Revisiting the Zero-Leverage Puzzle: the Perspectives of R&D, Market Competition and Equity Financing



Suyang Li

A thesis submitted to the University of Nottingham for the Degree of Doctor of Philosophy

Finance, Risk and Banking Department

Nottingham University Business School

University of Nottingham

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ABSTRACT

This thesis investigates a puzzling finding in capital structure literature. A large proportion of firms absolutely eschew debt financing, leaving a substantial fraction of their value on the table by not taking the tax benefit. This phenomenon is becoming increasingly prevalent around the world.

This thesis consists of three studies. Motivated by the literature on innovation, the first study investigates the effect of R&D on zero-leverage behaviour and shows that zero-leverage firms are concentrated in R&D firms. The difference-in-differences analysis using the implementation of state R&D tax credit also confirms the causal effect of R&D on the zero-leverage decision. The results suggest that the unique characteristics of R&D investment impede access to debt financing, resulting in a high probability of being zero-levered. Further analysis suggests that the strengthening sensitivity of the zero-leverage decision to R&D investments has more explanatory power than the rising trend of R&D investments on the trend of the zero-leverage puzzle.

The second study complements the first by linking product market competition to the zero-leverage puzzle. The results show that high market competition increases the probability of being unlevered. The difference-in-differences analysis using large tariff reduction also confirms the causal effect of market competition on zero-levered behaviour. Further evidence shows that market competition influences the zero-leverage decision through R&D investments. The results imply that high market competition increases firms' innovation incentive to achieve competitiveness, resulting in the high likelihood of becoming unlevered.

The final study investigates the equity financing of zero-leverage firms. Motivated by the conflicted prediction of the pecking order theory on zero-leverage firms' financing choices, the third study tests whether market timing theory can explain the zero-leverage puzzle. Consistent with the theory, favourable market timing conditions increase the probability of being zero-levered. The difference-in-differences analysis using the technology bubble also confirms the causal effect of market timing conditions on the zero-leverage decision. Further analysis suggests that firms in favourable market timing conditions eschew debt financing because low information asymmetry reduces the cost of equity. The third study also shows that the motive of zero-leverage firms' equity issuance is cash saving rather than the pressure of short-term cash needs. Overall, this thesis provides new insights into the zero-leverage phenomenon from the perspectives of innovation, market competition, and equity financing.

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Chapter 1. Introduction to the thesis

A capital structure decision is one of the central decisions in corporate financial policy; it has important implications for corporate profitability, growth opportunities, and financial risk. Optimal capital structure theory suggests that debt financing is less expensive than equity financing since the interest expense associated with debt is tax-deductible, but too much debt burden increases financial risk, leading to a high probability of financial distress. Therefore, the traditional capital structure theories suggest that firms should follow the trade-off between the tax benefits of debt and the costs of financial distress to maximize firm value.

However, an increasing number of studies have found empirical evidence that more and more firms hold zero debt in their capital structure, and such a phenomenon has been found in the US, the UK, and worldwide. Strebulaev and Yang (2013) first report the evidence that more than 10% of large public firms do not use debt financing and 20% of them have almost zero debt in the US, and these firms tend to maintain zero-leverage decisions persistently. Dang (2013) finds that the percentage of zero-leverage firms increased from 6% in the 1980s to 12.18% in the 2000s in the UK. Bessler et al. (2013) investigate the increasing trend in 20 developed countries and find that the percentage of zero-leverage firms increased from 8.5% in 1988 to 25.7% in 2011, suggesting that the rising trend of zero-leverage firms is a worldwide phenomenon.

Zero-leverage policies can cause firms to lose tax benefits on debt and affect firms' value. Graham (2000) finds that, on average, firms could have gained at least 5% firm value by levering up to the optimal level. Strebulaev and Yang

(2013) show that the potential forgone tax benefits amount to more than 7% of the market value of equity if zero-leverage firms raise leverage to the level of their counterparts, and more than 15% of the market value of equity if zero-leverage firms raise leverage to the optimal level. As the traditional finance theory implies that rational managers aim to maximize firm value and shareholder wealth, the zero-leverage policy violates the traditional capital structure theories because holding zero debt could reduce firms' value due to giving up tax advantage on debt financing. From the viewpoint of economic Darwinism, Darwinian selection governs the evolution and survival of corporate financial policies (Porter, 1990; Kole and Lehn, 1997; Graham and Harvey, 2001; Lensberg and Schenk-Hoppé, 2007; Deangelo, 2021). If zero-leverage behaviour hinders the goal of maximizing firm value and shareholder wealth, we should observe a downward, rather than an upward, trend for unlevered firms. Strebulaev and Yang (2013) refer to the phenomenon of holding zero debt as the zero-leverage puzzle.

The puzzle has subsequently attracted a great deal of attention from researchers, and a growing body of literature studies the reasons behind zero-leverage behaviour. Given that traditional capital structure theories fail to explain the zero-leverage puzzle, previous students highlight the financial constraint and financial flexibility theories in explaining the puzzle. For instance, Strebulaev and Yang (2013) find that a proportion of zero-leverage firms are less likely to be dividend payers, which supports the financial constraint explanation that they are forced to adopt zero-leverage decisions. Another proportion of firms tends to pay high dividends, which supports the financial flexibility explanation that they deliberately reserve borrowing capacity to avoid debt overhang. Similarly, Devos et al. (2012), Bessler et al. (2013), and Deangelo et al. (2018) find that financially constrained firms tend to follow a zero-leverage policy and

deleverage to enhance their financial flexibility. Lambrecht and Pawlina (2013) theoretically show that zero-leverage firms are concentrated in human capital-intensive industries because human capital is non-tradeable and increases firms' collateral constraints. Ghoul et al. (2017) suggest that the international zero-leverage phenomenon is concentrated in countries with high conservatism. Lotfaliei (2018) discovers that firms choose zero leverage to seek future debt benefits and hedge against bankruptcy risk. Kahl *et al.* (2019) argue that high fixed costs raise financial constraints, leading to a high probability of being zero-levered. Boustanifar and Verriest (2022) find that labour adjustment costs positively affect zero-leverage behaviour due to the demand for financial flexibility. Overall, previous studies suggest that financial constraint and financial flexibility theories are the most prevalent theories to explain the zero-leverage puzzle.

1.1. Motivations

The thesis explores the role of R&D, market competition and equity financing in shaping zero-leverage behaviour, and how these factors contribute to this puzzling trend. The whole thesis is motivated by the two findings on capital structure choices (i.e., the prevalence of zero-leverage firms and the trend of zero-leverage behaviour). The zero-leverage puzzle documented by previous studies casts doubt on traditional theories by forgoing the tax benefits of debt financing. Therefore, exploring the reasons behind the puzzle can deepen the understanding of firms' capital structure policy.

Chapter 4 is motivated by the literature on the characteristics of R&D investments and financing choices. R&D has long been recognized as a critical driver for long-term economic growth (e.g., Romer, 1990; Grossman and

Helpman, 1991; Aghion and Howitt, 1992), and firms can achieve a variety of benefits from innovation, including obtaining market shares (Ciftci and Darrough, 2016), improving productivity (Mansury and Love, 2008), firm value (Peters *et al.*, 2017) and resisting competitive pressures (Hombert and Matray, 2018). However, the unique characteristics of R&D investments raise the investment risk, which intensifies financial constants and impedes firms' ability to borrow. For instance, R&D investments are difficult to convert into profitable products due to the high output uncertainty (Himmelberg and Petersen, 1994; Carpenter and Petersen, 2002; Hall, 2002). The low salvage value and high adjustment costs of R&D investments increase the cost of withdrawing inputs (Mansfield, 1977; Harhoff et al., 1999). Although numerous studies highlight the risk embedded in R&D investments, the impact of R&D on zero-leverage behaviour is largely neglected in the literature. The motivation of the first study is to fill the literature gap by investigating the impact of R&D investments on zero-leverage behaviour.

A series of literature documents that R&D competition has become increasingly intense (Bates *et al.*, 2009; Brown *et al.*, 2009; He and Wintoki, 2016; Falato *et al.*, 2020). For instance, Brown et al. (2009) demonstrate that the investors' R&D preference induces firms to overinvest in R&D investment to cater to investors' appetite in the 1990s. If R&D decisions play a significant role in forming zero-leverage behaviour, the rising trend of R&D investments could explain why an increasing proportion of firms favour zero-leverage policies. Therefore, motivated by the literature on the rising trend of R&D investments, Chapter 4 aims to fill the literature gap on the trend of zero-leverage behaviour from the perspective of R&D investments.

Chapter 5 is motivated by the literature on market competition and its impact on debt financing and innovation. A stand of literature highlights that market competition increases the demand for financial flexibility (Haushalter *et al.*, 2007; Della Seta, 2011; Hoberg *et al.*, 2014; Morellec *et al.*, 2014) and hinders firms' ability to raise funds through debt financing (Valta, 2012; Xu, 2012; Boubaker *et al.*, 2018). However, whether market competition plays a role in zero-leverage decisions is ambiguous and overlooked in the literature. Another string of literature on industrial organizations and finance emphasizes the role of product market competition in innovation (Aghion and Howitt, 1996; Blundell *et al.*, 1999; Aghion *et al.*, 2001). If R&D decisions play a significant role in forming zero-leverage behaviour, market competition could explain why firms invest in R&D and maintain unlevered. Inspired by the literature gap between market competition and zero-leverage decisions, the second study extends the first study's finding by focusing on the role of product market competition in the zero-leverage decision.

Chapter 6 is motivated by literature on market timing theory and motives of equity issuance. Previous studies focus on zero-leverage firms' debt initiation decisions (Devos *et al.*, 2012; Strebulaev and Yang, 2013), but the role of equity financing in zero-leverage decisions is neglected in the literature. A series of studies documents that firms are incentivized to time the market by issuing equity, and the hierarchy between debt financing and equity financing can be reversed if the cost of equity is low enough (Baker and Wurgler, 2002; Dittmar and Thakor, 2007; Deangelo *et al.*, 2010). Since zero-leverage firms are more likely to be subject to financial constraints, market timing conditions could explain the zero-leverage puzzle because financially constrained firms tend to actively exploit equity market timing opportunities (Korajczyk and Levy, 2003; Covas and Den Haan, 2011; Chang *et al.*, 2019). In addition, if R&D decisions play a significant

role in forming zero-leverage behaviour, market timing behaviour could explain the zero-leverage puzzle because high R&D firms have the advantage of accessing the equity market due to the investors' R&D preference (Polk and Sapienza, 2009; Grundy and Li, 2010; Lewis and Tan, 2016). Motivated by the literature, the third study aims to fill the literature gap by exploring the role of equity issuance in zero-leverage decisions.

Chapter 6 further explores zero-leverage firms' motives for equity issuance. It is still unclear why zero-leverage firms use equity financing; even if equity financing is less costly during favourable market timing conditions, the abundant cash reserves allow them to rely less on external financing. Prior studies document that firms issue equity to stockpile cash (Deangelo *et al.*, 2010; Huang and Ritter, 2020; Denis and Mckeon, 2021), and equity issuance has been the primary source for cash holdings since the 1980s (Mclean, 2011). In addition, high cash reserves allow firms to meet future unexpected cash needs without raising costly external funds, and such benefits are especially valuable for financially constrained firms (Opler *et al.*, 1999; Han and Qiu, 2007; Harford *et al.*, 2014). However, in the literature on the zero-leverage puzzle, zero-leverage firms' source of cash holding remains ambiguous. Motivated by the literature, the last study aims to complement the literature on zero-leverage firms' source of cash policy.

1.2. Research questions

The first research question aims to answer whether high R&D can explain zero-leverage decisions and whether the rising R&D investments can explain the trend of the zero-leverage puzzle. Given that the unique characteristics of R&D investments intensify financial constants and impede firms' ability to borrow, I

expect that high R&D investment increases the probability of being zero-leverage, and the rising trend of R&D investments drives the increasing proportion of zero-leverage firms.

The second study aims to answer the following three questions. Does high product market competition increase the likelihood of being unlevered? Does the increasingly intensified competition explain the trend of the zero-leverage puzzle? Does market competition affect zero-leverage behaviour through R&D investments? I expect that market competition has a positive impact on the probability of firms becoming unlevered as competition raises the innovation incentive.

The third study focuses on three research questions. Does high equity financing increase the likelihood of being zero-leverage firms? If so, can market timing theory explain this impact? What motives zero-leverage firms to issue equity? Based on the explanations of financial constraint and financial flexibility, I expect that high equity financing has a positive impact on zero-leverage behaviour, and this relationship can be explained by market timing theory. Through actively exploiting market timing opportunities, zero-leverage firms cumulate cash reserves.

1.3. Main Findings

The first study documents that zero-leverage firms are concentrated in R&D firms. R&D investment positively affects the probability of a firm being unlevered, and the impact has been strengthened over time. Using the implementation of state R&D tax credit as the exogenous shock of R&D, I find that firms that operate in states with the R&D tax credit have a higher probability

of being unlevered than firms that operate in states without the policy. Therefore, the results suggest that R&D investment plays a non-trivial role in zero-leverage decisions. In addition, I decompose the trend of zero-leverage behaviour into the change in sensitivities and change in characteristics, implying that the intense R&D race has led companies to become increasingly conservative in their debt policies.

The second study further explores the drivers behind the intense innovation race and finds that zero-leverage firms are concentrated in firms with high market competition. Product market competition has a significant and positive effect on the probability of adopting the zero-leverage policy. Difference-in-differences (DID) analysis with the import tariff reduction further confirms the causal effect of market competition on the zero-leverage policy. In addition, the impact of competition on zero-leverage behaviour has strengthened over time and only exists for R&D firms. The results complement the findings in the first study by showing that the intensified competition spurs firms' innovation incentives, leading to the prevalence of unlevered decisions.

The third study further investigates the suboptimal financing choice of R&D investment and finds that zero-leverage firms rely heavily on external financing. This finding complements the first study by showing how zero-leverage firms fund R&D investment. The second main finding is that zero-leverage firms' equity issuance can be explained by market timing theory. They tend to issue equity since favourable market timing conditions reduce information asymmetry. Finally, the third study documents that zero-leverage firms' equity issuance motive is to save cash rather than the pressure of immediate cash needs. The results support the explanation of the precautionary motive that they demand high financial flexibility to fund and smooth R&D investment. Overall, the three

studies find the non-trivial role of R&D, product market competition and equity financing in shaping zero-leverage behaviour.

1.4. Contributions and implications

The whole thesis provides new insights into the zero-leverage phenomenon from the perspectives of innovation, product market competition, and equity financing. Firstly, the thesis contributes to the literature on the determinants of zero-leverage behaviour (Graham, 2000; Devos *et al.*, 2012; Strebulaev and Yang, 2013). Previous studies highlight the role of dividend payout (Strebulaev and Yang, 2013), creditor protection (Bessler *et al.*, 2013), financial friction (Dang, 2013; D'mello and Gruskin, 2014), culture (Ghoul *et al.*, 2017), agency costs (Devos *et al.*, 2012) and fixed costs (Lambrecht and Pawlina, 2013; Boustanifar and Verriest, 2022) in explaining zero-leverage puzzle. This thesis fills the literature gap from the perspective of investment decisions and competitive environments by documenting the non-trivial effects of R&D investments, product market competition and equity issuance on zero-leverage behaviour.

Secondly, this thesis complements the literature related to the trend of zero-leverage behaviour (Bessler *et al.*, 2013; Dang, 2013; D'mello and Gruskin, 2014) and provides a novel explanation for the evolving capital structure choice. Prior studies propose the viewpoint of economic Darwinism that the evolution and survival of corporate decisions reflect the change in the external environment and are subject to Darwinian selection (Porter, 1990; Kole and Lehn, 1997; Graham and Harvey, 2001; Lensberg and Schenk-Hoppé, 2007; Deangelo, 2021). The trend analysis of the zero-leverage puzzle provides supportive evidence for this viewpoint that the intense innovation race and product market competition are responsible for the prevalence of the zero-leverage phenomenon.

Thirdly, the thesis contributes to the literature related to innovation (Himmelberg and Petersen, 1994; Hall, 2002; Brown *et al.*, 2009) and product market competition (Mackay and Phillips, 2005; Valta, 2012; Xu, 2012). Previous studies highlight the importance and benefit of innovation, including obtaining market shares (Ciftci and Darrough, 2016), improving productivity (Mansury and Love, 2008) and firm value (Peters *et al.*, 2017), and resisting competitive pressures (Hombert and Matray, 2018). Another stand of literature highlights that market competition serves as an alternative mechanism of corporate governance (Hermalin, 1992; Nickell, 1996; Giroud and Mueller, 2010). This thesis highlights the dark side of aggressive innovation and product market competition that firms have to forgo a great proportion of firm value due to extremely conservative financial decisions.

Finally, this thesis contributes to the literature on equity issuance and cash saving (Deangelo *et al.*, 2010; Huang and Ritter, 2020; Denis and Mckeon, 2021). Literature related to the motive of equity issuance documents that a significant proportion of firms issue equity for stockpiling cash (Deangelo *et al.*, 2010; Mclean, 2011; Bolton *et al.*, 2013; Huang and Ritter, 2020). This thesis links these branches of literature with the zero-leverage puzzle by providing evidence that zero-leverage firms issue equity to stockpile cash rather than mitigate immediate cash needs. In addition, this thesis also complements the literature on the value of cash holding to financially constrained firms (Opler *et al.*, 1999; Han and Qiu, 2007; Harford *et al.*, 2014).

As for the theoretical contributions, the thesis mainly contributes to financial constraint, financial flexibility, and market timing theories. Firstly, previous studies document that severe financial constraint raises firms' precautionary

motives and demand for financial flexibility (Almeida *et al.*, 2004; Denis and Sibilkov, 2010; Hadlock and Pierce, 2010). This thesis provides evidence that supports the theories by linking the zero-leverage puzzle with risky investments and market structure. I show that the intense innovation race and product market competition worsen financial constraints and raise firms' demand for financial flexibility, which impedes firms from accessing the debt market and enjoying tax benefits.

Secondly, the thesis contributes to market timing theory by linking conservative debt financing decisions. Literature has provided an abundance of theoretical and empirical evidence for the impact of market timing opportunities on firms' equity financing decisions (Jung *et al.*, 1996; Baker and Wurgler, 2002; Deangelo *et al.*, 2010). This thesis extends the literature by highlighting the outcome of equity market timing from the perspective of debt financing. I provide evidence for the causal effect of market timing conditions on zero-leverage behaviour, which suggests that actively exploring equity time market opportunities could weaken the function of the debt market.

Finally, the thesis contributes to the financial constraint theory by linking it with the market timing theory. Previous studies document that financially constrained firms exploit equity market timing opportunities and financially unconstrained firms exploit debt market timing opportunities (Korajczyk and Levy, 2003; Covas and Den Haan, 2011; Chang *et al.*, 2019). This thesis provides supportive evidence that debt-financing-constrained firms are more likely to explore equity market timing opportunities.

The implications of the thesis are straightforward. Although R&D investments are recognised as a key solution to resist market competition and maintain long-

term growth (Bernard *et al.*, 2006a; Bloom *et al.*, 2016; Hombert and Matray, 2018), managers should consider the forgone benefit of debt financing when deciding to enter the innovation race. Since promoting innovation is one of the 17 goals for countries' sustainable development (Desa, 2016), it is crucial and necessary to facilitate innovation through policies. However, policymakers should consider this side effect of policies designed to promote innovation. In fact, the enactment of the R&D tax credit has revealed this implication, as the likelihood of being unlevered is significantly high for firms that experience the tax credit policy.

Another implication for policymakers is that this thesis highlights the drawback of promoting innovation through competition policy. For instance, prior studies provide evidence of using anti-trust policy to spur innovation (Audretsch *et al.*, 2001; Encaoua and Hollander, 2002; Norbäck and Persson, 2012). This thesis implies that excessive competition may weaken the function of debt markets.

For investors, it is well documented that market timing issuance benefits existing shareholders at the expense of new shareholders (Baker and Wurgler, 2002; Elliott *et al.*, 2008; Sloan and You, 2015), and passive investors gain more than active investors from firms that consequently issue equity to time the market. The findings in the thesis imply that this may not always be the case if firms subsequently adopt conservative debt financing; passive investors should take into account the costs of the suboptimal financial policy.

The rest of the thesis is structured as follows. Chapter 2 presents the literature review and hypothesis development for the three studies. Chapter 3 presents the details of the data and methodology. Chapters 4, 5 and 6 present empirical results

for the three studies, respectively. Chapter 7 presents the conclusion of the whole thesis, including the main findings, contributions, limitations, and future works.

Chapter 2. Literature review and hypothesis development

Section 2.1 reviews the capital structure theories and their explanatory power on the zero-leverage puzzle. Section 2.2 presents the literature on R&D, including the characteristics of R&D and financing choices for R&D, and presents hypothesis development related to R&D and zero-leverage behaviour. In Section 2.3, I discuss the literature review on the effect of product market competition on debt financing and the incentive of innovation, and hypothesis development related to product market competition and zero-leverage behaviour. Section 2.4 includes a discussion of the literature on the market timing theory, the incentive of equity issuance decisions and related hypotheses.

2.1. The theoretical background of the zero-leverage puzzle

The traditional capital structure theory dates back to Modigliani and Miller (1958) capital structure irrelevance theory. The optimal capital structure theory suggests that firms should trade off the benefit of tax shield and the cost of financial distress when making capital structure decisions (Modigliani and Miller, 1963; Miller and Modigliani, 1966; Kraus and Litzenberger, 1973; Deangelo and Masulis, 1980). The existence of zero-leverage firms is difficult to reconcile with the trade-off theory. These firms do not have a high default probability as firms' leverage is far from the deadweight of optimal leverage, and can lever up to take tax benefits from the unused debt capacity.

Pecking order theory only partially explains the low-leverage puzzle. Myers (1984) and Myers and Majluf (1984) propose that firms prefer internal financing due to the existence of information asymmetry. Once internal financing is

exhausted, firms prefer riskless debt to risky debt to fund profitable projects, and equity financing is the costliest way to raise funds. From the supportive perspective, prior studies document that low-leverage firms tend to have large cash reserves and pay high dividends (Graham, 2000; Devos *et al.*, 2012; Dang, 2013; Strebulaev and Yang, 2013). Thus, these firms may have sufficient internal funds and low demand for external funds. From the conflicting perspective, low-leverage firms do not use less equity than their counterparts (Strebulaev and Yang, 2013), which is inconsistent with the prediction of the debt and equity financing hierarchy.

Another potential explanation for the zero-leverage puzzle is agency theory. Jensen (1986) proposes that managers are incentivised to overinvest rather than pay dividends if they have excess free cash flows. They can benefit from increased control power or growth-related compensation by making firms grow beyond the optimal size. Payouts to shareholders can reduce free cash flows under the control of managers, thereby reducing agency costs. Similarly, debt can be viewed as a substitution for dividends because the financial obligation reduces managers' discretion on future free cash flows.

The zero-leverage phenomenon is difficult to reconcile with agency theory. If firms eschew debt financing because weak governance incentivizes managers to seek more discretion on cash flows, zero-leverage firms should pay lower dividends (Strebulaev and Yang, 2013). Devos et al. (2012) find no evidence that zero-leverage firms have high managerial entrenchment. Moreover, they also document the decision by zero-leverage firms to lever up (i.e., decide to initiate debt) is rarely accompanied by improvements in governance (i.e., an increase in takeover threats or the emergence of activist blockholders). Overall,

the zero-leverage puzzle is difficult to reconcile with the traditional capital structure theories.

2.1.1. Financial constraint theory and the zero-leverage puzzle

Prior studies document that financial constraint theory can partially explain debt conservativism. Firms facing high asymmetric information have limited access to external finance at a low cost. The underinvestment and asset substitution induced by the conflict of interests between debtholders and shareholders make debtholders unwilling to provide unsecured funds (Jensen and Meckling, 1976; Myers, 1977). However, if the debt is well collateralized, the expected loss of debtholders decreases during the event of default, and debtholders have lower concerns that borrowers invest in a risky project that only maximizes shareholders' interest. Numerous studies provide supportive evidence for financial constraints. Financially constrained firms tend to be small and young (Hadlock and Pierce, 2010), pay low dividends (Almeida *et al.*, 2004; Denis and Sibilkov, 2010), do not have bond rating (Whited, 1992; Kashyap *et al.*, 1994; Faulkender and Petersen, 2006), and rely more on internal funds (Fazzari et al., 1988).

Based on financial constraint theory, the zero-leverage puzzle can be explained as the consequence of financial constraint, i.e., unlevered firms could be forced to eschew debt financing due to the restriction of accessing cheap external funding. Consistent with the explanation, Strebulaev and Yang (2013) and Dang (2013) document that zero-leverage firms are small and young; they have a high market-to-book ratio and low tangible assets and are less likely to be dividend payers. Bessler *et al.* (2013) investigate the zero-leverage puzzle at the international level and find consistent evidence. Devos et al. (2012) find that

debt financing initiated by unlevered firms is more likely to be bank credit than publicly issued debt, implying that unlevered firms are difficult to access the public debt market even if they decide to lever up. Kahl *et al.* (2019) argue that high fixed costs raise financial constraints by increasing cash flow volatility and default probability, leading to a high probability of being zero-levered. Lambrecht and Pawlina (2013) provide theoretical evidence that human capital intensity increases zero-leverage firms because the non-tradeable characteristic of human capital increases firms' collateral constraints. Overall, previous studies provide clear evidence to support the financial constraint explanation.

However, financial constraint theory does not explain why unlevered firms use equity financing before exhausting internal funds, nor does it explain why unlevered firms have high dividend payouts. If financial constraint theory can fully explain the zero-leverage puzzle, then internal funds are more valuable for unlevered firms because internal funds are the main source to support their investments and growth (Strebulaev and Yang, 2013). Consequently, zero-leverage firms should pay low dividends and use less equity financing. In line with this argument, Dang (2013) finds that the cash flow-investment sensitivity of unlevered firms is lower than levered firms in the UK. This evidence is inconsistent with Fazzari et al.'s (1988) argument that financially constrained firms rely more on internal funds to support investment.

2.1.2. Financial flexibility theory and the zero-leverage puzzle

Zero-leverage firms could deliberately cumulate borrowing capacity to avoid underinvestment in the future. Firms with high precautionary motives have incentives to build financial flexibility. Myers (1977) theoretically shows that firms are willing to reduce debt financing and sacrifice a proportion of tax

advantage to avoid debt overhang. Myers and Majluf (1984) also present that firms should build financial flexibility by reserving cash and borrowing power to avoid using costly equity financing in the future. Deangelo and Deangelo (2007) propose a more comprehensive explanation related to low leverage and financial flexibility. Firms maintain low *ex-ante* leverage to achieve *ex-post* flexibility. The strategic use of debt can hedge future unanticipated negative cash flow shocks and meet the financing needs for unexpected investment opportunities. Consistent with financial flexibility theory, previous studies show survey evidence that chief financial officers consider financial flexibility as the most crucial factor for the capital structure decision (Graham and Harvey, 2001; Bancel and Mittoo, 2004; Brounen *et al.*, 2004).

In line with the prediction of financial flexibility theory, zero-leverage firms could intentionally eschew debt financing to cumulate borrowing capacity to meet the financing needs for unexpected future investment opportunities. In line with the explanation of financial flexibility theory, Korteweg (2010), Devos et al. (2012), Dang (2013), and Strebulaev and Yang (2013) investigate the debt-initiating decision of zero-leverage firms and find that they tend to have low contemporary investment opportunities and are more likely to use debt financing once investment opportunities arise in the future. Ghoul *et al.* (2017) investigate the relationship between the zero-leverage puzzle and culture. They find that the probability of unlevered firms is higher for countries where people behave more conservatively. Boustanifar and Verriest (2022) find that high labour protection makes it difficult for firms to discharge employees at a low cost, leading to higher demand for financial flexibility and the probability of being unlevered.

In sum, financial constraint and financial flexibility are the most prevalent theories to explain the zero-leverage puzzle, implying that the characteristics of

zero-leverage firms could be heterogeneous. Financial constraint theory focuses on the supply side of debt financing, i.e., firms are forced to eschew debt financing. Financial flexibility theory focuses on the demand side of debt financing, i.e., firms deliberately abandon debt financing to cushion future unexpected financing needs.

2.2. Literature review and hypothesis development for Chapter 4

2.2.1. The characteristics of R&D investment

Innovation is the key driver for firms' long-term business success; it can help firms develop new products and services, improve existing products and services, and convert primary inputs into output more efficiently. Previous studies have documented the benefits of innovation. For instance, Romer (1990), Grossman and Helpman (1991), and Aghion and Howitt (1992) attribute R&D as the real driving force for long-term economic growth. Ciftci and Darrough (2016) argue that successful R&D investments could make firms achieve a temporary monopolistic position in the market, resulting in extraordinary profits. Mukoyama (2003) argues that firms are incentivized to invest in R&D to imitate leaders' innovation and gain market shares.

Despite the well-documented benefits of innovation, its inputs involve costs due to the risk associated with R&D investments. Starting from Arrow (1962), Hall (2002) and Carpenter and Petersen (2002) highlight some crucial features of R&D investments. Firstly, R&D investments mainly create a knowledge-based intangible asset. This implies that R&D investments have high adjustment costs and low salvage value partly because most R&D spending pays the wages of intellectual scientists and engineers. In addition, Himmelberg and Petersen

(1994) suggest that the additional adjustment costs are derived from the leakage of knowledge and techniques to rivals by firing specialists. Secondly, R&D investments have high uncertainty in returns and are difficult to convert into financial success (Mansfield, 1977; Harhoff et al., 1999). The volatile return and uncertain success of R&D investments imply that debtholders cannot share the return exceeding predetermined pay-offs but must bear the risk of failure (Stiglitz, 1985). Finally, firms with intensive R&D investments suffer a high asymmetric information effect. Such an effect is due to the fact that the value of R&D projects is difficult to assess, and firms have the incentive to limit the information provided to the public (Stiglitz and Weiss, 1981; Brown et al., 2009).

2.2.2. The financing choices of R&D and zero-leverage puzzle

Internal funds are the most important source to support and smooth R&D investments. Managers who make R&D decisions often know more about the likelihood of success and the nature of particular R&D projects than outside investors, raising the investors' concern about information asymmetry (Akerlof, 1970; Leland and Pyle, 1977; Myers and Majluf, 1984; Hall and Lerner, 2010; Block, 2012). Due to the information asymmetry problem, internal financing is less costly than external financing. A series of studies finds supportive evidence for this argument. Himmelberg and Petersen (1994) document that internal financing is the primary way to support R&D investments for small, high-tech firms. Hall and Lerner (2010) find that large and established technology firms tend to actively manage internal funds to meet the financing needs for R&D investments. Brown and Petersen (2009) and Brown et al. (2009) find that internal cash flows and external equity issues are the primary sources for young firms to fund R&D in high-technology industries. Brown and Petersen (2011) also find that financially constrained firms use cash reserves to smooth R&D

investments and avoid adjustment costs incurred by cutting R&D. Bates et al. (2009) document that increased R&D intensity is an important determinant of the doubling of aggregate cash holdings from the 1980s to 1990s. Therefore, R&D-intensive firms have great incentive to build internal funds.

Equity issuance is the second-best financing choice to support R&D investments. Equity financing does not require collateral, and shareholders' upside returns are not bounded compared with debtholders' returns. Carpenter and Petersen (2002) suggest that the initial public offering (IPO) is crucial for financially constrained start-ups to fund R&D investments. Kim and Weisbach (2008) also find that R&D is a significant motivation that drives equity offerings at the international level. Brown et al. (2009) show that a considerable portion of the R&D boom from the late 1990s to the early 2000s in the US can be attributed to the bust of equity financing in the stock market. Martinsson (2010) investigates the R&D boom and equity financing for European firms and finds a similar trend. Another explanation is that investors have a preference for innovative firms, so high R&D investments allow firms to enjoy a low cost of equity financing (Polk and Sapienza, 2009; Grundy and Li, 2010). Consistent with this explanation, Lewis and Tan (2016) find that the equity issuance of R&D-intensive firms is more sensitive to stock misvaluation. Overall, if internal funds are insufficient, firms tend to issue equity to support R&D investments.

Debt financing is the most costly method to support R&D investments (Hall and Lerner, 2010). In line with this argument, Shi (2003) finds that R&D investments increase default risk and bond risk premium. Ciftci and Darrough (2016) also find a positive relationship between R&D intensity and loan spread, implying that debtholders are concerned more about volatility and uncertainty than future cash flow growth for R&D investments. As a financial intermediary, banks can

mitigate asymmetric information using private information and sophisticated techniques, so firms with long-term bank lending relationships may rely heavily on bank loans (Berger and Udell, 2002; Herrera and Minetti, 2007; Benfratello *et al.*, 2008; Amore *et al.*, 2013; Chava *et al.*, 2013; Berger *et al.*, 2014; Nanda and Nicholas, 2014). However, young and small high-tech firms may have insufficient time to establish a lending relationship with banks (Ritter, 1991; Guney *et al.*, 2017). In sum, internal financing tends to be the most crucial financing method for R&D investments, as it is less costly compared to external funding. If internal funds are insufficient, firms consider equity issuance as the suboptimal choice to support R&D projects. R&D investments are less suitable to be financed by debt financing.

From the perspective of financial constraint theory, R&D-intensive firms suffer a high asymmetric information effect due to the specific characteristics of R&D investment. They mainly rely on internal finance or external equity issues and are forced to choose zero-leverage for their capital structure policy. From the perspective of financial flexibility theory, R&D-intensive firms have high precautionary motives to reserve cash and borrowing capacity to ensure sufficient funds for R&D smoothing and other financing needs, thereby deliberately adopting the zero-leverage decision. Therefore, R&D investment is likely to significantly increase the probability of adopting the zero-leverage decision. Therefore, the first hypothesis is summarised in the following.

H1: Firms with higher R&D investment are more likely to be zero-leverage firms.

R&D intensity has noticeably increased in the US, especially during the 1990s (Bates et al., 2009; Brown et al., 2009; He and Wintoki, 2016). In order to promote innovation, the state R&D credit policy provides companies with the

opportunity to offset their income tax liability. Since the introduction of the US Federal R&D tax credit in 1981, 32 states provided a tax credit for company-funded R&D by 2006 (Wilson, 2009). The state R&D tax credit has become increasingly generous, encouraging more firms to take tax advantage of R&D spending and reduce the cost of capital (Falato and Sim, 2014). Prior studies find evidence that introducing a series of state R&D tax credits and the sizeable jumps in the average tax credit rate encouraged more firms to invest in R&D. Several studies find that the state R&D tax credit policies effectively increase R&D at the firm (Berger, 1993; Hall, 1993; Mccutchen Jr, 1993), industry (Mamuneas and Nadiri, 1996), state (Hall and Wosinska, 1999; Wilson, 2009), and country levels (Bloom et al., 2002).

Another explanation for the R&D boom is investors' R&D preference. Brown et al. (2009) find that stock market mispricing can accelerate R&D investment, as firms have incentives to cater to investors' tastes (Polk and Sapienza, 2009). Investors' positive expectations on R&D firms led to the overvalued stock price during the R&D boom in the 1990s, resulting in a growing number of equity issuers raising R&D investments to take the benefit of stock overvaluation. If the intensified R&D investments increase the probability of adopting the unlevered decision, the increasing trend of zero-leverage firms could be driven by the trend of R&D intensity.

The relationship between R&D and the low-leverage decision could strengthen over time. From the risk perspective, R&D firms tend to be increasingly riskier, reserve more financial flexibility and have shrinking debt capacity to respond to a changing and challenging environment (Bates *et al.*, 2009; Falato *et al.*, 2020). Therefore, based on the literature discussed above, the second hypothesis is as follows.

H2: The rising trend of zero-leverage is driven by the increasing trend of R&D investment, and the relationship between R&D and the low-leverage decision could strengthen over time.

2.3. Literature review and hypothesis development for Chapter 5

2.3.1. Market competition, financial flexibility and zero-leverage behaviour

High competition exposes firms to the threat of predation. Prior studies (Benoit, 1984; Fudenberg and Tirole, 1986) propose the predation theory to explain the financial decision in a competitive product market. The theory suggests that established firms have the incentive to reduce entrants' profit and force the entrant to quit the market by strategically increasing price (e.g., reduction in selling price) or intensifying non-price competition (e.g., increase in advertising and marketing). Financially constrained firms' weak financial position induces cash-rich competitors to adopt aggressive predatory strategies, leading to the erosion of their future profits (Bolton and Scharfstein, 1990).

As high competition increases predation risk, thereby increasing firms' precautionary motive and demand for financial flexibility. Della Seta (2011) and Morellec et al. (2014) theoretically show that high competition induces firms to build high financial flexibility. Therefore, the theoretical models predict that firms should build financial flexibility to offset the threat of predation. Consistent with the theoretical prediction, the empirical evidence in prior studies documents that cash-rich firms under high market competition are more likely to gain market share at the expense of their competitors (Hilke and Nelson, 1984;

Bolton and Scharfstein, 1990; Fresard, 2010; Shroff, 2016) and gain competitive advantages in the labour market (Fulghieri and Sevilir, 2011; Ghaly *et al.*, 2015; Chang and Jo, 2019). Therefore, financial flexibility is more valuable for firms facing intensive market competition because financial flexibility allows firms to resist predatory strategies from their rivals.

Firms facing high market competition have incentives to avoid high indebtedness and maintain low leverage. Theoretically, unused debt capacity is also an essential source of financial flexibility (Deangelo et al., 2011; Denis and Mckeon, 2012), as less debt financing provides more financial flexibility by reducing financial obligations and increasing the ability to resist predatory strategies (Chevalier and Scharfstein, 1996). The empirical evidence supports the argument that debt financing weakens firms' competitive ability in a competitive environment. Prior studies document that high debt indebtedness in competitive industries weakens pricing ability (Phillips, 1995; Kovenock and Phillips, 1997), survival ability (Zingales, 1998; Khanna and Tice, 2005), sales growth (Campello, 2003) and market share (Campello, 2006). In sum, high market competition raises firms' precautionary motives to escape predation threats and avoid the indebtedness burden, thereby demanding high financial flexibility and increasing the tendency to adopt the conservative debt policy.

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2.3.2. Market competition, financial constraints and zero-leverage behaviour

High market competition raises information asymmetry, raising financial constraints and restricting firms' access to debt financing. According to the proprietary cost theory (Verrecchia, 1983), managers are incentivised to withhold information even if it is good news because the information could be

used by their rivals for strategic purposes. As high market competition increases proprietary costs, firms in high competition intensity are reluctant to disclose information, leading to high information asymmetry and high borrowing costs. In line with the proprietary cost theory, Darrough (1993) and Bagnoli and Watts (2010) theoretically show that high competition is associated with low disclosure and poor disclosing quality. A series of empirical studies documents supportive evidence for the argument; intensive competition deteriorates adverse selection problems (Verrecchia and Weber, 2006), induces firms to manipulate information (Bernard, 2016), and increases the cost of bank debt (Valta, 2012) and public debt (Boubaker *et al.*, 2018). The survey by Dedman and Lennox (2009) also suggests that the intensity of competition is a significant consideration for managers to withhold information related to sales and costs. As high competition reduces firms' disclosure incentives, thereby increasing the cost of capital (Diamond and Verrecchia, 1991; Francis et al., 2008), under such conditions, firms are more likely to be financially constrained and restricted to access debt financing at a lower cost.

In sum, high market competition increases both precautionary motives and financial constraints, which are important drivers of unlevered behaviour (Graham, 2000; Devos et al., 2012; Bessler et al., 2013; Dang, 2013; Strebulaev and Yang, 2013). Therefore, I expect a positive effect of market competition on the likelihood of being zero-leverage firms.

H3: Firms facing high product market competition are more likely to be zero-leverage firms.

2.3.3. Market competition, innovation and zero-leverage puzzle

There has been a long debate on the relation between market competition and innovation incentives in the literature. The debate traces back to Schumpeter (1943), who argues that monopolistic firms have resources and sufficient cash flows to support innovation, implying that low competition encourages innovation. However, another influential study by Arrow (1962) argues that the new technology erodes the profit of existing technology, implying that high competition encourages innovation. Based on Arrow's (1962) and Schumpeter's (1943) works, a series of studies proposes theoretical explanations from the profit perspective. Gilbert and Newbery (1982) and Reinganum (1983) argue that high competition encourages radical innovation because radical innovation erodes the profitability of existing technology. Another series of studies present the Darwinian argument that competition forces firms to innovate to survive (Porter, 1990; Aghion *et al.*, 1999), become productive (Aghion and Howitt, 1996) and maintain competitiveness (Aghion *et al.*, 2001; Boone, 2001). Aghion et al. (2005) propose that market competition has an inverted U-shape relationship with innovation. As the pre-innovation benefit is more important for innovation incentives, market competition, on average, increases innovation. Overall, prior studies generally document a positive relationship between innovation and market competition.

It has been well documented in the literature that market competition affects firms' capital structure through firms' innovation. Theoretical studies highlight that the effect of competition on firms' leverage depends on the industry peer firms' innovation decisions (Maksimovic and Zechner, 1991), whether firms' technology is the technological core or fringe within industries (Williams, 1995; Fries *et al.*, 1997), and industries' technology growth (Miao, 2005). Consistent with the theoretical prediction, Mackay and Phillips (2005) find that the effect of competition on leverage varies with the firms' technological condition.

Therefore, the impact of market competition on capital structure is more profound for R&D firms.

I conjecture that market competition increases the probability of zero-leverage decisions through R&D investments. First, market competition increases the risk of innovation, which amplifies the financial constraints of R&D-intensive firms. Prior studies highlight that high competition increases firms' probability of shortage of future cash flows, leading to high failure rates of R&D investments (Gu, 2016) and low profitability of innovative outputs (Hou and Robinson, 2006). R&D firms with high market competition are more likely to be restricted access to debt financing as competition raises the risk of R&D projects. Second, market competition increases R&D firms' demand for financial flexibility because unused debt capacity can be used to protect a firm's intangible assets (Thakor and Lo, 2015; Klasa *et al.*, 2018); these firms may deliberately reserve debt capacity to gain the advantage of financial flexibility. In sum, high market competition could lead to a high probability of adopting zero-leverage decisions by increasing the risk of R&D investments and demand for financial flexibility. Therefore, the hypothesis is as follows.

H4: The effect of product market competition on the zero-leverage decision is stronger for R&D firms.

Finally, previous studies suggest that market competition has increased in the past few decades (Bils and Klenow, 2004; London, 2005). If market competition is a significant determinant for zero-leverage behaviour, then the trend of zero-leverage firms could be driven by the increasing trend of market competition. Combined with *Hypothesis 3*, I expect the increasing trend of zero-leverage induced by market competition could be more remarkable for R&D firms.

H5: The increasing trend of zero-leverage firms is attributable to the increasing product market competition, and the relationship is more profound for R&D firms.

2.4. Literature review and hypothesis development for Chapter 6

2.4.1. Equity issuance and market timing

Zero-leverage behaviour violates the prediction of the pecking order theory on the preference hierarchy of financing choices (Strebulaev and Yang, 2013), which is consistent with the literature arguing that the pecking order theory has limited explanatory power on firms' debt and equity financing (Leary and Roberts, 2010). Prior studies highlight the impact of market timing opportunities on firms' equity issuance decisions. Firms have an incentive to time the equity market by issuing equity at a high market valuation (Taggart, 1977; Asquith and Mullins Jr, 1986; Masulis and Korwar, 1986; Jung et al., 1996; Pagano et al., 1998; Dittmar and Thakor, 2007; Deangelo et al., 2010). The subsequent stock return tends to decrease following the equity issuance decision (Ritter, 1991; Loughran and Ritter, 1995; Spiess and Affleck-Graves, 1995; Brav and Gompers, 1997; Loughran and Ritter, 1997; Baker and Wurgler, 2000; Jegadeesh, 2000; Denis and Sarin, 2001; Pontiff and Woodgate, 2008). The survey evidence also suggests that CFOs have the incentive to time the market by issuing equity in the US (Graham and Harvey, 2001) and Europe (Bancel and Mittoo, 2004; Brounen et al., 2006).

Based on the market timing issuance, Baker and Wurgler (2002) are the first to investigate the long-run impact of market timing on capital structure and argue

that actively exploring market timing opportunities impedes firms from achieving the optimal capital structure. In line with this argument, prior studies find supportive evidence that market timing issuance negatively affects leverage, leading to a suboptimal capital structure (Welch, 2004; Leary and Roberts, 2005; Alti, 2006; Flannery and Rangan, 2006; Hovakimian, 2006; Kayhan and Titman, 2007; Elliott *et al.*, 2008; Huang and Ritter, 2009). Theoretically, Yang (2013) proposes a dynamic model and predicts that the optimal leverage is determined by the tax advantage of debt, default costs, and the benefit of issuing overvalued equity induced by the heterogeneous beliefs between the manager and outside investors. The model implies that the optimal leverage can adjust towards zero if the benefit of market timing is large enough.

However, equity issuance could be costly for shareholders, as it incurs costs for existing shareholders, including the dilution of both earnings per share (EPS) and control rights. Previous studies document that the concern for dilution significantly impacts firms' financing choices. For instance, Hovakimian *et al.* (2001) and Hovakimian *et al.* (2004) provide empirical evidence for the impact of dilution on firms' capital structure. Graham and Harvey (2001) and Brown *et al.* (2019) provide survey evidence that 69% of surveyed CFOs consider dilution when making equity issuance decisions, and 90% of surveyed institutional investors have dilution concerns around equity issuance. Huang *et al.* (2014) find that managers eschew equity issuance to avoid dilution of EPS if their compensation is closely related to EPS, which reduces the under-leverage problem. Therefore, given the abundant evidence for the negative impact of dilution on the equity issuance decision, firms should issue equity only if the dilution effect is low.

I expect that zero-leverage behaviour is driven by firms with high equity issuance for two reasons. Firstly, zero-leverage firms are subject to severe financial constraints (Graham, 2000; Devos *et al.*, 2012; Strebulaev and Yang, 2013), and are restricted access to cheap debt financing. As constrained firms tend to rely on equity financing if internal funds are insufficient (Fazzari *et al.*, 1988; Kaplan and Zingales, 1997; Hadlock and Pierce, 2010), zero-leverage firms may rely on equity financing if they do not have sufficient internal funds. Secondly, previous studies document that the impact of the dilution effect is lower during favourable market timing conditions, as the benefit of issuing overvalued stock offsets the dilution effect. In line with this argument, Eckbo *et al.* (2007) argue that issuing overvalued equity to new investors can transfer wealth to current shareholders. Larrain and Urzúa (2013) find that controlling shareholders are incentivised to allow the company to issue overpriced shares. Brown *et al.* (2019) provide survey evidence that 80% of surveyed institutional investors support managers' equity issuance decisions if market timing conditions are favourable.

Therefore, if equity issuance can explain unlevered decisions, market timing should explain the zero-leverage puzzle because the dilution effect of equity issuance is weak under favourable market timing conditions. This conjecture forms the first and second hypotheses.

H6: High equity issuance increases the probability of being a zero-leverage firm.

H7: Favourable market timing conditions increase the probability of being a zero-leverage firm.

2.4.2. Market timing and information asymmetry

As Baker and Wurgler (2002) illustrate, there are two versions of the market timing theory. The market timing effect on equity issuance can be explained by equity misvaluation and time-variant asymmetric information. From the equity misvaluation perspective, managers believe that investors are irrational, so they perceive that their stocks are overvalued and take advantage of misvaluation by issuing more equity (Ritter, 1991; Loughran and Ritter, 1995; Graham and Harvey, 2001; Baker and Wurgler, 2002). From the time-variant asymmetric information explanation, the adverse selection effect is time-variant; a weak adverse selection effect creates favourable market timing opportunities, which makes equity financing more favourable than debt financing (Lucas and Mcdonald, 1990; Korajczyk et al., 1991; Choe et al., 1993; Bayless and Chaplinsky, 1996; Lemmon and Zender, 2010). The logic behind the asymmetric information explanation and misvaluation explanation is similar; both predict that managers issue equity when the perceived cost of equity is low and repurchase when the perceived cost of equity is high.

The empirical results for the relationship between information asymmetry and market timing issuance tend to be mixed in the literature. For evidence supporting the time-variant asymmetric information, Korajczyk et al. (1991) argue that managers are incentivised to control the disadvantage of information asymmetry in the market by voluntarily reducing asymmetric information before exploiting the market timing opportunities. Choe et al. (1993) and Bayless and Chaplinsky (1996) explain that the cost of adverse selection varies counter-cyclically, which boosts the equity issuance during the expansion. Manuel et al. (1993) find that firms with good performance tend to issue equity after using dividend announcements to signal a superior value. On the contrary, Loughran

and Ritter (1995) argue that there is too little time variation in adverse selection costs to induce equity market timing. Chang et al. (2006) find that firms with high incentives to time the market tend to have higher information asymmetry.

If market timing theory explains the zero-leverage puzzle because firms actively reduce information asymmetry to exploit the favourable market timing opportunities, I expect to observe a negative relationship between information asymmetry and the zero-leverage decision, and the effect of market timing conditions is more profound on firms with low asymmetric information. Therefore, the hypotheses are as follows.

H8. Low information asymmetry increases the probability of adopting the zero-leverage policy.

H9. The effect of market timing conditions on the zero-leverage decision is more profound for firms with lower information asymmetry.

2.4.3. Equity issuance and cash saving

Zero-leverage firms could issue equity to build high cash reserves. Prior studies document that equity financing tends to be triggered by insufficient internal funds, as these firms require the proceeds of equity issuance to fund short-term cash needs and imperfectly anticipated investments. (Deangelo et al., 2011; Huang and Ritter, 2020; Denis and Mckeon, 2021). In line with this argument, Deangelo et al. (2010) also find that near-term cash needs are the primary motive for equity issuance. In their sample, 62.6% of issuers run out of cash in the year after the seasoned equity offerings if they do not receive the equity issuance proceeds. Another series of studies documents that firms issue equity for

stockpiling cash (Kim and Weisbach, 2008; Deangelo et al., 2010; Huang and Ritter, 2020). Mclean (2011) finds that equity issuance has been the primary source of cash reserves since 1985 in the US. Consistent with this argument, the equity issuance-cash saving relation is more profound for firms with high precautionary motives in the US (Bolton et al., 2013; Eisfeldt and Muir, 2016; Warusawitharana and Whited, 2016; Huang and Ritter, 2020) and internationally (Mclean and Zhao, 2018).

However, holding cash is not free. Prior studies highlight that firms' cash policies are the outcome of the trade-off between the costs of agency problem and the benefit of precautionary motives. From the precautionary motives, high cash reserves can hedge the cash flow volatility and allow firms to meet future unexpected cash needs without raising costly external funds, and such benefits are especially valuable for financially constrained firms (Opler *et al.*, 1999; Han and Qiu, 2007; Harford *et al.*, 2014). From the perspective of agency theory, high cash reserves induce managers to pursue their private interests through overinvestment or perquisite consumption, leading to loss of shareholder wealth (Dittmar *et al.*, 2003; Kalcheva and Lins, 2007; Gao *et al.*, 2013). Therefore, firms' cash policy should reflect the trade-off between the benefits and costs of high cash reserves.

I conjecture that zero-leverage firms issue equity to save cash for two reasons. The first reason is that unlevered firms have high precautionary motives and are subject to financial constraints (Graham, 2000; Devos et al., 2012; Bessler et al., 2013; Dang, 2013; Strebulaev and Yang, 2013), so the benefit of maintaining cash reserves is greater for zero-leverage firms. Secondly, previous studies find limited evidence to support the explanation of agency problems for zero-leverage behaviour (Devos *et al.*, 2012), so the concern of agency costs is lower

for zero-leverage firms. In sum, the benefits of cash reserves could outweigh its costs for zero-leverage firms, which incentivizes these firms to save high cash from the proceeds of equity issuance. Therefore, the last hypothesis is as follows.

H10. Zero-leverage firms issue equity for stockpiling cash.

Chapter 3. Data and methodology

In this chapter, I discuss the details of the data and methodology for the three studies. Section 3.1 presents the steps of sample selection, data source, sample period and the number of observations. Section 3.2 displays the regression model, measures of variables of interest and control variables.

3.1. Data

The thesis focuses on the US market, and the construction of most variables mainly relies on the accounting information collected from the Compustat North America database. Compustat North America is one of the most prevalent databases for the US market, providing primary and market information on active and inactive US-listed companies, including income statements, balance sheets and cash flow statements.

The sample period for Chapters 4 and 5 is from 1980 to 2017. I choose 1980 as the beginning of the sample period because it captures the first wave of R&D growth (Brown et al., 2009). Following Strebulaev and Yang (2013), I exclude financial and utility firms (Standard Industrial Classification in the range of 6000–6999 or 4900–4999), non-US firms (Foreign Incorporation Code not equal to the USA), non-publicly traded firms and subsidiaries (Stock Ownership Code (STKO) equals one or two). All nominal values are deflated into year-2000 dollar values using the US consumer price index (CPI) from the Organization for Economic Co-operation and Development (OECD). To reduce the effect of small firms' heterogeneous characteristics and the noise in accounting data, I follow previous studies to drop the observations with the total book value of

assets less than $10 million (Baker and Wurgler, 2002; Chang *et al.*, 2006; Strebulaev and Yang, 2013). As book leverage ratio is employed to identify zero-leverage firms, I also exclude observations with missing data on book leverage ratio. After the data cleaning steps, there are 154,712 firm-year observations for 15,218 unique firms in the sample.

Chapter 6 requires information on stock returns to construct the variables of interest. Therefore, I collect stock returns from the Center for Research in Security Prices (CRSP) database and merge them with the Compustat/CRSP merged (CCM) database. The CRSP database maintains the most comprehensive collection of securities price, return and volume data for US firms listed on the New York Stock Exchange, American Stock Exchange and Nasdaq stock markets. The sample period of the third study is from 1972 to 2017; I choose 1972 as the starting point of the sample because the CRSP began including Nasdaq firms in 1972. In addition to the data cleaning steps for the first two main chapters, I exclude the effect of American depositary receipts (ADRs) by keeping firms with ordinary common shares (Share Code equals 10 or 11). After the initial data cleaning steps, the sample contains 134,270 firm-year observations for 16,586 unique firms.

The channel tests in the last chapter rely on analyst forecasting data, which is obtained from the Institutional Brokers' Estimate System (I/B/E/S). The database collects and compiles different estimates of future earnings of listed firms from sophisticated analysts. For other publicly available data and variables used in this thesis, I report the corresponding data sources in Appendix A.

3.2. Methodology

This thesis mainly relies on the logit model to estimate the probability of being a zero-leverage firm. I focus on the logit model instead of the linear probability model because the linear probability model can produce predicted probabilities outside the 0-1 interval (Wooldridge, 2015). I employ the following equation to test the hypothesis:

$$ln\frac{P(probability\ of\ being\ zero-levered)_t}{1-P(probability\ of\ being\ zero-levered)_t} = \beta_i X_{i,t-1} + \varepsilon_{it}, \tag{1}$$

where $P = \frac{1}{\left[1+e^{-\left(\beta_i X_{i,t-1}+e\right)}\right]}$ is the probability that a firm is zero-levered in a given year. The left-hand side variable of Equation (1) is set to one if firm *i* has zero leverage in year *t*, and zero otherwise. A firm *i* is defined as a zero-leverage firm in year *t* if its total book leverage ratio, the sum of its short-term and long-term debts to the book value of total assets, equals zero in that year. Prior studies document that the conservative debt policy is mainly driven by the zero-leverage puzzle. Therefore, I also extend my analysis to almost zero-leverage firms since those firms are recognized as firms with conservative debt policies in the literature (Graham, 2000; Strebulaev and Yang, 2013). A firm *i* is defined as an almost zero-leverage firm if its total book leverage ratio is less than 5%. *X* is a vector of explanatory variables, including the following:

$$\begin{aligned}\beta_i X_{i,t-1} = {} & \beta_0 + \beta_1 Variables\ of\ interest + \beta_2\, Log(size)_{i,t-1} + \\ & \beta_3 Market - to - book_{i,t-1} + \beta_4 Profitability_{i,t-1} + \\ & \beta_5 Tangibility_{i,t-1} + \beta_6 Dividend\ payer_{i,t-1} + \\ & \beta_7 Dividend\ payout_{i,t-1} + \beta_8 Earnings\ volatility_{i,t-1} + \\ & \beta_9 Ind.Frac.ZL_{i-1} + \beta_{10} Init.ZL_i + \beta_{11} Capital\ expenditure_{i,t-1} +\end{aligned}$$

$$\beta_{12} Abnormal\ Cap.Ex_{i,t} + \beta_{13} Asset\ sale_{i,t-1} + \beta_{14} log(age)_{i,t-1} + v_j + v_t, \quad (2)$$

where *i*, *j*, and *t* denote firm, industry and year respectively. *Variables of interest* are a vector of key independent variables that are crucial to the hypothesis tests. In order to examine the relationship between firms' R&D investment and their zero-leverage behaviour, I use *R&D-to-assets*$_{i,t-1}$, *R&D-to-sales*$_{i,t-1}$, and *R&D dummy*$_{i,t-1}$ to measure a firm's R&D investment. *R&D-to-assets* is the ratio of R&D expenditure over total assets, *R&D-to-sales* is the ratio of R&D expenditure over sales, and *R&D dummy* is an indicator that equals one if a firm belongs to an R&D firm in a given year and zero otherwise. R&D firms are defined as firms with non-zero capitalized R&D stock, and non-R&D firms are firms with zero capitalized R&D stock in a given year[1]. R&D stock is based on all past R&D expenditures calculated using the perpetual inventory method following Hall et al. (2005).

In the second study, I investigate the impact of product market competition on zero-leverage behaviour. Therefore, *Variables of interest* represent *Market competition*$_{j,t-1}$. *Market competition* is measured by the Compustat Herfindahl-Hirschman index, which is computed as the sum of squared market shares based on firms' sales at the 3-digit sic code level (Giroud and Mueller, 2010). As

[1] I replace missing R&D with zero. Despite the fact that firms may strategically restrict their information about R&D (Koh and Reeb, 2015), Curtis et al. (2020) argue that the regulation of ASC 730 (formerly SFAS 2) requires separate disclosure of material amounts of R&D expenditures, leading to a lower proportion of firms with missing R&D. In addition, in Appendix B1, I exclude firms with missing R&D or replace missing R&D with median value of industry, the results remain qualitatively unchanged.

Compustat HHI is calculated at the industry level, I release the industry fixed effect in the model.

In the third study, the variables of interest are equity issuance and market timing conditions. Equity issuance is measured by the sales of common and preferred stock over total assets (*Equity issuance*$_{i,t-1}$). I also employ *Net equity issuance*$_{i,t-1}$ (the difference between sales and purchase of common and preferred stock over total assets) as an alternative measure for the robustness check.

To measure market timing conditions, I follow Deangelo et al. (2010) to construct *Prior 12month return*$_{i,t-1}$, *Future 36month return*$_{i,t+3}$ and *Standardized market-to-book*$_{i,t}$. The abnormal stock return is calculated as the raw return minus the contemporaneous return on the value-weighted market index. *Prior 12month return* is the 12-month cumulative abnormal stock returns ending at the last fiscal year's end month. *Future 36month return* is calculated as the 36-month cumulative abnormal stock return from the following month of the current fiscal year's end month[2]. A firm must have non-missing stock returns for at least 7 of the 12 months to calculate the prior 12-month and non-missing stock returns for 21 months to calculate the future 36-month abnormal stock returns. *Standardized market-to-book* is calculated as a firm's market-to-book divided by the same year and the industry's median market-to-book. Therefore, favourable market timing conditions are associated with high prior 12-month abnormal stock returns, high

[2] For example, a firm's fiscal year is 2000 and fiscal year's end month is December and the fiscal year's end month remains unchanged in the years 1999-2003. The prior 12-month abnormal stock returns for the year 2000 are the cumulative abnormal stock returns starting from January 1999 to December 1999, the future 36-month abnormal stock returns are the cumulative abnormal stock returns starting from January 2001 to December 2003.

contemporaneous standardized market-to-book ratios, and low future 36-month abnormal stock returns[3].

Previous research has shown that investor sentiment significantly impacts the extent of stock mispricing and market efficiency (Baker and Wurgler, 2006; Yu and Yuan, 2011; Stambaugh et al., 2012; Chen et al., 2019). Specifically, high investor sentiment attracts more uninformed investors to enter the stock market. These investors tend to be over-optimistic about the expected return, bidding up the stock price away from its fundamental value. Therefore, I also employ the investor sentiment index constructed by Baker and Wurgler (2006) as an alternative proxy of market timing for the robustness check.

In addition to the variables of interest, I include a variety of control variables that are known to have impacts on borrowing decisions. Firm size is related to information asymmetry problems (Ferri and Jones, 1979; Titman and Wessels, 1988) and direct bankruptcy cost (Warner, 1977) in the financial market. Typically, large firms have higher leverage than small firms because they can borrow at a lower cost. On the other hand, large firms are likely to have more retained earnings and, therefore, have less demand for external financing, which may enable firms to stay unlevered. *Log*(*size*) is measured by the logarithm of a firm's deflated total assets.

The market-to-book ratio captures firms' growth opportunities. Firms expecting high growth soon are likely to prefer equity finance (Rajan and Zingales, 1995). Therefore, the market-to-book ratio is expected to positively affect firms'

[3] Henceforth, prior 12-month abnormal stock returns are referred to as prior 12-month returns, and future 36-month abnormal stock returns are referred to as future 36-month returns.

likelihood of being zero-leverage. *Market-to-book* is measured by the ratio of the market value of total assets to the book value of total assets[4].

Profitability may have an ambiguous effect on leverage. According to the pecking order theory (Myers and Majluf, 1984), profitable firms could use cheap internal finance and have less incentive to borrow. On the other hand, market-timing theory (Baker and Wurgler, 2002) suggests that profitable firms may use their internal finance to purchase back outstanding equity when the share price is low, thereby increasing leverage. According to trade-off theory, profitable firms may prefer a higher debt level to maintain tax shield benefit. *Profitability* is the ratio of a firm's earnings before interest and tax over total assets.

Tangible assets can serve as collateral for debt financing, leading to a higher borrowing capacity, i.e., tangibility is expected to negatively affect the probability of being zero-leverage. However, when firms' leverage is low, managers have strong incentives to consume more than the optimal level of perquisites (Titman and Wessels, 1988), which produces a negative relation between firms' tangible assets and leverage ratio, i.e., tangibility is expected to positively affect firms' likelihood of being zero-leverage. *Tangibility* is measured by the ratio of fixed assets to total assets.

Dividend-paying firms are likely to be financially unconstrained (Fazzari et al., 1988; Almeida et al., 2004). They could have sufficient internal finance and prefer not to lever up (Strebulaev and Yang, 2013). Further, high dividend payouts and low leverage allow firms to access external financing in the future (Deangelo and Deangelo, 2007). Therefore, both the dividend-paying status and

[4] To avoid the multicollinearity problem, I exclude *Market-to-book* if the model includes *Standardized market-to-book*.

the payout amount are expected to negatively affect firms' zero-leverage behaviour. *Dividend payer* is a dummy variable equal to one if a firm pays dividends in the given year and zero otherwise. *Dividend payout* is the ratio of common dividend payouts to total assets.

Firms' earning volatility may indicate the liquidity risk to shareholders and debtholders, consequently affecting firms' ability to raise external finance. Graham (2000) suggests that firms with high cash flow volatility are more likely to adopt conservative debt financing. Therefore, Earnings volatility is expected to positively affect firms' probability of being unlevered. *Earnings volatility* is measured by the standard deviation of a firm's profitability in the past ten years with a minimum of three observations to be calculated.

Including the initial status of being zero-leverage of firms in the regressions captures the persistent effect of the zero-leverage phenomenon. I also include the fraction of zero-leverage firms in each industry to further control for such financing preferences across industries. *Ind.Frac.ZL* is the average fraction of zero-leverage firms in industry *j* where firm *i* belongs, i.e., the total number of zero-leverage firms divided by the total number of firms in industry *j*. *Init.ZL* is a dummy variable equal to one if firm *i* has zero leverage in its first year recorded in the Compustat and zero otherwise. Both *InitialZL* and *Ind.Frac.ZL* variables are expected to have positive signs.

I include capital expenditure and abnormal expenditure to capture firms' investment behaviour. In anticipation of future investment, firms would reserve their debt capacity to retain financial flexibility by keeping their current leverage low (Ovtchinnikov, 2010). *Capital expenditure* is the ratio of capital expenditure to total assets. *Abnormal Cap.Ex* is the abnormal capital expenditure, which is

the growth rate of current capital expenditure compared with the average capital expenditure in the past three years. Following Titman et al. (2004) and Strebulaev and Yang (2013), firms' contemporaneous abnormal investment (*AbnormalEXP*) is included to capture the anticipation of future investment. It is expected that firms with low abnormal investment have low investment opportunities, leading to the high probability of being zero-leverage, i.e., a negative sign of the *AbnormalEXP* variable.

Selling assets is a possible way for firms to raise funds (Arnold et al., 2018; Edmans and Mann, 2019). Indeed, Strebulaev and Yang (2013) suggest that zero-leverage firms tend to sell more assets to support other projects or retire debt, so asset sales are expected to positively affect the likelihood of being zero-leverage. *Asset sale* is measured by the ratio of asset sales to total assets.

Firm age is related to the information asymmetry problem. Older firms typically have more track records and better access to financial markets (e.g., Chittenden et al., 1996; Cooley and Quadrini, 2001). Hence, firm age may have an impact on firms' capital structure and their zero-leverage behaviour. *Log*(*age*) is measured by the logarithm of a firm's age plus one.

v_j and v_t are industry and year dummies, respectively. Industry j is defined by Fama and French's (1997) 12-industry classification. Controlling industry and year-fixed effects are essential in the capital structure literature (e.g., Titman and Wessels, 1988). Despite Strebulaev and Yang (2013) documenting that the zero-leverage phenomenon is widespread across different industries, the industrial effect is an important factor in explaining the increasing trend of the zero-leverage puzzle (Bessler et al., 2013; D'mello and Gruskin, 2014). Therefore, I control industry and year-fixed effects in the model. All the independent

variables are lagged by one period except *Abnormal Cap.Ex*, as it captures the contemporary investment needs (Titman et al., 2004; Strebulaev and Yang, 2013). In Appendix A, I report the details of variable construction.

Chapter 4. R&D and the zero-leverage puzzle

4.1. Introduction

Innovation has long been recognized as a critical driver for long-term economic growth (e.g., Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1992). Given the great implication of innovation, it has attracted great attention from researchers. A variety of studies highlight the benefit of innovation, including obtaining market shares (Ciftci and Darrough, 2016), improving productivity (Mansury and Love, 2008), firm value (Peters *et al.*, 2017) and resisting competitive pressures (Hombert and Matray, 2018). However, the costs of innovation inputs are also remarkable. Investment in R&D also entails the risk that the firms are unable to realize profits, leading to earnings manipulation (Gentry and Shen, 2013), credit constraints (Czarnitzki and Hottenrott, 2011), and drain on firms' financial and human resources (Van De Ven, 1986). However, the outcome of conservatism caused by R&D investments has been overlooked in the literature. In this study, I aim to fill the gap by exploring the impact of R&D on extremely conservative debt policy.

R&D investments create intangible assets and have high output uncertainty (Arrow, 1962; Hall and Lerner, 2010), which impedes firms from obtaining debt financing for R&D investments. Therefore, aggressive R&D investments could significantly increase the probability of being zero-leverage firms. In addition, the investors' preference for R&D in the stock market in the 1990s induced firms to accelerate R&D investment to cater to investors' tastes (Brown *et al.*, 2009). As a result, the rising trend of R&D investment could drive the zero-leverage phenomenon prevalent in the US market, which explains why an increasing

proportion of firms adopt the zero-leverage policy. The objective of this main chapter is straightforward; I investigate the impact of R&D investments on zero-leverage decisions, and to what extent the R&D investments contribute to the well-documented trend of the zero-leverage puzzle.

Using the data of US firms for the period 1980 to 2017, this study employs a logit model to examine whether R&D significantly affects firms' probability of becoming zero-levered. There are three main findings in this study. Firstly, zero-leverage firms are concentrated in R&D firms, and R&D investments have a significant and positive effect on zero-leverage behaviour. The results imply that R&D impedes firms from taking the tax benefit of debt financing. After confirming the impact of R&D on zero-leverage decisions, I next examine whether the increasing trend of zero-leverage firms is attributable to R&D investments. The results show that the impact of R&D on the probability of being zero-leverage firms has strengthened over the past four decades. Finally, I decompose the explanatory power of R&D into two parts: the impact due to the change in the value of R&D investments (changing factor) and the impact due to the change in sensitivity of the probability of becoming zero-levered to R&D investments (changing sensitivity). I find that the increasing trend of zero-leverage decisions is more attributable to the changing sensitivity component, suggesting that the aggregate capital structure has evolved to a more conservative level due to the intense innovation race.

To obtain the causal effect between R&D investment and zero-leverage behaviour, I employ the difference-in-differences analysis using R&D tax credit as a quasi-natural experiment. The US R&D tax incentive policy has induced more R&D investment but would not directly affect firms' capital structure. After utilizing this exogenous policy shock in a DID analysis with the propensity

score matching approach, the causal effect of R&D tax credit policy on the probability of becoming zero-levered further supports the non-trivial role of R&D investment in the zero-leverage puzzle.

4.2. Empirical results

In this section, I present and discuss the empirical results of the first study. The structure of this section is as follows. The first subsection presents the initial evidence for the relationship between R&D and the zero-leverage puzzle, and the results of the formal test for the effect of R&D on the probability of adopting the zero-leverage policy. In the subsequent subsection, I present the results of the trend analysis. Subsection 4.2.4. shows the results for the DID test. The last subsection presents the results for cross-sectional tests and additional robustness.

4.2.1. Initial results and summary statistics

Table 4.1 presents the annual numbers and percentages of zero-leverage (ZL) and almost zero-leverage (AZL) firms over the sample period. Consistent with the existing studies (e.g., Bessler et al., 2013; Strebulaev and Yang, 2013; D'mello and Gruskin, 2014), the results show a remarkably increasing propensity to use debt conservatively over the past three decades. Specifically, Columns 2 and 3 show that the numbers of zero-leverage and almost zero-leverage firms increased dramatically from the 1980s to the mid-2000s and decreased after the 2008 financial crisis. Columns 5 and 6 show that the proportion of zero-leverage firms has somehow persisted at a high level beyond the mid-2000s, though the proportion of almost zero-leveraged firms reduced mildly after 2010. Zero-leverage firms account for only 4.59% of the total listed firms in 1980, but the

proportion nearly quadrupled in 2017. Overall, an upward trend of the zero-leverage phenomenon can be observed during the past four decades in the US.

To check whether R&D firms drive the increasing trend of zero-leverage firms, I split the sample into R&D and non-R&D subsamples based on firms' capitalized R&D stocks[5]. Figure 4.1 illustrates the proportions of zero-leverage firms with R&D investment and without R&D investment over time. In the 1980s, both groups have a similar proportion of zero-leverage firms at around 3%. Since the early 1990s, the proportion of zero-leverage firms with R&D investment dramatically increased from about 4% to 14%.

In contrast, the proportion of zero-leverage firms without R&D investment only experienced a relatively trivial increase from about 4% to 5%. The finding implies that the initial evidence of the increasing trend of zero-leverage firms might be attributable to the R&D firms.

5 The findings remain unchanged if the sample is split based on whether a firm has R&D expenditure (Compustat XRD is larger than zero).

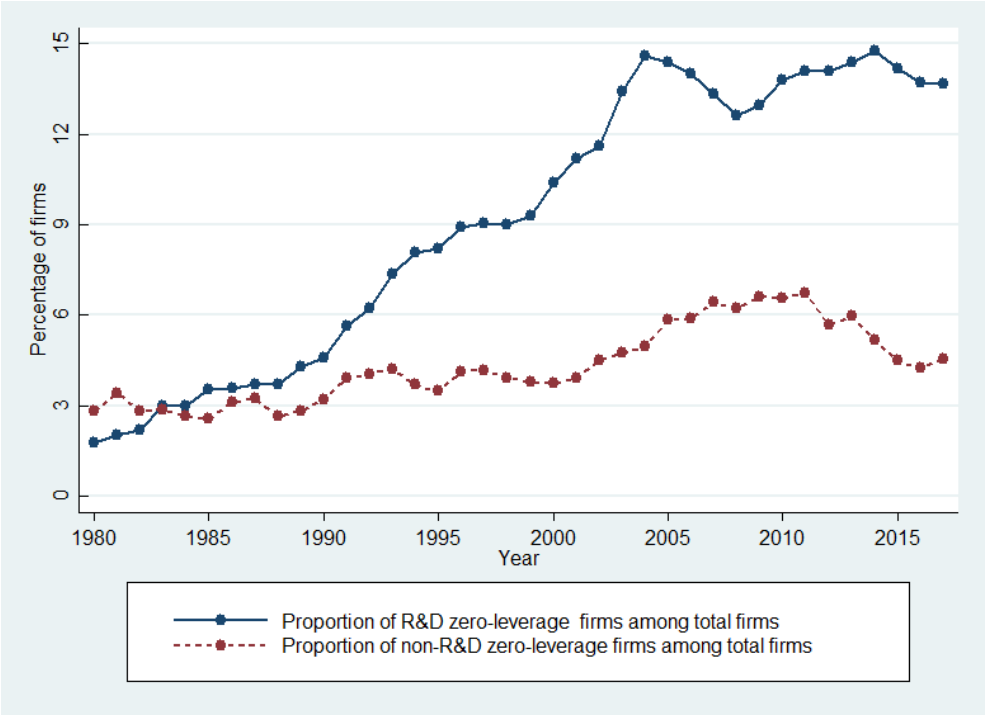
Table 4.1. Frequency of zero-leverage firms

This table shows the number and percentage of zero-leverage firms to the number of all firms in each given year. Zero-leverage firms (ZL) are firms that have zero debt, including long-term and short-term debts in a given year. Almost zero-leverage (AZL) are firms that have less than 5% book leverage ratio in a given year.

Year	Full (No.)	ZL (No.)	AZL (No.)	ZL (%)	AZL (%)
	(1)	(2)	(3)	(4)	(5)
1980	3183	146	385	4.59	12.1
1981	3421	186	475	5.44	13.88
1982	3359	169	476	5.03	14.17
1983	3600	212	669	5.89	18.58
1984	3588	203	592	5.66	16.50
1985	3511	214	571	6.1	16.26
1986	3637	244	620	6.71	17.05
1987	3753	261	631	6.95	16.81
1988	3557	226	560	6.35	15.74
1989	3411	244	583	7.15	17.09
1990	3349	262	617	7.82	18.42
1991	3448	330	758	9.57	21.98
1992	3698	380	900	10.28	24.34
1993	4133	479	1090	11.59	26.37
1994	4387	516	1125	11.76	25.64
1995	4734	554	1258	11.7	26.57
1996	5213	680	1532	13.04	29.39
1997	5312	702	1569	13.22	29.54
1998	5097	659	1380	12.93	27.07
1999	5044	660	1459	13.08	28.93
2000	4916	694	1554	14.12	31.61
2001	4377	661	1381	15.1	31.55
2002	4063	654	1282	16.1	31.55
2003	3843	697	1287	18.14	33.49
2004	3835	749	1362	19.53	35.51
2005	3793	767	1365	20.22	35.99
2006	3760	747	1317	19.87	35.03
2007	3725	736	1331	19.76	35.73
2008	3487	656	1140	18.81	32.69
2009	3272	639	1142	19.53	34.90
2010	3161	644	1161	20.37	36.73
2011	3063	637	1063	20.8	34.70
2012	2987	590	977	19.75	32.71
2013	3022	614	971	20.32	32.13
2014	3069	612	937	19.94	30.53
2015	3004	560	858	18.64	28.56
2016	2892	519	798	17.95	27.59
2017	2830	516	773	18.23	27.31
Mean	3684	468	940	12.68	25.12
Total	154,712	19,644	39,479	12.70	25.52

Figure 4.1. Percentage of zero-leverage subsamples by R&D

The figures compare the trend of zero-leverage firms by R&D during 1980-2017. The solid line represents the proportion of the number of zero-leverage firms that have R&D stock over the total number of firms in each year. The dashed line represents the proportion of non-R&D zero-leverage (almost zero-leverage) firms. The R&D (non-R&D) firms consist of firms with (without) non-zero capitalized R&D stocks in a given year.



To explore firms' features of zero-leverage behaviour, I further check the descriptive statistics of firm characteristics in Table 4.2. All the variables are winsorized at 1% to remove the influence of outliers and exclude the observations with missing values. Table 4.2 reports the moving average of the cross-sectional mean obtained by first calculating the cross-sectional mean of each year and then computing the time-series mean of all years. The figure in the last row is the average number of observations used to calculate the cross-sectional mean in each year. Using the moving average mean can eliminate the effect of short-run fluctuation and extreme values (Molugaram et al., 2017). On average, about 12% (319/2613) of all firms are zero-leverage in each year, a little

over two-thirds of the observations (218/319) are R&D active firms, and just under one-third (101/319) have no R&D investment.

Comparing firm characteristics of zero-leverage firms with all firms in Columns 1 and 2, zero-leverage firms spend more on R&D, are smaller in firm size and younger, pay more dividends, stay in an industry with a higher fraction of zero-leverage firms, and have higher market-to-book ratios, less profit, less tangible assets, higher earnings volatility, a higher proportion of firms which were zero-leverage initially, less capital expenditure, higher future investment opportunity, and higher asset sales.

However, a firm's leverage decision can be influenced by several factors, such as industry, firm size, calendar year, and dividend payout policy. These factors can lead to differences in firm characteristics between zero-leverage firms and other firms, resulting in misleading conclusions. Therefore, the difference in the leverage between zero-leverage firms and proxy firms can be purely attributed to other firm characteristics.

To make sure those factors would not drive the results, I follow Strebulaev and Yang (2013) to choose up to four proxy firms that are in the same three-digit SIC industry, in the same year, have similar book value of total assets, and follow the same dividend payout policy with zero-leverage firms.[6] Columns 2 and 3 further confirm the features that zero-leverage firms have higher R&D investment and market-to-book ratio, less tangible assets, generate more profit and pay more dividends to their shareholders than proxy firms.

[6] The similar book value of total assets is defined as up to four closest total assets that are between 0.5 and 2 times the corresponding zero-leverage firm's total assets.

I further split the zero-leverage sample by their R&D stocks in Columns 4 and 5 and report the p-value for the difference-in-means of firm characteristics between R&D and non-R&D firms in Column 6. Except for the initial zero-leverage status, abnormal capital expenditure, and age, all other variables are significantly different between the two groups. On average, R&D zero-leverage firms are smaller and much less profitable, pay lower dividends, stay in an industry with a higher fraction of zero-leverage firms, sell more assets, have a higher market-to-book ratio, higher earnings volatility, and less capital expenditure, less tangible assets, and are less likely to be dividends payers.

These features seem to show that R&D zero-leverage firms in our sample are relatively weak in their financial positions. Such noticeable different characteristics are possibly due to their risky R&D investment. Overall, the initial evidence suggests that R&D activities might explain firms' zero-leverage behaviour. The following sections present the results of formal tests.

Table 4.2. Descriptive statistics

This table shows the descriptive statistics of firm characteristics for the full sample, zero-leverage (ZL) firms, proxy, and zero-leverage subsamples by R&D stocks. R&D stock is calculated by the perpetual inventory method. For each zero-leverage firm, I choose up to four non-zero-leverage firms (Proxy) that are in the same three-digit SIC industry and year, have a similar book value of total assets, and follow the same dividend payout policy. Columns (1) to (5) report the moving average mean of cross-sectional means. Column (6) reports the p-value for the difference-in-mean tests of Columns (4) and (5). The bottom of the table reports the average number of observations used to calculate the cross-sectional mean in each year. Standard errors are reported in parentheses. All continuous variables are winsorized at their 1st and 99th percentiles. Detailed variable definitions are in Appendix A.

	Full sample	ZL	Proxy	R&D ZL	Non-R&D ZL	Diff.-in-Mean
	(1)	(2)	(3)	(4)	(5)	(6)
Book leverage	0.253	0.000	0.203	0.000	0.000	-
	(0.263)	(0.000)	(0.277)	(0.000)	(0.000)	-
R&D-to-sales	0.122	0.270	0.266	0.388	0.000	0.000
	(0.562)	(0.845)	(0.605)	(0.994)	(0.000)	
R&D-to-assets	0.039	0.073	0.073	0.107	0.000	0.000
	(0.077)	(0.099)	(0.103)	(0.105)	(0.000)	
R&D dummy	0.467	0.580	0.405	0.893	0.000	0.000
	(0.498)	(0.481)	(0.478)	(0.296)	(0.000)	
Log(size)	5.569	4.530	4.589	4.422	4.751	0.000
	(1.814)	(1.269)	(1.249)	(1.246)	(1.280)	
Market-to-book	1.684	2.234	1.911	2.363	1.960	0.000
	(1.123)	(1.611)	(1.348)	(1.674)	(1.413)	
Profitability	0.092	0.079	0.050	0.054	0.139	0.000
	(0.155)	(0.202)	(0.193)	(0.211)	(0.155)	
Tangibility	0.298	0.187	0.237	0.140	0.276	0.000
	(0.222)	(0.175)	(0.199)	(0.118)	(0.224)	
Dividend payer	0.411	0.387	0.280	0.329	0.510	0.000
	(0.472)	(0.440)	(0.396)	(0.413)	(0.472)	
Dividend payout	0.010	0.017	0.007	0.014	0.023	0.000
	(0.019)	(0.028)	(0.017)	(0.025)	(0.032)	
Earnings volatility	0.072	0.097	0.095	0.106	0.078	0.000
	(0.066)	(0.078)	(0.079)	(0.081)	(0.065)	
Init. ZL	0.109	0.363	0.164	0.352	0.361	0.613
	(0.306)	(0.477)	(0.361)	(0.477)	(0.472)	
Ind. Frac.ZL	0.124	0.150	0.167	0.175	0.108	0.000
	(0.065)	(0.066)	(0.060)	(0.063)	(0.040)	
Capital expenditure	0.062	0.049	0.056	0.040	0.066	0.000
	(0.062)	(0.053)	(0.060)	(0.038)	(0.070)	
Abnormal Cap. Ex.	0.052	0.092	0.064	0.081	0.108	0.425
	(0.754)	(0.891)	(0.842)	(0.886)	(0.876)	
Asset sale	0.028	0.052	0.036	0.059	0.034	0.000
	(0.088)	(0.124)	(0.104)	(0.129)	(0.094)	
Log(age)	2.432	2.302	2.283	2.275	2.364	0.179
	(0.529)	(0.512)	(0.516)	(0.504)	(0.521)	
Avg. No. of obs.	2613	319	675	218	101	

4.2.2. The impact of R&D on zero-leverage behaviour over time

Column 1 of Table 4.3 reports the original coefficients of the logit model in Equation (1). The result is in line with the findings of Strebulaev and Yang (2013), though my sample and sample period are different from theirs. However, the parameter estimates of a logit model (the original coefficients) are difficult to interpret, so I report the average marginal effect following Dang (2013) and Bessler et al. (2013) in the rest of the tests. Marginal effects indicate the change in the probability of being zero-leverage due to a change in a continuous independent variable holding all other variables in the model constant (Bartus, 2005). Therefore, the average marginal effect can be interpreted as the increase in the probability of firms being zero-leverage caused by the increase in one unit of an independent variable, holding other variables at the mean.

Columns 2 to 4 report the marginal effects of Equation (1) using the three measures of R&D investment. The results show that the R&D-to-sales ratio, R&D-to-assets ratio, and R&D dummy all have significant positive effects in determining firms' likelihood of zero-levered. Specifically, one unit increase in R&D-to-sales ratio and R&D-to-assets ratio leads to 1.6% and 18.5% increase in the probability of being zero-leverage firms, respectively. Compared with non-R&D firms, the likelihood of being unlevered for R&D firms is 1.4% higher.

Table 4.3. The effect of R&D on zero-leverage decision

This table presents the marginal effects of logit regression of R&D on the probability of being zero-leverage firms for the full sample. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. Column (1) reports the original logit coefficients and standard error (in parentheses) based on R&D-to-sales ratio, and Columns (2) to (4) report the average marginal effects and Delta-method standard errors. Industry and year fixed effects are included in all the regressions. All standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

	Original coefficient	Marginal effect		
	(1)	(2)	(3)	(4)
R&D-to-sales$_{i,t-1}$	0.189***	0.016***		
	(0.026)	(0.002)		
R&D-to-assets$_{i,t-1}$			0.185***	
			(0.026)	
R&D dummy$_{i,t-1}$				0.014**
				(0.006)
Log(size)$_{i,t-1}$	-0.446***	-0.037***	-0.037***	-0.037***
	(0.020)	(0.002)	(0.002)	(0.002)
Market-to-book$_{i,t-1}$	0.163***	0.013***	0.012***	0.014***
	(0.016)	(0.001)	(0.001)	(0.001)
Profitability$_{i,t-1}$	1.859***	0.154***	0.152***	0.107***
	(0.154)	(0.013)	(0.013)	(0.012)
Tangibility$_{i,t-1}$	-3.039***	-0.252***	-0.243***	-0.244***
	(0.238)	(0.019)	(0.020)	(0.020)
Dividend payer$_{i,t-1}$	0.091	0.008	0.008	0.008
	(0.085)	(0.007)	(0.007)	(0.007)
Dividend payout$_{i,t-1}$	15.537***	1.288***	1.317***	1.349***
	(1.433)	(0.119)	(0.119)	(0.119)
Earnings volatility$_{i,t-1}$	0.663*	0.055*	0.048	0.070**
	(0.358)	(0.030)	(0.030)	(0.029)
Ind. Frac.ZL$_{j,t-1}$	4.993	0.414	0.520	0.514
	(5.260)	(0.436)	(0.435)	(0.438)
Init. ZL$_{i,t-1}$	1.191***	0.099***	0.099***	0.099***
	(0.077)	(0.006)	(0.006)	(0.006)
Capital expenditure$_{i,t-1}$	1.748***	0.145***	0.112***	0.127***
	(0.485)	(0.040)	(0.041)	(0.041)
Abnormal Cap. Ex.$_{i,t}$	-0.056***	-0.005***	-0.004***	-0.004***
	(0.014)	(0.001)	(0.001)	(0.001)
Asset sale$_{i,t-1}$	2.192***	0.182***	0.179***	0.184***
	(0.166)	(0.014)	(0.014)	(0.014)
Log(age)$_{i,t-1}$	-0.033	-0.003	-0.004	-0.005
	(0.048)	(0.004)	(0.004)	(0.004)
Pseudo R^2	0.24	0.24	0.24	0.23
No. of obs.	91,681	91,681	92,154	92,154

Other control variables are all reasonable. The negative coefficients on firm size indicate that small firms are more likely to be zero-leverage. Firms with high market-to-book are more likely to be zero-leverage, as they may prefer to use equity financing to take advantage of the overvalued share price. Profitability is a positive factor, as profitable firms may have sufficient internal sources of financing. The coefficients on tangibility are significantly negative in all regressions, suggesting that high tangibility increases firms' chance of raising debt and makes them less likely to stay zero-leverage. Being a dividend payer does not seem to matter, but the amount of dividend payment increases firms' likelihood to be zero-leverage. Firms with volatile earnings may be perceived by external finance providers as risky and thus are more likely to be zero-leverage.

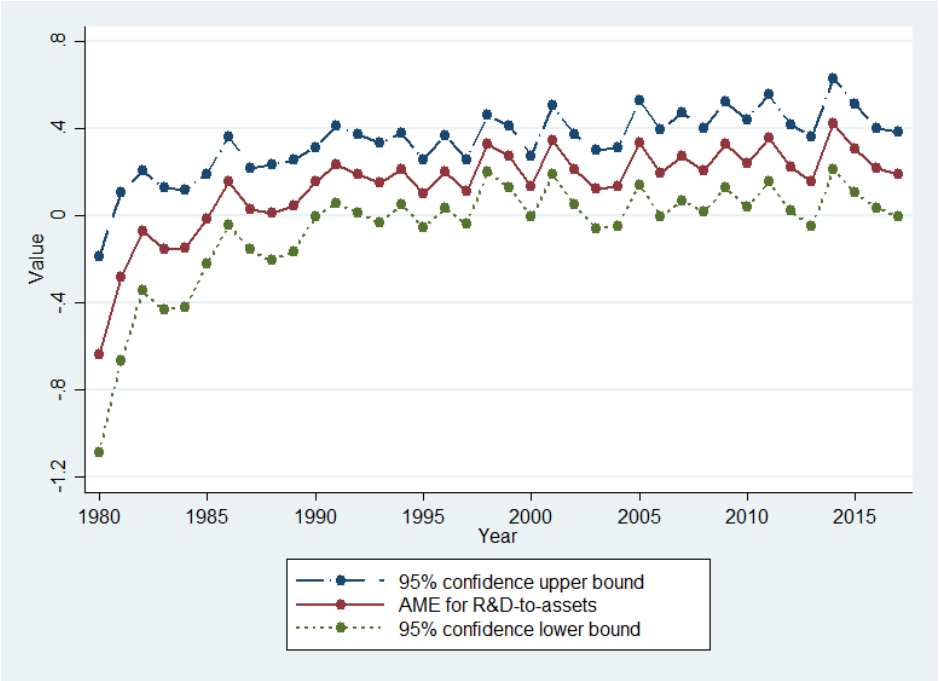
Given that industry fixed effects have been controlled, the industrial fraction of zero-leverage firms does not seem to influence individual firms' probability of being zero-levered. If firms were zero-leverage at the beginning of the period, they are likely to continue staying so. High capital expenditure and low abnormal capital expenditure lead to a high probability of staying zero-leverage. Asset sales would generate internal funds for firms and thus increase the chance of being zero-leverage as expected. Firm age does not seem to have a pronounced impact.

The results in Table 4.3 demonstrate that R&D has a strong impact on firms' zero-leverage behaviour. Brown et al. (2009) show that R&D investment has experienced three waves of growth from 1980 until 2000 and declines sharply in 2002. Therefore, I further examine the marginal effects over time. Figure 4.2 plots the coefficients on *R&D-to-assets* from the marginal effects of logit

regression by year.[7] It shows that the impact of R&D on the probability of becoming zero-levered varies over time and has increased somewhat sharply during the 1980s and 1990s but only had a mild increasing trend after that.

Figure 4.2. Average marginal effects of R&D from logit regressions with 95% confidence intervals

This figure plots the marginal effects on the R&D-to-assets ratio in cross-section yearly regressions from the model of Table 4.3. The solid line shows the average marginal effect of R&D-to-assets on the probability of being zero-levered for each year during 1980-2017. The solid-dashed and dashed lines represent 95% confidence lower bound and upper bound of the marginal effects, respectively.



Anzoategui et al. (2019) document that R&D activity may be subject to the influence of business circles, which affects financing costs in the capital market. For instance, due to the higher cost of external financing during a recession,

[7] I also used R&D dummy instead of the R&D-to-assets ratio to obtain the marginal effects of the same regression. The plot shows similar trend. The results are presented in Appendix B2.

companies could stay unlevered and have fewer resources and incentives to conduct R&D. Therefore, I next divide the sample into four periods based on the business cycles. The cut-off points include 1990, 2001, and 2007, which are selected based on the peak-through-peak turning points announced by the National Bureau of Economic Research (NBER)[8].

In Table 4.4, I report the results for the R&D-to-assets in Panel A and R&D dummy in Panel B, respectively. The subsample results show a consistent trend that R&D does not seem to impact firms' probability of being zero-levered (Column 1) before 1990. Column 2 shows that the R&D-to-assets ratio significantly affects the likelihood of becoming zero-levered from 1991 to 2001, though firms' R&D status remains insignificant. After 2002, the R&D effects are always significantly positive for both R&D measures (Columns 3 and 4). After controlling the effects of business cycles, the results in Table 4.4 confirm that the marginal effects of R&D on the probability of being zero-levered display an increasing trend over time.

Bessler et al. (2013) find that IPO waves play a significant role in determining firms' probability of being zero-levered. To release the concern of IPO effects, I exclude observations that had gone public over the past five years before year *t* and report the results in Appendix B3 and B4. The results remain qualitatively unchanged, suggesting that the increased sensitivity between R&D and zero-leverage decisions could not be attributable to the newly listed IPO firms. Overall, the results show that R&D has a significant positive impact on firms' probability of being zero-levered, and such effects have strengthened over time.

[8] The data can be found from https://www.nber.org/cycles/cyclesmain.html.

4.2.3. The impact of the changes in R&D investment vs. R&D sensitivity

Table 4.4. The marginal effect of R&D on zero-leverage policy over business cycles

This table reports the marginal effects of logit regressions of R&D on zero-leverage policy over business cycles. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. Panel A reports the results for the R&D-to-assets ratio, and Panel B reports the results for the R&D dummy. The business cycle periods are split based on the turning points announced by the NBER. All the regressions include control variables, industry and year fixed effects. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

Period	1980-1990	1991-2001	2002-2007	2008-2017
	(1)	(2)	(3)	(4)
Panel A. R&D measured by R&D-to-assets				
$R\&D\text{-}to\text{-}assets_{i,t-1}$	0.030	0.195***	0.206***	0.264***
	(0.054)	(0.037)	(0.058)	(0.058)
Pseudo R^2	0.25	0.22	0.20	0.23
No. of obs.	24,359	28,931	16,640	22,224
Panel B. R&D measured by R&D dummy				
$R\&D\ dummy_{i,t-1}$	-0.004	0.010	0.026**	0.034***
	(0.006)	(0.008)	(0.012)	(0.012)
Pseudo R^2	0.25	0.21	0.20	0.22
No. of obs.	24,359	28,931	16,640	22,224

Brown et al. (2009) find that both the aggregate R&D investment and the numbers of R&D firms have experienced steep increases and lasted for a decade. Although the results in Table 4.4 demonstrate that the impact of R&D on zero-leverage behaviour has been increasing since 1980, it is still unclear whether the change in R&D investment or the change in R&D sensitivity of zero-leverage status contributes more to the total effect of R&D on the probability of being zero-levered. Therefore, I follow He and Wintoki (2016) to decompose the effect of R&D on the probability of zero-levered into the effect due to the changes in R&D investment (i.e., changing factor) and the effect due to the changes in the sensitivity of R&D and the probability of being zero-leverage firms (i.e., changing sensitivity).

To conduct the tests, I compare two equal-length sample periods of 1980-1992 and 2005-2017 since Brown et al. (2009) state that the second R&D wave ended in 1992. The results are reported in Table 4.5. Columns 1 and 2 present the means of all the regression variables. Columns 3 and 4 present the coefficients on R&D of the marginal effects of the logit model for each period, respectively. The results for the R&D-to-assets ratio are reported in Panel A and the R&D dummy in Panel B. In Panel A, the mean of the R&D-to-assets ratio increased from 0.041 to 0.109, and the marginal effect of R&D on firms' probability of being zero-levered increases dramatically from 0.078 (marginally significant) to 0.262 (highly significant) from the first to the second sample period.

Assuming that the estimated effect of R&D in the first period remains unchanged in the second period, the percentage change in the probability of being zero-leverage firms due to the changing factor can be calculated as the difference in the mean of each variable between the two periods multiplying by the average marginal effect in the first period, i.e. [mean(2005-2017) – mean(1980-1992)] × AME(1980-1992). Since I hold the effect of the factors constant and only allow variation in the mean values of firm characteristics, the results reported in Column 5 can be attributed solely to the changing factor channel. For example, under the assumption that the marginal effect of R&D 0.078 during 1980-1992 remains constant during 2005-2017, the increase in the probability of being zero-levered due to the increase in a firm's R&D-to-assets ratio is (0.109-0.041)×7.8%= 0.53%.

Similarly, to calculate the percentage change in the probability of being zero-leverage firms arising from the changing sensitivity with the explanatory variables, I hold the mean of firms' characteristics constant and only allow variation in the sensitivity of firms' probability of being zero-levered to that

characteristic. The percentage change due to the changing sensitivity can be calculated as the mean of each variable in the first period multiplied by the difference in the average marginal effects between the two periods, i.e., mean(1980-1992) × [AME(2005-2017) - AME(1980-1992)]. Therefore, the numbers reported in Column 6 can be attributed only to the changing sensitivity channel. For instance, if the mean of R&D-to-asset ratio (0.041) during 1980-1992 remained constant during 2005-2017, the increase in the firms' probability of being zero-levered due to the changing sensitivity of the probability to R&D would be 0.041×(0.262-0.078) = 0.75%.

Column 7 presents the sum of Columns 5 and 6, which indicates how much variation in the probability of being unlevered is due to the change in R&D investment. Specifically, the change in R&D investment and the change in the sensitivity to R&D have increased the probability of being zero-leverage firms by 1.28% from the 1980-1992 period to the 2005-2017 period. Calculating using the figures in Column 4 of Table 4.1, the actual increase in the probability of being zero-leverage firms between these two periods was 12.82% (19.58% during 2005-2017, up from 6.76% during 1980-1992). This number implies that the total effects of R&D can explain 10% (1.28 %/12.82%) of the observed increase in the probability of being zero-leverage over the entire sample period, where the changing factor channel contributes 4.1% (0.53%/12.82%), and the changing sensitivity channel contributes 5.9% (0.75%/12.82%) to the total effect.

In summary, the results of Table 4.5 are highly consistent and clearly indicate that the change in sensitivity contributes more to the total effect of R&D on zero-leverage behaviour than the change in R&D investment.

Table 4.5. Decomposition of the increase in the probability of being zero-levered

This table decomposes the increase in the aggregate probability of adopting zero-leverage decisions into changes in firm characteristics (changing factor) and changes in sensitivity (changing sensitivities). Panel A is based on the R&D-to-assets ratio, and Panel B is based on the R&D dummy. Columns (1) and (2) present the mean values of each variable for zero-leverage firms during 1980-1992 and 2005-2017, respectively. Columns (3) and (4) present the average marginal effects (AME) for being zero-leverage firms during 1980-1992 and 2005-2017, respectively. The percentage change in the aggregate probability of being zero-leverage firms arising from the changing factor is reported in Column (5), which is calculated as [Mean(2005-2017) - Mean(1980-1992))×AME(1980-1992). The percentage change in the aggregate probability of being zero-leverage firms arising from the changing sensitivity is reported in Column (6), which is calculated as Mean(1980-1992)×[AME(2005-2017) - AME(1980-1992)]. Column (7) shows the total effect of variables that is the sum of the effects reported in Columns (5) and (6). Industry and year fixed effects are included in all the regressions. *, ** and *** indicate significance at the 10%, 5% and 1% level respectively.

	Mean	Mean	AME	AME	Changing factor	Changing sensitivity	Total
Period	1980-1992	2005-2017	1980-1992	2005-2017			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. R&D measured by R&D-to-assets							
$R\&D\text{-}to\text{-}assets_{i,t-1}$	0.041	0.109	0.078*	0.262***	0.53%	0.75%	1.28%
$Log(size)_{i,t-1}$	3.963	4.702	-0.023***	-0.052***	-1.70%	-11.53%	-13.23%
$Market\text{-}to\text{-}book_{i,t-1}$	2.178	2.620	0.012***	0.012***	0.51%	0.14%	0.65%
$Profitability_{i,t-1}$	0.121	-0.015	0.081***	0.208***	-1.11%	1.53%	0.42%
$Tangibility_{i,t-1}$	0.222	0.128	-0.090***	-0.284***	0.85%	-4.31%	-3.46%
$Dividend\ payer_{i,t-1}$	0.438	0.215	0.015**	0.005	-0.32%	-0.40%	-0.73%
$Dividend\ payout_{i,t-1}$	0.019	0.012	0.959***	1.245***	-0.67%	0.54%	-0.13%
$Earnings\ volatility_{i,t-1}$	0.082	0.115	0.160***	0.090	0.53%	-0.58%	-0.05%
$Ind.\ Frac.ZL_{j,t-1}$	0.133	0.169	0.331	0.484	1.19%	2.03%	3.22%
$Init.\ ZL_{i,t-1}$	0.535	0.449	0.081***	0.106***	-0.70%	1.34%	0.65%
$Capital\ expenditure_{i,t-1}$	0.063	0.036	-0.115**	0.292***	0.31%	2.56%	2.87%
$Abnormal\ Cap.\ Ex._{i,t}$	0.059	0.139	-0.006***	0.001	-0.04%	0.04%	0.00%
$Asset\ sale_{i,t-1}$	0.022	0.073	0.023	0.264***	0.12%	0.53%	0.65%
$Log(age)_{i,t-1}$	1.547	2.187	-0.007	0.000	-0.45%	1.03%	0.58%

Table 4.5. – *Continued*

No. of obs.	29125	30213	29125	30213			
Panel B. R&D measured by R&D dummy							
$R\&D\ dummy_{i,t-1}$	0.463	0.669	-0.004	0.032***	-0.09%	1.68%	1.59%
$Log(size)_{i,t-1}$	3.963	4.702	-0.023***	-0.052***	-1.69%	-11.68%	-13.37%
$Market\text{-}to\text{-}book_{i,t-1}$	2.178	2.620	0.012***	0.016***	0.55%	0.69%	1.24%
$Profitability_{i,t-1}$	0.121	-0.015	0.073***	0.142***	-0.99%	0.83%	-0.16%
$Tangibility_{i,t-1}$	0.222	0.128	-0.093***	-0.284***	0.87%	-4.24%	-3.37%
$Dividend\ payer_{i,t-1}$	0.438	0.215	0.014**	0.004	-0.32%	-0.44%	-0.76%
$Dividend\ payout_{i,t-1}$	0.019	0.012	0.954***	1.291***	-0.67%	0.64%	-0.03%
$Earnings\ volatility_{i,t-1}$	0.082	0.115	0.168***	0.113**	0.55%	-0.45%	0.10%
$Ind.\ Frac.ZL_{j,t-1}$	0.133	0.169	0.301	0.540	1.08%	3.17%	4.26%
$Init.\ ZL_{i,t-1}$	0.535	0.449	0.082***	0.106***	-0.70%	1.30%	0.59%
$Capital\ expenditure_{i,t-1}$	0.063	0.036	-0.110**	0.307***	0.30%	2.62%	2.92%
$Abnormal\ Cap.\ Ex._{i,t}$	0.059	0.139	-0.006***	0.001	-0.04%	0.04%	-0.01%
$Asset\ sale_{i,t-1}$	0.022	0.073	0.020	0.273***	0.10%	0.56%	0.66%
$Log(age)_{i,t-1}$	1.547	2.187	-0.008	-0.001	-0.48%	1.01%	0.53%
No. of obs.	29,125	30,213	29,125	30,213			

4.2.4. Exogenous policy shocks – state R&D tax credit

The US and European policymakers have been concerned about the technological development of their countries in the Twentieth Century. These concerns were sharpened by the success of the technology-based economy in Japan and South Korea (Bloom et al., 2002). To overcome the competitive threat, the US introduced the Economic Recovery Tax Act in 1981 to give firms a tax credit on incremental R&D expenditure. It has been well documented by a large body of literature that these tax incentives are effective in stimulating R&D investments (e.g., Berger, 1993; Hall, 1993; Mccutchen Jr, 1993; Mamuneas and Nadiri, 1996; Hall and Wosinska, 1999; Bloom et al., 2002; Wilson, 2009).

To explore the causal relationship between R&D and zero-leverage behaviour, I utilize R&D tax credit policies as exogenous shocks and conduct the DID tests. These policy shocks could directly impact firms' R&D investment but potentially not affect firms' zero-leverage policy.

I obtained information on the states that introduced R&D tax credit policy and the years of implementation from Falato and Sim (2014). Based on their identification, I match 38 states that implemented R&D tax credit policy from 1983 to 2011. These policy shocks induce qualified firms to join R&D efforts of a sudden and have no direct relation with firms' zero leverage decisions. Therefore, these tax credit policies would be exogenous to firms' zero leverage behaviour and suitable for the DID tests of the causality from R&D to zero leverage.

To avoid the problem that the results of the DID analysis are influenced by heterogeneous characteristics between different groups of firms, I employ a propensity score matching approach. Specifically, I first define a treatment group of firms operating in a state that has implemented the R&D tax credit policy and a control group of firms being otherwise.

Next, I calculate the propensity score that a firm would experience the implementation of the R&D tax credit incentive using the treatment group dummy as the dependent variable in a logit regression.

The propensity score is calculated using firm size, age, market-to-book, profitability, capital expenditure, dividend payer, and initial zero-leverage status. I choose firm size, age, and market-to-book as matching variables because they are common determinants of capital structure (Titman and Wessels, 1988). Prior studies (Bessler et al., 2013; Strebulaev and Yang, 2013; D'mello and Gruskin, 2014) suggest that zero-leverage policy tends to be persistent and can be explained by financial constraint and financial flexibility theories. Therefore, I also include the initial zero-leverage status to capture the persistency of zero-leverage behaviour, dividend payer to capture the status of financial constraint, and capital expenditure and profitability to capture the incentive of reserving financial flexibility.

The propensity score is the predicted value of this regression. Using the estimated propensity score of each firm in the treatment group, I select the firm with the closest propensity score in a radius of 1% from the firms that do not

Table 4.6. DID test for the impact of R&D tax credit policy on the probability of being zero-levered

This table reports the difference-in-differences analysis using the implementation of the R&D tax credit as the exogenous shock. The sample is from 1983 to 2011. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. *Treat* is a dummy variable that equals one if a firm operates in a state *s* that experiences the implementation of R&D tax credit and zero otherwise. Post is a dummy equal to one if a state *s* has introduced the R&D tax credit policy by the time *t*, and zero otherwise. I use the propensity score matching approach to select matched firms with the three closest propensity scores in a radius of 1% from the firms that operate in a state without R&D tax credit during the same year. The procedure is repeated for the R&D and non-R&D subsamples. Columns (1), (4) and (7) report the results for three years before and after the shocks interval. $Pre - trend_{i,t-1}$ ($Pre - trend_{i,t-2}$) in Columns (2), (5) and (8) is a dummy variable that equals one if a firm is headquartered in a state that implements the R&D tax credit policy in one year (two years) ahead and zero otherwise. Columns (3), (6) and (9) report the placebo test by falsely identifying the time of shock two years ahead. All regressions include control variables, year, state and industry fixed effects. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the state level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at 10%, 5% and 1% level respectively. Detailed variable definitions are in Appendix A.

	Full sample			R&D sample			Non-R&D sample		
	[+3,-3]	Pre-trend	Placebo	[+3,-3]	Pre-trend	Placebo	[+3,-3]	Pre-trend	Placebo
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Post_{i,t}$	-0.013	-0.013	0.001	-0.025	-0.026	0.006	-0.012	-0.012	-0.002
	(0.011)	(0.011)	(0.008)	(0.016)	(0.016)	(0.012)	(0.018)	(0.017)	(0.012)
$Treat_i$	-0.061***	-0.065***	-0.072***	-0.124***	-0.127***	-0.114***	-0.000	-0.005	-0.013
	(0.014)	(0.014)	(0.021)	(0.024)	(0.024)	(0.036)	(0.017)	(0.017)	(0.016)
$Post_{i,t}$×$Treat_i$	0.019*	0.019*		0.043***	0.040**		0.007	0.009	
	(0.011)	(0.011)		(0.016)	(0.016)		(0.014)	(0.014)	
$Pre - trend_{i,t-1}$		0.004			0.008			0.001	
		(0.005)			(0.008)			(0.004)	
$Pre - trend_{i,t-2}$		0.003			-0.002			0.006	
		(0.004)			(0.009)			(0.004)	
Placebo (-2)			0.005			0.003			0.006
			(0.006)			(0.010)			(0.007)
Pseudo R^2	0.25	0.25	0.25	0.29	0.29	0.29	0.23	0.23	0.23
No. of obs.	17,297	17,297	13,018	7363	7363	5605	9669	9669	7144

have R&D tax credit incentives in the same year to construct the matched firm group[9]. There are 1817 matched control firms and 2703 treated firms in the full sample. I also use the same procedure to choose the matched R&D (non-R&D) control firms for the treated R&D (non-R&D) firms, and find 739 matched R&D control firms for 1219 treated R&D firms, and 1078 matched non-R&D control firms for 1484 treated non-R&D firms. This matching procedure significantly reduces the possibility that firm characteristics may drive the difference in the zero-leverage probability between treated and control firms.

In the next step of DID test, I include all the control variables in Equation (2) to further mitigate the effect of different characteristics that potentially influence the zero-leverage decision. The following logit model is estimated for the DID test:

$$\Pr(ZL) = \beta_0 + \beta_1 Treat_i + \beta_2 Post_{i.t} + \beta_3 Treat_i \times Post_{i,t} + Control\ variables_{i,t-1} + v_t + v_j + v_s + \varepsilon_{i,t,} \quad (3)$$

$Treat_i$ is a dummy variable equal to one if firm *i* is affected by the policy shock, i.e., in an industry of a state that implements the R&D tax credit policy, and zero otherwise. $Post_{i,t}$ is a dummy variable equal to one if firm *i* has experienced the R&D tax credit policy shock by the time t, and zero otherwise. The interaction term $Treat_i \times Post_{i,t}$ is the variable of interest, and β_3 captures the causal effect of R&D tax credit implementation on the zero-leverage decision of the

[9] I use replacement procedure when the multiple treatment firms match the same control firm that has the closest propensity score. In other words, a control firm can be matched more than once. Replacement condition can always match the treated firms to the closest control firms. Therefore, it reduces bias and produces more balance than matching without replacement. Replacement condition can also make the order of matching procedure irrelevant, whereas the result generated by matching without replacement depends on the order that each match occurs (Caliendo and Kopeinig, 2008).

treated firms. $Control\ variables_{i,t-1}$ are exactly the same as the control variables in Equation (2). v_t, v_s and v_j are time, state and industry dummies, respectively, and $\varepsilon_{i,t}$ is an idiosyncratic error. Given that the variation in the implementation of R&D tax credit policy is at the state level, I use robust standard errors clustered by the state level to control for dependence in the error terms for firms in the same state.

Table 4.6 shows the DID results. For each of the full, R&D and non-R&D samples, I take data for three years before and after the shock year since firms may take time to react to the R&D credit shocks. In the full sample, β_3 is significantly positive, with values of 0.019 in Column 1. These results indicate that the probability of being zero-levered of treated firms increases by 1.9% more than that of matched firms in the control group three years after R&D credit shocks. Therefore, the results support the causal effect of R&D on zero-leverage behaviour.

If the shock truly reflects the impact of R&D on zero-leverage decisions, we should observe that the effect is more profound for the R&D subsample. Column 4 shows an even stronger effect in the R&D subsample, with the probability of being zero-levered of treated firms increasing by 4.3%. However, in the non-R&D subsample, β_3 is insignificant in Column 7. It suggests that implementing the R&D tax credit policies makes no difference in the chance of being zero-levered between treated and matched non-R&D firms.

A valid DID test relies on the fact that the treated and control groups share a similar time trend before the exogenous shock (Roberts and Whited, 2013). I follow prior studies (Acharya et al., 2014; Serfling, 2016; Park et al., 2019) to include $Pre-trend_{i,t-1}$, which is an interaction term between a dummy

variable indicating the fiscal year preceding the adoption of the R&D tax credit policy and the treat dummy. A significant coefficient of $Pre - trend_{i,t-1}$ suggests that the divergence of the probability of being zero-leverage between the treated and control groups already exists before the occurrence of the shock, implying a violation of the parallel assumption. Similarly, $Pre - trend_{i,t-2}$ is an interaction term between a dummy variable indicating two years preceding the adoption of R&D tax credit policy and the treat dummy.

Columns 2, 5 and 8 of Table 4.6 show insignificant variables of pre-treatment trend in each sample, suggesting that the pre-treatment trend for treated and control groups is statistically indistinguishable. Therefore, the results show no evidence for the violation of the parallel trend assumption, implying that the DID results are not biased by the pre-existing trend between the treated and control groups.

I also run placebo tests for each sample to further check the robustness following He and Wintoki (2016). I falsely define the policy shocks at *t*-2, take the sample period as three years before and after the false event year, and redo the same regressions. The results are reported in Columns 3, 6, and 9, respectively. I do not find any significant effects for the treated firms following the false shocks, which further supports that the actual shocks drive the DID results.

Overall, the DID tests show that after implementing the R&D tax credit policy, the probability of adopting the zero-leverage decision of treated firms is significantly larger than the matched firms, and the effect is more profound for R&D firms. This pattern cannot be found for non-R&D firms. The results confirm the positive causal relationship between R&D and firms' zero-leverage behaviour.

4.2.5. Cross-sectional test and additional robustness

As discussed in section 2, R&D-intensive firms are forced to choose zero-leverage for their capital structure policy due to the unique characteristics of R&D investment. In this case, the relationship between R&D and zero-leverage policy is more profound for firms with difficulty raising external financing. To test this prediction, I follow Whited and Wu (2006) and Hadlock and Pierce (2010) to use the WW index and SA index as the degree of financial constraint. The higher WW index and SA index imply a higher degree of financial constraint. I split the sample based on whether a firm's index is higher than the median value of a given year, and conduct the logit regression for the financially constrained and unconstrained groups separately.

Table 4.7. The effect of R&D on the zero-leverage decision by financial constraint

This table presents the marginal effects of logit regression of R&D on the probability of zero-leverage firms by financially constrained and unconstrained samples. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. R&D is measured by R&D-to-assets in Panel A and R&D dummy in Panel B. High and low WW index and SA index are identified based on whether the index is above the median value of a given year. Each column reports the average marginal effects and Delta-method standard errors. All regressions include control variables, year and industry fixed effects. All standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

	Low WW index	High WW index	Low SA index	High SA index
	(1)	(2)	(3)	(4)
Panel A. R&D measured by R&D-to-assets				
$R\&D\text{-}to\text{-}assets_{i,t-1}$	0.121^{***}	0.251^{***}	0.118^{***}	0.269^{***}
	(0.041)	(0.036)	(0.043)	(0.040)
Pseudo R^2	0.28	0.20	0.25	0.19
No. of obs.	48,096	39,141	59,443	32,711
Panel B. R&D measured by R&D dummy				
$R\&D\ dummy_{i,t-1}$	-0.004	0.047^{***}	-0.001	0.047^{***}
	(0.006)	(0.009)	(0.006)	(0.011)
Pseudo R^2	0.28	0.20	0.25	0.19
No. of obs.	48,096	39,141	59,443	32,711

Table 4.7 reports the results. Panel A shows that the R&D-to-assets ratio is significant in both financially constrained and unconstrained firms, regardless of the proxy of financial constraint. Nevertheless, the magnitude of the marginal effect is higher for constrained groups (High WW index and High SA index) than for unconstrained groups. In the untabulated results, the difference in coefficients between the two groups is statistically significant at 1%. Panel B shows that the R&D dummy has a highly significant positive effect on the probability of zero-leverage only for the financially constrained firms but not for the unconstrained group. The results support the hypothesis that R&D investments limit firms' borrowing capacity, leading to a higher likelihood of being unlevered.

Table 4.8 reports the additional tests for the almost zero-leverage phenomenon. Strebulaev and Yang (2013) argue that the low-leverage puzzle found by Graham (2000) is mainly driven by the zero-leverage puzzle. Therefore, I redo the main results for the almost zero-leverage decision. The results show consistent evidence. R&D investments have a positive effect on the probability of being almost zero-leverage firms, and the effect is significant at 1% for all the proxies of R&D investment.

Table 4.8. The effect of R&D on the almost zero-leverage decision

This table presents the marginal effects of logit regression of R&D on the probability of almost zero-leverage firms. The dependent variable is the almost zero-leverage dummy that equals one for almost zero-leverage firms and zero otherwise. Almost zero-leverage is defined as less than 5% book leverage ratio. Each column reports the average marginal effects and Delta-method standard errors. All regressions include control variables, year and industry fixed effects. All standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

	(1)	(2)	(3)
R&D-to-sales$_{i,t-1}$	0.028***		
	(0.003)		
R&D-to-assets$_{i,t-1}$		0.374***	
		(0.039)	
R&D dummy$_{i,t-1}$			0.028***
			(0.008)
Log(size)$_{i,t-1}$	-0.055***	-0.055***	-0.055***
	(0.002)	(0.002)	(0.002)
Market-to-book$_{i,t-1}$	0.031***	0.028***	0.033***
	(0.002)	(0.002)	(0.002)
Profitability$_{i,t-1}$	0.255***	0.270***	0.186***
	(0.018)	(0.018)	(0.016)
Tangibility$_{i,t-1}$	-0.426***	-0.406***	-0.407***
	(0.022)	(0.022)	(0.022)
Dividend payer$_{i,t-1}$	0.016*	0.017*	0.017*
	(0.009)	(0.009)	(0.009)
Dividend payout$_{i,t-1}$	1.955***	1.956***	2.021***
	(0.186)	(0.185)	(0.187)
Earnings volatility$_{i,t-1}$	0.076*	0.049	0.091**
	(0.043)	(0.044)	(0.043)
Ind. Frac.ZL$_{j,t-1}$	0.832	1.004*	1.010*
	(0.557)	(0.553)	(0.560)
Init. ZL$_{i,t-1}$	0.131***	0.129***	0.130***
	(0.009)	(0.009)	(0.009)
Capital expenditure$_{i,t-1}$	0.244***	0.192***	0.217***
	(0.047)	(0.048)	(0.048)
Abnormal Cap. Ex.$_{i,t}$	-0.011***	-0.009***	-0.010***
	(0.002)	(0.002)	(0.002)
Asset sale$_{i,t-1}$	0.220***	0.214***	0.223***
	(0.021)	(0.021)	(0.021)
Log(age)$_{i,t-1}$	-0.008	-0.009*	-0.011**
	(0.005)	(0.005)	(0.005)
Pseudo R^2	0.21	0.21	0.21
No. of obs.	91,681	92,154	92,154

4.3. Conclusion

This study investigates whether R&D investment can explain the zero-leverage puzzle using the data of US firms during the period 1980-2017. The results suggest that over the sample period, the increase in zero-leverage firms is likely to be driven by R&D firms, where two-thirds of zero-leverage firms are R&D intensive. The formal test shows that high R&D investment increases the probability of being a zero-leverage firm. The risk involved with R&D investment strengthens the effect of financial constraint, leading to high demand for financial flexibility and restricted access to debt financing.

I also provide evidence for the causal effect of R&D investments on the probability of being a zero-leverage firm through DID analysis. By investigating the effects of R&D investments on the zero-leverage decision, this study highlights the role of innovation in the zero-leverage puzzle. R&D can explain 10% of the increase in the probability of being zero-levered.

The second main finding is that the explanatory power of R&D on the zero-leverage puzzle has strengthened over time. The increased sensitivity of becoming zero-levered to R&D investment has made a more considerable contribution than incremental R&D investments.

This study makes several contributions to the literature. Firstly, it contributes to the zero-leverage literature by highlighting the role of risky investment decisions in forming the zero-leverage decision. Secondly, my finding provides evidence for financial constraint and financial flexibility theories. In contrast to the previous studies that focus on cash policy, I show that firms' conservatism resulting from increased financial constraints and the need for financial

flexibility can be reflected in financial policies. Thirdly, this study complements the literature related to the trend of zero-leverage behaviour. In line with the viewpoint of economic Darwinism, this study provides a novel explanation for the evolving capital structure choice by showing that the prevalence of a financing choice reflects the increasingly intensified innovation race.

For the implications, this study highlights the dark side of aggressive innovation. Managers and policymakers should pay attention to the side effect of innovation that firms have to forgo a great proportion of firm value due to extremely conservative financial decisions, which in turn harms shareholder wealth.

As R&D investments are a crucial determinant for zero-leverage behaviour, another question arises: what forces motivate firms to innovate and become unlevered? If firms anticipate that innovation inputs could hinder their ability to pursue the tax benefit of debt financing, rational managers should cut R&D investments and eschew zero-leverage decisions to maximize firm value. Why are they keen to invest in R&D? The next chapter aims to answer these questions and further explore the findings of this study.

Chapter 5. Product market competition and the zero-leverage puzzle

5.1. Introduction

In the previous chapter, I document that R&D investments play a non-trivial role in both the zero-leverage decision and the trend of zero-leverage firms. However, it is unclear what forces drive the innovation that leads to firms' decision to adopt the zero-leverage policy. To answer this question, I further explore the impact of market structure by focusing on the role of product market competition in the zero-leverage decision. This study aims to fill the literature gap on the determinant of conservative debt policy by investigating investment and financial policies in the context of market structure.

I conjecture that market competition significantly impacts zero-leverage decisions and drives the relationship between R&D and the zero-leverage decision. Prior literature has highlighted the role of competition in shaping firms' financial policy (Mackay and Phillips, 2005; Miao, 2005; Xu, 2012). From the supply side, the intensified market competition reduces information disclosure and increases the cost of capital, leading to a higher financial constraint effect (Valta, 2012; Bernard, 2016; Boubaker *et al.*, 2018). From the demand side, high market competition increases firms' precautionary motive, thereby reducing debt financing to reserve debt capacity (Haushalter *et al.*, 2007; Morellec *et al.*, 2014; Thakor and Lo, 2015). Market competition has been recognized as one of the most important factors for firms' innovation incentives (Nickell, 1996; Blundell *et al.*, 1999; Aghion *et al.*, 2005). Recent studies document ample evidence that market competition influences R&D racing, leading to a crucial

impact on firms' financial policy (Lyandres and Palazzo, 2015; Klasa *et al.*, 2018; Begenau and Palazzo, 2020).

Using the data of US firms for the period 1980-2017, I find that product market competition significantly increases firms' probability of being unlevered. DID analysis using the import tariff reduction further confirms the causal effect of market competition on the zero-leverage policy. The findings support the hypothesis that market competition hinders firms' ability to access the debt market, leading to the unlevered decision. The second main finding is that the impact of competition on zero-leverage behaviour has strengthened over time and only existed for R&D firms. The results complement the findings in the first study by showing that the intensified competition spurs firms' innovation incentives, leading to the prevalence of unlevered decisions. The next section presents the empirical results.

5.2. Empirical results

5.2.1. Initial results and summary statistics

Since several studies show that low-leverage firms have been increasing during the past three decades, I start my research with trend analysis. I split the sample by market competition to test whether market competition can explain the increasing trend of low-leverage firms. I use the Compustat HHI index to measure market competition. A higher value of Compustat HHI implies a lower level of product market competition, so a firm is considered in high (low) product market competition if Compustat HHI is lower (higher) than the median Compustat HHI in a given year.

Column 1 of Table 5.1 shows that the proportion of zero-leverage firms has a substantial increase from about 4% to 15% for firms with high market competition. In contrast, the proportion of zero-leverage firms has only experienced a relatively trivial increase from about 1% to 2% for firms with low competition in Column 2.

To show the trend more visible, I plot the percentage of zero-leverage firms with high and low market competition in Figure 5.1. The graph clearly shows the diverse trend of the two groups, implying that high market competition could be a critical driver for the zero-leverage decision and the increasing trend of zero-leverage firms. In addition, the most remarkable divergence between the two groups is during the 1990s and early 2000s, which coincide with the period of the R&D boom documented by Brown et al. (2009). Therefore, market competition could influence zero-leverage behaviour through R&D investments.

To explore zero-leverage firms' features, I further check the descriptive statistics of firm characteristics. Table 5.2 reports the moving average of the cross-sectional mean, obtained by first calculating the cross-sectional mean of each year and then computing the time-series mean of all years. Using the moving average mean can eliminate the effect of short-run fluctuation and extreme values (Molugaram et al., 2017).

Table 5.1. Frequency of low-leverage firms

This table shows the fractions of the firms in each given year. Zero-leverage firms (ZL) are firms that have zero book debt in a given year. Almost zero-leverage (AZL) are firms that have less than 5% book leverage ratio in a given year. High (low) competition is defined as a firm in an industry with Compustat HHI larger than the medium in a given year.

Year	ZL in high competition	ZL in low competition	AZL in high competition	AZL in low competition
	(1)	(2)	(3)	(4)
1980	3.46	1.13	8.77	3.33
1981	4.24	1.20	10.20	3.68
1982	3.78	1.25	10.48	3.69
1983	4.39	1.50	13.56	5.03
1984	4.07	1.59	11.98	4.52
1985	4.59	1.51	12.16	4.10
1986	5.11	1.59	12.40	4.65
1987	4.77	2.18	11.94	4.88
1988	4.27	2.08	11.19	4.55
1989	5.19	1.96	12.37	4.72
1990	5.43	2.39	13.14	5.29
1991	6.50	3.07	15.98	6.00
1992	8.63	1.65	20.85	3.49
1993	9.92	1.67	22.41	3.97
1994	10.17	1.60	21.72	3.92
1995	10.16	1.54	22.92	3.65
1996	11.38	1.67	25.55	3.84
1997	11.48	1.73	25.79	3.75
1998	11.56	1.37	23.56	3.51
1999	11.28	1.80	24.80	4.12
2000	12.96	1.16	28.84	2.77
2001	14.01	1.10	28.81	2.74
2002	14.69	1.40	28.65	2.90
2003	16.50	1.64	30.08	3.41
2004	17.84	1.69	32.07	3.44
2005	18.35	1.87	32.27	3.72
2006	17.71	2.15	30.80	4.23
2007	17.21	2.55	30.55	5.18
2008	16.12	2.70	27.65	5.05
2009	17.18	2.35	30.17	4.74
2010	17.62	2.75	30.91	5.82
2011	17.86	2.94	29.38	5.32
2012	17.04	2.71	27.42	5.29
2013	17.64	2.68	27.13	5.00
2014	17.14	2.80	25.77	4.76
2015	15.85	2.80	24.00	4.56
2016	15.35	2.59	23.03	4.56
2017	15.69	2.54	22.83	4.49
Total	10.83	1.86	21.41	4.11

Comparing firm characteristics of zero-leverage firms with all firms in Columns 1 and 2, zero-leverage firms have a lower value of Compustat HHI, suggesting that they suffer higher market competition. The other characteristics show that zero-leverage firms spend more on R&D, are smaller in firm size and younger, pay more dividends, stay in an industry with a higher fraction of zero-leverage firms, and have higher market-to-book ratios, less profit, less tangible assets, higher earnings volatility, a higher proportion of firms which were zero-leverage initially, less capital expenditure, higher future investment opportunity, and higher asset sales.

Figure 5.1. Percentage of zero-leverage subsamples by market competition

The figure compares the trend of zero-leverage firms by market competition during 1980-2017. The solid line represents the number of zero-leverage firms with high competition over the total number of firms in each year, and the dashed line represents the ratio for zero-leverage firms with low competition. High (low) market competition is defined based on whether a firm's Compustat HHI is lower (higher) than the median Compustat HHI in a given year.

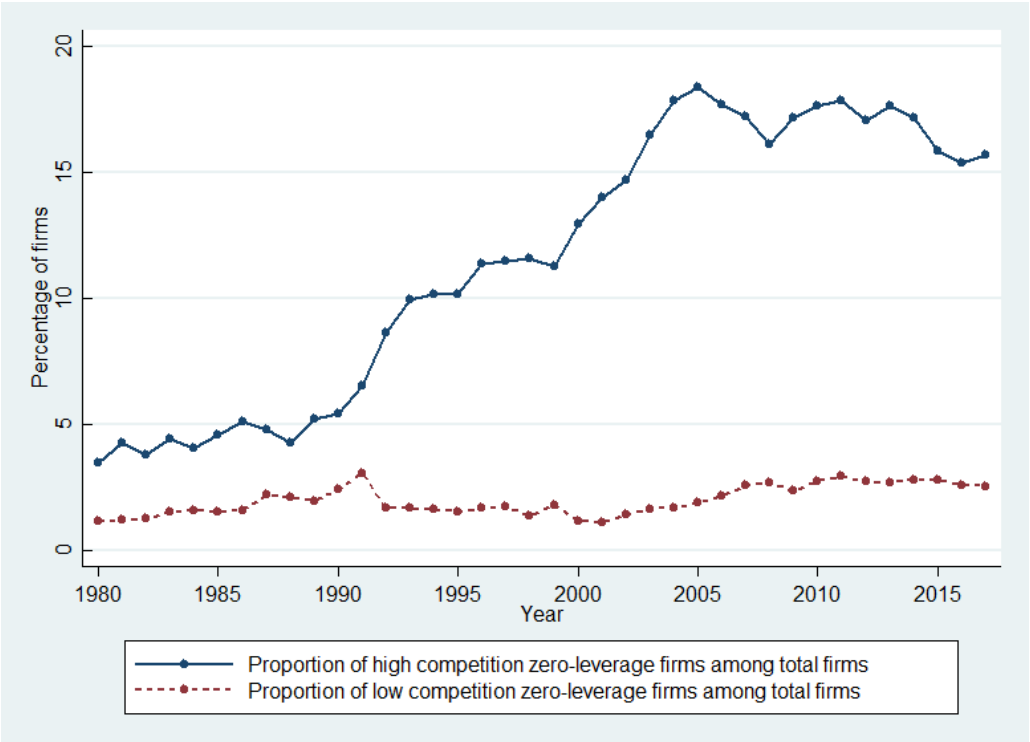


Table 5.2. Descriptive statistics

This table shows the descriptive statistics of firm characteristics for the full sample, zero-leverage (ZL) firms and zero-leverage subsamples by high and low market competition. High (low) market competition is defined as a firm's Compustat HHI lower (higher) than the median value of Compustat HHI in a given year. Columns (1) to (4) report the moving average mean of cross-sectional means. Column (5) reports the p-value for the difference-in-mean tests between Columns (3) and (4). The last row reports the average number of observations used to calculate the cross-sectional mean in each year. Standard errors are reported in parentheses. All continuous variables are winsorized at their 1st and 99th percentiles. Detailed variable definitions are in Appendix A.

	Full sample	ZL	ZL in high competition	ZL in low competition	Diff.-in-Mean
	(1)	(2)	(3)	(4)	(5)
Book leverage	0.253	0.000	0.000	0.000	.
	(0.263)	(0.000)	(0.000)	(0.000)	
Compustat HHI	0.228	0.205	0.146	0.500	0.000
	(0.169)	(0.157)	(0.074)	(0.149)	
R&D-to-assets	0.039	0.073	0.300	0.065	0.000
	(0.077)	(0.099)	(0.894)	(0.204)	
Log(size)	5.569	4.530	4.555	4.422	0.031
	(1.814)	(1.269)	(1.277)	(1.242)	
Market-to-book	1.684	2.234	2.271	1.949	0.001
	(1.123)	(1.611)	(1.610)	(1.444)	
Profitability	0.092	0.079	0.074	0.107	0.018
	(0.155)	(0.202)	(0.204)	(0.173)	
Tangibility	0.298	0.187	0.188	0.197	0.418
	(0.222)	(0.175)	(0.174)	(0.182)	
Dividend payer	0.411	0.387	0.370	0.497	0.004
	(0.472)	(0.440)	(0.430)	(0.482)	
Dividend payout	0.010	0.017	0.015	0.025	0.000
	(0.019)	(0.028)	(0.026)	(0.035)	
Earnings volatility	0.072	0.097	0.099	0.087	0.003
	(0.066)	(0.078)	(0.079)	(0.066)	
Init. ZL	0.109	0.363	0.374	0.317	0.001
	(0.306)	(0.477)	(0.479)	(0.466)	
Ind. Frac.ZL	0.124	0.150	0.156	0.111	0.000
	(0.065)	(0.066)	(0.064)	(0.038)	
Capital expenditure	0.062	0.049	0.050	0.044	0.019
	(0.062)	(0.053)	(0.054)	(0.047)	
Abnormal Cap. Ex.	0.052	0.092	0.093	0.071	0.559
	(0.754)	(0.891)	(0.885)	(0.885)	
Asset sale	0.028	0.052	0.054	0.038	0.020
	(0.088)	(0.124)	(0.124)	(0.100)	
Log(age)	2.432	2.302	2.284	2.428	0.046
	(0.529)	(0.512)	(0.507)	(0.521)	
Avg. No. of obs.	2613	319	274	45	

I further split the zero-leverage sample by high and low market competition in Columns 3 and 4, and Column 6 reports the p-value for the difference-in-mean for firm characteristics between the two groups. Except for the tangibility and abnormal capital expenditure, all other variables are significantly different between the two groups. R&D investments of zero-leverage firms in high-competition industries are more than fourfold compared with zero-leverage firms in low-competition industries, suggesting that zero-leverage firms in high-competition industries are also innovation-intensive firms. In addition, zero-leverage firms in high-competition industries tend to have more investment opportunities and a weaker financial position because they have a higher market-to-book ratio, higher capital expenditure, higher earnings volatility, higher asset sales, and lower dividend payout, are less profitable and less likely to pay dividends.

Overall, the initial evidence suggests that high market competition could positively affect firms' zero-leverage behaviour. The high R&D investment of zero-leverage firms in industries with high competition suggests that R&D could also play a role in the effect of market competition on the zero-leverage decision. The following sections present the results of the formal tests.

5.2.2. The impact of market competition on zero-leverage behaviour

Column 1 of Table 5.3 reports the original coefficients of the logit model for Equation (1). The significant negative coefficient of Compustat HHI indicates that firms facing high market competition (low Compustat HHI) are more likely to adopt the zero-leverage decision. The coefficient of R&D-to-assets is also significantly positive, which is consistent with the finding in Chapter 3.

Other control variables are all reasonable and consistent with the findings of Strebulaev and Yang (2013). Firms with smaller size and higher growth, less collateral value, and more asset sales are more likely to be zero-leverage, which is consistent with the explanation of financial constraints. Also, the puzzling evidence documented in the literature still remains; firms with higher profitability, capital expenditure, and dividend payout are more likely to be unlevered. Given that industry fixed effects are released, the average industrial fractions of zero-leverage firms significantly influence individual firms' probability of being zero-levered. Initial zero-leverage decisions also show a significant effect, consistent with the persistence of zero-leverage status.

As the original parameter estimates of a logit model are difficult to interpret, the table reports the average marginal effect following Dang (2013) and Bessler et al. (2013). The marginal effects estimate the change in the probability of being zero-leverage due to one unit change in a continuous independent variable, holding all other variables constant (Bartus, 2005), so they can be interpreted as the increase in the probability of firms being zero-leverage caused by the increase in one unit of an independent variable, holding other variables at the mean.

Column 2 of Table 5.3 reports the marginal effects of Equation (1). The results indicate that one unit decrease in Compustat HHI increases the probability of being zero-leverage by 5.3%. Overall, the results in Table 5.3 support *Hypothesis 3*; high market competition increases the probability of being zero-leverage firms.

Table 5.3. The effect of market competition on zero-leverage decision

This table presents the original coefficients and marginal effects of logit regressions of market competition on the probability of being zero-leverage firms for the full sample. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. Column (1) reports the original logit coefficients and standard error (in parentheses). Column (2) reports the average marginal effects and Delta-method standard errors. All the regressions include the year fixed effect. All standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All continuous variables are winsorized at 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

	Original coefficients	Marginal effects
	(1)	(2)
$Compustat\ HHI_{i,t-1}$	-0.632***	-0.053***
	(0.188)	(0.016)
$R\&D-to-assets_{i,t-1}$	2.330***	0.197***
	(0.305)	(0.026)
$Log(size)_{i,t-1}$	-0.441***	-0.037***
	(0.019)	(0.002)
$Market\text{-}to\text{-}book_{i,t-1}$	0.128***	0.011***
	(0.016)	(0.001)
$Profitability_{i,t-1}$	1.971***	0.166***
	(0.156)	(0.013)
$Tangibility_{i,t-1}$	-2.994***	-0.253***
	(0.236)	(0.020)
$Dividend\ payer_{i,t-1}$	0.031	0.003
	(0.084)	(0.007)
$Dividend\ payout_{i,t-1}$	15.258***	1.288***
	(1.433)	(0.121)
$Earnings\ volatility_{i,t-1}$	0.530	0.045
	(0.351)	(0.030)
$Ind.\ Frac.ZL_{j,t-1}$	2.025***	0.171***
	(0.497)	(0.042)
$Init.\ ZL_{i,t-1}$	1.207***	0.102***
	(0.075)	(0.006)
$Capital\ expenditure_{i,t-1}$	2.026***	0.171***
	(0.497)	(0.042)
$Abnormal\ Cap.\ Ex._{i,t}$	-0.043***	-0.004***
	(0.014)	(0.001)
$Asset\ sale_{i,t-1}$	2.193***	0.185***
	(0.169)	(0.014)
$Log(age)_{i,t-1}$	-0.047	-0.004
	(0.047)	(0.004)
Pseudo R^2	0.23	0.23
No. of obs.	92,154	92,154

I further test the moderating effect of R&D on the relationship between market competition and zero-leverage behaviour. The previous chapter documents that high R&D investment can increase the probability of unlevered decisions. As high market competition increases R&D intensity, therefore, market competition could influence zero-leverage policy through acceleration in R&D investment. To test *Hypothesis 4*, I split the sample based on whether firms have R&D investment and redo the regression of Equation (1) for R&D and non-R&D samples separately.

Table 5.4 reports the marginal effect of logit regression for the two samples separately. Columns 1 and 2 show that Compustat HHI has a significant negative effect on zero-leverage behaviour only for R&D firms but not for non-R&D firms. The results are consistent with *Hypothesis 4*; high market competition intensifies the innovation race, thereby increasing the probability of adopting unlevered decisions.

So far, I find that market competition significantly influences zero-leverage behaviour, and the effect is more profound for R&D firms. Prior studies document that market competition has increased dramatically (Bils and Klenow, 2004; London, 2005), so I further investigate whether the puzzling trend of zero-leverage firms is driven by the increasing sensitivity between competition and zero-leverage decisions.

Based on the business circles, I divide the sample into four periods with the cut-off points at 1990, 2001, and 2007. The cutoff points are based on the peak-through-peak turning points announced by the National Bureau of Economic Research (NBER).

Table 5.4. The effect of market competition on the zero-leverage decision by R&D and non-R&D samples

This table presents the marginal effects of logit regressions of market competition on the probability of being zero-leverage firms by R&D and non-R&D samples. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. All the columns report the average marginal effects and Delta-method standard errors. Column (1) is for the R&D sample, and Column (2) is for the non-R&D sample. All the regressions include the year fixed effect. All standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

	R&D sample	Non-R&D sample
	(1)	(2)
$Compustat\ HHI_{i,t-1}$	-0.090***	-0.019
	(0.029)	(0.016)
$R\&D-to-assets_{i,t-1}$	0.248***	0.029
	(0.035)	(0.147)
$Log(size)_{i,t-1}$	-0.046***	-0.029***
	(0.003)	(0.002)
$Market\text{-}to\text{-}book_{i,t-1}$	0.009***	0.016***
	(0.002)	(0.002)
$Profitability_{i,t-1}$	0.217***	0.087***
	(0.019)	(0.020)
$Tangibility_{i,t-1}$	-0.576***	-0.132***
	(0.048)	(0.016)
$Dividend\ payer_{i,t-1}$	-0.006	0.015**
	(0.014)	(0.007)
$Dividend\ payout_{i,t-1}$	1.423***	0.934***
	(0.228)	(0.119)
$Earnings\ volatility_{i,t-1}$	-0.062	0.124***
	(0.042)	(0.044)
$Ind.\ Frac.ZL_{j,t-1}$	0.328***	-0.088
	(0.069)	(0.062)
$Init.\ ZL_{i,t-1}$	0.101***	0.097***
	(0.009)	(0.008)
$Capital\ expenditure_{i,t-1}$	0.280***	0.106***
	(0.077)	(0.038)
$Abnormal\ Cap.\ Ex._{i,t}$	-0.004**	-0.005***
	(0.002)	(0.001)
$Asset\ sale_{i,t-1}$	0.196***	0.157***
	(0.019)	(0.023)
$Log(age)_{i,t-1}$	-0.015**	0.012**
	(0.006)	(0.005)
Pseudo R^2	0.25	0.20
No. of obs.	43,196	48,958

The subsample results in Panel A of Table 5.5 show that market competition does not seem to impact firms' probability of being zero-levered before the 1990s (Column 1). During the 1990s, the effect of Compustat HHI on the probability of being zero-levered becomes highly significant (Column 2). From 2002 to 2007, the effects of Compustat HHI are still significantly negative (Column 3), and the magnitude is even higher than the magnitude in the previous period. However, the effect tends to decrease after 2007 but still remains significant.

After controlling the effects of business cycles, the results in Table 5.5 confirm that the marginal effects of market competition on the probability of being zero-levered display an increasing trend over time, which is consistent with Figure 5.1.

Next, I further check the increasing effect of market competition on the zero-leverage decision for R&D and non-R&D samples. Panels B and C show that the increasing marginal effect of market competition exists in the R&D sample but not in the non-R&D sample.

Overall, the results of Table 5.5 are consistent with *Hypothesis 5*, the increasing trend of the low-leverage puzzle is attributable to the increasing effect of product market competition on the probability of being zero-levered, and the effect is more profound for R&D firms.

5.2.3. Exogenous policy shock - tariff reduction

In this section, I address the endogeneity between market competition and the zero-leverage decision using a difference-in-differences method. He and

Wintoki (2016) argue that market competition, R&D and cash holding are likely to be partially endogenous. Firms facing high market competition are more likely to respond by engaging in R&D and consequently become low-levered. Conversely, firms with ample cash flow and low debt may engage in R&D to exhaust rivals' ability to innovate and accelerate market competition. Therefore, it is possible that market competition and zero-leverage behaviour are also endogenously determined.

Table 5.5. The effect of market competition on the zero-leverage decision over time

This table reports the marginal effects of logit regressions of market competition on the probability of being zero-leverage firms for the full, R&D and non-R&D samples. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. Columns (1) to (4) are for the different business cycle periods. The business cycle periods are split based on the turning points announced by the NBER. Delta-method standard errors are reported in the parentheses. All the regressions include control variables and the year fixed effect. All standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

	1980-1990	1991-2001	2002-2007	2008-2017
	(1)	(2)	(3)	(4)
Panel A. Full sample				
Compustat $HHI_{i,t-1}$	-0.018	-0.058**	-0.102***	-0.060**
	(0.017)	(0.024)	(0.037)	(0.028)
Pseudo R^2	0.24	0.20	0.19	0.22
No. of obs.	24,359	28,931	16,640	22,224
Panel B. R&D sample				
Compustat $HHI_{i,t-1}$	0.010	-0.106**	-0.191***	-0.144***
	(0.025)	(0.255)	(0.068)	(0.048)
Pseudo R^2	0.27	0.24	0.18	0.21
No. of obs.	10,637	13,103	8388	11,068
Panel C. Non-R&D sample				
Compustat $HHI_{i,t-1}$	-0.041**	-0.030	-0.028	0.022
	(0.020)	(0.024)	(0.036)	(0.030)
Pseudo R^2	0.26	0.17	0.18	0.21
No. of obs.	13,722	15,828	8252	11,156

Table 5.6. DID test of market competition on the zero-leverage decision using large tariff reductions

This table reports the marginal effects of logit regressions for DID tests of market competition on the probability of being zero-leverage firms using the tariff rate reductions as a quasi-natural experiment. The dependent variable is the zero-leverage dummy, which equals one for zero-leverage firms and zero otherwise. The sample includes manufacturing firms from 1980 to 2005. Treated firms are firms in an industry that has experienced tariff reduction. Using the propensity score matching approach, I select control firms with the closest propensity score in a radius of 1% from the firms that do not experience tariff reduction and operate in different four-digit SIC industries in the same year. The procedure is repeated for the R&D and non-R&D subsamples. All the regressions include control variables, year and industry fixed effects. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the four-digit SIC industry level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at 10%, 5% and 1% level respectively. Detailed variable definitions are in Appendix A.

	Full sample			R&D sample			Non-R&D sample		
	[+3,-3]	Pre-trend	Placebo	[+3,-3]	Pre-trend	Placebo	[+3,-3]	Pre-trend	Placebo
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Post_{i,t}$	-0.043**	-0.041**	-0.020*	-0.064**	-0.061**	-0.028*	-0.000	-0.002	0.019
	(0.019)	(0.019)	(0.012)	(0.026)	(0.026)	(0.016)	(0.029)	(0.029)	(0.027)
$Treat_i$	-0.066***	-0.056**	-0.042***	-0.084***	-0.071**	-0.049***	-0.036	-0.045	-0.038
	(0.023)	(0.023)	(0.015)	(0.027)	(0.028)	(0.018)	(0.027)	(0.034)	(0.028)
$Post_{i,t}\times Treat_i$	0.043*	0.038*		0.065**	0.059**		-0.015	-0.008	
	(0.022)	(0.022)		(0.029)	(0.029)		(0.038)	(0.037)	
$Pre-trend_{i,t-1}$		0.000			0.000			-0.005	
		(0.007)			(0.008)			(0.024)	
$Pre-trend_{i,t-2}$		-0.015			-0.019			0.014	
		(0.009)			(0.011)			(0.017)	
Placebo (-2)			0.019			0.023			0.019
			(0.017)			(0.022)			(0.029)
Pseudo R^2	0.27	0.27	0.27	0.24	0.24	0.24	0.48	0.51	0.48
No. of obs.	4485	4485	3392	3252	3252	2510	811	811	568

The international trade literature has well documented that a large reduction in the tariff rate leads to lower trade barriers, which triggers a significant increase in domestic market competition (Bernard *et al.*, 2006b). The tariff changes are exogenous to the characteristics of firms as they do not reflect the choices of individual firms (Xu, 2012). Therefore, I utilize import tariff reductions at the industry level as exogenous market competition shocks to firms, which have been used by Fresard (2010), Valta (2012), Frésard and Valta (2016), and among others.

The tariff rate data for each 4-digit SIC industry and the year of tariff reduction is obtained from Frésard and Valta (2016), who identified 74 affected manufacturing industries from 1972 to 2005. To avoid the problem that the results of the DID analysis are influenced by heterogeneous characteristics between different groups of firms, I employ a propensity score matching approach[10].

Specifically, Following He and Wintoki (2016) and Frésard and Valta (2016), I first define the large industry-level reduction of tariff rate as the decrease of tariff rate in an industry in a given year that is three times larger than the average change of the industry's tariff rate.[11] Next, I define the treat dummy variable that equals one if a firm is in an industry that experiences a large tariff reduction in a given year, and zero otherwise.

[10] The procedure is exactly same as the difference-in-differences analysis in Chapter 4, please see the details and notes in section 4.2.4 in Chapter 4.

[11] I exclude the events that are followed by equivalently large increase over the subsequent three years, as well as the events that have less than 1% tariff rate. For industries that experience the tariff reduction shock more than once, I follow Valta (2012) to treat the largest tariff reduction as the event.

I regress the treatment group dummy on matching variables using the logit regression. The matching variables are exactly the same as the DID analysis in Chapter 3. The propensity score is the predicted value of this regression. Then, using the estimated propensity score of each firm in the treatment group, I select the firm with the closest propensity score in a radius of 1% from the firms that do not suffer the large tariff reduction in the same year to construct the matched firm group.

The same matching procedure is applied for R&D and non-R&D firms. This matching procedure can significantly reduce the possibility that firm characteristics could drive the difference in the probability of being zero-leverage firms between treated and control firms. To better isolate the effect of the shock, the sample includes all observations in the three years surrounding each event.

I include all the control variables in Equation (2) to further mitigate the effect of different characteristics that potentially influence the zero-leverage decision. The following logit model is estimated for the DID test:

$$\Pr(ZL) = \beta_0 + \beta_1 Treat_i + \beta_2 Post_{i.t} + \beta_3 Treat_i \times Post_{i,t} + Control\ variables_{i,t-1} + v_t + v_j + \varepsilon_{i,t,} \quad (3)$$

$Treat_i$ is a dummy variable equal to one if firm *i* is affected by the policy shock, i.e., in an industry that experiences a large tariff reduction, and zero otherwise. $Post_{i,t}$ is a dummy variable equal to one if firm i has experienced the tariff reduction shock by the time t, and zero otherwise. The interaction term $Treat_i \times Post_{i,t}$ is the variable of interest, and β_3 captures the causal effect of

tariff reduction on the zero-leverage decision of the treated firms. $Control\ variables_{i,t-1}$ are exactly the same as the control variables in Equation (2). v_t and v_j are time and industry dummies, respectively, and $\varepsilon_{i,t}$ is an idiosyncratic error. Given that the variation in the tariff reduction is at the 4-digit SIC industry level, I use robust standard errors clustered at the 4-digit SIC industry level to control for dependence in the error terms for firms in the same industry.

Table 5.6 reports the results of DID analysis. Columns 1, 4, and 7 show that the coefficients for $Post_{i,t}$, $Treat_i$ and $Treat_i \times Post_{i,t}$ are uniformly significant for both the full sample and the R&D sample but insignificant for the non-R&D sample. The results suggest that tariff rate changes have caused the difference in the probability of being zero-levered between treated and control firms for R&D firms but not for non-R&D firms.

A valid DID test relies on the fact that the treated and control groups share a similar time trend before the exogenous shock (Roberts and Whited, 2013). I follow prior studies (Acharya et al., 2014; Serfling, 2016; Park et al., 2019) to include $Pre - trend_{i,t-1}$, which is an interaction term between a dummy variable indicating the fiscal year preceding each tariff reduction event and the treat dummy. A significant $Pre - trend_{i,t-1}$ shows that the divergence of the probability of being zero-leverage between the treated and control groups already exists before the occurrence of the shock and therefore implies a violation of the parallel assumption. Similarly, $Pre - trend_{i,t-2}$ is an interaction term between a dummy variable indicating two years preceding each tariff reduction event and the treat dummy.

Columns 2, 5, and 8 of Table 5.6 show that all the pre-treatment trend variables are insignificant, suggesting that the pre-treatment trend for treated and control groups is statistically indistinguishable. For robustness, I also conduct the placebo test by falsely identifying the time of tariff reduction two years before the actual time of the event. Columns 3, 6, and 9 show that the interaction of the falsely identified variable and treat dummy is insignificant, suggesting that the DID tests are likely to be driven by the actual event.

Overall, the DID tests confirm that market competition has a positive effect on the increase in firms' likelihood of being zero-levered, and this effect is only significant when firms conduct R&D.

5.2.4. Additional robustness tests

I further test whether the low-leverage puzzle can be explained by product market competition. Table 5.7 provides further evidence for the almost zero-leverage decision. Consistent with the results of the zero-leverage decision, Column 1 shows that Compustat HHI has a significantly negative effect on almost zero-leverage policy, implying that firms facing intensive competition are more likely to adopt the almost zero-leverage decision. Columns 2 and 3 show that the effect of Compustat HHI on the almost zero-leverage decision is only significant in the R&D sample but insignificant in the non-R&D sample.

Another concern is that Compustat HHI could be a biased measure of market competition. On the one hand, the calculation of Compustat HHI relies on the firm's sales, which could be unstable or manipulated by firms. On the other hand, it does not consider private firms, as the Compustat database only includes financial information for public firms. Therefore, I follow prior studies (Hoberg

and Phillips, 2010; Hoberg et al., 2014; Hoberg and Phillips, 2016) to use TNIC HHI and Fitted HHI as alternative measures of market competition.

Table 5.7. The effect of market competition on the almost zero-leverage decision

This table presents the marginal effects of logit regressions of market competition on the probability of being almost zero-leverage firms for the full sample. The dependent variable is the almost zero-leverage dummy that equals one if a firm's leverage is lower than 5%, and zero otherwise. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include the year fixed effect. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

	Full sample	R&D sample	Non-R&D sample
	(1)	(2)	(3)
$Compustat\ HHI_{j,t-1}$	-0.044**	-0.139***	0.029
	(0.019)	(0.032)	(0.021)
$R\&D-to-assets_{i,t-1}$	0.415***	0.414***	0.100
	(0.039)	(0.049)	(0.208)
$Log(size)_{i,t-1}$	-0.056***	-0.062***	-0.048***
	(0.002)	(0.003)	(0.003)
$Market\text{-}to\text{-}book_{i,t-1}$	0.026***	0.019***	0.039***
	(0.002)	(0.002)	(0.004)
$Profitability_{i,t-1}$	0.297***	0.338***	0.193***
	(0.018)	(0.024)	(0.029)
$Tangibility_{i,t-1}$	-0.422***	-0.734***	-0.280***
	(0.022)	(0.045)	(0.022)
$Dividend\ payer_{i,t-1}$	0.008	-0.017	0.033***
	(0.009)	(0.015)	(0.010)
$Dividend\ payout_{i,t-1}$	1.907***	2.097***	1.498***
	(0.185)	(0.330)	(0.197)
$Earnings\ volatility_{i,t-1}$	0.055	-0.112**	0.186***
	(0.044)	(0.057)	(0.067)
$Ind.\ Frac.ZL_{j,t-1}$	0.289***	0.311***	0.018
	(0.053)	(0.080)	(0.081)
$Init.\ ZL_{i,t-1}$	0.135***	0.130***	0.133***
	(0.009)	(0.012)	(0.013)
$Capital\ expenditure_{i,t-1}$	0.274***	0.431***	0.181***
	(0.049)	(0.087)	(0.052)
$Abnormal\ Cap.\ Ex._{i,t}$	-0.010***	-0.010***	-0.010***
	(0.002)	(0.003)	(0.002)
$Asset\ sale_{i,t-1}$	0.227***	0.228***	0.180***
	(0.022)	(0.028)	(0.035)
$Log(age)_{i,t-1}$	-0.008	-0.030***	0.016**
	(0.005)	(0.008)	(0.007)
Pseudo R^2	0.21	0.22	0.17
No. of obs.	92,154	43,196	48,958

Table 5.8. Alternative proxy of market competition

This table reports the marginal effects of logit regressions of market competition on the probability of being zero-leverage firms using alternative measures of market competition. The dependent variable is the zero-leverage dummy in Columns (1) and (2) and almost zero-leverage dummy in Columns (3) and (4). Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include control variables and the year fixed effect. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

	Zero-leverage	Zero-leverage	Almost zero-leverage	Almost zero-leverage
	(1)	(2)	(3)	(4)
Fitted $HHI_{j,t-1}$	-0.365**		-0.469***	
	(0.152)		(0.175)	
TNIC $HHI_{i,t-1}$		-0.075***		-0.117***
		(0.013)		(0.015)
Pseudo R^2	0.24	0.21	0.21	0.22
No. of obs.	59,832	51,187	59,832	51,187

TNIC HHI is a firm-level product market competition measure based on a text-based analysis of product descriptions from 10-K filings. The TNIC classification is developed by Hoberg and Phillips (2016) using the number of common words in a firm's product description. Compared with the SIC industry classification, the unique set of peers for each firm identified by TNIC is time-varying, which is more accurate if firms change product lines (Foucault and Fresard, 2014; Rind et al., 2021). Fitted HHI is an industry-level competition measure that captures market competition for both private and public firms.

Table 5.8 reports the marginal effect of TNIC HHI and Fitted HHI on zero-leverage and almost zero-leverage behaviour. The significant negative coefficients of TNIC HHI and Fitted HHI in each column further confirm that high market competition leads firms to use debt more conservatively.

5.3. Conclusion

This study complements and deepens the findings in Chapter 4 by exploring forces that motivate firms to innovate and become unlevered. I link the market structure with the zero-leverage puzzle by highlighting the effect of product market competition on the zero-leverage decision. The first main finding is that high market competition increases the probability of being a zero-leverage firm, and such an effect has been strengthened over time. The DID test with the large tariff reduction also provides evidence for the causal effect. The finding is consistent with the hypothesis that predation risk induced by high market competition erodes firms' borrowing ability and raises the demand for financial flexibility.

The second main finding is that the effect of market competition on the probability of being zero-leverage is significant for R&D firms but not for non-R&D firms. This finding is consistent with the hypothesis that market competition increases the probability of being a zero-leverage firm through R&D investments, implying that market competition increases firms' incentive for innovation, leading to a higher probability of adopting the zero-leverage policy.

This study makes several contributions. Firstly, this study fills the literature gap on the determinant of the zero-leverage puzzle. By linking the market structure with corporate financial policies, it shows that market competition plays a critical role in shaping zero-leverage behaviour. Secondly, this study contributes to the literature related to the debate on innovation and competition. The findings show that intensified market competition affects unlevered decisions through R&D investments, highlighting the innovation race's outcome in a high-competition environment from the perspective of financing policy. Thirdly, this

study contributes to financial constraint and financial flexibility theories. Distinct from prior studies that focus on cash policy, I provide evidence that the extremely conservative financing policies reflect the financial frictions and the need for financial flexibility arising from intensive market competition. Finally, this study provides evidence for the viewpoint of economic Darwinism. The trend analysis shows that the increasingly intensified competition can explain why zero-leverage behaviour has become more prevalent, which is consistent with the Darwinian argument that firms make decisions to adapt to the change in the external environment.

This study has great implications for policymakers. The stylized fact in this study shows that the increased domestic market competition caused by the reduction in import tariffs makes firms forgo the great benefit of debt financing. This finding alerts policymakers to the drawback of promoting innovation through competition policy, as one of the potential outcomes is that it weakens the function of debt markets.

Overall, the first and second studies document that R&D investments and market competition lead to unlevered decisions by increasing financing constraints and demand for financial flexibility. However, it is still unclear whether the constraint effect makes zero-leverage firms forgo external financing or merely forgo debt financing. Another question is how they achieve internal sources if these companies rely more on internal financing. The final study aims to investigate alternative financing choices of zero-leverage firms and to provide answers to these two questions.

Chapter 6. Equity issuance, market timing and the zero-leverage puzzle

6.1. Introduction

Zero-leverage firms' equity issuance decisions have been largely neglected in the literature, as most prior studies tend to focus on zero-leverage firms' decisions to initiate debt financing (e.g., Devos et al., 2012; Strebulaev and Yang, 2013). On the one hand, internal funds are preferable to external financing according to the pecking order theory. Zero-leverage firms have high cash reserves and pay dividends, implying they have sufficient internal funds to cover daily operations and investments. On the other hand, zero-leverage firms issue more equity, which contradicts the prediction of the pecking order theory. This chapter investigates the equity issuance of zero-leverage firms and provides an explanation for their cash policy.

Market timing opportunities could lead to zero-leverage behaviour. Market timing theory indicates that managers are incentivised to time the equity market by issuing equity at a high market valuation and repurchasing equity at a low market valuation (e.g., Baker and Wurgler, 2002; Hovakimian, 2006; Deangelo et al., 2010). Previous studies document that financially constrained firms tend to exploit equity market timing opportunities and financially unconstrained firms exploit debt market timing opportunities (Korajczyk and Levy, 2003; Covas and Den Haan, 2011; Chang *et al.*, 2019). As zero-leverage firms are more likely to be subject to financial constraint, it is possible that they actively pursue equity market timing opportunities by issuing equity during favourable market timing conditions. Another stand of literature documents that investors have a preference for innovative firms, and managers have an incentive to over-invest

in R&D to cater to the tastes of outside investors (Polk and Sapienza, 2009; Grundy and Li, 2010; Lewis and Tan, 2016). The first study documents that zero-leverage firms are concentrated in R&D-intensive firms, implying that they have the advantage of exploiting market timing opportunities by catering to investors' R&D tastes.

Finally, I explore the motivation of zero-leverage firms' equity issuance decisions, as market timing theory cannot explain why zero-leverage firms use equity financing despite having sufficient internal funds. Prior studies document that equity issuance can be motivated by cash saving and the pressure of near-future cash needs (Kim and Weisbach, 2008; Deangelo et al., 2010; Warusawitharana and Whited, 2016; Huang and Ritter, 2020). I conjecture that cash saving is the primary motive of zero-leverage firms' equity issuance because cash holding is more valuable for financially constrained firms.

Using prior 12-month abnormal return, contemporaneous standardized market-to-book, future 36-month abnormal return, and investor sentiment index as proxies for market timing conditions, I find that firms with a favourable valuation of stock are more likely to adopt the zero-leverage decision. In addition, the significant effect of market timing conditions only exists in equity issuer or high equity issuance samples, confirming that market timing conditions impact the unlevered decision through equity issuance. Using the technology bubble as the exogenous shock of market timing conditions, I employ the DID analysis and find consistent evidence for the causal effect.

I further investigate whether zero-leverage firms issue equity to time the market because information asymmetry is low during favourable market timing conditions. The results suggest that firms with low information asymmetry are

more likely to be unlevered, and the effect of market timing conditions on the zero-leverage decision is significant in the low information asymmetry sample but insignificant in the high information asymmetry sample.

Using longitudinal analysis of cash surrounding equity issuance, I find that immediate cash needs are less likely to drive the zero-leverage firms' equity issuance decisions. These firms tend to reserve more equity issuance proceeds to maintain high cash reserves. In contrast, non-zero-leverage firms are more likely to issue equity under the pressure of severe short-term cash depletion because most of them have to alter their operating and financing decisions if equity issuance proceeds are not received.

Overall, the results suggest that favourable market timing conditions reduce information asymmetry, leading to a low cost of equity. Firms issuing equity during favourable market timing conditions could outweigh the tax benefit of debt, which in turn increases the probability of maintaining zero-leverage status. Combined with the market timing theory, zero-leverage firms could issue overvalued equity to cumulate high cash reserves, leading to lower demand for debt financing. The next section presents the empirical results of the third study.

6.2. Empirical results

6.2.1. Initial evidence

To check whether equity issuance drives the zero-leverage decision, I split the sample into issuers and non-issuers subsamples based on whether firms' net equity issuance is positive. Figure 6.1 illustrates the proportions of zero-leverage firms to all firms for issuers and non-issuers over time. Clearly, in the 1980s,

both groups have a similar proportion of zero-leverage firms at around 3%. Since the early 1990s, the proportion of zero-leverage firms with equity issuance has substantially increased from about 5% to 15%. In contrast, the proportion of zero-leverage firms without equity issuance has only experienced a relatively trivial increase from about 3% to 4%. The initial evidence suggests that zero-leverage firms are concentrated in equity issuers.

Table 6.1 reports the summary statistics for all the variables used in this study. Column 1 shows the mean and standard deviation for the observations with non-missing variables used in Equation (1). To make sure those factors would not drive the results, I follow Strebulaev and Yang (2013) to choose up to four non-zero-leverage proxies that are in the same three-digit SIC industry, in the same year, have a similar book value of total assets, and follow the same dividend payout policy with zero-leverage firms.

Columns 2 and 3 compare the firm characteristics of zero-leverage and non-zero-leverage proxies. On average, zero-leverage firms' equity issuance and net equity issuance are twice as large as those of non-zero-leverage firms, and the P-value in Column 3 shows this difference-in-means is statistically significant at 1%. Overall, the results offer further support for Figure 6.1.

Consistent with the market timing explanation, zero-leverage firms have higher prior 12-month returns, higher standardized market-to-book, and lower future 36-month returns than the non-zero-leverage proxy. The results support the market timing explanation that firms issue equity in high market valuation (e.g., Taggart, 1977; Jung et al., 1996) and suffer subsequent low returns (e.g., Ritter, 1991; Loughran and Ritter, 1995; Loughran and Ritter, 1997). Similarly, I also find that investor sentiment is higher for zero-leverage firms.

We construct three proxies to measure the degree of information asymmetry. Accrual uncertainty measures the uncertainty in accruals; high accrual uncertainty implies a high probability of earnings manipulation and poor reporting quality (Francis et al., 2005). Analyst forecast error measures the accuracy of performance forecasting, a firm with high analyst forecast error implies that financial experts are difficult to precisely predict the firm's performance (Mansi et al., 2011). The probability of informed trading measures the likelihood that investors discover and trade on private information (Brown and Hillegeist, 2007).

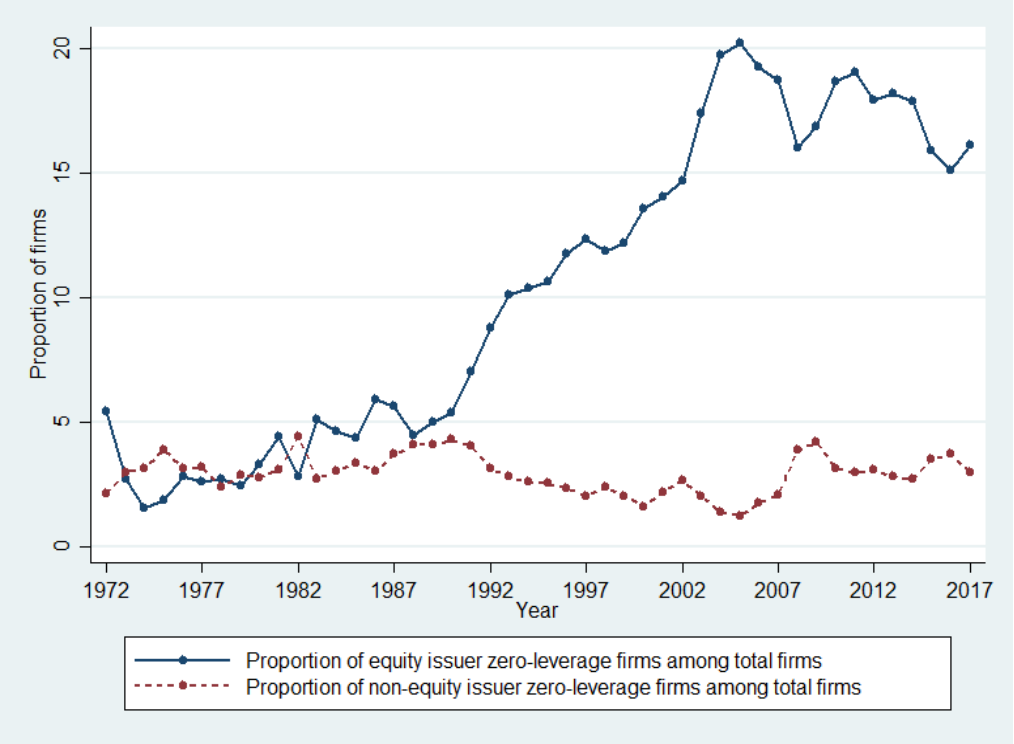
Table 6.1. Descriptive statistics

This table reports the mean, standard deviation, and P-value of the difference-in-mean for the full sample, zero-leverage firms, and non-zero-leverage proxy with non-missing values for the variables used in the baseline regression. Column (1) is for the full sample. Columns (2) and (3) are for the zero-leverage and proxy, respectively. Zero-leverage firms are defined as firms with a zero book leverage ratio. Proxy represents non-zero-leverage firms that are in the same industry and year, have a similar book value of total assets, and follow the same dividend payout policy as zero-leverage firms. Column (4) reports the P-value of the difference-in-mean between Columns (2) and (3). All the variables are winsorized at 1% and 99%. The details of variable construction are reported in Appendix A.

	Full sample	ZL	Proxy	Diff.-in-Mean
	(1)	(2)	(3)	(4)
Equity issuance	0.048	0.091	0.067	0.000
	(0.149)	(0.224)	(0.179)	
Net equity issuance	0.036	0.073	0.056	0.000
	(0.152)	(0.230)	(0.181)	
Prior 12month return	0.023	0.042	0.004	0.000
	(0.498)	(0.565)	(0.544)	
Future 36month return	0.103	0.056	0.101	0.000
	(0.879)	(0.885)	(0.962)	
Standardized M/B	1.435	1.827	1.498	0.000
	(2.462)	(2.492)	(2.866)	
Investor sentiment index	0.130	0.162	0.125	0.000
	(0.845)	(0.724)	(0.861)	
Accrual uncertainty	0.043	0.052	0.051	0.025
	(0.032)	(0.035)	(0.036)	
Analyst forecast error	0.066	0.201	0.210	0.000
	(0.453)	(0.106)	(0.108)	
Probability of informed trading	0.192	0.058	0.092	0.000
	(0.109)	(0.477)	(0.553)	
Firm size	5.179	4.143	4.329	0.000
	(2.039)	(1.618)	(1.646)	
Profitability	0.064	-0.008	0.018	0.000
	(0.228)	(0.323)	(0.267)	
Tangibility	0.289	0.156	0.263	0.000
	(0.225)	(0.169)	(0.220)	
Dividend	0.009	0.011	0.006	0.000
	(0.018)	(0.026)	(0.015)	
Dividend payer	0.378	0.257	0.265	0.061
	(0.485)	(0.437)	(0.441)	
Earnings volatility	0.101	0.169	0.128	0.000
	(0.418)	(0.570)	(0.438)	
Capital expenditure	0.064	0.045	0.059	0.000
	(0.068)	(0.057)	(0.067)	
R&D	0.481	0.644	0.524	0.000
	(0.500)	(0.479)	(0.499)	
Asset sales	0.028	0.059	0.027	0.000
	(0.093)	(0.150)	(0.093)	
$Log(age)$	12.343	12.044	12.150	0.177
	(9.010)	(8.555)	(8.739)	
Ind.Fra.AZL	0.259	0.322	0.286	0.000
	(0.119)	(0.109)	(0.117)	
Init. AZL	0.301	0.684	0.347	0.000
	(0.459)	(0.465)	(0.476)	
AZL	0.248	1.000	0.207	0.000
	(0.432)	(0.000)	(0.405)	
No. of obs.	134,270	17,502	39,584	

Figure 6.1. The trend of zero-leverage firms with equity issuance and without equity issuance

The figure compares the trend of zero-leverage firms by equity issuers and non-equity issuers during 1972-2017. The solid line represents the number of zero-leverage firms with equity issuance over the total number of firms in each year, and the dashed line represents the proportion of zero-leverage firms without equity issuance. Firms with equity issuance are defined as firms that have positive net equity issuance.



Therefore, high information asymmetry is associated with high accrual uncertainty, high analyst forecast error, and a high probability of informed trading. Compared with the proxies of information asymmetry, zero-leverage firms have slightly higher accrual uncertainty. However, they have lower analyst forecast error and probability of informed trading than the levered counterparty.

Other variables in Columns 2 and 3 are consistent with the results in the previous chapters. Zero-leverage firms are smaller in firm size and younger, are more likely to be R&D firms, pay more dividends, stay in an industry with a higher fraction of zero-leverage firms, and have higher standardized market-to-book

ratios, less profit, less tangible assets, higher earnings volatility, a higher proportion of firms which were zero-leverage initially, less capital expenditure, and higher asset sales. Overall, the initial evidence in Figure 6.1 and Table 6.1 is consistent with the conjecture that the zero-leverage decision is driven by equity issuance and market timing conditions. The following sections present the results of formal tests.

6.2.2. The impact of equity issuance on zero-leverage behaviour

Table 6.2 reports the average marginal effects of logit regressions for Equation (1). The marginal effects estimate the change in the probability of being zero-leverage due to a change in a continuous independent variable holding all other variables in the model constant (Bartus, 2005). In Columns 1 and 2, the marginal effects of equity issuance and net equity issuance are positive and significant at 10% and 1%, respectively. The marginal effects suggest that one unit increase in equity issuance and net equity issuance is associated with 3% and 1.1% increase in the probability of being zero-leverage firms, respectively.

The results are consistent with *Hypothesis 6*; high equity issuance increases the probability of being zero-leverage firms. Other control variables in Columns 1 and 2 of Table 6.2 are all reasonable and consistent with the results in prior chapters. Firms could choose equity financing instead of debt financing because market overvaluation reduces the cost of equity and makes equity financing more attractive. To test this conjecture, I group firms into high and low M/B samples based on the median value of standardized M/B for each year and conduct the regression of Equation (1) for the high and low standardized M/B separately. I expect that the positive effect of equity issuance on zero-leverage behaviour is more profound for the high M/B sample.

Table 6.2. The effect of equity issuance on the zero-leverage decision

This table reports the marginal effects of logit regressions of equity issuance on the probability of being zero-leverage firms. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. Columns (1) and (2) report the effect of equity issuance on zero-leverage behaviour using the full sample. Columns (3) to (6) are for subsamples with high and low standardized M/B. High and low M/B are defined based on whether firms have larger than the median of standardized M/B in a given year. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include year and industry fixed effects. The details of variable construction are reported in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	Full sample	Full sample	High M/B	Low M/B	High M/B	Low M/B
	(1)	(2)	(3)	(4)	(5)	(6)
$Equity\ issuance_{i,t-1}$	0.030***		0.047***	-0.005		
	(0.007)		(0.009)	(0.010)		
$Net\ equity\ issuance_{i,t-1}$		0.011*			0.032***	-0.031***
		(0.007)			(0.009)	(0.011)
$Standardized\ M/B_{i,t-1}$	0.001*	0.001	-0.000	0.001*	-0.000	0.001**
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
$Firm\ size_{i,t-1}$	-0.036***	-0.036***	-0.037***	-0.035***	-0.037***	-0.035***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
$Profitability_{i,t-1}$	0.073***	0.079***	0.097***	0.053***	0.092***	0.044***
	(0.007)	(0.007)	(0.011)	(0.009)	(0.010)	(0.009)
$Tangibility_{i,t-1}$	-0.260***	-0.259***	-0.322***	-0.212***	-0.324***	-0.212***
	(0.017)	(0.017)	(0.024)	(0.020)	(0.024)	(0.020)
$Dividend_{i,t-1}$	1.779***	1.771***	2.048***	1.594***	2.055***	1.596***
	(0.126)	(0.126)	(0.175)	(0.162)	(0.175)	(0.162)
$Dividend\ payer_{i,t-1}$	0.003	0.003	-0.010	0.010	-0.010	0.010
	(0.007)	(0.007)	(0.011)	(0.008)	(0.011)	(0.008)
$Earnings\ volatility_{i,t-1}$	0.000	-0.000	0.000	-0.000	0.000	0.000
	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
$Capital\ expenditure_{i,t-1}$	0.121***	0.115***	0.175***	0.072*	0.180***	0.078*
	(0.033)	(0.033)	(0.043)	(0.040)	(0.043)	(0.040)
$R\&D_{i,t-1}$	0.016***	0.016***	0.018**	0.012**	0.018**	0.012**
	(0.005)	(0.005)	(0.008)	(0.006)	(0.008)	(0.006)
$Asset\ Sale_{i,t-1}$	0.168***	0.169***	0.168***	0.168***	0.167***	0.165***
	(0.012)	(0.012)	(0.017)	(0.015)	(0.017)	(0.015)
$Log(age)_{i,t-1}$	-0.000	-0.000	-0.001**	0.000	-0.001**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Ind.Fra.AZL_{i,t-1}$	0.093***	0.092***	0.131***	0.055*	0.132***	0.056*
	(0.030)	(0.030)	(0.044)	(0.031)	(0.044)	(0.031)
$Init.AZL_{i,t-1}$	0.102***	0.102***	0.119***	0.085***	0.119***	0.085***
	(0.005)	(0.005)	(0.007)	(0.005)	(0.007)	(0.005)
Pseudo R^2	0.24	0.24	0.23	0.24	0.23	0.24
No. of obs.	119,871	119,871	55,481	64,379	55,481	64,379

Consistent with the prediction, Columns 3 and 5 show that equity issuance and net equity issuance significantly affect zero-leverage probability in the high M/B sample. On the contrary, Columns 4 and 6 show that equity issuance and net equity issuance negatively affect the probability of being zero-leverage in the low M/B sample. Overall, Table 6.2 suggests that equity issuance positively affects the likelihood of being unlevered, and the relationship is more profound for firms with overvaluation.

6.2.3. The impact of market timing conditions on zero-leverage behaviour

I next explore whether market timing conditions can explain the zero-leverage puzzle, as market timing theory indicates that firms tend to time the stock market by issuing overvalued equity. Favourable market timing conditions should have high prior 12-month returns and contemporaneous standardized market-to-book and low future 36-month returns. Similarly, investor sentiments positively affect investors' overvaluation of equity, so a higher investor sentiment index indicates more favourable market timing conditions. Therefore, if market timing theory could explain the zero-leverage puzzle, prior 12-month returns and contemporaneous standardized market-to-book should positively impact the probability of being unlevered, and future 36-month returns have a negative effect. Similarly, I expect the investor sentiment index to be positively associated with the zero-leverage decision.

In Columns 1 to 3 of Table 6.3, I test the effect of each market timing proxy separately on the probability of being zero-leverage firms. Consistent with the initial evidence of Table 6.2, the probability of being zero-leverage firms is positively associated with prior 12-month returns and contemporaneous standardized market-to-book and negatively associated with future 36-month

returns. In Column 4, I add the three market timing proxies together and find that all the market timing proxies are significant at 5%. The results suggest that high prior market valuation, high current market valuation, and low future market valuation increase the probability of being zero-leverage firms.

In Column 5, I use the alternative market timing proxy by replacing the three market timing proxies with the investor sentiment index in Equation (3). The results further confirm the positive effect of market timing conditions on the zero-levered probability.

If the relationship between market timing conditions and zero-leverage behaviour is due to firms' attempts to time the market through equity issuance, the effect of market timing conditions on the zero-leverage decision should be more profound for equity issuers than non-equity issuers. Therefore, I split the sample by equity issuers and non-equity issuance and test the effect of market timing on zero-leverage behaviour in the two subsamples separately.

The results in Columns 1 to 4 of Table 6.4 show that the significant effects of market timing conditions exist only for equity issuers but not for non-equity issuers, implying that market timing conditions influence the probability of being zero-levered through equity issuance. For robustness, I also split the sample into high and low equity issuance subsamples based on whether net equity issuance is higher than the median value in the given year. Similarly, Columns 5 to 8 show that market timing conditions are significant only in high equity issuance samples. Overall, consistent with *Hypothesis 7*, the results in Table 6.4 further support the explanation of market timing theory on the zero-leverage puzzle.

Table 6.3. Market timing effect on the zero-leverage decision

This table reports the marginal effects of logit regressions of market timing conditions on the probability of being zero-leverage firms. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. The effect of market timing conditions is measured by prior 12-month returns, future 36-month returns, and contemporary standardized M/B in Columns (1) to (4) and measured by the investment sentiment index in Column (5). Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include year and industry fixed effects. The details of variable construction are reported in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)
$Prior\ 12month\ return_{i,t-1}$	0.007***			0.005***	
	(0.002)			(0.002)	
$Future\ 36month\ return_{i,t+3}$		-0.004**		-0.003**	
		(0.002)		(0.002)	
$Standardized\ M/B_{i,t}$			0.001*	0.001**	
			(0.000)	(0.001)	
$Investor\ sentiment\ index_t$					0.005**
					(0.003)
$Firm\ size_{i,t-1}$	-0.039***	-0.038***	-0.036***	-0.039***	-0.036***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
$Profitability_{i,t-1}$	0.073***	0.067***	0.069***	0.071***	0.068***
	(0.008)	(0.010)	(0.007)	(0.011)	(0.007)
$Tangibility_{i,t-1}$	-0.282***	-0.262***	-0.262***	-0.262***	-0.263***
	(0.021)	(0.023)	(0.017)	(0.024)	(0.017)
$Dividend_{i,t-1}$	1.797***	1.911***	1.785***	1.833***	1.794***
	(0.144)	(0.156)	(0.126)	(0.159)	(0.127)
$Dividend\ payer_{i,t-1}$	0.004	-0.004	0.003	-0.003	0.003
	(0.008)	(0.008)	(0.007)	(0.008)	(0.007)
$Earnings\ volatility_{i,t-1}$	0.000	0.003	0.000	0.002	0.001
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
$Capital\ expenditure_{i,t-1}$	0.187***	0.144***	0.126***	0.151***	0.128***
	(0.039)	(0.044)	(0.033)	(0.046)	(0.033)
$R\&D_{i,t-1}$	0.017***	0.011*	0.016***	0.010	0.016***
	(0.006)	(0.006)	(0.005)	(0.007)	(0.005)
$Asset\ Sale_{i,t-1}$	0.176***	0.172***	0.166***	0.174***	0.167***
	(0.013)	(0.015)	(0.012)	(0.016)	(0.012)
$Log(age)_{i,t-1}$	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Ind.Fra.AZL_{i,t-1}$	0.111***	0.106***	0.093***	0.104***	0.095***
	(0.033)	(0.037)	(0.030)	(0.038)	(0.030)
$Init.AZL_{i,t-1}$	0.095***	0.098***	0.102***	0.096***	0.102***
	(0.006)	(0.006)	(0.005)	(0.007)	(0.005)
Pseudo R^2	0.25	0.26	0.24	0.26	0.24
No. of obs.	103,353	76,943	119,864	73,841	119,898

Table 6.4. Market timing effect on the zero-leverage decision by equity issuance

This table reports the marginal effects of logit regressions of market timing conditions on the probability of being zero-leverage firms by equity issuers and non-equity issuers. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. Columns (1) to (4) are for the equity issuers and non-equity issuers, which are defined based on whether firms have positive net equity issuance in a given year. Columns (5) to (8) are for the high and low equity issuance subsamples, which are defined based on whether firms have larger than the median of equity issuance in a given year. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include control variables, year and industry fixed effects. The details of variable construction are reported in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

	Equity issuers	Non-equity issuers	Equity issuers	Non-equity issuers	High equity issuance	Low equity issuance	High equity issuance	Low equity issuance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Prior\ 12month\ return_{i,t-1}$	0.008***	0.004			0.005*	0.003		
	(0.002)	(0.004)			(0.003)	(0.003)		
$Future\ 36month\ return_{i,t+3}$	-0.004**	-0.003			-0.005**	-0.002		
	(0.002)	(0.002)			(0.002)	(0.002)		
$Standardized\ M/B_{i,t}$	0.002***	0.000			0.002**	0.001		
	(0.001)	(0.001)			(0.001)	(0.001)		
$Investor\ sentiment\ index_t$			0.008*	0.004			0.010**	0.000
			(0.004)	(0.004)			(0.004)	(0.004)
Pseudo R^2	0.24	0.29	0.22	0.27	0.25	0.27	0.23	0.25
No. of obs.	40,257	33,584	63,842	56,056	37,274	36,567	62,228	57,670

6.2.4. Exogenous shock - technology bubble

Prior studies document a sharp increase in stock price from 1995 to the burst of the technology bubble in the early 2000s (Ofek and Richardson, 2003; Brunnermeier and Nagel, 2004; Griffin et al., 2011), and the stock price increased more significantly for high technology firms (Damodaran, 1999; Hobijn and Jovanovic, 2001).

However, Campello and Graham (2013) find that the stock valuation during the technology bubble also spread in manufacturing firms. This effect could derive from a spillover effect rather than increased fundamental firm values since market participants became overoptimistic about equity investments. The over-optimistic stock valuation caused by the technology bubble provides an opportunity to investigate the exogenous market timing shock on the zero-leverage decision through DID analysis.

Following Campello and Graham (2013), I identify the technology-related manufacturers[12] as a treated group from the manufacturing industry (SIC in the range of 200-399). These firms are most likely to be affected by the technology bubble's spillover effect because their businesses are related to high technology industries. The control group consists of the rest of the manufacturers; they are old economy firms and are less likely to be affected by the over-optimistic stock valuation.

[12] The technology-related manufacturers have 3-digit SIC that belongs to 227, 229, 232, 233, 234, 236 273 348, 351, 355, 357, 361, 362, 363 365, 366, 367, 369, 371, 372, 376, 379 381, 382, 384, 385, and 386 394.

I restrict the sample to five years that surround each event (five years before and five years after) to better isolate the effect of the over-optimistic stock valuation engendered by the technology bubble. The sample includes 19775 firm-year observations with 1811 unique treat firms and 2504 control firms. The following logit model is employed for the DID test:

$$\Pr(ZL) = \beta_0 + \beta_1 Treat_i + \beta_2 Post_{i.t} + \beta_3 Treat_i \times Post_{i,t} + Control\ variables_{i,t-1} + v_t + v_j + \varepsilon_{i,t,} \quad (4)$$

$Treat_i$ is a dummy variable equal to one if firm i is a technology-related manufacturer and zero if it is an old economy manufacturer. $Post_{i,t}$ is a dummy variable that equals one for the post-1995 period and zero otherwise. The interaction term $Treat_i \times Post_{i,t}$ is the variable of interest, and β_3 captures the causal effect of overoptimistic stock valuation on the zero-leverage decision between treated and control groups. $Control\ variables_{i,t-1}$ are the same as Equation (1). v_t and v_j are time and industry dummies, respectively, and $\varepsilon_{i,t}$ is an idiosyncratic error. I also conduct the tests for equity issuers and non-equity issuers separately to check whether overoptimistic stock valuation impacts zero-leverage behaviour through equity issuance.

Panel A of Table 6.5 shows the DID results for the full sample, equity issuers, and non-equity issuers. In the full sample and the equity issuers, β_3 is significantly positive in the 5-year window, with values of 0.021 in Column 1 and 0.036 in Column 3. The results indicate that the zero-levered probability of firms with over-optimistic stock valuation increases by 2.1% compared with less affected firms, and the incremental probability is even higher in equity issuers (3.6%). However, for the non-equity issuers, β_3 is insignificant in Column 5,

suggesting that overoptimistic stock valuation has no different effects on the chance of being zero-levered between treated and control firms for non-equity issuers.

To check robustness, I falsely define the technology boom three years ahead and take the sample period as five years surrounding the false event year and rerun the same logit regressions. The results are reported in Columns 2, 4, and 6 for each sample, respectively. There are no significant effects for the falsely defined shocks, alleviating the concern of parallel assumption and suggesting that the technology bubble indeed drives the DID results.

In addition, Panel B of Table 6.5 reports the results for the reversal of stock market overvaluation, i.e., the burst of the technology bubble in 2001[13]. In Columns 7 to 9, I define $Post_{i,t}$ that equals one for the post-2001 period and zero otherwise. The results suggest that an adverse market timing condition significantly reduces the probability of being zero-leverage firms for equity issuers. Overall, the DID analysis confirms the causal relationship between the market timing and firms' zero-leverage behaviour.

[13] The stock market indices drop sharply after 2001. See Figure 1 in Campello and Graham (2013).

Table 6.5. Difference-in-differences test for the market timing effect on the zero-leverage decision

This table reports the marginal effects of the logit regressions for the DID tests using the Doc-com bubble as exogenous shocks of market overvaluation. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. *Treat* equals one if a firm is a technology-related manufacturer and equals zero if a firm is a non-bubble manufacturer. *Post* equals one if the year is 1995 and 5 years thereafter, and zero for five years before 1995. Equity issuers and non-equity issuers are defined based on whether firms have positive net equity issuance in a given year. Columns (1), (3) and (5) of Panel A report the results for the five years interval around the technology bubble, Columns (2), (4) and (6) are for the placebo test in which the time of shock is falsely identified three years ahead. Panel B reports the results for the reversal of stock overvaluation. *Post* equals one if the year 2001 and 5 years thereafter, and zero for five years before 2001. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include control variables, year and industry fixed effects. The details of variable construction are reported in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

	Panel A. Stock market booming						*Panel B. Stock market crash*		
	Full	Full	Equity issuers	Equity issuers	Non-issuers	Non-issuers	Full	Equity issuers	Non-issuers
	[-5,+5]	Placebo	[-5,+5]	Placebo	[-5,+5]	Placebo	[-5,+5]	[-5,+5]	[-5,+5]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Post_t \times Treat_i$	0.021*	0.014	0.036**	0.022	0.007	0.003	-0.016	-0.031*	0.006
	(0.012)	(0.013)	(0.016)	(0.019)	(0.016)	(0.015)	(0.014)	(0.018)	(0.018)
$Post_t$	0.035***	0.051***	0.036*	0.064***	0.033**	0.045**	0.071***	0.074***	0.050**
	(0.012)	(0.013)	(0.020)	(0.021)	(0.016)	(0.018)	(0.015)	(0.020)	(0.021)
$Treat_i$	-0.021	-0.018	-0.029*	-0.022	-0.012	-0.009	-0.007	0.023	-0.021
	(0.013)	(0.015)	(0.016)	(0.019)	(0.018)	(0.021)	(0.014)	(0.016)	(0.019)
Pseudo R^2	0.22	0.26	0.19	0.23	0.28	0.32	0.20	0.16	0.27
No. of obs.	19,775	14,857	10,883	7970	8735	6735	20,297	12,302	7995

6.2.5. The impact of information asymmetry on zero-leverage behaviour

This section further explores the mechanism for the effect of market timing conditions on the zero-leverage decision. From the viewpoint of time-varying information asymmetry, firms time the market by actively reducing the information asymmetry. Therefore, I test the effect of information asymmetry on the unlevered decision and its role in the relationship between market timing conditions and the zero-leverage behaviour. As high accrual uncertainty, high analyst forecast error and high probability of informed trading indicate a high degree of information asymmetry, I regress the zero-leverage dummy on the information asymmetry proxy with the full set of the year and industry fixed effects and control variables in Equation (2) and expect a negative effect on the zero-leverage decision.

Table 6.6. The effect of information asymmetry on the zero-leverage decision

This table reports the marginal effects of logit regressions of information asymmetry on the probability of being zero-leverage firms. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. The degree of information asymmetry is measured by accrual uncertainty, analyst forecast error and probability of informed trading in Columns (1), (2) and (3), respectively. High information asymmetry is associated with high accrual uncertainty, high analyst forecast error and a high probability of informed trading. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include control variables, year and industry fixed effects. The details of variable construction are reported in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

	(1)	(2)	(3)
$Accrual$ uncertainty$_{i,t-1}$	-0.414***		
	(0.067)		
$Analyst\ forecast\ error_{i,t-1}$		-0.009***	
		(0.003)	
$Probability\ of\ informed\ trading_{i,t-1}$			-0.057***
			(0.021)
Pseudo R^2	0.24	0.27	0.21
No. of obs.	88,782	75,212	54,660

Table 6.6 presents the results for the three proxies of information asymmetry. Accrual uncertainty, analyst forecast error, and probability of informed trading are negatively associated with the probability of being zero-leverage, and the effects are significant at 1% significance level. Overall, Table 6.6 supports *Hypothesis 8* that firms with low asymmetric information are more likely to eschew debt financing.

I next test the role of information asymmetry in the relationship between market timing conditions and the zero-leverage decision. If firms prefer equity financing to debt financing during favourable market timing conditions because firms actively reduce information asymmetry, then the effect of market timing conditions on the zero-leverage decision should be more profound for firms with low information asymmetry. To test this hypothesis, I split the sample based on whether the proxy of information asymmetry is higher than the median value in a given year and then conduct Equation (3) for each subsample.

Columns 1, 3, 5, 7, 9 and 11 of Table 6.7 show that the effect of market timing conditions remains significant for firms with low information asymmetry. However, the rest of the columns show that the effect is insignificant for firms with high information asymmetry. Overall, the results in Table 6.7 support *Hypothesis 9* that firms remain unlevered during favourable market timing conditions by actively reducing information asymmetry.

6.2.6. Exogenous shock - brokerage merge events

Debt financing acts as a disciplining device by imposing cash flow obligations and the threat of bankruptcy (Jensen, 1986; Williamson, 1988). Therefore, one

endogeneity concern is that firms adopt zero-leverage firms to avoid the disciplining effect of debtholders, leading to high information asymmetry. Using the broker mergers and closures, I employ the DID analysis for the causal effect of information asymmetry on zero-leverage behaviour.

Prior studies document that broker mergers and closures reduce analyst coverage, leading to a deterioration of information asymmetry (e.g., Hong and Kacperczyk, 2010; Kelly and Ljungqvist, 2012; Chen et al., 2015; To et al., 2018). Hong and Kacperczyk (2010) identified 43 mergers with both bidder and target covered by I/B/E/S database, and provide a list of firms whose coverage has been affected due to mergers of brokerage houses. For each treated firm identified by Hong and Kacperczyk (2010), I select the control group as the unaffected firms with at least one analyst coverage and in the same industry and year. To better isolate the causal effect, the sample is restricted to five years around each event.

Similar to Section 6.2.4, I employ Equation (4) to test the effect of broker mergers and closures on the unlevered decision. $Treat_i$ is a dummy variable equal to one if the firm i experience the broker mergers and closures, and zero for the control group. $Post_{i,t}$ is a dummy that equals one for the post-event period and zero for the pre-event period. The interaction term $Treat_i \times Post_{i,t}$ is the variable of interest, and β_3 captures the causal effect of broker mergers and closures on the zero-leverage decision between treated and control groups. Similar to Table 6.5, I conduct the test for equity issuers and non-equity issuers separately to check whether broker mergers and closures affect zero-leverage behaviour through equity issuance.

Table 6.7. The effect of equity issuance on the zero-leverage decision by high and low information asymmetry

This table reports the marginal effects of logit regressions of market timing conditions on the zero-leverage decision. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. High accrual uncertainty, analyst forecast error and probability of informed trading are defined if the value is larger than the median in a given year. Columns (1) to (4) are for subsamples with high and low accrual uncertainty. Columns (5) to (8) are for subsamples with high and low analyst forecast error. Columns (9) to (12) are for subsamples with the high and low probability of informed trading. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include control variables, year and industry fixed effects. The details of variable construction are reported in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

	Low accrual uncertainty	High accrual uncertainty	Low accrual uncertainty	High accrual uncertainty	Low analyst forecast error	High analyst forecast error	Low analyst forecast error	High analyst forecast error	Low probability of informed trading	High probability of informed trading	Low probability of informed trading	High probability of informed trading
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$Prior\ 12month\ return_{i,t-1}$	0.006**	0.003			0.002	0.001			0.010***	-0.004		
	(0.003)	(0.003)			(0.003)	(0.003)			(0.003)	(0.005)		
$Future\ 36month\ return_{i,t+3}$	-0.007***	-0.002			-0.006**	0.002			-0.003	-0.001		
	(0.002)	(0.003)			(0.002)	(0.002)			(0.003)	(0.003)		
$Standardized\ M/B_{i,t}$	0.003***	0.002			0.002**	0.001			0.002*	-0.000		
	(0.001)	(0.001)			(0.001)	(0.001)			(0.001)	(0.001)		
$Investor\ sentiment\ index_t$			0.008**	0.006			0.009*	0.002			0.010**	0.007
			(0.004)	(0.005)			(0.005)	(0.005)			(0.005)	(0.006)
Pseudo R^2	0.21	0.31	0.30	0.27	0.19	0.29	0.28	0.26	0.25	0.19	0.23	0.19
No. of obs.	34,375	28,829	28,579	25,828	48,992	49,034	38,812	37,596	22,839	16,477	29,614	25,752

Table 6.8. Difference-in-difference test for the information asymmetry effect on the zero-leverage decision

This table reports the marginal effects of the logit regressions for the DID tests using the broker mergers and closures as exogenous shocks of information asymmetry. The dependent variable is the zero-leverage dummy that equals one for zero-leverage firms and zero otherwise. For each firm affected by the broker mergers and closures, I select firms with the same industry and year as control groups. *Treat* equals one if a firm suffers the merge of brokerage mergers and closures, and zero for the control groups. *Post* equals one if a firm has experienced the events and zero otherwise. Equity issuers and non-equity issuers are defined based on whether firms have positive net equity issuance in a given year. Columns (1), (3) and (5) report the results for five years intervals around the broker mergers and closures, and Columns (2), (4) and (6) are for the placebo test in which the time of shock is falsely identified three years ahead. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include control variables, year and industry fixed effects. The details of variable construction are reported in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	Full	Equity issuers	Equity issuers	Non-issuers	Non-issuers
	[-5,+5]	Placebo	[-5,+5]	Placebo	[-5,+5]	Placebo
$Post_t \times Treat_i$	-0.038**	-0.014	-0.040**	-0.016	-0.027	0.001
	(0.017)	(0.017)	(0.019)	(0.020)	(0.050)	(0.026)
$Post_t$	0.025*	0.008	0.024	0.012	0.033	0.012
	(0.014)	(0.016)	(0.017)	(0.019)	(0.028)	(0.019)
$Treat_i$	0.034*	0.024	0.037*	0.026	-0.001	-0.000
	(0.018)	(0.018)	(0.021)	(0.022)	(0.018)	(0.020)
Pseudo R^2	0.31	0.35	0.30	0.33	0.45	0.58
No. of obs.	12,451	9015	10,414	7229	1997	1510

Table 6.8 presents the results of the DID analysis. Consistent with the results in Table 6.6, Column 1 shows that the exogenous increase in information asymmetry reduces the probability of being zero-leverage firms for the treated group. Comparing Column 3 with 4, this effect is only significant in the equity issuers. To alleviate the concern of parallel assumption, I falsely identify the time of events three years ahead. Columns 2, 4, and 6 show no significance for the falsely identified DID estimator. Overall, Table 6.8 provides evidence for the causal effect of information asymmetry on the zero-levered decision, and the effect is more profound for equity issuers.

Table 6.9. Robustness for the almost zero-leverage decision

This table reports the marginal effects of equity issuance, market timing conditions and information asymmetry on the probability of being almost zero-leverage firms. The dependent variable is the almost zero-leverage dummy that equals one for almost zero-leverage firms and zero otherwise. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include control variables, year and industry fixed effects. The details of variable construction are reported in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Net\ equity\ issuance_{i,t-1}$	0.088***						
	(0.009)						
$Equity\ issuance_{i,t-1}$		0.112***					
		(0.009)					
$Prior\ 12month\ return_{i,t-1}$			0.021***				
			(0.003)				
$Future\ 36month\ return_{i,t+3}$			-0.010***				
			(0.002)				
$Standardized\ M/B_{i,t}$			0.002**				
			(0.001)				
$Investor\ sentiment\ index_t$				0.010***			
				(0.003)			
$Accrual$ uncertainty$_{i,t-1}$					-0.499***		
					(0.085)		
$Analyst\ forecast\ error_{i,t-1}$						-0.019***	
						(0.004)	
$Probability\ of\ informed\ trading_{i,t-1}$							-0.090***
							(0.026)
Pseudo R^2	0.23	0.23	0.25	0.23	0.22	0.26	0.22
No. of obs.	119,871	119,871	73,841	119,898	88,782	75,212	54,660

6.2.7. Robustness for the almost zero-leverage decision

Besides the various robustness tests for zero-leverage firms, I further conduct robustness tests for the effects of equity issuance, market timing conditions, and information asymmetry for the almost zero-leverage decision.

Table 6.9 reports the corresponding results. The positive effect of equity issuance on the almost zero-leverage decision is consistent with the results in Columns 1 and 2 of Table 6.2. The positive effect of favourable market timing conditions also holds, as shown in Columns 4 and 5 of Table 6.3. The negative effect of information asymmetry on the almost zero-leverage decision is consistent with the results in Table 6.6. Overall, Table 6.9 further confirms the significant role of equity issuance, market timing conditions, and information asymmetry in the low-leverage puzzle.

6.2.8. Comparing market timing effect and abnormal investment needs on zero-leverage behaviour

Prior studies also document that equity issuance is also driven by short-term investment needs (Deangelo et al., 2010; Huang and Ritter, 2020), so firms might issue equity to support unexpected investment opportunities. However, the investment incentive and market timing incentive tend to be exclusive. Bosworth (1975) finds that managers do not consider market valuation when they make investment decisions. Consistent with Bosworth, Blanchard and Watson (1982) and Blanchard et al. (1993) argue that market timing has a limited effect on investment decisions as stock price contains a critical element of irrationality. Similarly, Baker et al. (2003) find that equity financing firms' investment decisions are more sensitive to the non-fundamental component of stock prices.

Therefore, it is possible that firms' equity financing is motivated by abnormal investment rather than favourable market timing opportunities.

This section tests whether the market timing effect dominates abnormal investment needs on the probability of being zero-levered following the method in Deangelo et al. (2010). Specifically, I construct a proxy for abnormal investment needs following Titman et al. (2004) and Strebulaev and Yang (2013), and regress the zero-leverage dummy on the market timing proxies and abnormal investment needs for the equity issuer sample.

Next, I calculate the estimated probability of being zero-levered by substituting favourable (unfavourable) market timing conditions and unfavourable (favourable) abnormal investment needs and comparing the estimated probability conditional on the two effects' different combinations. For robustness, I also test the almost zero-leverage decision using the same procedure.

I consider five scenarios: (1) extremely favourable market timing condition, (2) extremely unfavourable market timing condition, (3) extremely high abnormal investment needs, (4) extremely low abnormal investment needs, and (5) opposite conditions between market timing and abnormal investment needs. Following Deangelo et al. (2010), the extremely favourable market timing condition is defined as 75% of the prior 12-month abnormal stock return, 3.0 of the standardized market-to-book, and -75% of the future 36-month abnormal stock return[14]. The extremely unfavourable market timing condition is defined as -75% of the prior 12-month abnormal stock return, 0.5 of the standardized market-to-book, and 75% of the future 36-month abnormal stock return. The

[14] A firm with equity market timing has high prior abnormal return and low future abnormal return, so I refer extremely favourable 36-month abnormal return as negative 75%.

moderate market timing condition is defined as 0 of the prior 12-month abnormal stock return, 1 of the standardized market-to-book, and 0 of the future 36-month abnormal stock return. For the abnormal investment needs condition, the extremely high, moderate, and low abnormal investment needs are defined as 25th, 50^{th,} and 75th percentile, respectively.

Panel A of Table 6.10 reports the original coefficients. The sign and significance of market timing proxies are consistent with the results in Table 6.4. The coefficients of abnormal capital expenditure are significantly positive in both Columns 1 and 2, suggesting that abnormal investment needs are more likely to be extremely low-leverage firms for equity issuers.

Panel B of Table 6.10 reports the predicted probability of being zero-leverage firms. In Column 1, when the market timing conditions and investment needs are moderate, the predicted probability of being zero-leverage is 13.1% (row 1). When the prior 12-month abnormal return is extremely favourable (+75%), the predicted probability of adopting zero-leverage increases to 13.7% (row 2), holding other conditions at a moderate value. The predicted probability of being zero-leverage increases to 13.6% if a firm is soon to experience a decrease in the 36-month abnormal return, as shown in row 3. Row 4 reports that the predicted probability of adopting zero-leverage for a firm with extremely favourable market-to-book increases to 15%.

In the last row of Panel B, a firm with extremely high investment needs increases the predicted probability of being zero-leverage to 13.4%, and this value suggests that the predicted probability of being unlevered is lowest for the condition of only high investment needs. Column 2 shows that the results for the almost zero-leverage decision are all consistent.

Table 6.10. Comparing the effects of market timing and investment needs

This table reports the estimated probability of zero-leverage (almost zero-leverage) firms. Column (1) is for zero-leverage firms and Column (2) is for almost zero-leverage firms. Panel A reports the original coefficients from logit regression of market timing conditions and abnormal capital expenditure on the zero-leverage (almost zero-leverage) decision using the equity issuer sample. Panel B reports the estimated probability of being zero-leverage (almost zero-leverage) firms by setting only one of the favourable market timing conditions or favourable abnormal capital expenditure, holding other variables at a moderate value. Following DeAngelo et al. (2010), the extremely favourable (unfavourable) market timing conditions are set as previous 12-month abnormal stock return equals 75% (-75%), future 36-month abnormal stock return equals -75% (75%) and standardized market to book equals 3 (0.5). The moderate market conditions are set as the previous 12-month abnormal stock return equals 0, future 36-month abnormal stock return equals 0 and standardized market to book equals 1. The extremely favourable, moderate and unfavourable abnormal investment needs are defined as abnormal capital expenditure equals 75%, 50% and 25%. Panel C reports the estimated probability of zero-leverage (almost zero-leverage) firms if a firm has favourable (unfavourable) market timing conditions and unfavourable (favourable) abnormal investment needs, holding other variables at a moderate level.

	Zero-leverage	Almost zero-leverage
	(1)	(2)
Panel A. regression for the effects of market timing and investment needs on the low-leverage decision		
$Prior\ 12month\ return_{i,t-1}$	0.065***	0.138***
	(0.024)	(0.018)
$Future\ 36month\ return_{i,t+3}$	-0.054**	-0.061***
	(0.021)	(0.017)
$Standardized\ M/B_{i,t}$	0.079***	0.079***
	(0.008)	(0.007)
$Abnormal\ investment\ needs_{i,t}$	0.068***	0.031**
	(0.016)	(0.013)
Pseudo R^2	0.007	0.008
No. of obs.	57,027	57,027
Panel B. Estimated probability of being low-leverage with favourable market timing conditions or investment needs		
1. Moderate market timing and investment needs	13.1%	26.1%
2. Extremely favourable prior 12month abnormal return only	13.7%	28.2%
3. Extremely favourable future 36month abnormal return only	13.6%	27.0%
4. Extremely favourable M/B only	15.0%	29.3%
5. Extremely high investment needs only	13.4%	26.3%

Table 6.10. - *Continued*

Panel C. Compare the effect of market timing conditions and investment needs on low-leverage decision		
6. Favourable prior 12month abnormal return/unfavourable investment needs	13.4%	27.9%
7. Unfavourable prior 12month abnormal return/favourable investment needs	12.9%	24.4%
8. Favourable future 36month abnormal return/unfavourable investment needs	13.4%	26.8%
9. Unfavourable future 36month abnormal return/favourable investment needs	13.0%	25.4%
10. Favourable M/B/unfavourable investment needs	14.8%	29.0%
11. Unfavourable M/B /favourable investment needs	13.0%	25.5%
12. Favourable three market timing conditions/unfavourable investment needs	15.9%	32.2%
13. Unfavourable three market timing conditions/favourable investment needs	12.0%	22.8%

The results in Panel B show that the extremely favourable market timing conditions measured by the three proxies tend to outweigh the extremely favourable investment needs. Besides, extremely favourable market-to-book has the most considerable impact on the predicted likelihood of adopting the zero-leverage decision.

Panel C of Table 6.10 reports the results of the predicted probability of being zero-leverage firms if the occasion of market timing is opposite to the occurrence of abnormal investment needs. In Column 1, firms that experience extremely favourable prior-12month abnormal stock return but extremely unfavourable abnormal investment needs have 0.5% higher predicted unlevered probability than the firms with the opposite conditions (row 6 minus row 7, 13.4%-12.9%). When a firm has an extremely favourable future 36-month abnormal return but extremely unfavourable abnormal investment needs, the predicted probability of being zero-leverage is 0.4% higher than firms with the opposite occasion (row 8 minus row 9, 13.4%-13.0%). The predicted probability of being unlevered for firms with extremely favourable market-to-book but extremely unfavourable abnormal investment needs is 1.8% (row 10 minus row 11, 14.8%-13.0%) higher than firms with the opposite conditions.

The last two rows of Panel C show that the extremely favourable three market timing conditions and extremely unfavourable abnormal investment needs increase the predicted probability of zero-leverage by 3.9% (row 12 minus row 13, 15.9%-12.0%). The results of the almost zero-leverage decision in Column 2 show a consistent pattern.

Overall, Table 6.10 shows that market timing conditions play a more dominant role in zero-leverage behaviour than immediate investment needs.

6.2.9. Longitudinal analysis of cash surrounding equity issuance

To test whether zero-leverage firms build high cash reserves from equity issuance proceeds, I use the longitudinal analysis to compare the cash change around equity issuance surrounding zero-leverage firms' and non-zero-leverage firms' equity issuance. Deangelo et al. (2010) and Huang and Ritter (2020) employ the method to investigate cash change around external financing. Deangelo et al. (2018) also use this method to analyze the change in cash around the deleveraging events. The longitudinal approach has two advantages. It allows researchers to detect changes in variables of interest to the target population at both group and individual levels, and it goes beyond a single point in time to create a sequence of events (Cook et al., 2002).

Table 6.11 reports the results. I start by standardizing the time of firms that have positive net equity issuance as $Year_0$, then calculate the median change in cash scaled by the total asset (*Cash/TA*) for the previous year ($Year_{-1}$) and next year ($Year_{+1}$). The results in Columns 2 and 3 of Table 6.11 show that the median zero-leverage issuers' cash ratio in the year before equity issuance is 0.344, which is more than fourfold of non-zero-leverage counterparts (row 1). The remarkable difference in cash ratio remains noticeable in the year of equity issuance and one year after equity issuance, as the zero-leverage issuers' cash ratio in $Year_0$ is 0.409 (0.545-0.136) higher than non-zero-leverage firms, and the cash ratio in $Year_{-1}$ is 0.384 (0.502-0.118) higher than non-zero-leverage firms. The results confirm the high cash holding held by zero-leverage firms.

One concern is that small and high-growth firms tend to hold high cash reserves, so the results in rows 1 to 3 could be driven by firm size, growth, and industrial characteristics. Therefore, I calculate *Excess Cash/TA* to check whether zero-leverage issuers' large cash reserves remain robust. Specifically, *Excess Cash/TA* is calculated by subtracting a normal *Cash/TA* from a firm's *Cash/TA*. To obtain the normal *Cash/TA*, I sort all firms in the same industry into three equal-sized groups based on total book assets and three equal-sized groups based on the market to book in each year, and then each observation is allocated to one of nine groups based on its size and market-to-book in each year. A normal Cash/TA is the median Cash/TA within each of the nine groups.

Rows 4 to 6 show a striking difference for *Excess Cash/TA*. *Excess Cash/TA* is positive for zero-leverage issuers in the years surrounding equity issuance, implying zero-leverage firms can maintain high abnormal cash reserves compared with their counterparts. The non-zero-leverage issuers' negative *Excess Cash/TA* in the years around equity issuance suggests that non-zero-leverage firms tend to have lower cash than their peers. Moreover, the results also suggest that zero-leverage firms have sufficient cash before equity issuance, implying that cash shortfalls do not motivate their equity issuance.

Table 6.11. Analysis of cash holding surrounding equity issuance decision

This table reports cash ratio, pro forma cash ratio, raw change in cash ratio and abnormal change in cash ratio around equity issuance. Column (1) is for the full sample, Columns (2) and (3) are for zero-leverage and non-zero-leverage equity issuers, and Columns (4) and (5) are for almost zero-leverage and non-almost zero-leverage equity issuers. In each row tile, I standardize the year of equity issuance as $year_0$, and $year_{+1}$ and $year_{-1}$ refer respectively to the year ends immediately before and immediately after the equity issuance. *Cash* is cash and cash equivalent asset, *TA* is the total asset, *Equity Issuance Proceeds* are the sale of common and preferred stock. *Excess Cash/TA* equals actual *Cash/TA* minus normal *Cash/TA*. The normal *Cash/TA* is calculated for a given year by sorting all industrial firms into (i) three equal-sized groups based on total book assets and (ii) three equal-sized groups based on market-to-book; each observation is then allocated to one of nine groups based on the relative size and market-to-book. Within each of the nine groups, the normal *Cash/Total* is calculated for each two-digit standard industrial classification as the median ratio among all firms in the industry for the year in question. *Pro Forma Cash/TA* measures the cash if firm does not receive the equity issuance proceeds, holding operating and other financing decisions remain unchanged. It is calculated as deducting equity issuance proceeds from the numerator and denominator of *Cash/TA*.

	Full	Zero-leverage	Non-zero-leverage	Almost zero-leverage	Non-almost zero-leverage
	(1)	(2)	(3)	(4)	(5)
1. Median *Cash/TA* in $year_{-1}$	0.109	0.344	0.077	0.276	0.057
2. Median *Cash/TA* in $year_0$	0.193	0.545	0.136	0.466	0.093
3. Median *Cash/TA* in $year_{+1}$	0.169	0.502	0.118	0.422	0.083
4. Median *Excess Cash/TA* in $year_{-1}$	0.000	0.114	-0.002	0.082	-0.008
5. Median *Excess Cash/TA* in $year_0$	0.002	0.135	0.000	0.111	-0.004
6. Median *Excess Cash/TA* in $year_{+1}$	0.000	0.104	-0.001	0.074	-0.007
7. Median *Equity Issuance Proceeds /TA* in $year_{-1}$	0.249	0.411	0.231	0.433	0.204
8. Median *Equity Issuance Proceeds /Cash* in $year_{-1}$	2.061	0.934	2.461	1.231	2.777
9. Median *Pro Forma Cash/TA* in $year_{+1}$	-0.012	0.351	-0.037	0.228	-0.048
10. Percentage of issuers with *Pro Forma Cash/TA*<0 in $year_{+1}$ (%)	52.1	24.5	58.3	31.9	63.3
11. Median *Pro Forma Excess Cash/TA* in $year_{+1}$	-0.127	-0.008	-0.139	-0.068	-0.141
12. Percentage of issuers with *Pro Forma Excess Cash/TA*<0 in $year_{+1}$ (%)	73.8	51.0	78.9	58.1	82.4
13. Median raw change in *Cash/Equity Issuance Proceeds* from $year_{-1}$ to $year_0$	0.150	0.376	0.115	0.392	0.071
14. Median raw change in *Cash/Equity Issuance Proceeds* from $year_{-1}$ to $year_{+1}$	0.117	0.358	0.092	0.303	0.067
15. Median abnormal change in *Cash/Equity Issuance Proceeds* from $year_{-1}$ to $year_0$	0.042	0.072	0.034	0.088	0.018
16. Median abnormal change in *Cash/Equity Issuance Proceeds* from $year_{-1}$ to $year_{+1}$	0.010	0.028	0.007	0.024	0.004

Another concern is whether the proceeds raised by equity issuance are essential to firms' current cash reserves. In row 7, the median equity issuance proceeds divided by total assets in the year before equity issuance for the zero-leverage issuers is 0.411, nearly double the median ratio of non-zero-leverage counterparts. The results are consistent with the previous results that zero-leverage firms use more equity financing. When I replace the total asset with the cash reserves in row 8, *Equity Issuance Proceeds /Cash* in $Year_{-1}$ for the zero-leverage issuers is only half of the non-zero-leverage issuers'.

The results suggest that the proceeds of equity issuance account for a significant proportion of funds for non-zero-leverage issuers' financial status, implying that the pressure of cash depletion is more likely to motivate the non-zero-leverage firms' equity issuance decision.

Next, I investigate whether the proceeds from equity issuance are essential to support the firms' operating and financing decisions year after equity issuance. Following Deangelo et al. (2010) and Huang and Ritter (2020), *Pro Forma Cash* and *Pro Forma Excess Cash* are calculated by hypothetically assuming that the issuers maintain the operating and financing decision without equity issuance proceeds. Negative *Pro Forma Cash* implies that firms cannot maintain future operating and financing decisions without the equity issuance proceeds, suggesting that they have to forgo the investment opportunity or raise funds through other financing methods.

In rows 9 to 12, the *Pro Forma Cash* in the year after equity issuance is 0.351 for zero-leverage issuers, implying that zero-leverage issuers can maintain high cash reserves even if equity issuance proceeds are not available. In contrast, the

negative *Pro Forma Cash* of non-zero-leverage issuers implies that they have to alter their investment or financing decision to avoid cash deficit if equity issuance proceeds are unavailable. Row 10 shows the proportion of issuers with a negative *Pro Forma Cash* among each sample. Holding all other decisions fixed, only less than 30% of zero-leverage issuers would run out of cash if the proceeds of equity issuance are unavailable. However, almost 60% of non-zero-leverage issuers would suffer severe liquidity problems.

Row 11 reports the median *Pro Forma Excess Cash*, and Row 12 reports the proportion of issuers with negative *Pro Forma Excess Cash* for each sample. The median *Pro Forma Excess Cash* is negative for more than half of zero-leverage issuers and almost 80% of non-low-leverage issuers, implying that both of them cannot maintain a typical cash ratio without equity issuance. However, the higher *Pro Forma Excess Cash* for zero-leverage firms indicates a less severe cash shortage. In addition, I also check the *Pro Forma Excess Cash* with unchanged debt issuance and unchanged capital expenditure, the results in Table B5 show qualitatively unchanged results.

Finally, I follow Kim and Weisbach (2008), Deangelo et al. (2010) and Huang and Ritter (2020) to calculate the change in cash scaled by equity issuance proceeds from one year before equity issuance to the year of equity issuance and one year after equity issuance, respectively. Kim and Weisbach (2008) document that one dollar in the SEOs contributes to 42 cents higher cash in the year after the SEO compared with the year before the SEO, which can be interpreted as evidence for stockpiling issuance proceeds.

In rows 13 and 14, the results suggest that each dollar raised by equity financing is associated with 37.6 cents increase in the median cash balances in $Year_0$ and

35.8 cents in $Year_{+1}$ for the zero-leverage issuers. The magnitude is triple of the non-zero-leverage issuers, implying that zero-leverage issuers stockpile more equity issuance proceeds than non-zero-leverage issuers.

For robustness, in rows 15 and 16, I also calculate the abnormal change in cash scaled by equity issuance proceeds. This proxy takes into account the fact that firms with incremental size require higher cash reserves. The abnormal change in cash is calculated as the dollar cash in a given year minus the dollar cash balance in the year before the equity issuance multiplied by one plus the rate of change in the inflation-adjusted total assets from the year before the equity issuance to the year in question.

The results show that the excess cash raised by equity issuance for the zero-leverage issuers is double that for non-zero-leverage issuers in the year of equity issuance (row 16). Moreover, the difference increases quadrupled in the year following equity issuance (row 17), which further supports that zero-leverage issuers stockpile more equity issuance proceeds than non-low-leverage issuers.

In Columns 4 and 5, I redo the test for almost zero-leverage firms. The results are qualitatively similar to zero-leverage firms. Overall, consistent with *Hypothesis 10*, Table 6.11 shows that zero-leverage firms do not issue equity to cover short-term cash depletion. Besides, the high pre-issuance cash balances allow zero-leverage firms to stockpile more equity issuance proceeds and maintain high cash reserves relative to non-low-leverage firms. Compared with zero-leverage firms, short-term cash depletion is a significant motive for non-zero-leverage firms; most of them will run out of cash if equity issuance proceeds are unavailable.

Table 6.12. The effect of equity issuance on the zero-leverage decision by cash subsamples

This table reports the marginal effects of logit regressions of equity issuance on the zero-leverage decision. The dependent variable is the zero-leverage dummy that equals one for almost zero-leverage firms and zero otherwise. Columns (1) to (4) are for cash surplus and deficit samples, and (5) to (6) are for high and low cash samples. All the continuous variables are winsorized at 1% level. Delta-method standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All the regressions include control variables, year and industry fixed effects. The details of variable construction are reported in Appendix A. All continuous variables are winsorized at their 1st and 99th percentiles. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

	Cash surplus	Cash deficit	Cash surplus	Cash deficit	High cash	Low cash	High cash	Low cash
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Net\ equity\ issuance_{i,t-1}$	0.022***	-0.006			0.017	0.003		
	(0.008)	(0.007)			(0.011)	(0.007)		
$Equity\ issuance_{i,t-1}$			0.043***	-0.006			0.037***	0.007
			(0.008)	(0.007)			(0.011)	(0.007)
Pseudo R^2	0.23	0.24	0.23	0.24	0.21	0.21	0.21	0.21
No. of obs.	89,615	29,510	89,615	29,510	58,548	60,577	58,548	60,577

In Table 6.12, I redo regressions in Equation (1) for cash surplus and cash deficit separately to check whether equity issuance influences zero-leverage behaviour through cash saving. Following Huang and Ritter (2020), firms with positive (non-positive) *ex-ante* cash are treated as the cash surplus (deficit) sample. Columns 1 and 3 show that equity issuance and net equity issuance significantly affect zero-leverage probability in the cash surplus sample. In contrast, I do not find a significant impact of equity issuance for firms with deficit cash reserves in Columns 2 and 4.

I also check the effect of equity issuance in high and low cash samples in Columns 5 to 7. The sample is split based on whether a firm's *ex-ante* cash is higher than the median *ex-ante* cash in the given year. The results show that the significant impact of equity issuance only exists in the high cash sample. Overall, Tables 6.11 and 6.12 show evidence for *Hypothesis 10* that zero-leverage firms issue equity to save cash instead of meeting short-term cash deficits.

6.3. Conclusion

This study aims to complement and deepen the findings of previous studies by investigating the puzzling phenomenon of zero-leverage firms' other financing options. As zero-leverage firms are subject to severe financial constraints, they could rely more on equity financing if internal funds are insufficient. In addition, equity financing is superior to debt financing for R&D firms due to the investors' appetite for R&D investments. The results show that equity financing is more important for zero-leverage firms, which is consistent with the financial constraint explanation of the zero-leverage puzzle.

Given the fact that equity financing is costly, this study further explores why zero-leverage firms rely on equity financing. Financially constrained firms are restricted from accessing the debt market, it is difficult for them to exploit debt market timing opportunities, so they could actively explore the equity market timing opportunities to reduce the cost of equity and alleviate the dilution effect. The results show that market timing conditions have a significant impact on zero-leverage behaviour for equity issuers, and DID tests using the technology bubble further confirm the causal effect of stock overvaluation on the zero-leverage decision. Consistent with the market timing theory, zero-leverage firms actively explore market timing opportunities to alleviate the cost of equity financing.

However, based on the real options theory, financially constrained firms' equity issuance decisions could be driven by investment opportunities. It is possible that investment opportunities are more important in explaining zero-leverage behaviour. Therefore, in the subsequent test, I compare the impact of investment opportunity with the impact of market timing to clarify the mechanism behind unlevered firms' equity issuance decisions. The results show that market timing theory has higher explanatory power than real options theory on the zero-leverage puzzle, implying that large investment opportunities do not drive zero-leverage firms' equity issuance.

In order to achieve an integrated picture of zero-leverage firms' equity financing, the final tests explore the motivation behind their equity issuance decisions to reconcile the conflicting prediction of the pecking order theory on their financing choices. Consistent with the argument that cash reserves are more valuable to financially constrained firms, and zero-leverage firms' equity issuance is more likely to be driven by cash stockpiling than the pressure of immediate cash needs.

This study makes several contributions to the literature. In distinction to previous studies that focus on debt initiation, this study focuses on alternative financing options for zero-leveraged firms, and contributes to the literature on zero-leverage behaviour by providing a comprehensive analysis of zero-leverage firms' financing choices. The second contribution is that this study provides evidence for financial constraint and market timing theories; zero-leverage firms are more likely to explore equity market timing opportunities, which supports the argument that financially constrained firms are more likely to be equity market timers. Finally, this study contributes to the literature on the incentives of equity financing. Consistent with financial constraint and financial flexibility theories that cash reserves are more valuable to financially constrained firms because they demand high financial flexibility, I show evidence that cash stockpiling is more likely to motivate zero-leverage firms' equity issuance than immediate cash shortage.

For the implications, the study suggests that managers should trade off the benefit and cost when dealing with equity issuance proceeds. On the one hand, saving cash from the proceeds allows firms to gain great financial flexibility. On the other hand, they should also consider the costs of deviating far from the optimal leverage and over-reliance on internal funds and equity financing. Existing and passive shareholders gain benefits from issuing equity to take advantage of market timing opportunities, but they also need to consider the forgone benefit of debt financing if firms rely too much on equity financing and pursue extremely conservative debt financing.

Chapter 7. Conclusion to the thesis

This thesis explores the determinant for zero-leverage behaviour, a puzzling capital structure decision that has attracted considerable researchers' attention in the literature. Specifically, this thesis provides new insights into the zero-leverage phenomenon from the perspectives of innovation, market competition, and equity financing. The final chapter begins by summarising the main findings of the three chapters, then highlights the contributions and ends with a discussion of limitations and future work.

Chapter 4 highlights the crucial impact of R&D on the zero-leverage decision. It shows that zero-leverage firms are concentrated in R&D firms. The results imply that the unique characteristics of R&D investment impede access to debt financing, resulting in a high probability of a firm being zero-levered. Using the implementation of state R&D tax credit as the exogenous shock of R&D, I find the causal effect that firms that operate in states with the R&D tax credit have a higher probability of being unlevered than firms that operate in states without the policy. The decomposition analysis shows that the strengthening sensitivity of the zero-leverage decision to R&D investments has more explanatory power than the rising trend of R&D investments on the trend of the zero-leverage puzzle.

After exploring the role of R&D in the zero-leverage decision, I investigate the driving forces that motivate firms to innovate and become unlevered. Chapter 5 shows that intensified market competition has a significant and positive effect on the probability of adopting the zero-leverage policy. DID analysis using the import tariff reduction also confirms the causal effect of market competition on the zero-leverage decision. In addition, further tests show that the effect of

market competition on the zero-leverage decision is more profound for R&D firms than non-R&D firms, implying that market competition influences the zero-leverage decision through R&D investments. The sensitivity of the zero-leverage decision to market competition shows an increasing trend for R&D firms. Therefore, Chapter 5 complements and deepens the findings of Chapter 4 by showing that market competition increases the innovation race and firms' incentive for innovation, leading to a higher probability of adopting the zero-leverage policy.

Chapter 6 investigates the zero-leverage firms' equity financing since equity financing is the suboptimal financing choice for R&D investment, and financially constrained firms rely more on equity financing if internal funds are insufficient. I find that firms using more equity financing are more likely to adopt the zero-leverage decision. This evidence is striking because zero-leverage firms have sufficient internal funds. I then explore whether market timing theory can explain the zero-leverage puzzle; as financially constrained firms are restricted from accessing the debt market and are difficult to exploit debt market timing opportunities, they could actively explore the equity market timing opportunities to reduce the cost of equity and alleviate dilution effect. Consistent with the prediction of market timing theory on the choices of external financing, favourable market timing conditions significantly and positively affect the zero-leverage decision.

In the final section of Chapter 6, I explore the motives behind zero-leverage firms' equity issuance to achieve an integrated picture of their financing choices. I show that zero-leverage firms' equity issuance is more likely to be driven by cash stockpiling than the pressure of immediate cash needs, which supports the

financial constraint theory that cash reserves are more valuable if firms suffer severe financial constraints.

In sum, this thesis documents a novel story for the zero-leverage puzzle. High market competition increases firms' innovation investment to gain competitiveness. These firms become more financially constrained due to the risk embedded in R&D investment, and they reserve high cash by issuing equity during the timing of low cost of equity, leading to the conservative debt policy.

This thesis makes several contributions and has great implications. Firstly, this study contributes to the literature on the determinants of the zero-leverage puzzle by linking the zero-leverage puzzle with the investment decision, market structure and time of equity issuance decision. The three studies provide the causal effect of R&D investments, market competition and market timing opportunities in shaping unlevered decisions.

Secondly, this study contributes to economic Darwinism by providing a novel explanation for the puzzling capital structure choice. As Darwinism's explanation suggests that the evolution and survival of corporate decisions reflect the change in the external environment and are subject to Darwinian selection, this thesis identifies the increasingly intensified innovation race and market competition in explaining the puzzling prevalence of unlevered decisions documented in the literature.

Thirdly, the thesis contributes to the literature on innovation and market structure by highlighting the dark side of R&D and market competition from the perspective of financial policy. Innovation has long been recognized as the key to firms' competitive advantage, productivity and long-term growth, while

market competition acts as a governance mechanism to reduce agency costs, which has a non-trivial impact on shareholders' wealth. This study provides evidence that an aggressive innovation strategy in a high competition environment could incentivize firms to pursue a conservative debt financing policy, which harms shareholders' wealth due to the forgone tax benefit.

Fourthly, this study contributes to the literature on the motives of equity issuance. Literature related to the motive of equity issuance documents that a great proportion of firms issue equity for stockpiling cash rather than supporting investment opportunities; this study complements the literature by showing that unlevered firms' equity issuance decisions are more likely to be triggered by cash-saving motives.

The theoretical contribution of this study mainly focuses on financial constraint, financial flexibility and market timing theories. This study provides evidence for financial constraint and financial flexibility theories from the perspective of risky investments and market structure, and highlights the outcome of debt financing and cash policies. Secondly, this study shows that actively exploiting the equity market timing opportunities may crowd out debt financing and lead to unlevered decisions, which contributes to market timing theory from the perspective of debt financing decisions. Finally**,** this study also contributes to the financial constraint and market timing theories by providing evidence that financially constrained firms are more likely to explore market timing opportunities.

For the implications, managers and policymakers should pay attention to the side effect of innovation that firms have to forgo a great proportion of firm value due to extremely conservative financial decisions, which in turn harms shareholder

wealth. This study also calls the attention of policymakers to the drawback of promoting innovation through competition policy, as one of the potential outcomes is that it weakens the function of debt markets. Finally, the study suggests that managers should trade off the benefits and costs when dealing with equity issuance proceeds. On the one hand, saving cash from the proceeds allows firms to gain great financial flexibility. On the other hand, they should also consider the costs of deviating far from the optimal leverage and over-reliance on internal funds and equity financing. Existing and passive shareholders gain benefits from issuing equity to take advantage of market timing opportunities, but they also need to consider the forgone benefit of debt financing if firms rely too much on equity financing and pursue extremely conservative debt financing.

For the limitations, despite the theoretical viewpoint suggesting zero-leverage behaviour reduces firm value, it is still unclear whether it harms firm value and impedes future growth of R&D-intensive firms. Debt financing acts as a disciplining device by imposing cash flow obligations and the threat of bankruptcy (Jensen, 1986; Williamson, 1988). Without the discipline of debtholders, managers could take more risks, and the effects of managerial myopia (Grossman and Hart, 1982) lead to more investment in innovation (Stein, 1988). However, prior studies document that the innovation process of both large public companies and small start-ups tends to be significantly inefficient (Bhide, 1992; Jensen, 1993; Chesbrough, 2002). The constraint of debtholders on firms' operations provides a strong *ex-ante* incentive for managers to innovate in ways that generate positive cash flows and distributable rents (Aghion and Bolton, 1992; Choi et al., 2016). Therefore, exploiting stock performance and total factor productivity of zero-leveraged companies with high R&D intensity will be a fruitful area for further research.

Another limitation is that the impact of R&D investments on the zero-leverage decision may be heterogeneous and depends on firms' innovation efficiency. Recent studies find that a proportion of firms use patent portfolios as collateral to secure debt, as high patent value serves as a signal of low innovation risk, which reduces moral hazard and adverse selection problems of R&D investments (Hochberg et al., 2018; Mann, 2018; Farre-Mensa et al., 2020). Consistent with this argument, Hsu et al. (2015) find that firms with high quantity, impact, originality, and generality of patent portfolios have a lower probability of default, leading to a lower cost of debt. Combined with the above literature, innovation efficiency could play a significant role in the relationship between the zero-leverage phenomenon and R&D intensity.

Market competition does not promote all types of R&D. Therefore, the effect of market competition on the zero-leverage decision through which particular type of R&D still remains ambiguous. Specifically, innovation can be categorized as product innovation (e.g., new products or services introduced to meet the needs of external customers) and process innovation (e.g., innovation in production or service operations to reduce costs or improve product quality). Prior studies document that market competition boosts product innovation and hinders process innovation (Cohen and Klepper, 1996; Bonanno and Haworth, 1998; Weiss, 2003), so market competition could influence zero-leverage firms through product R&D investments. However, process R&D and product R&D are interdependent (Bhoovaraghavan *et al.*, 1996; Pisano, 1997; Reichstein and Salter, 2006), implying that endogeneity could be a crucial challenge for investigating through which type of R&D investment market competition affects zero-leverage behaviour. Another challenge in this research direction is that it is difficult to identify US firms' process innovations and product innovations accurately.

Finally, it remains unclear how long the impact of market timing conditions on zero-leverage behaviour could last, i.e., whether the persistent impact of market timing proposed by Baker and Wurgler (2002) can explain the zero-leverage puzzle. Baker and Wurgler (2002) argue that observed capital structure is the cumulative outcome of past attempts to time the equity market, but prior studies find mixed empirical evidence for the prediction (Leary and Roberts, 2005; Hovakimian, 2006; Kayhan and Titman, 2007). In addition, Strebulaev and Yang (2013) document that the zero-leverage decision is quite persistent, so investigating whether this phenomenon is attributable to past attempts to time the equity market is also a topic worth exploring. Overall, the zero-leverage phenomenon still contains many mysteries that await to be revealed in future research.

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Appendix

Appendix A. Variable definitions

The abbreviations in the parentheses are the variable names used in Compustat.

Book leverage: the sum of long-term debt and short-term debt divided by the total asset ((DLC+DLTT)/AT).

Zero-leverage firms: zero-leverage firms are firms with zero book leverage in a given year.

R&D stock: R&D stock is capitalized past R&D expenditure, which is defined by Hall et al. (2005). It is calculated by the perpetual inventory method: $G_{it} = (1-\delta)G_{it-1} + R\&D_{it}$, where *t* refers to the calendar year, G_{it} is the R&D stock in year *t.* $R\&D_{it}$ (adjusted to 2000 dollars) is the R&D expenditure of firm *i* in year *t*, and δ is the depreciation rate. The initial R&D stock equals the R&D expenses in the first year when the firm's record appears in the Compustat divided by a fixed depreciation rate of 15%, following Hall et al. (2005).

R&D-to-sales: the ratio of R&D expenditure to total sales (XRD/SALE).

R&D-to-assets: the ratio of R&D expenditure to total assets (XRD/AT).

R&D dummy: equals one if R&D expenditure is positive, and zero otherwise.

Log(size): the natural logarithm of total assets adjusted to 2000 dollars using CPI (published by Federal Reserve bank of St. Louis Economic Research Database).

Market-to-book: the ratio of market value to book value of total assets ((LT+PSTKL_TXDITC+CSHO×PRCC_F)/AT).

Profitability: the ratio of earnings before interests, taxes, and depreciation to total assets (OIBDP/AT).

Tangibility: the ratio of fixed assets to total assets (PPENT/AT).

Dividend payer: dummy variable equals one if a firm pays dividend in a particular year and zero otherwise.

Dividend payout: the ratio of common dividend to total assets (DVC/AT).

Earnings volatility: standard deviation of profitability (OIBDP/AT) using past ten years rolling window if there are at least three years consecutive observations for the firm. Otherwise, I treat it as missing.

Init. ZL: dummy variable equals one if firms' leverage in the first year recorded in Compustat is zero, and zero otherwise.

Ind.Frac.ZL: the number of zero-leverage firms in a given industry over the total number of firms in that industry.

Capital expenditure: the ratio of capital expenditure to book assets (CAPX/AT).

Abnormal Cap. Ex.: the growth rate of current capital expenditure compared with the average of the past three years' capital expenditure, i.e. $\frac{CE_t}{(CE_{t-1}+CE_{t-2}+CE_{t-3})/_3} - 1$.

Asset sale: the ratio of asset sales to total assets ((SPPE+SIV)/AT).

Log(age): the natural logarithm of the number of years since the firm's record first appears in the Compustat plus one.

Treat (R&D tax credit): dummy variable equals one if a firm operates in a state that implements the R&D tax credit policy, and zero otherwise.

Post (R&D tax credit): dummy variable equals one for the post-R&D tax credit policy period, and zero otherwise.

Industry fixed effect: Fama and French's 12-industry classification.

WW index: Following Whited and Wu (2006), this index is calculated as (-0.091×Cash flow – 0.062×Dividend payer + 0.021×Long-term debt – 0.044×Log(size) + 0.102×Industry growth – 0.035×Sales growth). Cash flow is operating income before depreciation, less interest and taxes, scaled by book assets ((OIBDP-XINT-TXT)/AT). Long-term debt is long-term

debt scaled by assets (DLC/AT), Industry growth is the four-digit SIC industry sales growth rate and Sales growth is the firm sales growth rate.

SA index: Following Hadlock and Pierce (2010), the index is calculated as $(-0.737\times\text{Log(size)} + 0.043\times\text{Log(size)}^2 - 0.040\times\text{firm age})$. Log(size) is the natural logarithm of total assets adjusted to 2000 dollars using CPI. Firm age is the number of years since the firm's record first appears in the Compustat.

Compustat HHI: Compustat Herfindahl-Hirschman index is computed as the sum of squared market shares based on firms' sales (SALE) in Compustat at the 3-digit SIC code level. Specifically, first, I calculate a firm's market share for each firm and year, which is the firm's sales over the total sales in the firm's industry. Then Compustat HHI is calculated as the sum of squared market shares for each industry and year.

Fitted HHI: Industry concentration ratio at the three-digit SIC code level created by Hoberg and Phillips (2010). This HHI covers private and public firms and is not restricted to manufacturing firms. Data are available at: https://hobergphillips.tuck.dartmouth.edu/industryclass.htm.

TNIC HHI: Industry concentration ratio based on the textual description of the product classification (Hoberg and Phillips, 2010; Hoberg et al., 2014; Hoberg and Phillips, 2016). Data are available at: https://hobergphillips.tuck.dartmouth.edu/industryclass.htm.

Treat (tariff reduction): dummy variable equals one if a firm operates in a manufacturing industry (industries are classified by 4-digit SIC code) that experiences the tariff reduction shock, and zero otherwise. Data for tariff rate are available at Philip Valta's personal website: http://www.valta.ch

Post (tariff reduction): dummy variable equals one if a manufacturing industry *j* has undergone a tariff reduction shock by time *t*, and zero otherwise.

Equity issuance: the ratio of the sale of common and preferred stock over total assets (SSTK/AT).

Net equity issuance: the ratio of net equity issued over total assets ((SSTKC-PRSTKC)/AT).

Ex-ante cash: Following Huang and Ritter (2020), *Ex-ante cash* is the sum of *Cash* and *NCF* in the previous years. *Cash* is cash and short-term investments (CHE). *NCF* is the difference between the internal cash flow and the sum of investment, change in non-cash net working capital, and dividends (*ΔCHE-ΔE-ΔD* or *ICF – NS* if the absolute value of the difference between the uses and sources of funds in year t is greater than 0.5% of asset in the previous year, or a major merger is identified by the Compustat footnote for net sales being AB, FD, FE, or FF). *ΔE* is the change in equity from the cash flow statement, which equals the sale of common and preferred stock (SSTK) – purchase of common and preferred stock (PRSTKC). *NS* equals *Investments* + ΔNon-Cash NWC + cash dividends (DV). *ΔNon-Cash NWC* equals ΔNWC – ΔCash.

For firms reporting format codes 1 to 3, *ΔD* equals long-term debt issuance (DLTIS) – long-term debt reduction (DLTR) – current debt changes (DLCCH). *ICF* equals income before extraordinary items (IBC) + extraordinary items and discontinued operations (XIDOC) + depreciation and amortization (DPC) + deferred taxes (changes) (TXDC) + equity in net loss (earnings) (ESUBC) + sale of property plant and equipment and investments gain (Loss) (SPPIV) + funds from operations other (FOPO) + sources of funds other (FSRCO). *Investments* equal capital expenditures (CAPX) + increase in investments (IVCH) + acquisitions (AQC) + uses of funds other (FUSEO) – sale of property (SPPE) – sale of investments (SIV). *ΔNWC* equals working capital change other (WCAPC) + cash and cash equivalents increase (decrease) (CHECH).

For firms reporting format code 7, *ΔD* equals DLTIS – DLTR + DLCCH. *ICF* is internal cash flow. *ICF* equals IBC + XIDOC + DPC + TXDC + ESUBC + SPPIV + FOPO + accounts payable and accrued liabilities increase (decrease) (APALCH). *Investments* equal CAPX + IVCH + AQC – SPPE – SIV – investing activities other (IVACO). ΔNWC equals accounts receivable decrease (increase) (RECCH) – inventory decrease (increase) (INVCH) – accounts payable and accrued liabilities increase (decrease) (APALCH) – income taxes accrued increase (decrease) (TXACH) – assets and liabilities other net change (AOLOCH) + cash and cash equivalents increase (decrease) (CHECH) – change in short-term investments (IVSTCH) – financing activities other (FIAO).

Prior 12month return: the 12-month cumulative abnormal stock return ending in the last fiscal year's end month. Abnormal stock return is calculated as the raw return minus the contemporaneous return on the value-weighted market index.

Future 36month return: the 36-month cumulative abnormal stock return starting from the following month of the current fiscal year's end month.

Standardized M/B: a firm's market-to-book scaled by the median market-to-book in the same year and industry.

Treat (technology bubble): dummy variable equals one if a firm belongs to the old economy manufacturers, and zero for technology manufacturers.

Post (technology bubble): dummy variable that equals one for the post-1995 period and zero otherwise.

Accrual uncertainty: I follow Francis et al. (2005) to calculate the standard deviation of abnormal accruals. Specifically, I regress the following equation for each Fama and French 48 industry and year:

$$TA_{i,t} = \beta_0 + \beta_1 CFO_{i,t} + \beta_2 CFO_{i,t-1} + \beta_3 CFO_{i,t+1} + \beta_4 \Delta REV_{i,t}/ ASSETS_{i,t-1} + \beta_5 PPE_{i,t}/ASSETS_{i,t-1} + \varepsilon_{i,t},$$

where TA is total accruals in a given year ($TA=((ACT_{i,t}-ACT_{i,t-1})-(LCT_{i,t}-LCT_{i,t-1})-(CHE_{i,t}-CHE_{i,t-1})+(DLC_{i,t}-DLC_{i,t-1})- DP_{i,t})/AT_{i,t-1}$), CFO is cash flow divided by lagged total asset ($OANCF_{i,t}/AT_{i,t-1}$), ΔREV is the change in revenue ($SALE_{i,t}-SALE_{i,t-1}$), ΔREC is the change in receivables ($RECT_{i,t}-RECT_{i,t-1}$) and PPE is property, plant and equipment ($PPEGT_{i,t}$). Accrual uncertainty is calculated as the standard deviation of residuals using a five-year rolling window.

Analyst forecast error: the absolute value of the difference between actual earnings per share minus the median forecasted value deflated by the stock price (Mansi et al., 2011). Data are collected from the Institutional Broker Estimate System (I/B/E/S) database.

Probability of informed trading: the likelihood that investors discover and trade on private information (Brown and Hillegeist, 2007). The probability of informed trading (PIN) is based on Easley et al.'s (1997) theoretical microstructure model. Specifically, the model assumes that timing and sequences of trades reflect the motivation of traders and their private information. Brown and Hillegeist (2007) estimate the structural parameters of the model using the daily number of buys and sells over an annual period, and calculate PIN as the fraction of trades in a day that arises from informed traders. Data are available at: https://scholar.rhsmith.umd.edu/sbrown/pin-data.

Treat (broker merge and closure): dummy variable equals one if a firm experiences the broker mergers and closures, and zero otherwise. Data for the treated firms are available at Harris Hong's personal website: http://www.columbia.edu/~hh2679/

Post (broker merge and closure): dummy variable equals one if a firm *i* has experienced the broker mergers and closures by time *t*, and zero otherwise.

Appendix B1. Dealing with missing R&D

This table presents the marginal effects of logit regressions of R&D on the probability of being zero-leverage firms. Panel A reports the results for the sample that excludes firms with missing R&D expenditure. Panel B reports the results for the sample that replaces missing R&D with industry median. Column (1) reports the original logit coefficients and standard error (in parentheses) based on R&D-to-sales ratio, and Columns (2) to (4) report the average marginal effects and Delta-method standard errors. All regressions include control variables, year and industry fixed effects. All standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

	(1)	(2)	(3)
Panel A. Excluding firms with missing-R&D			
R&D-to-sales$_{i,t-1}$	0.006***		
	(0.001)		
R&D-to-assets$_{i,t-1}$		0.176***	
		(0.031)	
R&D dummy$_{i,t-1}$			0.010
			(0.014)
Pseudo R-sq	0.23	0.24	0.23
No. of obs.	52,799	53,099	53,096
Panel B. Replacing missing-R&D with the industry median			
R&D-to-sales$_{i,t-1}$	0.010***		
	(0.001)		
R&D-to-assets$_{i,t-1}$		0.041**	
		(0.018)	
R&D dummy$_{i,t-1}$			0.014**
			(0.006)
Pseudo R^2	0.24	0.23	0.23
No. of obs.	91,681	92,154	92,154

Appendix B2. The effect of R&D on the zero-leverage decision over time

This table shows the marginal effects and P-value of the R&D-to-assets ratio and R&D dummy in cross-section yearly regressions from the model of Table 3.3. Columns (1) and (2) are for R&D-to-assets, and Columns (3) and (4) are for R&D dummy.

Year	Marginal effect for R&D-to-assets	P-value	Marginal effect for R&D dummy	P-value
	(1)	(2)	(3)	(4)
1980	-0.637	0.006	-0.011	0.238
1981	-0.282	0.152	-0.006	0.535
1982	-0.071	0.612	-0.001	0.881
1983	-0.152	0.288	0.003	0.799
1984	-0.151	0.270	-0.018	0.094
1985	-0.013	0.900	-0.006	0.549
1986	0.159	0.127	-0.010	0.434
1987	0.031	0.745	-0.010	0.420
1988	0.012	0.911	-0.002	0.882
1989	0.046	0.668	-0.001	0.933
1990	0.156	0.054	0.014	0.318
1991	0.236	0.009	-0.001	0.926
1992	0.190	0.038	-0.010	0.471
1993	0.151	0.108	-0.010	0.463
1994	0.214	0.010	0.008	0.566
1995	0.100	0.205	0.008	0.609
1996	0.200	0.020	0.008	0.546
1997	0.109	0.145	0.008	0.585
1998	0.331	0.000	0.020	0.139
1999	0.271	0.000	0.038	0.009
2000	0.134	0.061	0.023	0.141
2001	0.347	0.000	0.020	0.222
2002	0.211	0.011	0.011	0.482
2003	0.121	0.189	0.015	0.401
2004	0.132	0.148	0.033	0.073
2005	0.334	0.001	0.036	0.043
2006	0.195	0.053	0.045	0.018
2007	0.272	0.009	0.012	0.530
2008	0.207	0.034	0.007	0.696
2009	0.327	0.001	0.025	0.165
2010	0.240	0.020	0.026	0.190
2011	0.356	0.000	0.048	0.012
2012	0.221	0.030	0.054	0.003
2013	0.158	0.090	0.059	0.003
2014	0.421	0.000	0.032	0.091
2015	0.307	0.003	0.024	0.196
2016	0.218	0.020	0.021	0.244
2017	0.190	0.055	0.041	0.032

Appendix B3. The effect of R&D on the zero-leverage decision for non-IPO firms

This table presents the marginal effects of logit regressions of R&D on the probability of being zero-leverage firms for the non-IPO sample. The dependent variable is the zero-leverage dummy which equals one for zero-leverage firms and zero otherwise. All the columns report the average marginal effects and Delta-method standard errors. All regressions include control variables, year and industry fixed effects. All standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

	(2)	(3)	(4)
R&D-to-sales$_{i,t-1}$	0.016***		
	(0.002)		
R&D-to-assets$_{i,t-1}$		0.179***	
		(0.028)	
R&D dummy$_{i,t-1}$			0.011*
			(0.006)
Pseudo R^2	0.24	0.24	0.24
No. of obs.	85,465	85,858	85,858

Appendix B4. The changing effect of R&D on the zero-leverage decision over business cycles for non-IPO firms

This table reports the marginal effects of the logit regression of R&D on the probability of being zero-leverage firms by different intervals for the non-IPO sample. The dependent variable is the zero-leverage dummy which equals one for zero-leverage firms and zero otherwise. The business cycle periods are based on the turning points announced by the NBER. Delta-method standard errors are in parentheses. All regressions include control variables, year and industry fixed effects. All standard errors in parentheses are adjusted for heteroscedasticity and clustered at the firm level. All continuous variables are winsorized at their 1st and 99th percentiles. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. Detailed variable definitions are in Appendix A.

Period	1980-1990	1991-2001	2002-2007	2008-2017
	(1)	(2)	(3)	(4)
Panel A. R&D measured by R&D-to-assets				
$R\&D\text{-}to\text{-}assets_{i,t-1}$	0.005	0.198***	0.218***	0.253***
	(0.067)	(0.042)	(0.060)	(0.060)
Pseudo R^2	0.25	0.21	0.20	0.23
No. of obs.	20,397	24,157	15,778	21,186
Panel B. R&D measured by R&D dummy				
$R\&D\ dummy_{i,t-1}$	-0.006	0.003	0.025**	0.032**
	(0.007)	(0.008)	(0.013)	(0.013)
Pseudo R^2	0.25	0.21	0.20	0.22
No. of obs.	20,397	24,157	15,778	21,186

Table B5. Additional cash analysis surrounding equity issuance

This table reports the pro forma cash ratio that takes capital expenditure and debt issuance into account. Column (1) is for the full sample, Columns (2) and (3) are for zero-leverage and non-zero-leverage firms, respectively. In each row tile, I standardize the year of equity issuance as $year_0$, and $year_{+1}$ and $year_{-1}$ refer respectively to the year ends immediately before and immediately after the equity issuance. In rows 1 to 4, *Pro Forma Cash/TA* is the cash ratio if firm does not receive the equity issuance proceeds and no increased capital expenditure. In rows 5 to 8, *Pro Forma Cash/TA* is the cash ratio if firm does not receive the equity issuance proceeds and debt issuance proceeds. In the rest of the rows, *Pro Forma Cash/TA* is the cash ratio if firm does not receive the equity issuance proceeds and debt issuance proceeds, and no increased capital expenditure.

	Full	Zero-leverage	Non-zero-leverage
	(1)	(2)	(3)
Pro Forma Cash/TA assuming no equity issuance proceeds and capital expenditure unchanged			
1. Median *Pro Forma Cash/TA* in $year_{-1}$	0.044	0.369	0.011
2. Percentage of issuers with *Pro Forma Cash/TA*<0 in $year_{-1}$ (%)	42.2	21.3	46.8
3. Median *Pro Forma Excess Cash/TA* in $year_{-1}$	-0.090	0.014	-0.102
4. Percentage of issuers with *Pro Forma Excess Cash/TA*<0 in $year_{-1}$ (%)	65.8	47.7	69.9
Pro Forma Cash/TA assuming no equity issuance proceeds and no debt issuance proceeds received			
5. Median *Pro Forma Cash/TA* in $year_{-1}$	-0.074	0.342	-0.120
6. Percentage of issuers with *Pro Forma Cash/TA*<0 in $year_{-1}$ (%)	58.4	26.5	65.6
7. Median *Pro Forma Excess Cash/TA* in $year_{-1}$	-0.231	-0.021	-0.267
8. Percentage of issuers with *Pro Forma Excess Cash/TA*<0 in $year_{-1}$ (%)	75.8	51.8	81.2
Pro Forma Cash/TA assuming no equity issuance proceeds, no debt issuance proceeds received and capital expenditure unchanged			
9. Median *Pro Forma Cash/TA* in $year_{-1}$	-0.030	0.358	-0.071
10. Percentage of issuers with *Pro Forma Cash/TA*<0 in $year_{-1}$ (%)	52.6	23.8	59.1
11. Median *Pro Forma Excess Cash/TA* in $year_{-1}$	-0.181	0.004	-0.210
12. Percentage of issuers with *Pro Forma Excess Cash/TA*<0 in $year_{-1}$ (%)	71.7	49.1	76.7