Venture Capital Contract Design and Innovation

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June 2025

Abstract: This study examines how venture capital (VC) contract terms influence startup innovation. Using a hand-collected sample of 741 Series A financing contracts from U.S. VC-backed startups between 2002 and 2016, we find that downside protection provisions in VC contracts, particularly participation rights and full-ratchet terms, substantially deter innovation measured by patent and citation count. Larger VC syndicate size and California's founder-friendly environment mitigate these negative effects. The impact follows a dynamic pattern: minimal in year one, peaking in year two, and diminishing by year three post-financing. Using the Global Financial Crisis (GFC) and Rule 144/145 amendments as external shocks and applying propensity score matching (PSM), we explore how VC contract terms causally influence innovation outcomes. This study demonstrates how contractual arrangements affect startups' innovative capacity beyond financial performance and shows that VCs actively influence innovation through contractual mechanisms rather than merely selecting innovative firms. These findings provide insights for reducing contract friction and transaction costs between VCs and startups.

Keywords: venture capital contract, cash flow rights, control rights, entrepreneurial finance, innovation

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1. Introduction

Venture capital (VC) has played a pivotal role in the success of numerous large market-cap firms such as Apple, Microsoft, Alphabet, Amazon, Tencent, Tesla, and Meta (Facebook). This form of financing has become crucial for driving innovation, particularly in the realm of technology (Busenitz, 2007; Dessí & Yin, 2012). Having distinct responsibilities compared to traditional financial intermediaries, VCs endeavour to address the risks inherent in innovation, including project uncertainty and information asymmetry between investors and entrepreneurs (Janeway et al., 2021; Kerr & Nanda, 2015), by employing intricate contractual arrangements, pre-investment screening processes, and post-investment monitoring mechanisms (Kaplan & Strömberg, 2001).

While early-stage entrepreneurs seek VC funding due to their limited cash flow capacity (Kortum & Lerner, 1998), venture capitalists are willing to inject significant amounts of capital into startups because they can anticipate high growth and substantial returns (Elango et al., 1995). However, the tension between VCs and startups is the need for VCs to tolerate potential failure to spur innovation (Tian & Wang, 2014) while ensuring close monitoring to prevent the loss of capital. The design of VC contracts at this stage aims to mitigate agency conflicts and information asymmetry between VCs and startups, thereby making VC contracts more than just financial agreements (Gornall & Strebulaev, 2022; Kaplan & Strömberg, 2003, 2004; Sapienza & Timmons, 1989).

Existing literature on venture capital has extensively examined the significant role of venture capital involvement in fostering innovation (Bernstein et al., 2016; Kortum & Lerner, 1998; Lerner & Nanda, 2020). Considering the inherently unpredictable nature of innovative activities, Holmstrom (1989) posits that innovation demands tolerance for failure, but this tolerance shouldn't lead to reduced effort. As a result, investors must monitor more closely to maintain accountability. Aghion and Tirole (1994) argue that allocating property and control rights between investors and startups is critical, and the difficulties in predicting innovation outcomes ex-ante make these allocations particularly impactful. However, while contract terms are essential methods to mitigate agency issues, we still lack an understanding of how they shape innovation outcomes. This study aims to fill this gap by investigating how VC contractual terms in first-round financing affect the innovation performance of early-stage U.S. startups.

Venture capital contracts serve as a framework for outlining the allocation of cash flow rights and control rights between VCs and startups. Cash flow rights refer to the claim to the firm's residual value, as discussed in the agency theory framework by Jensen and Meckling (1976) and the financial contracting theory by Hart (2001). Control rights, on the other hand, refer to decision-making authority over the management and strategic direction of the firm's assets (Aghion & Tirole, 1994; Hart, 2001). Cash flow and control rights are contingent on the startup's financial and non-financial performance, if the startup is profitable or exits successfully, VCs are likely to convert their preferred shares into common shares to participate in the upside. However, if the startup performs poorly, VCs may exercise their cash flow rights (downside protection provisions) in the event of liquidation to recover their investment ahead of common shareholders and may enforce their control rights over the startup, as Kaplan and Strömberg (2003) outlined. These concepts align with Hart & Moore's incomplete contract theory, which emphasises the role of contracts in situations where all future contingencies cannot be accounted for. When contracts fail to address unforeseen situations, residual control rights determine how decisions are made. These rights become crucial during disputes, as they establish the bargaining positions of parties who must then negotiate a resolution. Control rights from investors remain critical for monitoring startups before the market takes over the role of monitoring (Holmstrom, 1989). These rights serve as a key contractual mechanism through which VCs address multiple agency problems, they reduce moral hazard by enabling direct oversight of management decisions, mitigate adverse selection through enhanced information access, prevent hold-up problems by replacing CEO, and decrease information asymmetry through increased involvement in firm governance (Gompers & Lerner, 2001; Hellmann, 1998; Kaplan & Strömberg, 2003, 2004). Reducing these agency problems is expected to spur innovation by ensuring that entrepreneurs and VCs are aligned in their efforts and goals, fostering an environment conducive to innovative outcomes. The optimal contract incentivises startups to achieve a high return level and imposes underperformance penalties (Loyola & Portilla, 2024). Overall, this thesis will investigate how venture capital contracts impact innovation. Specifically, we explore the following research questions.

RQ1: How do cash flow rights affect innovation? Which cash flow rights inspire or restrict innovation?

RQ2: How do control rights affect innovation? Which control rights inspire or restrict innovation?

The first part of this research analyses how the cash flow rights in VC contracts impact startup innovation. Cash flow rights in venture capital contracts include dividends, liquidation preference, participation, anti-dilution rights, redemption, and pay-to-play provisions, which collectively determine the fraction and the allocation of the startup value between VCs and entrepreneurs (Ewens et al., 2022; Gornall & Strebulaev, 2020). These provisions provide downside protection to investors (Bengtsson & Sensoy, 2011) because entrepreneurs will lose a significant portion of their share of the firm value if the startup underperforms. While venture capitalists incorporate cash flow rights into financing contracts to incentivise value maximisation, excessive downside protection can paradoxically harm innovation. This occurs because downside protection will exacerbate a startup's risk aversion by imposing penalties for failures, diminishing the incentives for risk-taking, and inhibiting innovation (Manso, 2011). Consistent with this, Tian and Wang (2014) demonstrate that a failure-tolerant environment enhances innovation outcomes. Accordingly, we expect to observe that weaker downside protection in venture capital contracts fosters greater innovation performance.

The second part of this research examines how control rights shape innovation outcomes. Typical control rights in venture capital contracts include voting rights, protective provisions (veto rights), and board seats. The strength of the possession of these rights directly determines the VCs' control over the entrepreneur. For example, strong voting power authorises the investor to replace the CEO (Cumming & Johan, 2008). As central features of financial contracts (Kaplan & Strömberg, 2003), control rights enhance portfolio firm governance and performance through two primary channels (Hochberg, 2012). First, these rights enable VCs to reduce information asymmetry through closer interaction with portfolio companies, leading to better project evaluation and decision-making. Second, control rights strengthen VCs' ability to address agency problems through active monitoring (Aghion & Tirole, 1994; Bernstein et al., 2016). Through these mechanisms, stronger VC control rights may improve innovation. However, some literature suggests competing effects of control rights on innovation. For instance, Francis, Hasan, and Sharma (2011) find that weak control through golden parachutes enhances innovation outcomes, while Seru (2014) demonstrates that centralised control rights can impede innovation by reducing managers' incentives to pursue bold ideas under close monitoring. These findings further illustrate the complex relationship between control rights and innovation, suggesting that while control can enhance accountability, excessive control may diminish the entrepreneurial spirit necessary for innovation.

The first empirical problem in performing this research is the lack of publicly available data. VCs are typically reluctant to disclose their financial data in the same way as public companies regulated by securities laws, leading to a lack of comprehensive and authentic research data (Kaplan & Lerner, 2016). The situation becomes even more challenging when obtaining financing contracts due to their confidentiality (Ewens et al., 2022; Fu et al., 2022). To overcome the challenge of data availability, we construct a new data set consisting of 739 Series A financing contracts from VC-backed startups from 2002 to 2016. We manually collect contract terms from the Certificate of Incorporation (COI), encompassing their financial structures and all preferred rights entitled to VCs. Also, legal language, particularly in contracts, contains centre-embedded clauses and long-distance syntactic dependencies much higher than standard English texts, making these documents inaccessible to a typical layperson (Martínez et al., 2023). The complexity of VC contracts, verification difficulties, and high error rate are why we choose hand-collect rather than automated extraction of keywords by machine learning-based methods. Additionally, we gathered data on startup innovation outcomes from the United States Patent and Trademark Office (USPTO). Furthermore, we collect VC and Startup characteristics as control variables to enhance our data analysis.

Endogeneity is another critical issue that can distort the relationship between VC contract terms and startup innovation, with the main sources including selection bias, omitted variables, and reverse causality. For instance, selection bias could occur if serial founders, who are more experienced and tend to secure better contract terms (Nahata, 2019), are also more likely to lead innovative startups, resulting in a non-random sample that skews the observed relationship. Omitted variables, such as the underlying quality of startups and VCs, may reflect that their innovative abilities could influence contract terms and innovation outcomes, creating a spurious correlation. Finally, reverse causality may arise if highly innovative startups negotiate more favourable contract terms due to their potential for success, making it unclear whether the contract terms drive innovation. To address these endogeneity problems, we provide a source of external market and regulation variation in VC contract terms and conduct a series of tests to ensure that endogeneity problems do not mainly drive our findings.

Specifically, the 2008 financial crisis and concurrent amendments to Securities Act Rules 144/145[2] created a perfect storm that reshaped venture capital contract negotiations. As the crisis severely limited IPO exit options, VCs increasingly prioritised control rights to facilitate M&A exits, often against founder resistance, as entrepreneurs typically oppose trade sales that

[2] on February 15, 2008, the reversions to Rules 144 and 145 under the Securities Act of 1933[2] went into effect, which reduced the holding periods and restrictions on the resale of restricted and controlled securities. www.sec.gov/files/rules/final/2007/33-8869.pdf

end their leadership positions (Cumming, 2008). Simultaneously, regulatory changes reduced holding periods and restrictions on reselling securities, lowering transaction costs for M&A deals and increasing the value of having control over exit timing. By exploiting this dual shock as a market variation, we can isolate the effect of contract terms on innovation from unobserved confounding factors. While methodologically difficult to separate these concurrent shocks, their combined effect pushed in the same direction, enhancing the importance of control rights as M&A became the critical exit channel during constrained liquidity periods, providing a clean identification strategy to examine how resulting contract term changes influenced innovation outcomes.

In addition, to address the selection bias, we employ Kernel propensity score matching to create comparable groups. Using HighDPI as an indicator variable in our probit model, we match startups with high downside protection to similar startups without it, based on key characteristics (Startup Age, Pre-Val, Same State, Series A Deal Size) along with industry and year fixed effects. This method creates a balanced sample where startups have similar observable characteristics, isolating the impact of contract terms and reducing selection bias when analysing their effect on innovation outcomes.

The summary of our empirical findings is as follows: We found that the strength of downside protection is negatively associated with startup innovation. The patent and citation counts in three years following the Series A financing will decrease by 6.4% and 10.2%, respectively, with one DPI score increase. When we look at the following three years after Series A finance individually, we find that the negative effect of downside protection on patent count exhibits a dynamic pattern, intensifying over time. Specifically, the negative impact of downside protection is minimal in year 1, peaks in year 2, and then diminishes in year 3. Similarly, the effect on patent citations follows a delayed trajectory, remaining insignificant in year 1 but becoming pronounced in year 2 and year 3, suggesting that downside protection terms have a causal effect on innovation outcomes. The Control right index (CRI) is not statistically significant in explaining startups' innovation performance, measured by patent counts and citations. This insignificance may stem from the dual effects of control rights: while governance oversight can provide strategic direction, excessive control may stifle entrepreneurial autonomy, potentially offsetting any net impact (Burkart et al., 1997; Pagano & Röell, 1998).

We then conduct a more in-depth analysis to identify which specific VC contract terms influence startup innovation outcomes. First, we find that participation rights negatively affect innovation performance. Participation entitles preferred shareholders the right to participate in the distribution of the startup's residual value after the liquidation preference claim, in addition to recovering their initial investment. On one hand, the debt-like nature of this term induces the entrepreneurs to exert their effort to keep the startup on track. On the other hand, the combination with the term liquidation can create a scenario where entrepreneurs receive minimal returns or incur significant losses when the startup exits at a low valuation; this is more pronounced with higher preferences, such as 2x or 3x participation. This term imposes substantial pressure on entrepreneurs, potentially leading to short-term decision-making and risk aversion, diminishing the incentive to pursue innovative but risky endeavours.

Second, full-ratchet anti-dilution rights deter startup innovation outcomes while safeguarding VCs from ownership dilution in subsequent financing rounds. Under a full-ratchet mechanism, the total dollar amount initially invested by VCs is reallocated into a greater number of shares at the lower per-share price of the new round, thereby substantially increasing the VCs' ownership stake at the expense of both the startup and incoming investors. This dilution dynamic significantly raises the equity cost for startups in future rounds, making it more challenging to secure additional funding. The restrictive nature of these terms limits startups' ability for subsequent capital raising. This distorts their innovation strategy by constraining their financial flexibility and hindering investments in research and development (R&D) and other innovation-driven activities.

Next, we perform three cross-sectional tests to examine whether the strength of downside protection weakens as the syndication size increases. First, we predict that the effect of downside protection depends on the syndication size because more investors in the syndication enhance the investor’s ability to add value, monitor startups, and simultaneously spread the risk of startup failure. We found that the syndication size moderates the negative impact of downside protection on the patent count. This result aligns with the theory that greater institutional ownership improves innovation outcomes (Aghion et al., 2013). Second, to explore regional variation in VC contracting effects, we examine California's distinct business environment, where Saxenian (1996) identified unique innovation-fostering characteristics through open labour markets and knowledge sharing. Bengtsson and Bernhardt (2014) further documented less common downside protections among California VCs. We isolate California-based startups to test whether our main findings persist in this founder-friendly institutional context. Our results indicate that the "California effect" partially mitigates the negative impacts of downside protection and control provisions on innovation, consistent with the region's more entrepreneur-friendly contracting practices and innovation-conducive ecosystem, supporting Bengtsson and Bernhardt's observations. Third, startups with pre-investment patents experience amplified negative effects from restrictive terms, aligning with Ma's (2024) finding that lenders impose stricter loan covenants on patent-rich firms, suggesting VCs seek greater downside protection from startups with valuable intellectual property that signals both technological successes with higher profit potential and serves as valuable collateral.

To ensure the robustness of our results, we employ Poisson regression, which better handles the count nature of patent data (Cohn et al., 2022). Due to the variance exceeding the mean in our sample, we apply a modified Poisson model, the Negative Binomial method, to confirm our main findings. The negative relationship between the downside protection index (DPI) and innovation is statistically significant across specifications, reinforcing our earlier results.

This study contributes to several branches of literature and offers practical implications. First, it contributes to the literature on venture capital by examining how VC contracts impact firm innovation performance. Gornall and Strebulaev (2020) studied 135 US VC-backed unicorns and found that the over-valuation problem is common in the venture capital industry. Ewens et al. (2022) reveal how the contract terms impact the valuation and ownership of the startups and how the value and ownership are split between VC and entrepreneur. They primarily focus on startup valuation and ownership stakes. Our study complements this stream of research by analysing how VC contracts impact startup innovation performance. This offers VCs and startups a new dimension to consider when both parties enter financing contracts.

Second, this study is also related to the literature on financing innovation. Lerner and Nanda (2020) point out that venture capital has three limitations in financing technological innovation: focusing on specific industries, especially IT and healthcare, concentrated capital among few investors, and less corporate governance emphasis over startups. These issues may have ongoing detrimental effects on the rate and direction of innovation in the broader economy. Janeway et al. (2021) emphasise how technological and economic booms affect contract rights negotiation and shape innovation outcomes. By examining how specific contractual provisions, including cash flow rights and control rights, influence innovation, our study provides evidence that the design of VC contracts serves both an incentivising and monitoring function in fostering innovation within startups. This adds a novel dimension to the literature by demonstrating that the contractual structure of VC investments is instrumental in promoting firm-level innovation.

Third, this study offers empirical support to the ongoing debate on whether venture capital primarily drives innovation at the firm level or simply selects inherently more innovative firms. Kortum and Lerner (1998) find that increases in venture capital activity are significantly associated with higher patenting rates at an industry level. Conversely, some studies argue that there is no substantial evidence of venture capital impacting innovation at the individual firm level, suggesting that the higher innovation rates of VC-backed firms are due to pure selection effects (Caselli et al., 2009; Engel & Keilbach, 2007; Peneder, 2010). Contrarily, Bernstein (2016) counters these claims by demonstrating that increased interactions within existing portfolio companies, facilitated by VCs' on-site monitoring, lead to notable innovation at the firm level. Building on Bernstein's work, our study further explores how venture capital fosters innovation from the contract level, providing empirical evidence that supports the role of VC in stimulating innovation beyond mere selection effects.

Finally, this study provides practical insights that can help reduce contract friction and transaction costs between venture capital and startups. Given the significant power imbalance, where VCs are seasoned experts and startups are often first-time entrepreneurs, inefficient contracting has risks due to information asymmetry and bargaining power disparities. By examining how specific VC contract terms impact firm innovation performance, this research equips startups with the knowledge to negotiate more effectively. This can lead to more balanced contracts that foster innovation and reduce transaction costs, ultimately contributing to a more efficient and equitable venture capital financing market.

2. Theoretical Connection and Hypothesis

2.1. Prior litearture

The financial market serves as a critical engine for economic growth by directing capital to firms with superior potential to commercialise new technological innovation (Brown et al., 2009; Comin & Nanda, 2019; Hsu et al., 2014). However, despite their innovative potential, early-stage entrepreneurs face significant financing constraints due to limited cash flow generation capacity (Kortum & Lerner, 1998) . Venture capital (VC) has emerged as a specialised intermediary that effectively mitigates these constraints through comparatively cost-efficient financing mechanisms (Hall & Lerner, 2010). VCs not only supply the capital to startups but also implement sophisticated contracts and governance activities that help mitigate the agency issues inherent in financing innovation (Kaplan & Strömberg, 2001, 2003, 2004; Sapienza & Timmons, 1989). Kortum and Lerner (1998) examined 20 industries over 30 years in the US and found that the patenting rate increased with more VC activities involved. VCs eliminate information asymmetry and agency problems by screening investee firms in the pre-investment stage and monitoring them in the post-investment stage. They found that one dollar supplied by VC can be up to ten times more effective than traditional R&D regarding innovation stimulation. Highlighting VC's unique capacity to catalyse technological innovation.

In contrast, some literature argues that better innovation performance observed in VC-backed startups may primarily be due to a selection effect rather than value-added contributions. According to this view, VCs selectively identify and invest in startups with higher innovative potential, focusing on accelerating the commercialisation process through improved sales and employment. Several empirical studies find limited evidence that VCs necessarily enhance firm-level innovativeness (Caselli et al., 2009; Engel & Keilbach, 2007; Peneder, 2010). One explanation is the methodological challenge of controlling the endogeneity of VC investments on innovation outcomes (Dessí & Yin, 2012). Specifically, the possibility that unobserved factors simultaneously influence both VC selection and innovation. The endogeneity issue raises the fundamental question of whether VC actually promotes innovation or merely identifies and funds start-ups that already have the prerequisites for innovative success.

Bernstein's (2016) research makes substantial progress in addressing these endogeneity concerns. Bernstein investigated the fact that VCs indeed spur innovation at the firm level by avoiding the selection issue. He exploits an exogenous source of variation in VC investments: the introduction of new airline routes, which effectively reduce travel times for VCs to their portfolio firms. This approach effectively isolates the causal impact of increased VC involvement from selection effects. Bernstein conducted A large-scale survey as part of the study and found that 90% of the VCs reported that direct flights increased interactions with startups, improving their understanding of the startups and thereby reducing information asymmetry. Bernstein's findings strongly suggest that the positive relationship between venture capital and innovation reflects genuine value creation through monitoring activities, not merely selection skills.

How do investors select startups and structure their contracts, and how do these decisions impact startup innovation (Janeway et al., 2021)? What is the nature of the optimal contract between VCs and startups that can motivate startups to be more innovative (Chemmanur & Fulghieri, 2014)? To answer these important questions raised by scholars and complement

Bernstein's causal evidence, our study investigates the venture capital-innovation relationship through a novel contractual perspective.

Inspired by Kaplan and Strömberg's (2003) study on VC contracting, we systematically analyse how specific contract provisions influence startup innovation outcomes through three complementary financial contracting frameworks: agency theory, which examines information asymmetries and moral hazard problems between VCs and startups; contract theory, which focuses on incentive alignment mechanisms; and control theory, which addresses VC's monitorings on startups. This integrated theoretical approach enables us to identify the mechanisms through which different contractual terms enable or constrain innovative activities.

By examining how VC contracts impact innovation outcomes, our study contributes theoretical insights into contract-innovation mechanisms while providing practical guidance for both VCs and startups. Our detailed evidence reveals the precise contractual pathways through which venture capital influences innovation, thereby implementing and extending the causal relationships established in prior literature.

2.2. Agency theory in VC contracting

Asymmetric information and moral hazard problems between investors and entrepreneurs are two main issues that get the most attention from scholars. Entrepreneurs always have more information and a better understanding of the probability of success than investors (Kaplan & Strömberg, 2004). The innovation financing market sounds more like a "lemons" market described by Akerlof (1970). Moral hazard occurs when entrepreneurs control the allocation of capital supplied by investors, resulting in the possibility that founders may pursue projects that are beneficial to them personally but detrimental to their investors, such as investing too much R&D money in technically interesting but commercially limited innovations. Additionally, founders might engage in window dressing or manipulating performance metrics to appear more successful, thereby maintaining investor confidence while masking underlying business challenges. Therefore, an optimal venture capital contract design ensures the risks are shared between venture capitalists and entrepreneurs (Bergemann & Hege, 1998).

The temporal structure of information flow further underscores the importance of effective contracting in innovation financing. Holmstrom (1989) highlights that startups' information advantage exists primarily before the contract is established, while investors begin acquiring information only after the contract is in place. This dynamic makes contract design particularly critical for mitigating agency costs in venture capital relationships. The contract not only defines the terms of investment but also creates mechanisms for progressive information revelation and risk-sharing, thereby addressing both ex-ante and ex-post information asymmetries.

Venture capitalists adopt three methods to mitigate agency problems between investors and entrepreneurs: screening, contracting, and monitoring (Kaplan & Strömberg, 2001). While screening helps VCs select promising ventures (Gompers et al., 2020; Kaplan & Strömberg, 2000) and monitoring enhances portfolio companies' innovation and success (Bernstein et al., 2016), contracting emerges as the cornerstone for managing the relationship. Well-designed contracts are particularly crucial because they establish the framework for both parties' effort contributions in a dual moral hazard setting (Casamatta, 2003; Hellmann, 2006; Schmidt, 2003).

Holmstrom (1989) argued that the terms of financing contracts influence the firm's operation and its members' behaviour in fostering innovation. The availability and conditions of financial capital are not just about the amount of funding; they also determine how effectively firms can harness that capital for innovative activities. Potential incentive problems can arise if investors do not carefully structure these terms.

2.3. Cash flow rights in VC contracts and innovation

While venture capital is a major vehicle in entrepreneurial finance, the inherently uncertain nature of innovation creates significant challenges. VCs face a fundamental trade-off because encouraging innovation requires accepting the risk of failure, while they also need to protect their invested capital from losses in unsuccessful startups. This tension shapes how VCs structure their investment contracts and manage their portfolio firms, thereby impacting the innovation outcomes of their funded startups. VCs often receive convertible preferred shares in their portfolio firms to mitigate this risk and maximise liquidation values in case of bankruptcy. In practice, investors convert their preferred shares into common shares when the return is high, such as IPO, making the contract more equity-like. Conversely, investors exercise their preferential rights to recover their investments if the startup's valuation is low and liquidation is triggered, making the contract more debt-like. The contractual relationship remains dynamic between VCs and startups. An effective contract is thus designed to reward startups for strong performance while protecting VCs in the event of failure.

Cash flow rights include dividends, liquidation preference, participation, anti-dilution rights, redemption, and pay-to-play provisions, which collectively represent the claim to the firm's residual value; they protect investors' interests and impact innovation by directly affecting a startup's ability to capture and benefit from innovation profits. It shapes the startups' ownership structure (Ewens et al., 2022). Ownership of the firm is constituted by the residual rights to its tangible and intangible assets (Holmstrom, 1989). Therefore, the more cash flow rights allocated to venture capitalists (VCs), the greater their ownership stake in the firm. As a result, startups retain a smaller share of ownership, which diminishes their motivation to innovate since they cannot fully enjoy the benefits of their innovations. This reduced incentive may lead to less innovative effort, potentially hindering the startup's overall innovation performance.

Participation rights, like liquidation preferences, come into effect during liquidation events. After VCs receive their liquidation preference payments, they have the right to convert their preferred shares into common shares. This allows VCs to participate in the distribution of the firm's remaining residual equity alongside common shareholders. This provision enhances the protective features of the VCs' investment, reinforcing the contracts' debt-like characteristics. By offering additional downside protection to VCs, participation rights increase the financial pressure on startups (Williams, 2017).

Similarly, redemption rights grant VCs the ability to compel startups to repurchase their preferred shares at a predetermined price within a specified period, typically three to five years. This provision places significant financial pressure on startups, as they must plan for the possibility of substantial cash outflows to meet redemption obligations. Consequently, startups may prioritise short-term financial goals to ensure they have sufficient liquidity, and divert resources and attention away from long-term, high-risk, innovative projects that require sustained investment and development.

Full-ratchet anti-dilution provisions restrict startups' ability to raise capital if startups valuations decline, which increases risk aversion. Under this mechanism, if the startup is raising capital at a lower valuation than the previous financing round, a down round occurs, and the conversion price of preferred stock is automatically reduced to match the new lower share price, regardless of how much money is raised in that round. This adjustment allows VCs to convert their original investment into substantially more shares, significantly increasing their ownership stake at the expense of founders, employees, and new investors. This dilution dynamic raises the equity cost for startups in future financing rounds, making it more challenging to secure additional funding and limiting their ability for subsequent capital raising, particularly when the startup might be underperforming. This distorts their innovation strategy by constraining their financial flexibility and hindering investments in research and development (R&D) and other innovation-driven activities that typically require sustained capital commitment and tolerance for uncertain outcomes.

These heightened pressures from participation rights, redemption rights, and full-ratchet provisions can lead startups to become more risk-averse, focusing on short-term objectives rather than pursuing innovative but uncertain projects. By altering incentive structures and encouraging more conservative decision-making, these cash flow rights may ultimately diminish a startup's innovation performance. Based on the above arguments, we formulate our hypothesis 1 as follows:

H1. The cash flow rights in venture capital contracts negatively impact the innovation performance of startups.

2.4. Control rights in VC contracts and innovation

Control rights, including voting rights, protective provisions (veto rights), and board seats, refer to decision-making authority over the management and strategic direction of the firm's assets (Aghion & Tirole, 1994; Hart, 2001). Veto rights grant investors the authority to approve or block significant actions proposed by a startup, effectively giving them control rights in the company regardless of their minority voting position. This control can include decisions about issuing new shares, alterations in ownership structures, rights of preferred shareholders, declaration or payment of dividends, asset sales, asset purchases, and other major corporate decisions. While these rights protect investors' interests and ensure prudent management, they can inadvertently stifle innovation by limiting a startup's operational autonomy. The requirement for approval on key decisions can lead startups to a reluctance to engage in innovative projects that may not align with the VCs' risk appetite. Consequently, veto rights, though safeguarding investments, may constrain a startup's innovative potential by imposing financial pressure and restricting strategic choices.

Board seats represent a primary control right that VCs negotiate during financing agreements with startups. They are defined in the Certificate of Incorporation (COI) and are typically divided into common shareholder board seats and preferred shareholder board seats, the latter often held by VCs. These board seats enable VCs to be effectively and efficiently involved in the startup's governance, allowing them to express their views, vote at board meetings, and protect their interests at the board level. Through board representation, VCs gain access to the startup's most current and core business information, which is crucial for assessing the success of their investment and planning their exit strategy. Moreover, board seats empower VCs to influence critical decisions within the startup. They can assist startups in hiring the management team (Amornsiripanitch et al., 2019) and provide advice and oversight on strategic decisions (Hellmann & Puri, 2002). This governance mechanism greatly influences the innovation trajectory of startups by influencing the allocation of resources to R&D projects, setting parameters for risk tolerance, and determining which innovations will be continuously supported or terminated.

Aghion and Bolton (1992) developed a theory of control rights allocation in financial contracting. They argue that the allocation of control rights to investors determines how they monitor and influence entrepreneurs' behaviour. For example, while the replacement of the CEO cannot be directly observed in financial contracts, investors often negotiate more board seats in their financing contracts to ensure they have the authority to make such decisions (Lerner, 1995), thereby fulfilling their oversight and monitoring needs. Innovation performance improves in environments where investors hold greater control rights, as these rights facilitate the replacement of underperforming CEOs, creating stronger incentives for management to pursue innovation. By enabling potential takeovers or leadership changes in response to underperformance, enhanced control rights contribute to a more dynamic and innovation-driven startup environment.

However, the relationship between control and innovation is not straightforward. Contrary to the findings discussed above, some research suggests that weaker control over management can actually foster innovation. For instance, by investigating the relationship between innovation and CEOs' compensation contracts, Francis, Hasan, and Sharma (2011) found that golden parachutes, which imply weaker control, are positively correlated with patents and citations. Moreover, Seru (2014) use patents as a measure of innovation found that centralised control rights in the resource allocation process can lead to mediocrity in innovation. This occurs because centralised control may blunt the incentives of managers, who are less motivated to pursue bold, innovative ideas when they are closely monitored and controlled.

From the theoretical discussion, we found that there are contrasting predictions. These theoretical debates emphasise the complexity of the relationship between VCs and startups, particularly in how control rights are structured to manage conflicts of interest. While some theories suggest that these control rights effectively address potential agency problems and the challenges of information asymmetry, others raise concerns that over-control may diminish innovation incentives. Given these divergent views, whether strong control rights positively or negatively impact the innovation performance of startups is an empirical question. We, therefore, formulate our second hypothesis in its null form.

H2. Stronger control rights in venture capital contracts will not impact the innovation performance of startups.

3. Data sources, Sample and Variables

3.1. Data sources and Sample criteria

Collecting venture capital contract data is difficult due to their confidentiality (Ewens et al., 2022; Fu et al., 2022). VCs are typically reluctant to disclose their financial and managerial information in the same way as public companies. This leads to a lack of comprehensive and reliable research data, positing a significant challenge to academic researchers (Kaplan & Lerner, 2016). We collected venture capital and startup data from Preqin and Pitchbook, two databases that enhance the quality and coverage of Certificate of Incorporation (COI) [3] and financial round information such as startup age, deal size, and syndication size. We gather data on innovation from the US Patent and Trademark Office (USPTO), a U.S. Department of Commerce agency that serves as the national patent office and trademark authority, guiding intellectual property policy, protection, and enforcement while promoting stronger IP protection globally.

Our sample includes both private and public firms in the United States. The unfiltered sample coverage was 8733 VC-backed firms that exited over the 15 years between 2002 and 2016. We began our analysis in 2002 because the Dot-Com Bubble burst occurred between 2000 and 2002, and we concluded in 2016 to allow for a three-year window for collecting patent and citation data. We examine patents generated within three years after startups receive their Series A funding and allow an additional three years for citation accumulation.

[3] Certificate of Incorporation (COI) is a legal document issued by a state's Secretary of State office in the United States. The COI includes essential information about the company, such as its name, purpose, registered office address, the names of its initial directors or officers, and details about the authorised shares of stock.

The primary data of this study are manually extracted from the Certificate of Incorporation (COI), also known as Articles of Incorporation. COI is a statement of the designations and the rights, limitations and restrictions for each class of shareholders of the portfolio company. When a US company changes its firm structures, such as issuing new preferred stocks, the legal document Certificate of Incorporation (COI) must be filed with the state. COI includes the critical elements of the contract between investors and startups, such as the number of preferred shares to be issued, the number of board seats allocated to investors, and the protective provisions in the contract. We manually checked these 8733 firms and identified 1,024 with available Series A COI. After removing firms without available control variables, we end up with a final sample of 739 venture capital-backed firms. For these firms, we obtained their detailed financing information capturing both startup and VC characteristics as control variables, including deal date, deal size, state, pre-money valuation, age, lead investor, VC asset under management (AUM), fund size and syndication size. Next, we focus on their Series A preferred shares rights as the independent variables. We code these rights into two classes, as Kaplan and Strömberg (2003) defined. First, cash flow rights include dividend rate, liquidation preference, participation rights, anti-dilution rights, conversion rights, and redemption rights. Second, control rights include voting rights, board seats, and protection provisions (veto rights). Section 3.3 explains how we define these specific contract terms.

3.2. Measure of Innovation

We construct two metrics for measuring startups' patenting activities as a proxy of startups' innovation performance. The first metric assesses innovation quantity through the number of patent applications that were finally granted within three years after the startup received its first round of finance. We use the patent application year rather than the grant year because it better represents the actual time of innovation (Griliches, 1998) and allows us to capture innovative activity more immediately following Series A funding, despite the typical two to three-year processing period for patent grants.

The second metric measures innovation quality through the total citations a patent receives within three years of being granted. This approach captures the patents' impact and relevance, as citations reflect the influence and importance of the innovation over time.

Overall, we focus on a six-year window following Series A funding: the first three years to capture patent applications and an additional three years to track citations. This timeframe aligns with the investment cycle and innovation research framework established by Nanda and

Rhodes-Kropf (2013), who recognise the lag between patent application and granting, thus ensuring a more accurate measurement of both innovation outputs and their subsequent impact.

3.3. Cash flow rights and downside protection index

Cash flow rights in venture capital contracts include dividends, liquidation preference, participation, anti-dilution rights, redemption, and pay-to-play provisions, which collectively determine the allocation of the startup value between VCs and entrepreneurs (Bengtsson & Sensoy, 2011; Ewens et al., 2022). VCs typically hold convertible preferred shares that are senior to common shares and carry preferential provisions. In successful outcomes such as high-return IPOs, VCs convert their preferred shares into common shares, voluntarily waiving their preferential rights. However, in downturns where startup valuations are low, and liquidation is triggered, VCs exercise these preferential rights to recover their investments and costs. Consequently, entrepreneurs who hold common shares may lose a significant portion of their ownership value due to these protective provisions.

We applied the downside protection index (DPI) developed by Bengtsson and Sensoy (2011) to test the relationship between cash flow rights and startup innovation outcomes. Following Bengtsson and Sensoy (2011), we code the cash flow rights into three categories—(0), (1), and (2) where: (0) refers to less protection, (1) refers to moderate protection, and (2) refers to strong protection.

In the context of venture capital financing, Non-cumulative dividends are required to be calculated and paid annually, creating immediate financial obligations for startups. A higher dividend means stronger protection for VCs. For our analysis, we classified dividend provisions based on the dividend rates, we coded our observations with dividend rates less than 6% as (0), dividend rates between 6% to 8% as (1), and dividend rates over 8% as (2).

Liquidation preference determines the payout priority and multiple that VCs receive before common shareholders in the event of a firm sale or liquidation. Standard liquidation preference is 1X, meaning investors receive their original investment amount back before other shareholders. For our classification, we coded the standard 1X liquidation preference as moderate investor protection (1), and no liquidation preference is coded as minimal protection (0), as these rare arrangements provide no downside protection for VCs. Liquidation preferences exceeding 1X (such as 1.5X, 2X, or higher) were coded as strong investor protection (2), as these provisions allow VCs to receive multiples of their original investment before other shareholders in proceeds. Higher liquidation multiples create significantly greater hurdles for startups to receive proceeds during exits, potentially influencing their risk-taking behaviour and innovation decisions.

Participation rights provide investors with additional claims on exit proceeds beyond their standard liquidation preference. When participation rights are included, VCs first receive their liquidation preference, then participate with common shareholders in distributing the remaining proceeds according to their ownership percentage, effectively "double-dipping." Participation highlights their prevalence as investor protection mechanisms. We classified standard 1X participation rights as moderate protection (1), and more aggressive participation provisions exceeding 1X were coded as strong protection (2); if the term is not included, we code it as (0). These stronger participation rights significantly reduce startups' potential returns during exits, potentially affecting their willingness to pursue high-risk innovation paths that might lead to moderate-sized exits.

Redemption rights provide investors with a contractual "put option" that requires startups to repurchase the preferred shares at a predetermined price after a specific time period, typically 3-5 years following the investment. This provision acts as a safety valve for VCs if a startup remains private longer than anticipated without providing a clear path to exit. For our analysis, contracts containing redemption rights were coded as (1), while those without such provisions were coded as (0). The presence of these provisions creates potential financial pressure on startups, as they must either generate sufficient cash flows to redeem shares or seek additional financing to meet these obligations. This financial constraint may influence how startups allocate resources between short-term cash generation and longer-term innovative pursuits.

Anti-dilution provisions protect VCs' ownership percentages from being significantly diluted during subsequent financing rounds at lower valuations (down rounds). These provisions function by adjusting the conversion price at which preferred stock converts to common stock. We coded the weighted average method of anti-dilution protection as (1). This moderate approach adjusts the conversion price based on both the price and volume of new shares issued, providing reasonable investor protection while maintaining some flexibility for startups. Contracts contain no anti-dilution provisions, coded as (0), leaving VCs fully exposed to dilution risk. The most aggressive form, full-ratchet anti-dilution is coded as (2). Full-ratchet provisions reset the conversion price to match any lower price in subsequent rounds regardless of size, potentially causing severe dilution to startups. These stronger protections can significantly influence startups' financing options and risk-taking behaviour, particularly when facing challenging market conditions.

Pay-to-play provisions represent a unique startup-friendly term among the otherwise investor-protective cash flow rights in VC contracts. Unlike other provisions that protect investors, pay-to-play clauses require VCs to participate in future financing rounds proportionate to their ownership stake or convert their preferred shares to common stock to lose their preferred share rights. This mechanism helps startups secure follow-on financing by incentivising existing investors to continue supporting the startup during subsequent funding rounds. Given its distinct function in balancing negotiating power toward startups, we coded the presence of pay-to-play provisions as negative one (-1) for downside protection, reflecting its role in reducing VCs' protection and increasing startups' leverage. This coding approach acknowledges that pay-to-play provisions counterbalance other investor-favourable terms by creating obligations for VCs rather than providing them with additional rights.

Table 1

Downside protection index and Control rights index coding rules

Panel A presents the coding rules for cash flow rights (downside protection) and Panel B shows the coding rules for control rights. We classify each cash flow right and control right on a scale from 0 to 2, representing the strength of the downside protection and control. A value of 0 indicates less protection/control for VC investors (more favourable for startups), 1 indicates moderate protection/control, and 2 indicates the strongest protection/control for VC investors (or harshest terms for startups).

Panel A: Downside protection	**0 (less protection)**	**1 (moderate protection)**	**2 (strong protection)**
Dividend	Dividend <6	6<= Dividend <=8	Dividend >8
Liquidation	Liquidation < 1X	Liquidation 1X	Liquidation>1X
Participation	Not in contract	Participation 1X	Participation >2X
Redemption	Not in contract	Redemption	N/A
Anti-dilution	Not in contract	Weighted average	Full ratchet
Pay-to-play	Not in contract	Pay-to-play (negative)	N/A

Panel B: Control rights	**0 (less control)**	**1 (moderate control)**	**2 (strong control)**
VC power	<50%	50%-75%	76%-100%
Veto rights	<8	8-12	>12

3.4. Control rights and control right index

Typical control rights in venture capital contracts include voting rights, protective provisions (veto rights), and board seats. The intensity of the possession of these rights determines the VCs' control over the entrepreneur.

We applied the same logic from the study of Bengtsson and Sensoy (2011), to develop a similar coding system to explain the strength of the control rights.

Board seats enable VCs to effectively and efficiently engage in the startup's governance, allowing them to express their views, vote at board meetings, and protect their interests at the board level. This involvement extends the VCs' influence beyond mere financial support, embedding them deeply into the operational and strategic fabric of the startup.

While the number of board seats occupied by VCs indicates their involvement, startups often have varying board sizes, making raw board seat counts inconsistent and incomparable across different startups. To address this issue, we introduce the concept of VC Power, which is defined as the proportion of VC-held board seats relative to the total number of board seats in a startup. If VCs hold more than 50% of the board seats, they effectively have absolute decision-making power within the startup.

The variable *VC Power* is defined as is coded as (1) for values between 50% and 75%, (0) for values below 50%, and (2) for values above 75%.

$$VC\ Power = \frac{Number\ of\ VC\ Board\ Seats}{Total\ Number\ of\ Board\ Seats}$$

The VCs commonly negotiate protective provisions or veto rights in a typical financing deal. They clinch the control rights in the company regardless of a minority voting position. VCs have veto rights over changes in the number of shares, changes in the ownership and preferences of preferred shareholders, declaring or paying any dividend, asset sales, asset purchases, and other decisions. In many cases, startups cannot make any decisions without VCs' permission. We count the number of protective provisions granted to preferred shareholders. A higher number of such provisions indicates stronger control over the startup. We code startups with veto rights count 8-12 as (1), less than 8 as (0), and over 12 as (2).

3.5. Control variables

We also considered additional control variables, grouping them into two categories: startup characteristics and VC characteristics.

First, the startup characteristics include the Startup Age at Series A financing. Older startups are expected to have more accumulated experience and technology development, potentially leading to greater innovation output. However, Shan (1994) found that the Startup Age does not significantly influence innovation. Deal size refers to the total amount of funds raised during the Series A round. The Startup industry is important as innovation outputs can vary across industries. Pre-money valuation refers to the size of the startup before Series A finance, it captures some unobserved startup qualities, and larger startups are expected to allocate more resources to innovation, resulting in greater output (Shan et al., 1994).

Second, the VC characteristics include VC fund size, which reflects the amount of capital VCs have raised from investors. VC age and VC experience also play a role, as more experienced VCs tend to perform better than less experienced VCs. This statement follows the survivorship bias because VCs with poor performance struggle to secure follow-up funds. Experienced VCs typically offer superior monitoring and incentives for their portfolio startups. The VC and startup being in the same state improves onsite participation, leading to better monitoring and increased innovation, as well as a higher likelihood of successful exits (Bernstein et al., 2016). Finally, syndication size refers to the number of VCs in a syndicate. Syndicated VCs often provide more support for innovation and operational improvements post-IPO (Tian, 2012).

3.6. Descriptive Statistics

Table 3 presents the descriptive statistics for the sample, highlighting the key patterns observed in the data. Panel A shows that startups generated an average of 1.74 patents in the three years after receiving VC investment. This measure helps quantify innovation activities' output, highlighting the significance of early-stage VC investment in fostering technological advancements. Citation count represents the number of citations received by patents within three years of their grant date, reflecting the impact and importance of the innovation. On average, granted patents received 7.6 citations in the following three years, with citations ranging from a minimum of 0 to a maximum of 625. This variation suggests that while some patents have broad influence, others have minimal impact.

The control variables are divided into startup characteristics and VC characteristics, providing a more detailed understanding of the entities involved. On average, startups received their Series A financing at the age of 1.86 years. The average deal size for Series A financing in this sample was $8.87 million, reflecting the substantial early-stage investment that startups receive from VCs to scale their innovations.

The average VC age in the sample was 17.22, with the oldest firm operating for 94 years. This suggests that senior investors with considerable experience are key players in backing early-stage startups. The largest VC in the sample managed assets worth $185 billion. Nearly

57% of the VCs focus on local investments they tend to fund startups located in the same state as their operations, suggesting a preference for geographical proximity in their investment decisions. On average, VCs syndicate deals with 3 investors, reflecting the collaborative nature of early-stage investment, where risk-sharing and expertise-pooling are common practices.

Panel B presents summary statistics for both cash flow and control rights across 741 VC investments. For cashflow rights, the Dividend Rate averages 6.67% (ranging from 0% to 100%). Participation rights are common (69.8% of deals), and Redemption rights appear in 32.8% of cases. Full Ratchet (1.89%) and Pay to Play (9.31%) provisions are less frequent. The DPI ratio averages 2.722, ranging from 0 to 7.

In terms of control rights, Independent Directors are rare (2.57%), while VC Power averages 0.515, indicating VCs hold majority voting power in about half the cases. Veto Rights Count shows substantial variation, averaging 9 vetoes per deal with a range from 0 to 19. The Control Rights Index (CRI) averages 1.8 on a 0-4 scale, suggesting moderate VC control overall. This pattern indicates VCs maintain oversight primarily through voting power and veto rights rather than board representation.

Panel C of Table 3 presents the industry distribution for the startups in our sample. The data reveal that more than 57% of the startups in the sample come from IT industry and 22% from healthcare. This heavy representation from IT and healthcare is consistent with the findings of Ewens et al. (2022), who similarly document these industries in VC-backed startups. The prominence of IT and healthcare highlights the strategic focus of VCs on sectors with rapid innovation cycles, significant technological advancements, and scalable business models, aligning with broader trends observed in venture capital investment dynamics.

Table 4 presents the correlation matrix for all variables included in the model, offering a comprehensive assessment of potential multicollinearity issues. To ensure robustness in the model's estimations, we perform a multicollinearity check to detect cases where two or more independent variables exhibit high correlations. High multicollinearity can inflate standard errors of the estimated coefficients, thereby obscuring the true relationship between venture capital contract terms and innovation outcomes. By identifying and addressing multicollinearity, the analysis mitigates potential biases and ensures the precision of the coefficient estimates.

4. Regression Models and Results

This section outlines the regression model, addresses potential selection biases and endogeneity, and performs robustness checks to thoroughly examine the relationship between VC contract terms and innovation outcomes.

4.1. Baseline regression model

To test our hypothesis, we employ the standard Ordinary Least Squares (OLS) regression framework as follows:

$$Innovation_{i} = \alpha_0 + \beta_1 DPI_{i} + \beta_2 CRI_{i} + \beta_3 Control_{i} + Industry_{i} + Year_{i} + \varepsilon_{i,} \quad (1)$$

In Equation 1, i indicates firm and t indicates the year of Series A finance. Innovation $_I$, refers to innovation output for firm i, measured 3 years after VC cash injection. DPI $_i$, is one of the main analysis variables, which includes dividend rate, dividend cumulative, liquidation over 1X, participation, redemption, full-ratch and pay-to-play clauses. CRI_i is another main variable that captures control rights, including independent directors, VC power, and the number of veto rights. VC power is a ratio that represents VCs' influence on decision-making, which is calculated by VC board seats over total board seats. We also raw count the number of veto rights in the contract to reflect VCs' control power over startups. The matrix $Control_{i,}$ includes startup characteristics, such as age, deal size and pre-money value, and VC characteristics, such as VC age, VC AUM, and syndication size. $Industry_i$ refers to industry-level fixed effects, and $Year_i$ refers to year-fixed effects to control for unobserved heterogeneity across sectors.

Patent and citation count, as measures of innovation, are typically right-skewed because a small number of firms hold a large number of patents, while most firms have few or none. To address this skewness and approximate a normal distribution, we apply a logarithm transformation to the patent and citation count to reduce skewness. Specifically, we use the logarithm of the patent and citation number plus one to ensure that all startups are included in the analysis, even those that do not have any patents granted during the period, because zero patents is also a valid result, to measure the impact of contract terms, which reflects low innovation outcomes.

Table 5 reports the result of the OLS baseline regression model (1). Columns 1-3 use Logarithms of total patent count cumulated in the first three years, in which columns 1 and 2 report the results of the DPI and CRI separately. Column 3 shows the results of DPI and CRI together. Columns 4-6 use Logarithms of total citation count cumulated in the three years after the patent was granted, in which columns 4 and 5 report the result of the DPI and CRI separately. Column 6 shows the results of DPI and CRI together.

Table 5 demonstrates that downside protection provisions (DPI) are consistently negatively correlated with innovation outcomes. The results in columns 1 and 3 indicate that each unit increase in DPI score is associated with at least a 6.4% decrease in patent generation. This negative effect remains robust (-6.7%) even when controlling for control rights intensity (CRI) in column 3. Similarly, columns 4 and 6 reveal an even stronger negative relationship with citation quality, where each unit increase in DPI corresponds to at least a 10.2% decrease in citations. This effect persists (-10.6%) when accounting for CRI in column 6.

In contrast, CRI does not show statistically significant effects across any models, whether examined independently (columns 2 and 5) or alongside DPI (columns 3 and 6). This lack of significance suggests control rights may have counterbalancing effects: while stronger control can enhance monitoring capabilities that support innovation, excessive oversight might simultaneously restrict entrepreneurial flexibility, resulting in no clear overall impact on innovation outcomes.

4.2. The effect of DPI and CRI in individual years

To account for the lagged effects of contract terms on innovation outcomes, we measure patent count within three separate years following the Series A financing year. Additionally, we track cumulative citations across these same three separate years. VC contracts influence startups' strategic decisions and resource allocation, but their impact on innovation unfolds over time. While patent filings respond relatively quickly to financial constraints and incentives, the recognition of innovation quality, as reflected in citations, takes longer to materialize.

Table 6 demonstrates the dynamic trajectory of how protective provisions affect innovation outcomes across three years following Series A financing. For downside protection (DPI), we observe no significant effect on patent counts in year 1, but the effect becomes negative and statistically significant in year 2. This corresponds to approximately a 5.7% decrease in patent counts. Although the coefficient in year 3 returns to insignificance, the negative impact persists for citations, with significant decreases of 6.7% in year 2 and 6.3% in year 3.

For control rights (CRI), we observe a delayed effect pattern. The coefficients remain statistically insignificant for patent counts across all years and for citations in years 1 and 2.

However, control rights significantly reduce citations in year 3, suggesting a 7.5% decrease. These results are consistent with our hypothesis that control rights have counterbalancing effects on innovation: while stronger monitoring may support innovation activities, excessive control can limit entrepreneurial flexibility, potentially explaining the initial insignificant positive effects in column 4 followed by later negative outcomes for citations.

4.3. The effect of individual contract terms on innovation

After examining the aggregate effects of downside protection and control rights on innovation outcomes, we now investigate how specific contractual provisions within each category independently influence innovation performance. This granular analysis reveals which particular terms drive the observed relationships. Keeping the same control variables and fixed effects, we estimate Equation 2 to analyse their independent effects.

$$
\begin{aligned}
Log\ (PatentCount{+}1)_i = {} & \alpha_0 + \beta_1\ Dividend\ Rate_i + \beta_2\ Dividend\ Cumulative_i + \beta_3\ Liquidationover1X_i \\
& + \beta_4\ Participation_i + \beta_5\ Redemption_i + \beta_6\ Full\text{-}ratchet_i + \beta_7 Pay\text{-}to\text{-}play_i \\
& + \gamma_1\ Independent\ Director_i + \gamma_2\ VC\ power_{i,} + \gamma_3\ Veto\ rights\ count_{i,} + \gamma_4\ Total\ provisions_{i,} \\
& + \delta_1\ Startup\ Age_i + \delta_2\ IPO\ Dummy_i + \delta_3\ Pre\text{-}Val_i + \delta_4\ Same\ state_i + \delta_5\ Series\ A\ Deal\ Size_i \\
& + \delta_6\ VC\ Age_i + \delta_7\ VC\ AUM_i + \delta_8\ Syndication\ Size_i + \delta_9\ Series\ B + \delta_{10}\ Series\ C \\
& + Industry + Year + \varepsilon_i \qquad (2)
\end{aligned}
$$

In Table 7 Panel A, column 1 presents the baseline correlations between innovation outcomes and contract terms without control variables and fixed effects. However, these relationships may be influenced by industry-specific characteristics and temporal factors. For instance, certain industries may exhibit structurally different patterns, and technological breakthroughs (such as ChatGPT's introduction in November 2022) can significantly impact innovation in a specific year. To address these potential sources of heterogeneity, Column 2 incorporates both industry and year-fixed effects, controlling for industry-specific characteristics and time-varying factors. The coefficient estimates reveal several significant associations between specific contract terms and innovative output.

Cumulative dividend provisions, which allow startups to defer dividend payments until liquidation rather than making annual distributions, are associated with a 16.9% increase in patent counts. Similarly, pay-to-play provisions, which incentivise investors to participate in subsequent financing rounds, correspond to a 24.1% increase in innovative output. These startup-friendly provisions demonstrate positive effects on innovation.

Conversely, investor-protective terms exhibit negative relationships with innovation. Participation rights, which enhance investor claims upon liquidation, correlate with a 3.9% reduction in patent counts in year 2. Redemption rights show a negative impact of 8.8% in year 2 patent generation. Most notably, full-ratchet anti-dilution protection demonstrates the strongest negative association, corresponding to a 24.4% decrease in patent production in year 2 and a 25.6% decrease when controlling for industry and year fixed effects. The analysis reveals that these effects are most pronounced in years 1 and 2 following the financing event, suggesting that contractual structures have their strongest impact on innovation in the early to mid-term post-investment period.

Table 7 Panel B extends our analysis by examining the relationship between VC contract terms and the quality of innovation as measured by patent citations. While patent counts capture the quantity of innovation, citation counts provide insight into the impact and quality of these innovations.

Startup-friendly provisions consistently demonstrate strong positive associations with innovation quality. Cumulative dividend provisions correlate with a 37.2% increase in average citation counts and a 37.7% increase when considering the first year post-investment. This effect persists through year 3, with a 27.5% increase. These findings suggest that allowing startups to defer dividend payments until liquidation not only increases innovation quantity as previously observed, but also enhances innovation quality. Pay-to-play provisions show a positive relationship with citation counts. However, the significance disappears after controlling for industry and year fixed effects, and the coefficient remains insignificant across individual years. This pattern suggests that the apparent relationship between pay-to-play provisions and citation may be driven by industry-specific factors or time trends rather than a direct causal effect of the contractual provision itself.

Downside protection provisions demonstrate negative relationships with innovation quality. Redemption rights correlate with a 15.9% decrease in citation counts in year 2. Full-ratchet anti-dilution protection exhibits the strongest negative association, corresponding to a 39.6% decrease in year 2, and a 33.3% decrease in year 3.

The analysis reveals that the effects of contractual provisions on innovation quality are most pronounced in years 2 and 3, suggesting that while innovation quantity may respond earlier to VC contract terms, the quality impact becomes more evident as innovations mature and accumulate citations over time.

These findings complement our patent count analysis and provide stronger evidence that VC contractual structures significantly influence not only how much startups innovate but also the quality of their innovations. The consistent negative relationship between downside protection provisions and both innovation quantity and quality suggest that excessive downside protection may constrain entrepreneurs' ability to pursue high-quality, impactful innovations. These findings are consistent with the hypothesis that VC contract terms affect downside protection and influence startup risk-taking behaviour and resource allocation decisions that ultimately shape innovative outcomes.

4.4. Syndication size as a moderator of DPI and CRI effects on innovation

Bengtsson and Sensoy (2011) suggest that VC abilities are highly related to the strength of downside protection, and VCs with stronger governance abilities focus less on obtaining downside protection. When VC investors form a syndicate to co-invest in a startup, the diverse skills, industry expertise, information, and networks of syndicate members enable them to provide a wide array of strategic and operational support to entrepreneurial firms (Tian, 2012). We predict that larger VC syndicates, through their enhanced collective governance capabilities and risk-sharing mechanisms, will moderate the relationship between contract terms and innovation outcomes. In Equation 3, we maintain the same control rights and fixed effects to test with interaction terms, *SyndicationSize_DPI* and *SyndicationSize_CRI*, to measure their impacts on innovation outcomes.

$$Innovation_i = \alpha_0 + \beta_1 DPI_i + \beta_2 CRI_i + \beta_3 Control_{i,} + \beta_4 SyndicationSize\_DPI_i + \beta_5 SyndicationSize\_CRI_i + Industry_i + Year_i + \varepsilon_{i,} \quad (3)$$

The results in Table 8 provide evidence of syndication size moderating the DPI effect, but limited evidence for CRI moderation. For downside protection (DPI), we find a significant positive interaction effect with syndication size for patent count. The total effect on patent count can be expressed as: -0.140 + 0.027 * *Syndication size*. This reveals that when syndication size is small, DPI exerts a substantial negative effect on patent count (-0.140). However, as syndication size increases, this negative effect progressively diminishes, suggesting that larger syndicates can partially mitigate the innovation-dampening effects of excessive downside protection**.**

5. Endogeneity Concern

One concern in our research is that the test results may be influenced by selection bias in the startups included in the analysis. The estimated coefficients could be biased and inconsistent for several potential reasons. First, data availability may be biased due to the selection criteria of the database. Specifically, we obtained 741 samples out of 8,733 startups because of the limited availability of Certificate of Incorporation (COI). This incomplete sample could impact the test results and potentially bias the conclusions. Second, innovation outcomes can vary based on the nature of the industry. Venture capitalists often prefer to invest in sectors that offer quick returns and high growth rates, such as IT and healthcare. Third, the negotiation of VC contract terms depends on the quality and bargaining power of both the VC and the startup. The final contract represents an equilibrium reflecting the relative power of both parties. Specific characteristics of VCs and startups can influence this negotiation process, potentially leading to endogeneity problems. For instance, VCs may offer high-quality startups comparatively lenient contractual provisions, and these startups often have better resources, talent, and capabilities, which naturally lead to higher levels of innovation.

5.1. Propensity score matching (PSM)

To address these endogeneity concerns, we employ propensity score matching (PSM) to construct a matched sample using a Kenel propensity score approach, which is appropriate given our relatively small sample size. The propensity scores are estimated from a probit model, allowing us to create comparable treatment and control groups while maximizing the use of available observations. The dependent variable, HighDPI, is an indicator variable that takes a value of one if the downside protection index is higher than the average score of 3 and zero otherwise. In the PSM model, we include firm characteristics as control variables from the baseline model, including Startup Age, Pre Val, Same State, and Series A Deal Size, as well as the industry and year fixed effect, to ensure comparability between high downside protection and low downside protection startups. This matching approach helps mitigate selection bias by creating a balanced sample for subsequent analysis.

Table 9 presents the results of our propensity score matching (PSM) methodology showing that downside protection negatively impacts innovation output. We use kernel matching as our main model while using nearest-neighbour matching (1:3) as a robustness check. Our analysis shows downside protection index (DPI) coefficients ranging from -6.9% to -14.1% across PSM specifications, with consistent negative effects on both Log Patent Count and Log Citation. Specifically, Column 1 shows a DPI coefficient of -6.9% on Log Patent Count, Column 2 reveals a stronger effect of -14.1%, Column 3 shows an effect of -7.2%, and Column 4 demonstrates the strongest effect on Log Citation with -12.2%. These estimates closely mirror our baseline results (-6.4% to -10.6%), demonstrating remarkable stability across different econometric approaches. The economic significance is substantial; each unit increase in downside protection is associated with approximately a 7-14% reduction in startup innovation outcomes. This consistent negative relationship across both patent quantity and quality metrics strongly suggests that stronger downside protection causally reduces innovation outcomes rather than merely reflecting differences in underlying firm characteristics or selection effects.

5.2. Market shocks and contracting environment changes

The Global Financial Crisis (GFC) represents a profound external shock that fundamentally transformed the venture capital ecosystem (Block & Sandner, 2009; Di Lorenzo et al., 2024). Originating from an extensive credit boom that peaked in mid-2007, the crisis unfolded through the collapse of subprime mortgages and securitized products before escalating into a systemic banking panic by September 2008, plunging global economies into deep recession (Ivashina & Scharfstein, 2010). Post-GFC regulations forced banks to implement stricter risk assessment frameworks, increasing costs of small business financing. At the same time, capital commitments to US venture funds unexpectedly fell by half in 2009 (Di Lorenzo et al., 2024), further constraining funding for startups with risky business models. The nature of the GFC provides a powerful identification strategy for examining causal relationships, as the shock originated in financial markets and propagated to entrepreneurial financing without being driven by startup innovation trends. This dramatic shift in economic conditions significantly altered bargaining dynamics during contract negotiations between VCs and startups, creating a natural empirical setting to examine how financial contracting responds to external shocks.

During periods of constrained liquidity like the Great Financial Crisis, venture capitalists increasingly emphasise control rights as M&A becomes the more viable exit option when IPO opportunities are effectively limited. VCs require stronger governance authority to secure these acquisition pathways, often against entrepreneur resistance. Founders typically oppose trade sales that terminate their leadership positions and associated private benefits. These enhanced control provisions enable VCs to monetise their investments through M&A when traditional exit channels like public offerings become severely restricted by adverse market conditions.

Complementing these crisis-driven changes, the February 15, 2008 revisions to Rules 144 and 145 under the Securities Act of 1933[4] further influenced this shifting contractual landscape. These regulatory changes reduced holding periods and restrictions on the resale of restricted and controlled securities[5], effectively stimulating the M&A market by lowering transaction costs for trade sales. These regulatory changes provide additional incentives for VCs to secure enhanced control rights during ex-ante contract negotiations, as the improved liquidity for the secondary market increased the value of having control rights over exit timing and methods. This setting provides a clean identification strategy as the regulatory changes affect contract term negotiations through M&A enhancement while being plausibly exogenous to firms' underlying innovation processes, though we acknowledge the absence of a control group limits our causal identification. By examining the combination of these two shocks, we can explore how the resulting changes in contract terms influence innovation outcomes.

It is important to note that the GFC and Rule 144/145 amendments occurred nearly simultaneously, making it methodologically challenging to isolate their individual effects. However, both shocks likely operated in the same direction, enhancing the importance of control rights as M&A activity became a more critical exit channel. The GFC constrained IPO markets, while the regulatory changes reduced friction in private secondary transactions. Rather than attempting to distinguish these concurrent phenomena, we exploit their combined effect as a temporal variation in VC contracting practices, as both ultimately incentivised greater emphasis on control rights in VC financing contracts.

To test how the GFC and Rule 144&145 amendments correlate with changes in contract terms and innovation patterns, we use a [−5, 5] years window around the February 2008 regulatory change. We define [2003, 2007] as the pre-period and [2008, 2012] as the post-period. The results in Table 10 are consistent with our prediction that enhanced M&A activities following from GFC and Rule 144/145 amendments shift VCs' emphasis from cash flow rights to control rights. Prior to the shocks (2003-2007), the downside protection index (DPI) exhibits a significant negative relationship with innovation outcomes (-0.101 for patent count, -0.139 for citations), while the control rights index (CRI) shows no significant impact. This pattern

[4] www.sec.gov/files/rules/final/2007/33-8869.pdf

[5] https://www.sec.gov/about/reports-publications/investorpubsrule144

reverses in the post-period (2008-2012): DPI becomes statistically insignificant, while CRI demonstrates a significant negative relationship with both patent quantity (-0.121**)** and citation impact (-0.184)**.** These findings suggest that as M&A became an increasingly dominant exit pathway, VCs shifted their contractual emphasis from cash flow rights toward control rights during financing negotiations.

While we cannot claim true causal identification due to the absence of a proper control group, this temporal analysis around plausibly exogenous market shocks provides suggestive evidence of how different contractual provisions may affect startup innovation performance and allows us to examine the association between environmental changes and contracting practices**.**

6. Additional Robustness Checks

To further validate the robustness of our empirical findings, we adopt an alternative estimation method by re-estimating our model using Poisson regression, which is well-suited for counting data such as patent counts. Cohn et al. (2022) suggest that the Poisson regression model designed for count-based outcomes provides more efficient estimates and offers more natural interpretations without requiring special assumptions to mitigate inherent biases. However, a key assumption of Poisson regression is that the dependent variable follows a Poisson distribution, where the variance equals the mean. Given that the variance substantially exceeds the mean, we employ a Negative Binomial regression model, an extended version of the Poisson model that introduces a dispersion parameter to account for overdispersion. By allowing the variance to exceed the mean, the Negative Binomial model provides more reliable standard errors and robust inference. This approach ensures that our estimation method remains appropriate given the characteristics of our data. Our main results remain consistent under this specification, reinforcing our conclusions on the impact of venture capital contract terms on innovation outcomes.

In Table 11, we present the Negative Binominal regression analysis results. The negative coefficients for *DPI* on innovation remain statistically significant, consistent with our earlier findings, and contract terms included in DPI may make startups more risk-averse, potentially reducing their innovative activities. Consequently, these findings reinforce the robustness of our results and underscore the impact of specific contract terms on startup innovation.

7. Conclusion

This study uses a novel, hand-collected dataset of Series A financing contracts to examine how venture capital contract terms affect startup innovation and measure innovation through patent counts and citation outcomes. Our empirical findings reveal that downside protection provisions, particularly participation rights and full-ratchet terms, significantly deter innovation, with economically meaningful reductions in patenting activity. The dynamic analysis shows that these effects follow a distinct pattern: effects were negligible in year 1, become negative and statistically significant in year 2, and then diminish by the third year post-financing, suggesting a complex adjustment process in innovation activities following financing.

Our cross-sectional analysis reveals important moderating factors. Larger syndication sizes mitigate the negative effects of downside protection and control rights on innovation outcomes, with syndication size primarily functioning as a moderator rather than directly affecting innovation in the control rights context.

To strengthen our identification and address potential endogeneity concerns, we exploit temporal variation around the 2008-2009 financial crisis and contemporaneous Rule 144/145 amendments. While these external shocks originated outside the startup innovation sector, the absence of a proper control group limits our ability to establish clean causal identification. We complement this temporal analysis with propensity score matching techniques to address selection concerns. Together, these empirical strategies provide suggestive evidence that VC contract structures may meaningfully influence startup innovation trajectories, though we acknowledge that establishing definitive causality remains challenging given the inherent limitations of our identification approach.

Our research makes two key contributions to the literature. First, we complement existing studies on the impact of VC contracts on startup valuation by analysing the non-financial aspects of firm performance, specifically innovation. By focusing on innovation outcomes, we offer VCs and startups a new dimension to consider when making investment decisions, highlighting how contractual arrangements can influence a startup's innovative capacity. Second, our study contributes to the ongoing debate on whether venture capital primarily drives innovation at the firm level or simply selects inherently more innovative firms. These findings suggest that venture capital does more than just selection. They actively influence startups to innovate through contractual mechanisms.

This study opens several promising avenues for future research. While our analysis focuses on downside protection provisions, other contract terms such as dividend rates, cumulative dividends, pay-to-play provisions, independent directors, and veto rights did not show statistical significance but merit deeper investigation. These provisions may influence innovation through different channels or under specific market conditions not captured in the current analysis. Future research could also explore how these contract terms interact with various institutional environments, market cycles, and industry characteristics. Such investigations would provide a more nuanced understanding of venture capital contract design and its impact on startup innovation, offering valuable insights for investors structuring deals, entrepreneurs negotiating terms, and policymakers crafting regulations for venture capital markets.

Appendix

Contract terms definition

Dividends

In public companies, a dividend is the distribution of corporations' earnings or profits to stockholders based on ownership. However, in the context of venture capital financing, dividends come in two classes: cumulative dividends and non-cumulative dividends. Cumulative dividends are calculated annually but not paid out until the company is in a liquidation or merger and acquisition (M&A) situation.

Liquidation Preference

Startups enter a liquidation event when they are merged, acquired or sold. VCs, as preferred shareholders, have the priority to receive a certain amount of payment over common shareholders, and this right is Liquidation preference.

Participation Rights

Participation rights, similar to liquidation preferences, come into effect during liquidation events. Following receipt of their liquidation preference payment, preferred shareholders are entitled to convert their preferred shares into common shares, thereby participating in the distribution of the company's residual equity alongside common shareholders. This provision enhances the protective features of VC's investment, further emphasising the contract's debt-like characteristics.

Anti-dilution Rights

Anti-dilution is a common feature in venture financing agreements, designed to protect preferred shareholders in the event that a company raises capital in a "down round," where the valuation is lower than in previous rounds. In such cases, anti-dilution protection functions by adjusting the conversion price of preferred stock into common stock, thereby giving venture capitalists (VCs) additional shares. Initially, the conversion price is set equal to the original purchase price of the preferred stock, and preferred shares convert into common shares at the conversion ratio. However, when anti-dilution rights are triggered, the conversion price is reduced as compensation for dilution; this right allows the preferred stock to convert into a larger number of common shares.

Anti-dilution protection typically comes in two forms: weighted average and full-ratchet. In the weighted average form, the conversion price is adjusted based on the extent of dilution—the greater the capital raised in the new round, the more the conversion price declines. This form provides some protection to investors but takes into account the size of the financing round. In contrast, full-ratchet anti-dilution offers stronger protection by ensuring that the valuation of the VC's initial investment remains unchanged, regardless of the size of the new financing round. Full-ratchet, therefore, offers more complete protection compared to the weighted average approach, making it a more favourable option for VCs seeking to minimise dilution risk.

Pay-to-Play

Pay-to-play is one of the few startup-friendly provisions found in VC contracts. It requires preferred shareholders to participate in subsequent financing rounds continuously, or their preferred shares will automatically convert into common shares, resulting in the loss of all preferred share rights. Startups with stronger negotiating positions may seek to incorporate a pay-to-play clause as part of the anti-dilution mechanism.

Redemption Rights

Redemption rights in VC contracts grant VCs the ability to compel startups to purchase back their preferred shares at a pre-determined price in a specified period, typically three to five years. To activate this right, all VC investors within the syndicate must vote collectively to reach the required percentage. Startups may purchase back all these preferred shares in a single transaction or multiple instalments.

Voting Rights

VCs exercise their voting rights to influence key decisions or actions within the corporation based on the percentage of the ownership stake they hold in the startup. When matters are presented to shareholders at board or general meetings, VCs use their voting rights to guide their actions or express their considerations on strategic decisions. While most VCs have voting rights in their financing contracts, the entitlement to board seats is often a more critical factor in shaping their influence.

Board Seats

VCs negotiate board seats in a startup's board of directors, and the voting rights in contracts decide the number of board seats. As a primary control right, the board seats enable VCs to be effectively and efficiently involved in the startups' governance, to express their views and vote at board meetings, and to protect their interests at the board level. Board seats provide VCs access to startups' most current and core business information, allowing investors to judge the success of their investment in the company and their subsequent exit strategy. Board seats empower the VCs to assist portfolio companies in hiring the management team (Amornsiripanitch et al., 2019) and advise and monitor strategic decisions (Hellmann & Puri, 2002). Board seats are divided into common shareholder board seats and preferred shareholder board seats. This distinction is crucial for accurately calculating the weighted influence of VCs on the board.

VC Power

The number of board seats varies across firms, making the raw count of VC-held seats difficult to compare directly. To better assess the influence of VCs on the board, we calculate VC power by using the ratio of VC-held board seats to the total number of board seats, which includes both VC-held and common shareholder board seats. If VCs hold more than 50% of the board seats, they effectively have absolute decision-making power within the startup.

Protective Provisions (Veto rights)

The VCs commonly negotiate protective provisions or veto rights in a typical financing deal. They clinch the control rights in the company regardless of a minority voting position. VCs have veto rights over changes in the number of shares, changes in the ownership and preferences of preferred shareholders, declaring or paying any dividend, asset sales, asset purchases, and other decisions. In many cases, startups cannot make any decisions without VCs' permission. A higher number of such provisions indicates stronger control over the startup.

Total Provisions

The number of total provisions granted to preferred shareholders. It serves as an indicator of the overall control and influence VCs have over the startup. A greater number of contract terms typically reflects stronger investor protections and more control over key decisions, potentially creating a more rigid framework for the startup's operations. While these provisions are designed to safeguard VC interests, they may also limit the startup's flexibility, potentially stifling innovation.

Table 2

Variable Definitions

This definition includes all dependent variables, independent variables, and control variables.

*This table contains the definitions of all variables in the paper. Some variables are not used in the baseline model because they are highly correlated with others; however, they are essential to define here to provide comprehensive explanations.

Independent Variables	**Definition**
Cash Flow Rights	
Dividend Rate	The dividend rate of the Series A finance.
Dividend Cumulative	A dummy variable is equal to 1 if the dividends are calculated annually but not paid out until the company is in a liquidation event.
Liquidation	The liquidation rate that the startup needs to pay back the VC's investment in a deemed liquidation event.
Liquidation over 1X	A dummy variable is equal to 1 if the liquidation multiple exceeds 1X, in which entrepreneurs need to pay back the investors more than 100% of the investment.
Participation	The participation rate that after VCs claim the liquidation preference on the residual value of common shares in a liquidation event.
Redemption	A dummy variable is equal to 1 if VCs are authorised to sell back their shares to a startup at a predetermined price in a certain number of years.
Anti-dilution rights	A dummy variable is equal to 1 if the company issues additional shares to VCs because the company raises a new financing round with a lower valuation than investors paid previously.
Weighted average	A dummy variable is equal to 1 if the contract terms include a weighted average in the anti-dilution provision.
Full Ratchet	A dummy variable is equal to 1 if the contract terms include a full ratchet in the anti-dilution provision. The investment valuation in the portfolio company remains the same regardless of the capital size in the new round.
Pay-to-play	A dummy variable is equal to 1 if the VCs are required to invest in future financing rounds continually. Otherwise, the preferred shares they hold will automatically convert into common shares and lose all preferred stock rights.
Total Provisions	The total count of the contract terms.
Control Rights	
Voting Rights	A dummy variable is equal to 1 if VCs have voting rights in the first financing round.
Protective Provisions (Veto rights)	The number of veto rights.
Board seats	The number of board seats VCs have in the Series A financing round.
VC Power	The VC's power on the board is measured as the ratio of the VC's board seats to the total number of board seats, including both preferred share board seats and common share board seats.
Control Variables	
Startup Characteristics	
Startup Age	The age of startup at Series A financing.
Series A Deal Size ($m)	The total capital raised in Series A financing.
Serial Founder	A dummy variable is equal to 1 if the startup founder ran multiple businesses despite being previously successful or not.
Startup Industry	The industry of startup operates in Series A financing.
Pre-money valuation ($m)	The startup's market value before the Series A financing.
Post-money valuation ($m)	The startup's market value after the Series A financing.
VC Characteristics	
VC Age	The age of the VC when they invest in the startup's Series A finance.
VC AUM ($m)	Total assets under VC's management.
Same State	A dummy variable is equal to 1 if the VC and startup are in the same US state.
Syndication Size	The number of VCs in the Series A financing.

Table 3
Descriptive Statistics
This sample includes 741 US VC-backed startups from 2002-2016. Panel A presents the patent count and citation count as proxies of innovation outcomes and the startups and VC characteristics as control variables. Panel B presents independent variables, including dividend, liquidation, participation, redemption, pay-to-play, independent director VC power, veto rights, and the count of the contract terms. Panel C is the distribution of all industries in the sample.

Panel A

	(1)	(2)	(3)	(4)	(5)
Dependent Variables	N	mean	sd	min	max
Patent Count	741	1.740	5.354	0	70
Citation Count	741	7.646	38.13	0	625

	(1)	(2)	(3)	(4)	(5)
Control Variables	N	mean	sd	min	max
Startup characteristics					
IPO Dummy	741	0.161	0.367	0	1
Startup Age (Year)	741	1.857	2.156	0	11.03
Pre-Val ($M)	741	16.64	27.23	0.130	193.6
Series A Deal Size ($M)	741	8.870	10.40	0.020	60
Healthcare Dummy	741	0.224	0.417	0	1
VC characteristics					
VC Age (Year)	741	17.22	14.13	0	94
VC AUM ($M)	741	11,152	27,113	0.880	185,000
Same State	741	0.566	0.496	0	1
Syndication Size	741	3.047	2.226	1	13

Panel B

	(1)	(2)	(3)	(4)	(5)
Cashflow Rights	N	mean	sd	min	max
Dividend Rate (% of share price)	741	0.0667	0.0568	0%	100%
Dividend Cumulative	741	0.200	0.400	0	1
Liquidation	741	1.018	0.185	0	3.740
Participation	741	0.698	0.955	0	4
Redemption	741	0.328	0.470	0	1
Full Ratchet	741	0.0189	0.136	0	1
Pay-to-Play	741	0.0931	0.291	0	1
DPI	741	2.722	1.097	0	7

	(1)	(2)	(3)	(4)	(5)
Control Rights	N	mean	sd	min	max
Independent Director	741	0.0257	0.189	0	3
VC Power (%)	741	0.515	0.285	0	1
Veto Rights Count	741	8.981	3.357	0	19
CRI	741	1.800	1.063	0	4

Panel C

	(1)	(2)	(3)
Industry Classification	Freq.	Percent	Cum.
Business Services	36	4.86	4.86
Consumer Discretionary	43	5.80	10.66
Energy & Utilities	17	2.29	12.96
Financial & Insurance Services	12	1.62	14.57
Healthcare	166	22.40	36.98
Industrials	9	1.21	38.19
Information Technology	424	57.22	95.41
Raw Materials & Natural Resources	3	0.40	95.82
Telecoms & Media	31	4.18	100.00
Total	741	100	

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) LogPatentCount	1.00																		
(2) LogCitation	0.74*	1.00																	
	(0.00)																		
(3) DPI	-0.04	-0.05	1.00																
	(0.22)	(0.14)																	
(4) CRI	0.02	-0.01	0.20*	1.00															
	(0.66)	(0.82)	(0.00)																
(5) StartupAge	0.00	0.00	0.08*	0.06	1.00														
	(0.96)	(0.94)	(0.02)	(0.13)															
(6) HealthcareDummy	0.21*	0.14*	0.12*	0.19*	0.00	1.00													
	(0.00)	(0.00)	(0.00)	(0.00)	(0.97)														
(7) IPODummy	0.29*	0.31*	-0.03	0.07*	-0.09*	0.34*	1.00												
	(0.00)	(0.00)	(0.42)	(0.05)	(0.02)	(0.00)													
(8) PreVal	0.14*	0.11*	-0.11*	-0.10*	0.17*	-0.05	0.03	1.00											
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.15)	(0.40)												
(9) FundAge	0.04	0.04	0.13*	0.10*	0.15*	0.12*	0.12*	-0.04	1.00										
	(0.27)	(0.22)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.28)											
(10) FundVintage	-0.08*	-0.06	-0.27*	-0.07*	-0.05	-0.07	-0.13*	0.12*	-0.57*	1.00									
	(0.03)	(0.09)	(0.00)	(0.05)	(0.20)	(0.05)	(0.00)	(0.00)	(0.00)										
(11) FundSize	0.05	0.03	-0.09*	0.06	-0.03	-0.05	-0.03	0.12*	-0.07*	0.05	1.00								
	(0.18)	(0.44)	(0.01)	(0.10)	(0.37)	(0.15)	(0.39)	(0.00)	(0.04)	(0.16)									
(12) VCPower	0.04	0.03	0.13*	0.74*	0.07	0.19*	0.12*	-0.11*	0.11*	-0.09*	0.06	1.00							
	(0.30)	(0.41)	(0.00)	(0.00)	(0.08)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.12)								
(13) SameState	0.01	0.02	-0.08*	-0.01	-0.06	-0.19*	-0.02	-0.02	-0.09*	0.12*	0.01	0.00	1.00						
	(0.81)	(0.58)	(0.03)	(0.70)	(0.08)	(0.00)	(0.62)	(0.52)	(0.02)	(0.00)	(0.71)	(0.92)							
(14) SeriesADealSize	0.22*	0.14*	-0.07	0.12*	0.15*	0.22*	0.27*	0.58*	0.06	0.05	0.12*	0.12*	-0.09*	1.00					
	(0.00)	(0.00)	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.10)	(0.15)	(0.00)	(0.00)	(0.01)						
(15) VCAge	0.03	0.03	-0.09*	0.00	0.03	-0.07	0.03	0.15*	-0.02	0.03	0.32*	-0.02	0.01	0.10*	1.00				
	(0.40)	(0.34)	(0.01)	(0.93)	(0.34)	(0.07)	(0.45)	(0.00)	(0.51)	(0.42)	(0.00)	(0.66)	(0.79)	(0.01)					
(16) VCAUM	0.09*	0.12*	0.01	-0.03	-0.01	-0.02	0.06	0.18*	0.03	-0.05	0.19*	-0.04	0.01	0.18*	0.19*	1.00			
	(0.02)	(0.00)	(0.85)	(0.43)	(0.87)	(0.51)	(0.12)	(0.00)	(0.47)	(0.18)	(0.00)	(0.31)	(0.79)	(0.00)	(0.00)				
(17) SyndicationSize	0.08*	0.10*	-0.14*	-0.04	0.03	0.06	0.15*	0.04	0.06	0.10*	-0.03	-0.05	0.00	0.11*	-0.04	0.01	1.00		
	(0.03)	(0.01)	(0.00)	(0.24)	(0.39)	(0.09)	(0.00)	(0.25)	(0.10)	(0.00)	(0.38)	(0.16)	(0.91)	(0.00)	(0.31)	(0.77)			
(18) SeriesB	0.14*	0.10*	-0.03	0.03	-0.22*	0.00	0.15*	-0.09*	-0.07*	-0.12*	0.07	0.07*	0.04	0.00	0.06	0.09*	-0.04	1.00	
	(0.00)	(0.00)	(0.48)	(0.42)	(0.00)	(0.96)	(0.00)	(0.02)	(0.05)	(0.00)	(0.07)	(0.05)	(0.33)	(0.97)	(0.13)	(0.01)	(0.22)		
(19) SeriesC	0.13*	0.13*	-0.07	-0.03	-0.11*	-0.10*	0.19*	-0.04	0.02	-0.07*	0.02	0.02	0.01	-0.02	0.07	0.09*	0.08*	0.43*	1.00
	(0.00)	(0.00)	(0.07)	(0.49)	(0.00)	(0.00)	(0.00)	(0.30)	(0.55)	(0.05)	(0.60)	(0.58)	(0.86)	(0.56)	(0.06)	(0.02)	(0.04)	(0.00)	

Table 5

The impact of DPI and CRI on innovation outcomes

Table 5 reports OLS regression results of the impact of VC contract terms on innovation quantity and quality. The sample includes Series A financial contracts of 741 VC-backed US startups that eventually exited during the period of 2002-2016. In columns 1-3, the dependent variable is the logarithm of total patent count cumulated in the first 3 years, and in columns 4-6, the dependent variable is the logarithms of total citation count cumulated in the three years after the patent was granted. DPI and CRI are key independent variables that represent the strength of downside protection for VC investors and controls over startups. Industry and year-fixed effects are controlled.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	LogPatentCount	LogPatentCount	LogPatentCount	LogCitation	LogCitation	LogCitation
	DPI	CRI	DPI_CRI	DPI	CRI	DPI_CRI
DPI	-0.064*		-0.067**	-0.102**		-0.106**
	(0.033)		(0.033)	(0.049)		(0.050)
CRI		-0.029	-0.033		-0.057	-0.062
		(0.031)	(0.030)		(0.048)	(0.048)
TotalProvisions	0.036	0.013	0.046*	0.062	0.028	0.082*
	(0.026)	(0.023)	(0.027)	(0.039)	(0.034)	(0.042)
StartupAge	0.004	0.002	0.005	0.013	0.011	0.015
	(0.014)	(0.014)	(0.014)	(0.021)	(0.021)	(0.021)
IPODummy	0.423***	0.433***	0.420***	0.900***	0.916***	0.896***
	(0.104)	(0.104)	(0.104)	(0.189)	(0.189)	(0.188)
PreVal	0.003	0.002	0.002	0.004	0.004	0.004
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
SameState	0.110*	0.115*	0.114*	0.121	0.129	0.128
	(0.061)	(0.061)	(0.061)	(0.090)	(0.089)	(0.089)
SeriesADealSize	0.005	0.007	0.006	-0.004	-0.001	-0.003
	(0.004)	(0.004)	(0.005)	(0.007)	(0.007)	(0.007)
VCAge	0.001	0.001	0.001	0.000	0.001	0.000
	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)
VCAUM	0.000	0.000	0.000	0.000**	0.000*	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SyndicationSize	0.018	0.018	0.018	0.028	0.029	0.028
	(0.014)	(0.014)	(0.014)	(0.023)	(0.023)	(0.023)
Constant	0.248	0.263	0.202	-1.232***	-1.223***	-1.319***
	(0.918)	(0.876)	(0.898)	(0.434)	(0.402)	(0.423)
Observations	741	741	741	741	741	741
R-squared	0.165	0.162	0.167	0.157	0.155	0.160
Industry_FE	Yes	Yes	Yes	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors are reported in parentheses; *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 6

The impact of DPI and CRI on innovation outcomes in three years

Table 6 presents the OLS regression results examining how contract terms influence innovation outcomes over a three-year period. In Columns 1-3, we report the effects on innovation quantity, measured by the logarithm of patent counts in years 1, 2, and 3 respectively. Columns 4-6 display the effects on innovation quality, measured by the logarithm of citation counts in years 1, 2, and 3 after the patent was granted.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	LogPatentCount t1	LogPatentCount t2	LogPatentCount t3	LogCitation t1	LogCitation t2	LogCitation t3
DPI	-0.022	-0.057**	-0.021	-0.029	-0.067*	-0.063*
	(0.018)	(0.023)	(0.024)	(0.033)	(0.036)	(0.034)
CRI	-0.005	-0.010	-0.030	0.007	-0.040	-0.075**
	(0.016)	(0.020)	(0.022)	(0.032)	(0.034)	(0.035)
TotalProvisions	0.008	0.027	0.031	0.009	0.043	0.071**
	(0.016)	(0.018)	(0.019)	(0.030)	(0.029)	(0.029)
StartupAge	0.004	0.015	0.009	0.017	0.027*	0.015
	(0.008)	(0.010)	(0.009)	(0.015)	(0.015)	(0.015)
IPODummy	0.074	0.201***	0.280***	0.372***	0.518***	0.569***
	(0.058)	(0.075)	(0.083)	(0.133)	(0.144)	(0.149)
PreVal	0.002	0.001	0.003**	0.003	0.002	0.005**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
SameState	0.061*	0.073*	0.081*	0.076	0.099	0.087
	(0.032)	(0.041)	(0.045)	(0.063)	(0.062)	(0.065)
SeriesADealSize	0.002	0.002	0.004	0.000	-0.006	-0.005
	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.005)
VCAge	-0.001	0.001	-0.001	0.000	0.001	-0.002
	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)
VCAUM	0.000	0.000	-0.000	0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SyndicationSize	0.006	0.008	0.024**	0.018	0.015	0.019
	(0.007)	(0.010)	(0.011)	(0.016)	(0.015)	(0.018)
SeriesB	0.003	0.109***	0.074*	-0.048	0.115*	0.034
	(0.034)	(0.040)	(0.044)	(0.063)	(0.059)	(0.061)
SeriesC	0.080	0.104	0.076	0.142	0.167	0.219**
	(0.053)	(0.070)	(0.076)	(0.098)	(0.113)	(0.109)
Constant	0.014	0.215	0.154	-0.655**	-0.879***	-0.982***
	(0.370)	(0.611)	(0.552)	(0.262)	(0.283)	(0.270)
Observations	741	741	741	741	741	741
R-squared	0.092	0.134	0.182	0.096	0.126	0.182
Industry_FE	Yes	Yes	Yes	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors are reported in parentheses; *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 7a
The effect of individual contract terms on patent count

The table presents OLS regression results examining the impact of individual contract terms on patent count. This analysis aims to determine how VC contract terms influence innovation and identify whether these terms have positive or negative effects on innovation outcomes. Patent counts are using log(1+patent count) to properly include startups with zero patents in the analysis. Column 1 incorporates all control variables and fixed effects into the model. Columns 2, 3, and 4 examine the patent counts separately for each of the first three years following the Series A financing. Robust standard errors are reported in parentheses; *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	(1) LogCitation Industry & Year FE	(2) LogCitation t1	(3) LogCitation t2	(4) LogCitation t3
DividendRate	0.039	-0.038	-0.204	0.160
	(0.507)	(0.284)	(0.184)	(0.388)
DividendCumulative	0.099	-0.021	0.046	0.061
	(0.090)	(0.046)	(0.063)	(0.065)
Liquidation	-0.046	-0.101**	0.050	-0.072
	(0.113)	(0.045)	(0.084)	(0.082)
Participation	-0.039	-0.012	-0.039**	-0.009
	(0.028)	(0.014)	(0.018)	(0.021)
Redemption	-0.063	0.009	-0.089*	-0.037
	(0.074)	(0.039)	(0.048)	(0.053)
Fullratchet	-0.246*	-0.165**	-0.242***	-0.063
	(0.134)	(0.073)	(0.083)	(0.116)
PaytoPlay	0.006	-0.077	0.026	0.051
	(0.128)	(0.063)	(0.086)	(0.096)
IndependentDirector	0.104	-0.012	0.067	0.065
	(0.157)	(0.061)	(0.100)	(0.113)
VCPower	-0.108	-0.051	0.022	-0.100
	(0.117)	(0.071)	(0.075)	(0.083)
VetoRightsCount	-0.000	-0.000	-0.002	0.003
	(0.009)	(0.005)	(0.006)	(0.007)
TotalProvisions	0.025	0.014	0.018	0.015
	(0.037)	(0.020)	(0.022)	(0.028)
StartupAge	0.006	0.002	0.011	0.005
	(0.015)	(0.008)	(0.010)	(0.010)
PreVal	0.003	0.002	0.001	0.003**
	(0.002)	(0.001)	(0.001)	(0.002)
SameState	0.133**	0.065**	0.081*	0.094**
	(0.062)	(0.032)	(0.042)	(0.046)
SeriesADealSize	0.010**	0.004	0.004	0.006**
	(0.004)	(0.003)	(0.003)	(0.003)
VCAge	0.000	-0.001	0.001	-0.001
	(0.002)	(0.001)	(0.002)	(0.001)
VCAUM	0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
SyndicationSize	0.022	0.006	0.009	0.028**
	(0.016)	(0.008)	(0.010)	(0.012)
SeriesB	0.159**	0.003	0.116***	0.085*
	(0.062)	(0.034)	(0.040)	(0.045)
SeriesC	0.218**	0.105**	0.153**	0.134*
	(0.102)	(0.052)	(0.072)	(0.075)
Constant	0.118	0.019	0.124	0.260
	(0.821)	(0.359)	(0.623)	(0.551)
Observations	741	741	741	741
R-squared	0.159	0.092	0.122	0.159
Industry_FE	Yes	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes	Yes

Table 7b
The effect of individual contract terms on citation count
The table presents OLS regression results examining the impact of contract terms on citation count. The citation count is log-transformed to include startups with zero patent citations, thereby capturing the effect of contract terms on innovation output. Column 1 incorporates all control variables and fixed effects into the model. Columns 2, 3, and 4 examine the citations in individual years. Robust standard errors are reported in parentheses; *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	(1) LogCitation Industry & Year FE	(2) LogCitation t1	(3) LogCitation t2	(4) LogCitation t3
DividendRate	0.968	0.947	-0.100	0.906
	(1.021)	(1.046)	(0.377)	(0.666)
DividendCumulative	0.379***	0.092	0.119	0.276**
	(0.146)	(0.092)	(0.093)	(0.113)
Liquidation	0.260	-0.006	0.270	0.029
	(0.200)	(0.099)	(0.187)	(0.114)
Participation	-0.062	-0.008	-0.053*	-0.045
	(0.043)	(0.030)	(0.031)	(0.029)
Redemption	-0.120	-0.053	-0.158**	-0.054
	(0.118)	(0.084)	(0.069)	(0.089)
Fullratchet	-0.493**	-0.206	-0.393***	-0.331**
	(0.218)	(0.177)	(0.104)	(0.141)
PaytoPlay	0.125	-0.067	0.150	0.140
	(0.193)	(0.117)	(0.135)	(0.150)
IndependentDirector	-0.013	0.048	0.031	-0.063
	(0.209)	(0.154)	(0.159)	(0.122)
VCPower	-0.076	0.009	-0.056	-0.131
	(0.180)	(0.124)	(0.121)	(0.134)
VetoRightsCount	-0.007	0.000	0.000	-0.004
	(0.013)	(0.009)	(0.008)	(0.009)
TotalProvisions	0.005	-0.003	0.026	0.011
	(0.059)	(0.042)	(0.033)	(0.044)
StartupAge	0.005	0.011	0.021	0.005
	(0.022)	(0.015)	(0.015)	(0.016)
PreVal	0.004	0.003	0.002	0.005**
	(0.003)	(0.002)	(0.002)	(0.002)
SameState	0.192**	0.092	0.126**	0.127*
	(0.092)	(0.063)	(0.063)	(0.069)
SeriesADealSize	0.005	0.005	-0.002	-0.001
	(0.006)	(0.004)	(0.004)	(0.004)
VCAge	0.001	0.000	0.001	-0.002
	(0.004)	(0.002)	(0.003)	(0.002)
VCAUM	0.000	0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
SyndicationSize	0.049**	0.028	0.030*	0.034*
	(0.025)	(0.017)	(0.018)	(0.019)
SeriesB	0.127	-0.031	0.141**	0.063
	(0.093)	(0.065)	(0.059)	(0.063)
SeriesC	0.411***	0.223**	0.269**	0.337***
	(0.154)	(0.102)	(0.123)	(0.115)
Constant	-1.527***	-0.731**	-1.231***	-0.825**
	(0.582)	(0.354)	(0.424)	(0.397)
Observations	741	741	741	741
R-squared	0.133	0.083	0.099	0.151
Industry_FE	Yes	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes	Yes

Table 8

The impact of DPI and CRI on innovation outcomes with different syndication sizes

When multiple VC investors form a syndicate to co-invest in a startup, they combine their diverse skills, industry expertise, information, and networks. This collective capability allows them to provide a broader range of strategic and operational support to startups. Therefore, we anticipate that the size of the VC syndicate will influence both the syndicate's governance capabilities and their preferences regarding downside protection. We use moderator variables *SyndicationSize_DPI* and *SyndicationSize_CRI* to test their effects on innovation outcomes. Robust standard errors are reported in parentheses; *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
	LogPatentCount_Syndi_DPI	LogPatentCount_Syndi_CRI	LogCitation_Syndi_DPI	LogCitation_Syndi_CRI
VARIABLES	LogPatentCount	LogPatentCount	LogCitation	LogCitation
DPI	-0.140***	-0.066**	-0.173**	-0.104**
	(0.045)	(0.033)	(0.069)	(0.050)
CRI	-0.038	-0.077	-0.067	-0.054
	(0.030)	(0.052)	(0.047)	(0.085)
SyndicationSize_DPI	0.027**		0.025	
	(0.013)		(0.020)	
SyndicationSize_CRI		0.015		-0.003
		(0.016)		(0.027)
TotalProvisions	0.045*	0.045	0.082**	0.082**
	(0.027)	(0.027)	(0.041)	(0.041)
StartupAge	0.004	0.005	0.013	0.014
	(0.014)	(0.014)	(0.021)	(0.021)
IPODummy	0.426***	0.425***	0.892***	0.891***
	(0.104)	(0.105)	(0.187)	(0.187)
PreVal	0.002	0.002	0.004	0.004
	(0.002)	(0.002)	(0.003)	(0.003)
SameState	0.116*	0.117*	0.131	0.130
	(0.061)	(0.060)	(0.089)	(0.089)
SeriesADealSize	0.005	0.006	-0.003	-0.003
	(0.005)	(0.005)	(0.007)	(0.007)
VCAge	0.001	0.001	0.000	0.000
	(0.002)	(0.002)	(0.003)	(0.003)
VCAUM	0.000	0.000	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
SyndicationSize	-0.050	-0.007	-0.023	0.042
	(0.033)	(0.028)	(0.053)	(0.049)
Constant	0.409	0.284	-1.193***	-1.378***
	(0.884)	(0.908)	(0.440)	(0.443)
Observations	741	741	741	741
R-squared	0.171	0.167	0.163	0.161
Industry_FE	Yes	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes	Yes

Table 9
Propensity score matching for startups exits with IPO

To address endogeneity concerns, we employ kernel propensity score matching (PSM) to create comparable treatment and control groups while maximizing observations from our small sample. Our PSM model includes firm characteristics, such as Startup Age, Pre-val, Same State, Series A Deal Size and industry and year fixed effects to ensure comparability. In Table 9, columns 1 and 2 present results confirming downside protection negatively impacts innovation output, with nearest-neighbour matching (1:3) in columns 3 and 4 as a robustness check.

	(1)	(2)	(3)	(4)
VARIABLES	LogPatent_PSM	LogCitation_PSM	LogPatent_PSM_robust	LogCitation_PSM_robust
DPI	-0.069*	-0.141**	-0.072*	-0.122**
	(0.037)	(0.057)	(0.040)	(0.062)
CRI	-0.026	-0.071	-0.022	-0.061
	(0.036)	(0.062)	(0.040)	(0.066)
TotalProvisions	0.045	0.096*	0.058*	0.084
	(0.033)	(0.052)	(0.033)	(0.054)
StartupAge	0.006	0.019	0.007	0.028
	(0.017)	(0.030)	(0.019)	(0.032)
PreVal	0.002	0.000	0.001	-0.004
	(0.002)	(0.003)	(0.003)	(0.003)
SameState	0.099	0.125	0.105	0.197
	(0.069)	(0.113)	(0.076)	(0.130)
SeriesADealSize	0.013***	0.005	0.009**	0.008
	(0.005)	(0.008)	(0.005)	(0.008)
VCAge	0.003	0.001	0.005*	0.007
	(0.002)	(0.003)	(0.003)	(0.006)
VCAUM	0.000	0.000**	0.000	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
SyndicationSize	0.034*	0.070**	0.050**	0.064*
	(0.019)	(0.032)	(0.024)	(0.036)
Constant	-1.216***	-1.405**	-1.274**	-1.449**
	(0.439)	(0.611)	(0.531)	(0.687)
Observations	733	733	435	435
R-squared	0.190	0.145	0.226	0.170
Industry_FE	Yes	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes	Yes

Robust standard errors are reported in parentheses; *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 10

External shock: The Great Financial Crisis (GFC) and Rules 144 and 145 under the Securities Act of 1933

The Great Financial Crisis created a natural experiment in VC-startup contracting dynamics, with VCs increasingly emphasizing control rights as M&A became the primary exit option when IPOs were limited. VCs sought stronger governance to secure acquisitions despite founder resistance, as entrepreneurs typically oppose trade sales that end their leadership positions. Simultaneously, the February 2008 revisions to Securities Act Rules 144/145 reduced restrictions on the resale of securities, stimulating the M&A market and further incentivizing VCs to secure enhanced control rights during negotiations. , we use a [−5, 5] years window around the February 2008 regulatory change. We define [2003, 2007] in columns 1 and 2 as the pre-period and [2008, 2012] in columns 3 and 4 as the post-period to test the effects of DPI and CRI on innovation outcomes.

VARIABLES	(1) LogPatentCount 2003-2007	(2) LogCitation 2003-2007	(3) LogPatentCount 2008-2012	(4) LogCitation 2008-2012
DPI	-0.101**	-0.139**	0.008	-0.070
	(0.040)	(0.062)	(0.070)	(0.109)
CRI	-0.022	-0.063	-0.121**	-0.184**
	(0.040)	(0.064)	(0.056)	(0.086)
TotalProvisions	0.031	0.033	0.077	0.175**
	(0.035)	(0.053)	(0.054)	(0.078)
StartupAge	0.007	0.023	-0.020	-0.016
	(0.016)	(0.026)	(0.020)	(0.033)
IPODummy	0.432***	0.830***	0.388*	0.758*
	(0.123)	(0.210)	(0.203)	(0.396)
PreVal	0.002	0.003	-0.001	-0.003**
	(0.002)	(0.003)	(0.001)	(0.001)
SameState	0.174**	0.193*	0.018	0.059
	(0.078)	(0.117)	(0.107)	(0.173)
SeriesADealSize	0.002	-0.009	0.019**	0.029**
	(0.005)	(0.008)	(0.008)	(0.013)
VCAge	0.001	0.004	0.001	-0.004
	(0.002)	(0.004)	(0.004)	(0.006)
VCAUM	0.000	0.000*	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
SyndicationSize	0.028	0.061	0.044**	0.045
	(0.026)	(0.047)	(0.020)	(0.041)
Constant	-0.215	-0.408	-0.326	-0.941**
	(0.397)	(0.536)	(0.331)	(0.474)
Observations	399	399	261	261
R-squared	0.175	0.164	0.259	0.244
Industry_FE	Yes	Yes	Yes	Yes
Year_FE	Yes	Yes	Yes	Yes

Robust standard errors are reported in parentheses; *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 11

Negative Binominal Regression

To further validate the robustness of our empirical findings, we adopt an alternative estimation method by re-estimating our model using Negative Binominal regression, which is well-suited for counting data such as patent counts. The Poisson regression model designed for count-based outcomes provides more efficient estimates and offers more natural interpretations without requiring special assumptions to mitigate inherent biases.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	LogPatentCount	LogPatentCount	LogPatentCount	LogCitation	LogCitation	LogCitation
	DPI	CRI	DPI_CRI	DPI	CRI	DPI_CRI
DPI	-0.329***		-0.324***	-0.438**		-0.423**
	(0.109)		(0.107)	(0.194)		(0.194)
CRI		0.079	0.054		-0.126	-0.105
		(0.093)	(0.089)		(0.141)	(0.142)
TotalProvisions	0.130	-0.070	0.110	0.143	-0.086	0.167
	(0.085)	(0.079)	(0.089)	(0.172)	(0.138)	(0.171)
StartupAge	-0.018	-0.040	-0.018	-0.038	-0.033	-0.043
	(0.041)	(0.042)	(0.041)	(0.059)	(0.061)	(0.058)
IPODummy	0.697***	0.786***	0.722***	1.399***	1.408***	1.320***
	(0.200)	(0.204)	(0.202)	(0.328)	(0.328)	(0.329)
PreVal	0.009*	0.010*	0.009*	0.015**	0.012	0.014*
	(0.005)	(0.005)	(0.005)	(0.008)	(0.009)	(0.008)
SameState	0.232	0.226	0.214	0.502	0.581*	0.544*
	(0.194)	(0.195)	(0.192)	(0.316)	(0.307)	(0.318)
SeriesADealSize	0.018*	0.022*	0.017	-0.000	0.017	0.003
	(0.011)	(0.011)	(0.011)	(0.016)	(0.017)	(0.017)
VCAge	0.010*	0.010	0.010	-0.003	0.000	-0.003
	(0.006)	(0.006)	(0.006)	(0.010)	(0.010)	(0.010)
VCAUM	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SyndicationSize	0.022	0.013	0.018	0.059	0.062	0.074
	(0.039)	(0.039)	(0.039)	(0.059)	(0.059)	(0.060)
lnalpha	1.442***	1.468***	1.441***	2.725***	2.742***	2.723***
	(0.102)	(0.101)	(0.102)	(0.091)	(0.091)	(0.091)
Constant	-0.025	0.650	0.182	-1.040	-0.254	-1.131
	(1.202)	(1.264)	(1.240)	(1.650)	(1.589)	(1.659)
Observations	732	732	732	732	732	732
Industry_FE	Yes	Yes	Yes	No	No	No
Year_FE	Yes	Yes	Yes	No	No	No

Robust standard errors are reported in parentheses; *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

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