per year.

3.2.2. Independent variable

As in *The Content and Format of Information Disclosure Standards for Publicly issued Securities Companies No. 2 – Content and Format of Annual Reports*, CSRC requests listed companies to disclose the relevant information of the top five customers who account for a percentage of their total sales, and encourages them to disclose the names of the top five customers. This helps us identify major customers of the sampled firms. Specifically, in the annual report, if the listed company is unwilling to disclose the names of the top five customer companies, they will use "No.1" to refer to the specific name of the first largest customer company. Similarly, the second – to fifth-place customer companies also follow this naming rule. Following prior research (Dhaliwal et al., 2016), the independent variable, *CC*, is measured by the ratio of the top five customers' sales to the firm's total sales weighted square sum for the year. The specific formula is as follows:

$$CC_{i,t} = \sum_{j=1}^{J} \left(\frac{Sales_{i,j,t}}{Totalsales_{i,t}}\right)^2 \tag{1}$$

where $Sales_{i,j,t}$ represents the sales of Firm i to Customer j in Year t, and $Totalsales_{i,t}$ represents the total sales of Firm i in Year t.

3.2.3. Moderators

We use the Herfindahl-Hirschman Index (hereafter HHI) as an indicator of *competitive intensity*, which reflects competitive pressure (Chen et al., 2015; Patatoukas, 2012; Ramaswamy, 2001). The lower the value of the HHI, the higher the competitive intensity. The formula is as follows:

$$HHI_{i,t} = \sum_{i=1}^{N} \left(\frac{X_{i,t}}{X_t}\right)^2 \tag{2}$$

where $X_{i,t}$ represents the sales of Firm i in the industry in Year t.

As one of the largest emerging markets, China is transforming to a more market-oriented direction through innovation-driven development (Fang et al., 2017). More and more firms begin to pay attention to innovation because innovation can make them more competitive (Brown et al., 2017). However, the actual quality of China's IPR varies significantly in different regions, which means considerable differences in the interpretation and enforcement of IPR laws across regions (Ang et al., 2014; Huang et al., 2017). The heterogeneity of *IPR protection* in 31 provinces, municipalities and autonomous regions of China is measured based on the relevant index in China's intellectual property development status evaluation report. Published annually by the China National Intellectual Property Administration (CNIPA), the report is based on a large-scale survey and data collection effort to better understand and explore constraints on the creation, implementation, protection, management and service of IPR in various regions of China. We then manually collected the IPR protection quality index from the report.

Measuring *management myopia* is a difficult task because it cannot be captured directly. Following Tunyi et al. (2019), we use accounting metrics (return on capital employed, ROCE) and market metrics (average daily abnormal stock return, AAR) to measure executive attention. This measurement is not only based on the financial data of the listed company, but also measures the existing strategy rather than the expected one.

First, we calculate *ROCE*. *ROCE* is calculated as the ratio of net operating income before tax and depreciation (*EBITDA*) to total capital. Second, we calculate the daily abnormal return (*DAR*) using the following formula:

$$DAR_{i,t} = R_{i,t} - (\widehat{\alpha}_i + \widehat{\beta}_i R_{m,t}) \tag{3}$$

DAR for a company i at time t is calculated by the difference between the company's actual stock return ($R_{i,t}$) and the expected stock return ($\widehat{\alpha}_i + \widehat{\beta}_i R_{m,t}$) at time t. Average the DAR of the trading days to obtain the annual average abnormal return (*AAR*). Then, we calculate the industry median for ROCE and AAR. Each firm's ROCE and *AAR* are classified as "high" if their *ROCE* and *AAR* are greater than or equal to its industry median in that year, and "low" if otherwise.

3.2.4. Control variables

First, we control for several firm characteristics that affect firm R&D investment, including return on assets (*ROA*), financial leverage (*LEV*), firm size (*SIZE*), and revenue growth (*GROWTH*). Specifically, firms with better performance are more likely to invest in R&D (Hitt et al., 1996), so we control for the accounting performance (*ROA*). We also control for the financial leverage (*LEV*), because when a firm's debt ratio is high, managers are less willing to take risks in R&D investment (MacCrimmon & Wehrung, 1990). Moreover, we control for the firm size (*SIZE*) as R&D investment increases with firm size (Rogers, 2004). Revenue growth (*GROWTH*) may affect firm R&D investment because firms with high levels of revenue growth may invest more in R&D; however, if they want to preserve their operating profit margin, they might reduce R&D investment to keep costs low.

Second, we control for the corporate governance variables associated with firm R&D investment, including board size (*BDSIZE*), board independence (*IND*), and ownership concentration (*OWNER*). Research has shown that firms with larger board sizes have more human capital to invest in R&D (Gales & Kesner, 1994). And we control for board independence because board independence influences the innovation activities of the firm (Balsmeier et al., 2017). In addition, we also control for the ownership concentration (*OWNER*) because the firms with ownership concentration are more likely to pursue innovation activities (Chen et al., 2014).

Finally, we control for the industry variable and the year-fixed effect because firm R&D investments vary across industries and years. The definitions of all variables are presented in Appendix A.

3.2.5. Model specification

Our H1 suggests that CC is negatively associated with firm R&D investment. Therefore, we construct Equation (4) to assess whether CC affects R&D investment as follows:

$$RD_{i,t} = \alpha_0 + \alpha_1 CC_{i,t} + \alpha_2 LEV_{i,t} + \alpha_3 ROA_{i,t} + \alpha_4 IND_{i,t} + \alpha_5 BDSIZE_{i,t} + \alpha_6 OWNER_{i,t} + \alpha_7 GROWTH_{i,t} + \alpha_8 SIZE_{i,t} + \sum Year + \sum Industry + \varepsilon_1 \tag{4}$$

In addition, we use Equations (5)-(7) to examine the boundary mechanisms (i.e., competitive intensity, IPR protection and management myopia) of CC and firm R&D investment:

$$RD_{i,t} = \beta_0 + \beta_1 CC_{i,t} + \beta_2 HHI_{i,t} + \beta_3 (CC_{i,t} \times HHI_{i,t}) + \beta_4 LEV_{i,t} + \beta_5 ROA_{i,t} + \beta_6 IND_{i,t} + \beta_7 BDSIZE_{i,t} + \beta_8 OWNER_{i,t} + \beta_9 GROWTH_{i,t} + \beta_{10} SIZE_{i,t} + \sum Year + \sum Industry + \varepsilon_2 \tag{5}$$

Table 2
Summary statistics and correlations (N = 14,203).

Variable	Mean	SD	*RD*	*CC*	*HHI*	*IPR*	*MYOPIA*	*LEV*	*ROA*	*IND*	*BDSIZE*	*TOP10*	*GROWTH*	*SIZE*
RD	0.02	0.02	1.00											
CC	0.05	0.10	−0.07***	1.00										
HHI	0.09	0.11	−0.15***	0.05***	1.00									
IPR	0.75	0.14	0.18***	−0.06***	−0.04***	1.00								
MYOPIA	0.30	0.46	0.12***	0.00	−0.03***	0.06***	1.00							
LEV	0.42	0.22	−0.30***	0.02***	0.04***	−0.13***	−0.24***	1.00						
ROA	0.05	0.06	0.19***	−0.03***	−0.00	0.09***	0.43***	−0.42***	1.00					
IND	0.37	0.06	0.04***	0.02***	−0.01	0.01	−0.00	−0.02***	−0.02***	1.00				
BDSIZE	2.25	0.18	−0.11***	0.01	0.05***	−0.07***	−0.03***	0.16***	−0.00	−0.49***	1.00			
TOP10	59.02	15.58	0.08***	0.03***	0.04***	0.10***	0.16***	−0.18***	0.29***	0.04***	0.00	1.00		
GROWTH	0.21	0.47	0.01	0.03***	0.01	−0.02***	0.09***	0.04***	0.23***	0.00	−0.02***	0.10***	1.00	
SIZE	21.90	1.23	−0.21***	0.00	0.06***	−0.09***	−0.05***	0.49***	−0.06***	0.01	0.25***	0.08***	0.06***	1.00

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% Level, respectively.

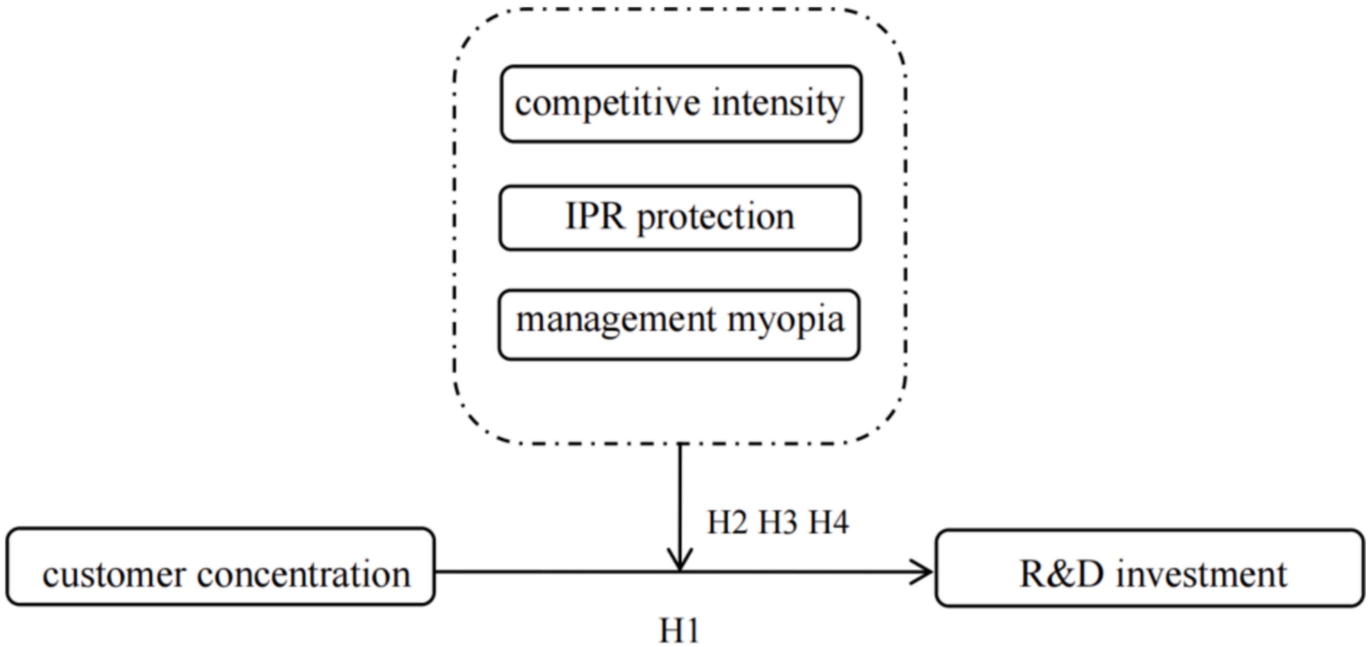

Fig. 1. Conceptual model.

Table 3
OLS Regression results.

Variable	(1) RD	(2) RD	(3) RD	(4) RD	(5) RD	(6) RD	(7) RD
CC	−0.004***	−0.003**	0.010*	−0.004***	−0.006***	−0.004***	−0.002
	(−3.00)	(−2.51)	(1.86)	(−2.90)	(−3.75)	(−3.04)	(−1.40)
HHI		−0.011***	−0.012***				
		(−8.37)	(−8.59)				
CC × HHI			0.022**				
			(2.39)				
IPR				0.016***	0.017***		
				(17.15)	(16.54)		
CC × IPR					−0.019**		
					(−2.48)		
MYOPIA						0.001***	0.001***
						(3.66)	(4.31)
CC × MYOPIA							−0.006**
							(−2.37)
LEV	−0.005***	−0.004***	−0.004***	−0.005***	−0.005***	−0.004***	−0.004***
	(−6.23)	(−5.00)	(−5.03)	(−6.25)	(−6.19)	(−6.00)	(−5.98)
ROA	0.037***	0.035***	0.035***	0.036***	0.036***	0.033***	0.033***
	(14.94)	(14.31)	(14.33)	(14.82)	(14.82)	(12.58)	(12.61)
IND	0.007***	0.009***	0.009***	0.007***	0.007***	0.007***	0.007***
	(2.96)	(3.49)	(3.52)	(2.89)	(2.96)	(2.99)	(2.97)
BDSIZE	0.001	0.002**	0.002**	0.001	0.001	0.001	0.001
	(1.54)	(2.43)	(2.53)	(1.41)	(1.48)	(1.56)	(1.51)
OWNER	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(5.03)	(3.61)	(3.61)	(5.19)	(5.24)	(4.90)	(4.91)
GROWTH	−0.001**	−0.000*	−0.000*	−0.001**	−0.001**	−0.001**	−0.001**
	(−2.07)	(−1.85)	(−1.83)	(−2.18)	(−2.21)	(−2.06)	(−2.09)
SIZE	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***
	(−10.24)	(−9.91)	(−9.87)	(−10.04)	(−10.08)	(−10.18)	(−10.16)
Year FE	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES
Constant	0.018***	0.006*	0.005	0.021***	0.021***	0.018***	0.018***
	(5.48)	(1.79)	(1.47)	(6.23)	(6.26)	(5.33)	(5.31)
N	14,203	14,203	14,203	14,203	14,203	14,203	14,203
R^2	0.333	0.337	0.337	0.347	0.347	0.334	0.334
Adj.R^2	0.33	0.33	0.34	0.35	0.35	0.33	0.33

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% Level, respectively.

$$RD_{i,t} = \chi_0 + \chi_1 CC_{i,t} + \chi_2 IPR_{i,t} + \chi_3 (CC_{i,t} \times IPR_{i,t}) + \chi_4 LEV_{i,t} + \chi_5 ROA_{i,t} + \chi_6 IND_{i,t} + \chi_7 BDSIZE_{i,t} + \chi_8 OWNER_{i,t} + \chi_9 GROWTH_{i,t} + \chi_{10} SIZE_{i,t} + \sum Year + \sum Industry + \varepsilon_3 \quad (6)$$

$$RD_{i,t} = \delta_0 + \delta_1 CC_{i,t} + \delta_2 MYOPIA_{i,t} + \delta_3 (CC_{i,t} \times MYOPIA_{i,t}) + \delta_4 LEV_{i,t} + \delta_5 ROA_{i,t} + \delta_6 IND_{i,t} + \delta_7 BESIZE_{i,t} + \delta_8 OWNER_{i,t} + \delta_9 GROWTH_{i,t} + \delta_{10} SIZE_{i,t} + \sum Year + \sum Industry + \varepsilon_4 \quad (7)$$

where $RD_{i,t}$ is the ratio of R&D expenditures to revenues in Year $_t$; i indexes the firm and t indexes the year.

4. Results

4.1. Descriptive statistics

Table 2 presents summary statistics and correlations. The mean of the R&D intensity ratio is 0.02 with a standard deviation of 0.02, showing the differences among the samples. The CC ratio has a mean of 0.05 with a standard deviation of 0.10, indicating that many firms have a diversified customer base. CC correlates negatively with R&D intensity.Fig. 1

4.2. Regression results

Table 3 presents the OLS model regression results. Model 1 lists the effect of CC on R&D intensity. The regression results show that the CC is negatively and significantly related to RD (b = -0.004, $p < 0.01$), consistent with H1. In the statistical sense, with a one-unit rise in CC, R&D intensity will reduce by 0.004 units.

Models 2 and 3 demonstrate the moderating effect of competitive intensity on CC and firm R&D intensity. Model 2 shows the direct impact of competitive intensity on R&D innovation. Based on Model 2, Model 3 includes the interaction term for CC and competitive intensity (*CC* × *HHI*) to the regression. The interaction term is positive and significant (b = 0.022, $p < 0.05$). According to the statistical results, high concentration and low competition alleviates the negative correlation between CC and firm R&D innovation, that is, low concentration and high competition significantly strengthens the negative impact between CC and firm R&D innovation, supporting H2.

Models 4 and 5 report the moderating effect of IPR protection on CC and firm R&D intensity. Model 4 shows the impact of IPR protection alone on R&D innovation. On the basis of Model 4, Model 5 adds the interaction term for the CC and IPR protection. The interaction term (*CC* × *IPR*) is negative and significant (b = -0.019, $p < 0.05$), aligned with H3.

Similarly, Models 6 and 7 report the moderating effect of management myopia on CC and firm R&D intensity. Model 6 shows the impact of management myopia alone on R&D innovation. On the basis of Model 6, Model 7 adds the interaction term (*CC* × *MYOPIA*), which is significant and negative (b = -0.006, $p < 0.05$), in line with H4.

Table 4
2SLS Regression results.

Variable	(1) 1st stage *CC*	(1) 2nd stage *RD*
CCIV	0.002***	
	(3.92)	
CC		−0.113**
		(−2.41)
LEV	0.006	−0.004***
	(1.25)	(−4.08)
ROA	−0.044***	0.032***
	(−2.67)	(8.53)
IND	0.046***	0.012***
	(2.71)	(3.28)
BDSIZE	−0.003	0.001
	(−0.53)	(0.88)
OWNER	0.000***	0.000***
	(2.67)	(4.66)
GROWTH	0.010***	0.001
	(5.35)	(0.93)
SIZE	−0.009***	−0.002***
	(−10.62)	(−5.05)
Year FE	YES	YES
Industry FE	YES	YES
Constant	0.187***	0.039***
	(3.92)	(3.94)
N	14,203	14,203

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% Level, respectively.

4.3. Robustness and endogeneity tests

4.3.1. Endogeneity tests

To ensure the reliability of the study conclusions, we conducted two extra tests to address potential endogeneity problems. First, we used the two-stage least squares estimation (2SLS) including instrumental variables to address the reverse causation issue. Second, we applied propensity score matching analysis (PSM) to mitigate potential endogeneity issues caused by unobserved factors.

4.3.1.1. Instrumental variable method. An instrumental variable must satisfy two conditions to be considered a valid instrument (Larcker & Rusticus, 2010): (1) the relevance condition requires instrumental variables to be highly correlated with the independent variable measure; (2) but not with the error term after controlling for the set of control variables. Thus, instruments are associated with a firm's R&D investment only through their correlation with CC indicators. Drawing on previous studies (Dhaliwal et al., 2016; Saboo et al., 2016), we have selected the average industry CC as an instrumental variable.

Table 4 reports results from 2-Stage Least Squares regressions relating R&D investment to CC using instrumental variable. Specifically, Model 1 shows the 1st-stage IV regression analysis where we employ the average industry CC as an independent variable of interest while positioning CC as a dependent variable. Model 2 reports the 2nd-stage IV regression analysis where we employ CC (instrumented) which is predicted in the 1st-stage IV analysis as an independent variable of interest while positioning R&D intensity as a dependent variable. According to Model 1, CC is significantly positively correlated with its instrumental variable *CCIV* at 1 %. The rationality of the selection of instrumental variables is verified. In addition, according to Model 2, CC and R&D intensity (*RD*) are negatively correlated at the significance level of 5 %, which supports our hypotheses.

4.3.1.2. Propensity score matching analysis (PSM). PSM is a useful tool to correct the sample selection bias in empirical tests in order to effectively eliminate the influence of individual selection bias on the processing effect (Rosenbaum & Rubin, 1983). Such endogenous problems may result in that the dependent variable (R&D investment) is not significantly affected by the independent variable (CC). The levels of CC may not be random, and may be influenced by some factors. Thus, there may be natural differences between the samples of high CC and low CC.

We undertook PSM proposed by Rosenbaum and Rubin (1983). If CC is greater than or equal to the median values of industry CC every year, it is categorized as the treatment group (high CC group); if CC is less than the median values of industry CC every year, it is categorized as the control group (low CC group). There are 7,101 samples in the treated group and 7,102 samples in the control group. The propensity score is estimated for each sample through a Logit regression model to match the

Table 5a
The balance test results of psm.

Logistic regression		Balance test						
Variable	Coefficient	Sample	Mean value		% bias	% reduction | bias |	T-test	
			Treated group	Control group			t	p>| t |
LEV	0.279***	Before Match	0.406	0.424	−8.1	81.9	−4.84	0.000
	(2.56)	After Match	0.406	0.403	1.5		0.87	0.383
ROA	−1.493***	Before Match	0.047	0.051	−6.9	93.2	−4.13	0.000
	(−4.17)	After Match	0.047	0.046	0.5		0.28	0.783
IND	0.068	Before Match	0.372	0.373	−0.9	−102.7	−0.55	0.585
	(0.19)	After Match	0.372	0.371	1.9		1.13	0.257
BDSIZE	0.176	Before Match	2.247	2.261	−8.1	60.2	−4.82	0.000
	(1.47)	After Match	2.247	2.252	−3.2		−1.93	0.053
OWNER	0.005***	Before Match	58.96	59.082	−0.8	24.1	−4.07	0.6.40
	(4.27)	After Match	58.96	59.053	−0.6		−0.36	0.722
GROWTH	0.122***	Before Match	0.217	0.2000	3.7	39.4	2.18	0.029
	(3.12)	After Match	0.217	0.227	−2.2		−1.23	0.217
SIZE	−0.350***	Before Match	21.715	22.077	−30.0	94.8	−17.86	0.000
	(−18.81)	After Match	21.715	21.734	−1.6		−0.98	0.329

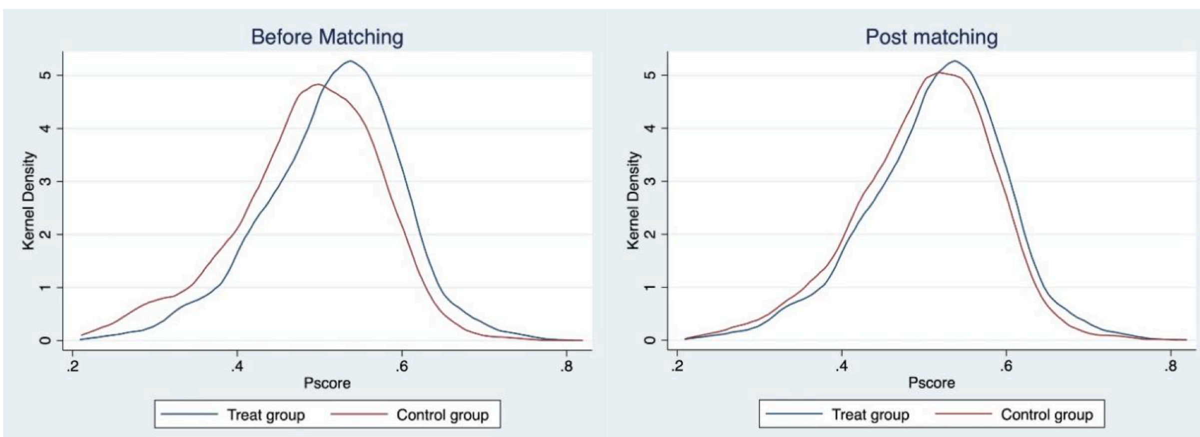

Fig. 2. The probability density function (PDF) distributions before and after matching.

high CC group (treatment group) with the low CC group (control group). The matching criteria are: financial leverage (*LEV*), return on assets (*ROA*), board independence (*IND*), board size (*BDSIZE*), ownership concentration (*OWNER*), revenue growth (*GLOWTH*), firm size (*SIZE*) and other basic firm characteristics. In line with Tang et al. (2024), we apply the 1:1 nearest-neighbor matching with replacement. Table 5a presents the results of the balancing test of pre- and post-match. After matching, there is no significant difference between the treatment group (high CC group) and the control group (low CC group). The absolute value of bias driven by all covariates is within 5 %, and the T-test results for each covariate are no longer significant after matching, which indicates that the results remain robust.

Fig. 2a and 2b illustrate the probability density function (PDF) distributions before and after matching, respectively. As shown in the PDF distribution plots, after matching, the treatment group and control group exhibit similar distributions, with both displaying a similar shape. This suggests that the PSM has effectively addressed the distributional imbalance between the treatment and control groups, and the matching results satisfy the common support assumption.

Table 5b presents the results of post-match PSM regression. According to Model 1, after correcting for the endogeneity problems of sample self-selection, CC exhibits a negative correlation with firm R&D investment (*RD*), and the result is statistically significant at the 1 % level. Furthermore, Models 3, 5, and 7 are used to examine the moderating effects, and the results show that the signs and significance are consistent with their respective counterparts in Table 5b. Consistent with previous findings, endogeneity problems or bias due to observables are unlikely to affect the results.

In addition, we employed coarse-exact matching (CEM) to improve the robustness of the results. The CEM post-matching regression results are shown in Appendix B. The level of L1 with post-matching exhibits a decrease in comparison to its level of pre-matching, with the matching effect of CEM proving to be superior. The CEM post-matching regression results are shown in Table 6. The estimated coefficient on the dependent variable is −0.003 and is significant at the 10 % significance level. The results of the CEM are similar to those of the PSM, confirming what was found through the PSM.

4.3.2. *Robustness tests*

4.3.2.1. Alternative estimation methods. To examine the robustness of the baseline regression and tackle the left skewness problem of the dependent variable (R&D intensity), we used the Tobit regression model to examine the robustness of our results. As shown in Table 7, there is no essential difference between Tobit and OLS model regression results in terms of sign and significance when we rule out the year and industry effect, which is in line with our baseline regression and also proves the robustness of the regression results.

4.3.2.2. Exclusion of the observations of super first-tier cities. Like other emerging economies (Crescenzi & Jaax, 2017), China's R&D and innovation activities are characterized by geographical imbalance. There is

Table 5b
Regression results after PSM.

Variable	(1) RD	(2) RD	(3) RD	(4) RD	(5) RD	(6) RD	(7) RD
CC	−0.004***	−0.003**	0.011*	−0.004***	−0.006***	−0.004***	−0.002
	(−2.98)	(−2.49)	(1.89)	(−2.88)	(−3.67)	(−3.03)	(−1.37)
IPR		1.575***	1.684***				
		(17.22)	(16.61)				
CC × *IPR*			−0.019**				
			(−2.50)				
HHI				−1.035***	−1.173***		
				(−8.08)	(−8.27)		
CC × HHI					0.021**		
					(2.27)		
MYOPIA						0.108***	0.140***
						(3.72)	(4.38)
CC × MYOPIA							−0.006**
							(−2.40)
LEV	−0.468***	−0.374***	−0.376***	−0.468***	−0.464***	−0.452***	−0.450***
	(−6.26)	(−5.03)	(−5.06)	(−6.26)	(−6.21)	(−6.03)	(−6.01)
ROA	3.669***	3.487***	3.492***	3.638***	3.637***	3.312***	3.318***
	(14.92)	(14.31)	(14.33)	(14.82)	(14.82)	(12.55)	(12.57)
IND	0.754***	0.879***	0.886***	0.730***	0.745***	0.762***	0.756***
	(3.02)	(3.55)	(3.58)	(2.93)	(2.99)	(3.05)	(3.03)
BDSIZE	0.122	0.194**	0.202**	0.112	0.117	0.124	0.119
	(1.48)	(2.37)	(2.47)	(1.35)	(1.42)	(1.50)	(1.45)
OWNER	0.004***	0.003***	0.003***	0.004***	0.004***	0.004***	0.004***
	(4.96)	(3.51)	(3.51)	(5.11)	(5.15)	(4.83)	(4.83)
GROWTH	−0.055**	−0.049*	−0.049*	−0.058**	−0.059**	−0.055**	−0.056**
	(−2.07)	(−1.86)	(−1.85)	(−2.16)	(−2.19)	(−2.06)	(−2.09)
SIZE	−0.124***	−0.118***	−0.118***	−0.122***	−0.123***	−0.123***	−0.123***
	(−9.91)	(−9.53)	(−9.49)	(−9.77)	(−9.82)	(−9.85)	(−9.83)
Constant	1.755***	0.527	0.421	2.012***	2.025***	1.704***	1.696***
	(5.29)	(1.57)	(1.25)	(6.05)	(6.10)	(5.14)	(5.11)
N	14,188	14,188	14,188	14,188	14,188	14,188	14,188
R^2	0.334	0.347	0.348	0.337	0.337	0.334	0.335
Adj.R^2	0.33	0.35	0.35	0.34	0.34	0.33	0.33

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% Level, respectively.

Table 6
The results of CEM regression.

Variable	(1) RD
CC	−0.003*
	(−1.81)
LEV	−0.194**
	(−2.19)
ROA	5.215***
	(15.36)
IND	1.592***
	(4.13)
BDSIZE	0.434***
	(3.56)
OWNER	0.002**
	(2.12)
GROWTH	−0.085***
	(−2.74)
SIZE	−0.141***
	(−9.55)
Constant	0.885*
	(1.93)
Industry	Yes
Year	Yes
N	11,339
R^2	0.333
Adj.R^2	0.33

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% Level, respectively.

an obvious path-dependent effect in innovation activities. China's eastern and southern coastal cities, which opened up before the rest of the country, are more active in R&D and innovation activities than inland regions (Crescenzi & Rodríguez-Pose, 2017) because these regions have better product markets, factor markets, market intermediaries, and institutional environment. Based on this, we removed the R&D values of super first-tier cities (Beijing, Shanghai, Guangzhou and Shenzhen) from the sample observations and re-estimated the equation. As shown in Table 8, the regression results are consistent with the baseline regression results in Table 3, which confirms the robustness of our results.

4.3.2.3. Heterogeneity test of the nature of ownership. We conducted an extra robustness test of our results by dividing our samples into SOEs and POEs according to the nature of ownership, and further explore the impact of CC on the heterogeneity of R&D investment of SOEs and POEs.

Table 9 presents the regression results of SOEs and POEs. Model 1 lists the effect of CC on POEs' R&D intensity. The regression results show that the CC is negatively and significantly related to *RD* ($b = -0.008$, $p < 0.01$), consistent with H1. Models 2–4 demonstrate the moderating effect of the competitive intensity, IPR protection and management myopia on CC and POEs' R&D intensity respectively. Specifically, Model 2 includes the interaction term for CC and competitive intensity to the regression. The interaction term (*CC* × *HHI*) is positive and significant ($b = 0.040$, $p < 0.001$), supporting H2. Model 3 includes the interaction term for CC and IPR protection to the regression. The interaction term (*CC* × *IPR*) is negative and significant ($b = -0.022$, $p < 0.1$), in line with H3. Similarly, Model 4 adds the interaction term for the CC and management myopia. The interaction term (*CC* × *MYOPIA*) is negative and significant ($b = -0.008$, $p < 0.05$), aligned with H4. Model 5 shows the direct impact of CC on SOEs' R&D intensity. The regression results show that the CC is not significantly related to SOEs' R&D intensity.

Since SOEs do not fully pursue the maximization of their own interests and free market choice, there are fundamental differences between SOEs and POEs in resource allocation, business model,

Table 7
Tobit Regression results.

Variable	(1) *RD*	(2) *RD*	(3) *RD*	(4) *RD*	(5) *RD*	(6) *RD*	(7) *RD*
CC	−0.006***	−0.005***	0.016**	−0.006***	−0.008***	−0.006***	−0.005**
	(−3.84)	(−3.27)	(1.99)	(−3.70)	(−3.99)	(−3.88)	(−2.31)
HHI		−0.013***	−0.014***				
		(−7.79)	(−7.78)				
CC × HHI			0.021*				
			(1.73)				
IPR				0.021***	0.022***		
				(17.70)	(17.11)		
CC × IPR					−0.029***		
					(−2.74)		
MYOPIA						0.001***	0.001***
						(3.26)	(3.70)
CC × MYOPIA							−0.006*
							(−1.76)
LEV	−0.008***	−0.007***	−0.007***	−0.008***	−0.008***	−0.007***	−0.007***
	(−7.91)	(−6.87)	(−6.89)	(−7.92)	(−7.89)	(−7.70)	(−7.67)
ROA	0.043***	0.040***	0.040***	0.043***	0.043***	0.039***	0.039***
	(13.83)	(13.15)	(13.17)	(13.75)	(13.74)	(11.63)	(11.66)
IND	0.008**	0.009***	0.009***	0.008**	0.008**	0.008***	0.008**
	(2.56)	(2.90)	(2.91)	(2.51)	(2.55)	(2.58)	(2.56)
BDSIZE	0.002*	0.003***	0.003***	0.002	0.002*	0.002*	0.002*
	(1.74)	(2.74)	(2.80)	(1.61)	(1.66)	(1.74)	(1.70)
OWNER	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(6.30)	(4.69)	(4.72)	(6.46)	(6.50)	(6.20)	(6.20)
GROWTH	−0.001**	−0.001**	−0.001**	−0.001**	−0.001**	−0.001**	−0.001**
	(−2.29)	(−2.17)	(−2.16)	(−2.43)	(−2.45)	(−2.28)	(−2.31)
SIZE	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***
	(−7.69)	(−7.15)	(−7.10)	(−7.52)	(−7.53)	(−7.63)	(−7.63)
Constant	0.003	−0.013***	−0.015***	0.006	0.006	0.003	0.003
	(0.74)	(−3.00)	(−3.29)	(1.47)	(1.49)	(0.61)	(0.60)
N	14,203	14,203	14,203	14,203	14,203	14,203	14,203

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% Level, respectively.

governance mechanism and many other aspects. Therefore, we predict that CC cannot influence SOEs' R&D investment behavior by increasing the power imbalance and improving the operational risks of firms. The specific reasons are as follows.

First, SOEs have a third-party endorsement from the government. State ownership lowers the cost of debt for SOEs because the government can provide an implicit guarantee for repayment and protection against bankruptcy (Borisova & Megginson, 2011). Especially in crisis situations, government guarantees can help SOEs withstand the uncertainty of the external environment. For instance, Beuselinck et al. (2017) found that state ownership significantly increased the market value of SOEs and their stock returns during financial crises. This is because the positive impact of government guarantees in mitigating the impact of the crisis outweighs the negative impact caused by agency costs. Therefore, compared with POEs, SOEs not only demonstrate that they are guaranteed and supported by the government, but also send important reputational signals to stakeholders, helping to weaken the asymmetrical power structure caused by excessive CC.

Second, SOEs tend to benefit from a variety of non-market rents. State ownership gives enterprises scarce non-market resources, such as tariff protection, exclusive rights to certain industries or geographical areas, administrative privileges, which are difficult for POEs to obtain (Lazzarini, 2015). The government will provide assistance to SOEs through various channels such as fiscal subsidies, tax exemptions and preferential interest rate financing, thus easing the soft budget constraints of SOEs (Megginson et al., 2014). For example, Boubakri and Saffar (2019) empirically tested a significant positive correlation between state ownership and bank debt financing. Compared with POEs, SOEs have a more favorable operating environment. Therefore, SOEs may obtain scarce non-market resources and financial support through government channels to mitigate operational risks caused by high CC.

4.3.2.4. Additional analysis. To further explore how differences in R&D investment levels correlate with variations in CC across firms, according to Certo et al. (2017), we incorporated the population averaging model, which used the generalized estimating equations (GEE) model and Hybrid model to further examine the impact of CC on RD. Specifically, as shown in Table 10 (please see below), Model 1 lists that CC still has a significant negative impact on R&D after using the population averaging model, which confirms the impact of between-firm CC changes on R&D. Then we construct two variables, namely the company-level CC mean (MCC) and the difference between annual CC and CC mean (DelCC). Model 2 shows that the regression coefficient of MCC on RD is significantly negative, while that of DelCC on RD is not, which further confirms that the difference of CC between-firm leads to the change of RD.

In addition, we further provided an Intraclass Correlation Coefficient (ICC) score, as suggested by Certo et al. (2017), too, to substantiate the reliance on between-firm variations in this study. As shown in Table 11, the ICC value of RD is 0.742, which means that 74.2 % of the variance is driven by between-firm variations, while only less than 26 % of the variance is driven by within-firm differences. Similarly, the ICC value for CC is 0.722, meaning that 72.2 % of the variance is due to differences between groups, while only 27.8 % of the variance is due to changes within groups over time. Thus, the results show that the variations in R&D investment correlate with differences in CC across firms.

5. Discussion

R&D investment is crucial for firms to develop new technological processes (Del Monte & Papagni, 2003), introduce new products, and enter new product-market domains, ultimately leading to competitive advantages and superior performance (García-Manjón & Romero-Merino, 2012; Lin, 2003). However, previous research has overlooked the profound impact of customers and their concentration on a firm's R&D investment. This study addresses this important question of whether CC, as a measure of a firm's reliance on its major customers

Table 8
Exclusion of the observations of super first-tier cities regression results.

Variable	(1) *RD*	(2) *RD*	(3) *RD*	(4) *RD*
CC	−0.003**	0.009	−0.004***	−0.002
	(−2.00)	(1.37)	(−2.58)	(−0.96)
HHI		−0.007***		
		(−4.04)		
CC × *HHI*		0.018*		
		(1.78)		
IPR			0.014***	
			(13.12)	
CC × *IPR*			−0.015*	
			(−1.65)	
MYOPIA				0.002***
				(4.25)
CC × *MYOPIA*				−0.005*
				(−1.65)
LEV	−0.003***	−0.003***	−0.003***	−0.003***
	(−3.38)	(−3.32)	(−3.32)	(−3.14)
ROA	0.038***	0.038***	0.038***	0.034***
	(14.23)	(14.21)	(14.21)	(11.85)
IND	0.008***	0.008***	0.008***	0.008***
	(2.74)	(2.78)	(2.78)	(2.77)
BDSIZE	0.002***	0.002***	0.002***	0.002***
	(2.66)	(2.62)	(2.62)	(2.61)
OWNER	0.000***	0.000***	0.000***	0.000***
	(5.64)	(5.77)	(5.77)	(5.49)
GROWTH	−0.001***	−0.001***	−0.001***	−0.001***
	(−3.08)	(−3.16)	(−3.16)	(−3.07)
SIZE	−0.001***	−0.001***	−0.001***	−0.001***
	(−9.12)	(−9.08)	(−9.08)	(−9.02)
Constant	0.015***	0.002	0.016***	0.014***
	(4.00)	(0.58)	(4.39)	(3.82)
N	10,455	10,455	10,455	10,455
R^2	0.289	0.302	0.290	0.290
Adj.R^2	0.29	0.30	0.29	0.29

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% Level, respectively.

(Dhaliwal et al., 2016; Patatoukas, 2012), affects a firm's decision on R&D investment. Drawing on RDT and ABV, we propose that reliance on a small number of customers will hurt firms' R&D investment propensity; under the conditions of high competition intensity, strong IPR protection and myopic management, this negative effect of CC will worsen.

Using a proprietary panel dataset of 14,203 annual observations of A-share listed firms in Shanghai and Shenzhen stock markets spanning 2008–2017, the empirical findings are interesting. First, CC has a negative impact on firm R&D investment, that is, the smaller the number of major customers, the lower level of R&D investment a firm has. Second, competitive intensity, IPR protection, and management myopia worsen the negative impact.

This study's theoretical implications are fourfold. First, it enriches the research on CC by uncovering the impact of heavy dependence on major customers on firms' R&D investment, demonstrating the dark side of this reliance. While CC research is growing (Campello & Gao, 2017; Chu, 2012; Crawford et al., 2020; Huang et al., 2016; Irvine et al., 2016; Patatoukas, 2012), it has been silent on how CC influences firm R&D decisions, which are strategically important to businesses. Using arguments from RDT, our study posits that having CC can damage a firm's ability to invest in R&D through loss of the discretionary decision space and autonomy to engage in innovation resource allocation activities, as well as the increase of operational risk (Gu et al., 2017; Itzkowitz, 2013; Kalwani & Narayandas, 1995). Firms depending on a small number of customers tend to face a higher level of power imbalance with their major customers with constant pressure to strive to satisfy their expectations (Handley & Benton, 2012; Irvine et al., 2016). This causes a stretched resource allocation which squeezes the firm's investment in R&D.

Table 9
Heterogeneity test of the nature of ownership.

Variable	(1) *RD*	(2) *RD*	(3) *RD*	(4) *RD*	(5) *RD*
CC	−0.008***	0.009	−0.017***	−0.006**	0.001
	(−4.71)	(0.92)	(−7.10)	(−2.56)	(0.44)
HHI		−0.014***			
		(−7.89)			
CC × *HHI*		0.040***			
		(3.03)			
IPR			0.021***		
			(15.04)		
CC × *IPR*			−0.022*		
			(−1.80)		
MYOPIA				0.002***	
				(4.19)	
CC × *MYOPIA*				−0.008**	
				(−2.34)	
LEV	−0.004***	−0.012***	−0.004***	−0.004***	−0.006***
	(−3.90)	(−11.17)	(−3.73)	(−3.66)	(−4.79)
ROA	0.041***	0.046***	0.041***	0.037***	0.029***
	(13.15)	(13.37)	(13.21)	(10.98)	(7.30)
IND	0.009***	0.011***	0.010***	0.009***	0.005
	(2.65)	(2.99)	(2.83)	(2.61)	(1.39)
BDSIZE	0.002	0.001	0.002*	0.002	0.002
	(1.36)	(1.13)	(1.75)	(1.32)	(1.48)
OWNER	0.000	−0.000	−0.000	0.000	0.000***
	(1.21)	(−0.36)	(−0.26)	(1.13)	(5.13)
GROWTH	−0.001**	−0.000	−0.001**	−0.001**	−0.000
	(−2.27)	(−1.33)	(−2.08)	(−2.30)	(−0.22)
SIZE	−0.002***	−0.002***	−0.001***	−0.001***	−0.001***
	(−8.20)	(−11.98)	(−7.96)	(−8.16)	(−5.85)
Constant	0.023***	0.008	0.058***	0.022***	0.013***
	(4.43)	(1.56)	(10.72)	(4.32)	(2.82)
N	9047	9047	9047	9047	5156
R^2	0.298	0.317	0.289	0.299	0.301
Adj.R^2	0.30	0.31	0.29	0.30	0.30

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% Level, respectively.

Table 10
The results of generalized estimating equations and hybrid model.

Variable	(1) GEE Model *RD*	(2) hybrid Model *RD*
CC	−0.003*	
	(−1.88)	
MCC		−0.008***
		(−2.88)
DelCC		−0.002
		(−1.06)
LEV	−0.002*	−0.002**
	(−1.74)	(−2.29)
ROA	0.015***	0.015***
	(5.26)	(7.26)
IND	0.000	0.000
	(0.14)	(0.12)
BDSIZE	0.000	0.000
	(0.40)	(0.51)
OWNER	0.000***	0.000***
	(3.66)	(5.02)
GROWTH	0.000	0.000
	(0.19)	(0.30)
SIZE	−0.002***	−0.002***
	(−9.68)	(−14.88)
Constant	0.048***	0.050***
	(8.14)	(11.40)
N	14,203	14,203

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% Level, respectively.

Table 11
Intraclass correlation coefficients for variables.

Variable	ICC(1)
RD	0.742***
CC	0.722***
LEV	0.787***
ROA	0.450***
IND	0.624***
BDSIZE	0.755***
OWNER	0.752***
GROWTH	0.016***
SIZE	0.819***

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% Level, respectively.

Second, it enriches the study of operational risk management by revealing how a concentrated customer base can inhibit a firm's R&D investment due to heightened operational risks. Existing studies have focused on identifying variables of operational risk, with little research examining its role arising from the customer base, which can have a profound impact on firm innovation. This study reveals the impact of CC on inhibiting R&D investment, enhancing our understanding of how these risks can be predicted and addressed.

Third, it further adds to the RDT research through the provision of analyses of the boundary conditions for the CC- R&D investment relationship. While RDT suggests that environmental factors affect resource-dependent relationships between organizations (Hillman et al., 2009; Pfeffer & Salancik, 1978), little research has considered the boundary conditions of resource dependence (Pfeffer & Salancik, 2003). Following RDT and ABV, we extend the existing research to consider industrial, institutional and cognitive mechanisms (competitive intensity, IPR protection and management myopia). Our study uncovers that these factors reinforce the negative impact of CC on R&D investment by highlighting the relevance of conditional factors in influencing the effect of a firm's resource dependence (Hillman et al., 2009; Wry et al., 2013). It offers a nuanced understanding of how CC's negative impact upon firm R&D investment changes under these conditions, further extending the insights of RDT.

Fourth, our study expands the ABV literature by conducting one of the earliest empirical analyses of ABV-based predictions. A serious weakness of ABV studies is the lack of confirmation from statistical analyses of large-scale empirical data to validate its predictions (Ocasio et al., 2018). Our research addresses this gap by theorizing and quantitatively testing an ABV-based factor (i.e., management myopia) and its effect (Ocasio, 1997). Previous studies have used textual analyses of LTS or company publications to measure top management team (TMT) or CEO attention (Cho & Hambrick, 2006; Eggers & Kaplan, 2009; Yadav et al., 2007; Zhong et al., 2021). However, LTS is likely to be inherently subjective, written to convey a positive image of the company to a specific business audience (Leung et al., 2015; Merkl-Davies & Brennan, 2011). Responding to Zhong et al. (2021)'s call for improving the operationalization and validity of management myopia measurement, we adopt a method of using secondary data to measure management myopia (Tunyi et al., 2019). In doing so, our study contributes to the ABV literature by presenting an early attempt to conduct a quantitative investigation of an ABV-derived relationship.

Our study also offers valuable managerial implications. First, managers should be aware that heavy dependence on a small number of major customers may hurt their ability to invest in R&D, which is very important for their sustainable competitive advantage. Our findings show the higher the percentage of transactions with the major customers, the less investment the firm makes into its R&D. The reliance on a restricted number of customers will cost the firm its bargaining power with its customers, which will curtail the availability of resources for R&D activities. Therefore, they need to expand the customer base. Second, managers need to understand that the negative impact of CC on R&D investment can be worsened under a few conditions including intensified competition, better IPR protection regime and a short-term orientation among their management. Therefore, they need to be mindful and stay supportive of R&D activities, particularly when these conditions exist. Third, boards should be cautious in selecting managers who exhibit myopia in pursuit of short-term profit goals, as this can reduce a firm's R&D investment, particularly when it has a high CC. Decision-makers should establish reasonable compensation and incentive systems to effectively guide management toward strategic priorities. Finally, government agencies should consider developing policies that encourage businesses to diversify their customer bases, thereby driving investment in R&D. Given the significant impact of CC on R&D investment and strategic decision-making, policies aimed at fostering a broader customer base can be beneficial. Furthermore, enhancing rules for public firms to disclose information about their major customers can help investors and regulators better understand the size and composition of a firm's customer base, thereby reducing investment risks associated with information asymmetry. Such transparency will also aid in the evaluation of target firms. Addressing these considerations can improve regulatory efficiency and enhance overall information transparency.

This research is not free from limitations, which can form research opportunities for peer academics. First, we focus on the impact of CC on firms' innovation decisions only. An important aspect in firm customer relationship management, an avenue for future research would be to investigate whether and how CC affects other key business decisions and consequences other than R&D investment, for example, innovation outcomes, which will yield a more comprehensive understanding of the whole process of how CC influences firm behaviors and outcomes. Second, another avenue for future research will be to investigate the antecedent factors across multiple contextual settings to identify and mitigate operational risks that affect firm innovation and entrepreneurship. Peer researchers can synthesize different perspectives of operational risks and specify and quantify different types of operational risks and then investigate the best ways to respond to them in firm innovation and entrepreneurship. Third, due to limited data availability, our research exclusively focuses on inter-firm analysis. However, it is worth noting that peer researchers can delve into the inner-firm perspective to obtain a more comprehensive understanding of how CC influences a firm's R&D investment level historically. Fourth, although we have explored the boundary mechanisms of CC on firm R&D investment from three aspects, future research can further explore the moderating effect of firms' resource endowment heterogeneity, for example, the nature of firm ownership, and financing constraints, which may exert different impacts. Fourth, our research sample was selected from Chinese A-share listed companies, and future research may benefit from testing our findings in other contexts to further explore its generalizability and identify contextual conditions if any.

CRediT authorship contribution statement

Shan Zhao: Writing – original draft, Formal analysis, Data curation, Conceptualization. **Xinming He:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **Baichao Ma:** Methodology, Formal analysis, Data curation. **Wenming Zuo:** Supervision, Resources, Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that support the findings of this study are available and were derived from the following resources available in the public domain: the China Stock Market and Accounting Research (CSMAR) database at https://us.gtadata.com/ and in the Wind Economic Database at https://www.wind.com.cn/portal/en/EDB/index.html.

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Appendix A. . The definitions of the main variables

Variable name	Variable	Measure	Sources
R&D intensity	*RD*	the ratio of R&D expenditures to revenues × 100 %	Wind Economic Database
Customer concentration	*CC*	the ratio of the top five customers' sales to the firm's total sales weighted square sum	CSMAR database
Competition intensity	*HHI*	Herfindahl index of sales of the top 4 firms in the industry by market share	CSMAR database
IPR protection	*IPR*	IPR protection quality index from China's intellectual property development status evaluation report	CNIPA
Management myopia	*MYOPIA*	"high" accounting performance and "low" stock performance	CSMAR database
Financial Leverage	*LEV*	the ratio of total debt to total assets	CSMAR database
Return on assets	*ROA*	the ratio of net income to average total assets	CSMAR database
Board independence	*IND*	the ratio of the number of outside directors to board size	CSMAR database
Board size	*BDSIZE*	the natural log of the number of board members	CSMAR database
Ownership concentration	*OWNER*	the top 10 shareholdings ratio	CSMAR database
Revenue growth	*GROWTH*	the change in revenue from year t − 1 to year t divided by revenue in year t − 1	CSMAR database
Firm size	*SIZE*	the natural logarithm of a firm's total assets	CSMAR database

Appendix B. . The regression results of the covariates

Variable	Sample	Mean Difference	L1	Observations	
				Control group	Treatment group
LEV	Before Match	−0.02	0.07	7111	7109
	After Match	−0.00	0.04	5697	5645
ROA	Before Match	−0.00	0.04	7111	7109
	After Match	−0.00	0.04	5697	5645
IND	Before Match	−0.00	0.04	7111	7109
	After Match	−0.00	0.00	5697	5645
FEMALE RATIO	Before Match	0.00	0.04	7111	7109
	After Match	−0.00	0.00	5697	5645
BDSIZE	Before Match	−0.01	0.05	7111	7109
	After Match	−0.00	0.00	5697	5645

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