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Firm-level Political Risk and Corporate R&D Investment

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FIRM-LEVEL POLITICAL RISK AND CORPORATE R&D INVESTMENT

BY

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THESIS ACCEPTANCE PAGE

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This thesis is approved as a creditable and independent investigation by a candidate for the master's degree and is acceptable for meeting the thesis requirements for this degree. Acceptance of this does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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ABSTRACT

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I examine how firms make R&D investment decisions during periods of political uncertainty. To minimize stickiness and overly generalized assumptions, I employ quarterly data. I find that firms invest more in R&D when facing high levels of political risk. The results suggest that this positive relationship between political risk and R&D investment is more pronounced for competitive and politically sensitive firms. Additionally, the positive association is evident among firms with higher growth opportunities and more liquid assets. The results are robust to the test for correlation, addressing endogeneity, and alternative proxies adopted for the variables of interest. Overall, the findings of this study support the strategic growth option theory, which suggests that firms follow a preemptive strategy during periods of high uncertainty.

Keywords: Firm Political Risk, R&D, Real Option, Strategic Growth Theory, Uncertainty

CHAPTER ONE

BACKGROUND OF THE STUDY

1.0 Introduction

The Russians' invasion of Ukraine, the US-China trade war, and the United Kingdom's vote to leave the European Union, to the repeated shutdowns of the U.S. federal government have led to concerns from economists and financial analysts on how political instabilities impact firms' corporate decisions. From a corporate standpoint, because macroeconomic policies matter, all of these turbulences and more beg the question of how firms make investment decisions in the face of political uncertainties. On the narrow part of the ongoing conversation about the relationship between uncertainty and investment, a specific research question yet to be investigated thoroughly is whether firm-level political risk increases or decreases R&D investment.

Analogous to economic uncertainty, political uncertainty is like exogenous macro shocks in the market which affect how firms exert, manage, and capitalize on the political pressures emanating from regimes, policies, and institutions. These pressures are empirically aggregated as the firms' political risk in the literature. Empirical evidence shows that these political pressures matter in corporate decisions and behaviors (Kobrin, 1979; Erb et al., 1996; Keillor et al., 2005; Jensen, 2008). I attempt to extend the conversation on firm political risk by examining its role from the firm's research and development (hereafter, R&D) perspective.

Firms undertake R&D investment to generate growth in the future (Kumar & Li, 2016) through technological progress, which increases the productivity and efficiency of capital investment (Lin, 2012). Thus early R&D investment is linked to more potential for a firm's expansion prospects irrespective of the risk associated. R&D investment is not only beneficial to a firm's success, but it is also a source of improving the economic growth of a country (Romer, 1990). Although R&D requires a lot of costs, the intended outcome is never guaranteed, and R&D investment may not be successful. Based on the probability of success, scholars offer two opposing views on how uncertainty affects R&D investment. Each school draws its conclusions from the theories - real options theory (strategic growth option theory) – which suggests that R&D investment declines(increases) in the face of uncertainty.

On the nexus of investment and uncertainty, the real options theory is the baseline in the finance literature to examine both themes. The theory draws from the assumption that investment is not irreversible. Thus, firms can not start an investment project at time t and at time t+1 decide to opt out of the investment and still be able to recoup their money. The theory also assumes there is imperfect competition in the market and that uncertainty significantly negatively impacts capital investment because it increases the value of waiting to invest. While this may strictly be true for capital investment, it does not necessarily hold for R&D investment. Studies such as (Grossman and Shapiro (1986); Pindyck (1993); Bar-Ilan and Strange (1996); Kulatilaka and Perotti (1998); and Atanassov et al. (2015)) argue that not all investments decline with increased uncertainty. While studies like Bulan 2005; Panousi & Papanikolaou, 2012; Hassan et al. 2019; Hasan et al. 2022; and Choi et al. 2022 finds a strict negative relationship between political uncertainty and corporate capital investment. However, the effect of uncertainty on R&D investment is mixed (Czarnitzki and Toole, 2011, Stein & Stone, 2013), and it is under-researched.

I rely on Hassan et al. (2019) data on firm-level political risk and the R&D investment expenditure data from Compustat to demonstrate the trends of R&D

investment and firm-level political risk (PRisk) pictorially in figure 1. Figure 1 shows the sampled firms' average firm-level political risk (solid blue line) and the average R&D investment expenditure (dotted red line). I note that firm-level political risk is always high in elections, war, crises, and the covid-19 pandemic quarters. R&D investment spikes in some quarters where firm-level political risk is high and also decline in other quarters where there is high firm-level political risk. Figure 1 evidence supports what Czarnitzki and Toole (2011) and Stein & Stone (2013) posit about how R&D behaves in periods of uncertainty. Figure 1 is evidence that R&D investment can increase (decrease) during periods of political uncertainties as suggested by the strategic growth options theory (the real options theory). Figure 1 shows that the average political risk was at an all-time high in the second quarter of 2020. In the first quarter of 2020, the United States recorded its first covid-19 case. The number of COVID-19 deaths cases reported daily skyrocketed in the second quarter of 2020. On May 29, 2020, the president of the United States threatened to terminate the US relationship with the World Health Organization. Again, the election to welcome the 46th president of the United States was also approaching. So, it is unsurprising that political risk was at an all-time high in the second quarter of 2020.

On the other hand, the average R&D investment was at an all-time high in the second quarter of 2021. In this period, the tech companies and the health industries are still trying to find means to bring life to normalcy. Most firms have to increase their R&D investment to devise new ways to keep their operations going while adjusting to the covid-19 pandemic. Within this period, the health industry actively engaged in laboratory research to fully understand the virus and improve vaccine efficacy. According to the 2021 State of Manufacturing Report, 94% of the respondents expressed concern about their supply chain, while 91% said they have to increase their investment in R&D in the digital transformation of their company to meet demand.

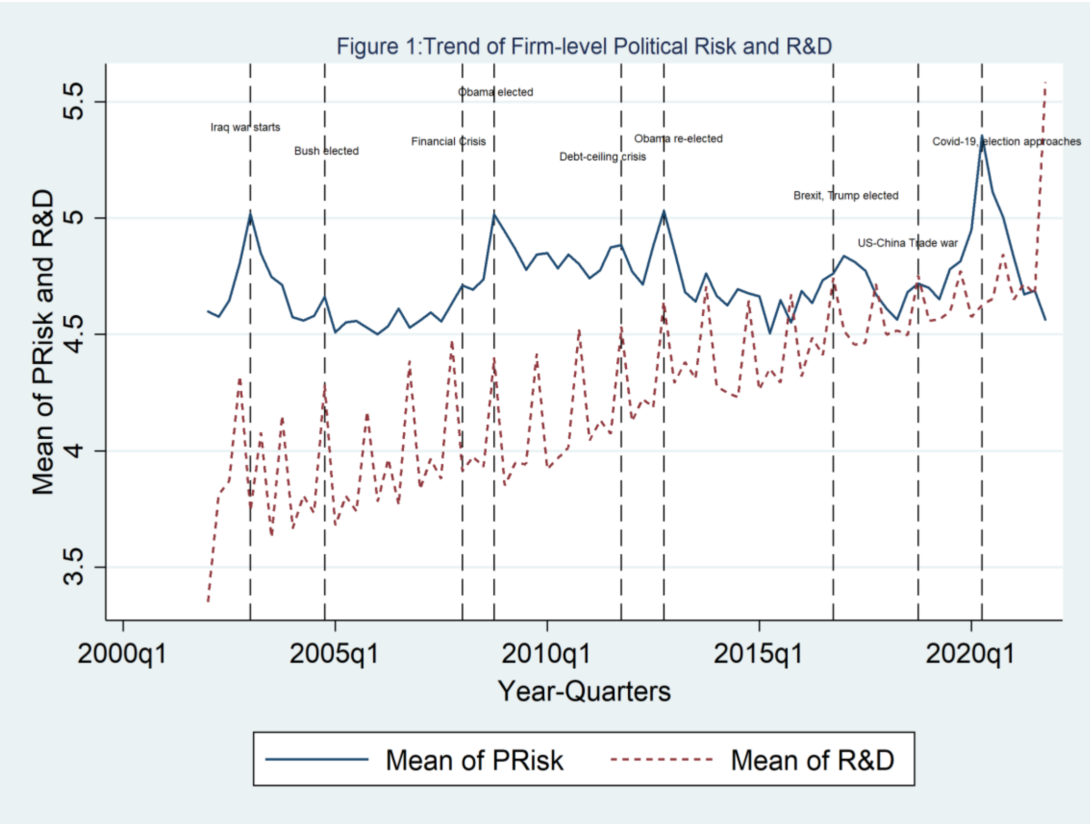


Figure 1: The Trend of Firm-Level Political Risk and R&D Investment

Hassan et al. (2019) and Choi et al. (2022) assert that firms adversely impacted by political risk can mitigate their risk by using internal mechanisms or firm-level factors such as campaign donations, lobbying, and corporate social responsibility (CSR) activities to mitigate their political risk exposure. If political risk positively impacts firms, then industry characteristics such as the degree of competition in the market and firms' growth potential can enhance the positive effect (Van Vo & Le, 2017). A firm’s liquidity can also moderate how uncertainty affects investment. Intuitively, firms with a lot of working capital and cash reserve can finance most of their investment projects compared to a firm with low working capital and cash reserve. A liquid firm is one with more cash reserve and working capital.

1.1 Research Objectives

This research seeks to achieve the following objectives:

1. To investigate the effect of firm-level political risk on corporate R&D investment Intensity.
2. To analyze the moderating role of growth opportunities, product market competition, liquidity, and politically sensitive industries on mitigating or enhancing the impact of political risk on corporate R&D investment.

To offer an insight into the competing theories and the research question, I rely on firm-level political risk data from Hassan et al. (2019), quarterly financial data from Compustat North America for US firms, the US Bureau of Economic Analysis, and the Economic Policy Uncertainty Index. The merged data of non-utility and non-financial firms led to 74,643 firm-quarter observations for 43 industries from the first quarter of 2005 through the second quarter of 2021. I perform batteries of empirical tests and address endogeneity concerns. The result suggests that firms invest more in R&D in periods of high political risk. This finding is consistent with the strategic growth option theory. Also, the result holds when using alternative proxies for R&D investment intensity and firm-level political risk as well as all the measures of the subset topics of firm-level political risk. Furthermore, the results show that: the positive relationship between firm-level political risk and R&D investment intensity is more pronounced for firms in a highly competitive industry and firms in highly politically sensitive industries. The positive effect of firm-level political risk on R&D intensity is more substantial for liquid firms and firms with higher growth opportunities.

To check the robustness of the results, I use an instrumental variable to deal with any potential endogeneity. I specifically use the IV-2SLS regression models with the industry average political risk as an instrument, as used in Gyimah et al. (2022). The results of this study still hold and are even stronger under the 2SLS. I also use one-step difference GMM regressions, quantile regression, and propensity score matching; the results are consistent.

This paper intends to fill the gap in the existing literature by examining how political risk affects corporate R&D investment using Hassan et al. (2019) measure of political risk. Since the results are valid and robust through a series of econometric applications, I offer the following contributions. First, I add to the empirical and theoretical arguments on the firm-level political risk that political pressure affects capital projects. Second, I add to the increasing number of studies on the relationship between uncertainty and investment. Here, I show that the strategic growth option theory is a robust interpretation. Third, I demonstrate how firms can take advantage of their exposure to political risk by using specific firm and industry attributes to amplify R&D investments.

I organize the remaining parts of the paper as follows. Section 2 discusses the existing literature. Section 3 describes the data collection and methodology. Section 4 presents the results, and section 5 concludes.

CHAPTER TWO

LITERATURE REVIEW

In this section, I review some of the empirical studies done on R&D investment and political risk. I also discuss the arguments on the relationship between uncertainty and investment. Each argument on uncertainty and investment will motivate a hypothesis development. Also, I discuss the moderating role of some industry and firm characteristics in the relationship between firm-level political risk and R&D intensity.

2.1 Related Literature on R&D Investment

Research and development (R&D) is described as any methodical and innovative effort carried out to enhance the body of knowledge and the use of this knowledge to develop novel applications that improves a firm's product and also increase the productivity of man (UNESCO). Why does R&D investment matter? Van Vo & Le (2017) gave the following example to demonstrate why R&D investment is very important to the sustainability and growth of a firm. "In the 1990s and early 2000s, Nokia held the position of the leading mobile phone vendor. However, the company was left behind in the smartphone market as its competitors capitalized on new phone technologies by carrying out multiple R&D projects. This caused Nokia's share price to drastically drop from $40 in late 2007 to less than $2 in mid-2012. Eventually, in 2013, Microsoft acquired Nokia's mobile business."

According to Heeley et al. (2006), firms that invest more in R&D are more likely to engage in acquisitions. R&D investment is strongly associated with firm acquisition under the condition of great environmental dynamism. Kim et al. (2021) looked at how the R&D investment intensity of financially constrained firms affects the firm value. They reported that R&D intensity is positively related to firm value for financially constrained firms and that the effect is more pronounced in firms that have dividend payout policies. Their result suggested that financially constrained firms engaging in R&D investment can use dividend policy to send a positive signal to the financial market. Alam et al. (2020) suggested that there is a positive relationship between R&D investment and firm performance. They also asserted that the relationship between R&D and firm performance is contingent on the external environment. Their findings posited that country-level investor protection is significant in increasing R&D investment and in return boosting firm performance.

2.2 Related Literature on Political Risk

According to Weston and Sorge (1972), political risk occurs when national governments interfere with or prevent economic transactions, change the terms of agreements, or confiscate totally or partially foreign-owned businesses. Greene (1974) defined political risk as government interference in the operations of a business. Political risk may also arise from events such as the US and China trade war, and the BREXIT. In this paper, firm-level political risk is a perceived risk that arises as a result of changes in government policies or decisions that affect the business environment and the financial market.

Generally, political risk can be either firm-specific or country-specific. A firm-level political risk is when a government makes a deliberate attempt to interfere in a particular firm's operations or make decisions targeted at some specific firms or industries (Kobrin, 1979). By contrast, country-level political risks are decisions made by governments that affect firm performance and investment in the country, but such decisions are not directed at any firm (Bekaert et al. 2014). While firm-specific political risk can be managed, country-specific political risk is less likely to be managed. Foreign portfolio investors are more likely to be affected by country-level risks, such as an unexpected increase in interest rates or a currency devaluation. In contrast, direct investors or shareholders are more likely to be affected by firm-level political risks (Wagner, 2000).

Political risk affects almost every aspect of a firm, from capital structure, growth, and investment decisions to firm performance. During periods of considerable political uncertainty, corporate valuation suffers as investors seek compensation for increased risks. Political uncertainty raises the cost of external financings, such as equity risk premium (Pastor and Verones, 2012), bank loan pricing (Francis, Hasan, and Zhu, 2014), corporate bond spreads (Waisman, Ye, and Zhu, 2015), and the cost of capital (Waisman, Ye, and Zhu, 2015). Political risk also raises the probability of R&D investment yielding no return (Bloom et al. 2007). The argument on how corporate investment decisions is impacted by political uncertainty is among the ongoing conversation on the deterministic impact of political uncertainty on firm performance.

According to Bloom et al. (2007) and Julio and Yook, (2012), firms that face high exposure to political risk decrease investment in fixed assets and also tend to face increased stock return volatility. While this reasoning appears to be persuasive, there is also the possibility that uncertainty may have a positive impact on firm-level fixed investments (Segal et al. 2015). This is because uncertainty raises a company's cost of capital and top management may not want to postpone fixed-asset investments. Thus, R&D expenses, which are considered fixed costs, are likely to follow the same behavior as expenditures on fixed assets. Hence, the relationship between R&D investment and political risk can be positive or negative.

2.3 Arguments on Investment and Uncertainty

There are two schools of thought on how uncertainty affects corporate investment. These theories are the real options theory and the strategic growth options theory. Estimating the impacts posited by the theories of investment (capital investment and R&D investment) under uncertainty have proven problematic due to the complexity of quantifying uncertainty and establishing causation. The limited empirical research done on this topic yielded mixed results. This section presents a review of related literature in line with the specific theory and objectives of the study. The papers selected for the review are based on their measurement of political risk. Specifically, I included two papers that used stock return volatility, two papers that used national events (election and terrorism), and two papers that used Hassan et al. (2019) methodology.

2.3.1 The Deferral Real Options Theory

The real options theory posits that increased uncertainty decreases a firm's corporate investment due to the irreversibility of the investment (Myers, 1977). The main assumption of this theory is that a firm has a monopoly power on a particular investment opportunity and this investment opportunity has no impact on product pricing or market structure.

Firms have two actual alternatives when it comes to R&D investment: "growth option" and "deferral option". The value a firm will place on the growth option (investing in R&D) is determined by the income that will be generated when the R&D innovations are commercialized (Li et al. 2022). On the other hand, the company may choose not to invest in the R&D in the present year when it feels there is a high probability of not recouping the amount spent in the R&D investment, and in so doing the firm is opting for the deferral option. The higher the irreversibility of investment (particularly in R&D), the higher the firm will value deferring its investment from a period of high uncertainty to a period of low uncertainty.

Following the deferral argument, the firm-level political risk may force companies to limit their R&D expenditure because political risk induces uncertainty and raises the willingness of firms to defer R&D investment. This is because, in a period of uncertainty, firms place a higher value on the option to wait rather than immediately making an irreversible and costly investment decision (Van Vo and Le, 2017).

Real options analysis demonstrates that under conditions where investment is not reversible and even if the investment is a non-lumpy capital investment, uncertainty will heighten the value a firm places on its option to defer the investment (Pindyck, 1990). During periods of uncertainty, there is a high risk of project failure and no return on investment. According to Weeds' (2002) theoretical analysis, uncertainty about R&D projects' returns will significantly increase the value of a firm's deferral options. That is, the value the firm places in the deferral option will outstrip the value they place in the growth options. This argument suggests that firm-level political risk hurts firms' R&D investment.

2.3.1.1 Related Literature and Hypothesis Development

Studies that found a negative relationship between investment (R&D and Capital Investment) and uncertainty (firm-level political risk) include Khan et al. (2020), Li et al. (2022), Choi et al. (2022), and Hassan et al. (2022).

Khan et al. (2020) did a country-specific study on how uncertainty impacts the R&D investment decisions of firms and also looked at the moderating role of product market competition. They used sample data of all non-financial Chinese firms (A-share) listed on the Shanghai (SSE) and Shenzhen (SZSE) stock exchanges within the periods of 2000 to 2017 with a total of firm-year observations of 25,001. The study used three measures of uncertainty, market uncertainty, economic policy uncertainty, and firm-specific uncertainty. The study also used three measures of R&D investment, the ratio of R&D expenditure to sales, the ratio of R&D expenditure to total assets, and R&D capital (see Chan et al. 2015) to total assets. They employed a two-stage GMM model and found that uncertainty negatively affects corporate R&D investments and that the effect is more pronounced for firms in a more competitive industry. They also argued that firm size matters because the negative effect is mitigated for large firms.

Li et al. (2021) used 211,869 firm-year observations from 48 countries from 2002 to 2017 to assess how terrorism affects a firm's R&D investment. In their paper, they noted that terrorism creates fear and an unfriendly environment for firms to operate. Thus, terrorism induces uncertainty and multinational companies are less willing to invest in their subsidiary companies when it is in countries that are prone to terrorist attacks. Using difference-in-difference and ordinary least squares regression, they found that terrorism will force businesses to cut R&D expenses because terrorism-induced uncertainty enhances the firm's willingness to defer investment. They argued that a nation with resilient national institutions, such as strong intellectual property rights protection and minimal expropriation risks, may minimize firms' unwillingness to invest in R&D even when the country is prone to terrorist attacks. Additionally, multinational companies, firms with higher total assets and more cash flow will be less affected by uncertainty in their R&D decisions.

Choi et al. (2022) employed the firm-level political risk (PRisk) index developed by Hassan et al. (2019), the firm's internal mechanisms, and a proxy for corporate investment (capital expenditure scaled by the book value of total assets) to empirically examine how a firm's internal mechanisms can be used to mitigate the impact of political risk on corporate investment decisions in North American firms. Their findings suggest that firm-level political risk negatively impacts a firm's capital investment.

Hasan et al. (2022) like Choi et al. (2022) also used the robust firm-level political risk data developed by Hassan et al. (2019) to investigate the effect of firm-level political risk on corporate cash holdings. They argued that firm-level political risk increases the credit market allocation and equity risk premium, aggravating the capital market's financing friction, which will increase default risk and cost of equity financing and hence resulting in the firm using internal funds in its operations.

An ordinary least square regression analysis was used to suggest a positive relationship between firm-level political risk and corporate cash holdings. The reason is that, when a firm experiences high political risk, it tends to suffer extreme difficulties to finance from external sources because of increased financial frictions and volatility in cash flows. The study solved the endogeneity problem by carrying out three estimations: a natural experiment with difference-in-difference (DID) estimations; the instrumental variable approach (2SLS); and using a matched sample following propensity score matching (PSM). The paper concluded that during periods of high political risk, firms prefer to delay their long-term investment until some of the uncertainty resolves, leading to an increase in cash holdings. Thus, this paper also indirectly posits a negative relationship between political uncertainty and investment just like Choi et al. (2022). Based on the real options theory, I propose the following:

Hypothesis: There is a negative relationship between firm-level political risk and R&D Investment

2.3.2 The Strategic Growth Option Theory

Strategic growth option theory is synonymous with the phrase “The early bird catches the early worm”. As opposed to the deferral real options theory, the strategic theory posits that in periods of high uncertainty firms undertake more investment. The main assumption of the strategic growth option theory is that there exists imperfect competition in the product market and players in this market act like players in the Cournot competition. Each firm chooses its strategy taking into consideration the other players' strategies and the first mover gains the larger market share. According to the strategic growth option theory, uncertainty may drive firms to invest in a growth option rather than wait to have most of the uncertainty resolved before investing (deferral option). The rationale behind this theory is uncertainty creates investment opportunities that are crucial to a firm’s growth and the firm that acts first gains market share and competitive advantage over its competitors. Delaying investments may allow other competitors to take advantage of the investment opportunity. Thus, "immediate action may discourage entrants and enhance market share and profits" (Kulatilaka & Perotti, 1998), thereby boosting future competitive advantage.

The strategic growth option model developed by Kulatilaka and Perotti (1998) demonstrates how uncertainty might stimulate investment in growth opportunities under imperfect competition. The rationale for this is that when a firm invests in a project, the initial amount invested in the project is viewed as the amount used to purchase growth potentials which will give the firm a competitive advantage over its competitors in the future. As a result, when the project the firm invested in has a substantial preemptive effect, it leads to the firm gaining greater market share and increasing the firm’s profits more than when the firm does not invest in growth options. With a strong strategic advantage, periods of heightened uncertainty might stimulate investment in growth options. For example, the Covid pandemic (which is a form of uncertainty) lead pharmaceutical firms to invest in R&D to understand the virus and come up with a vaccine. These companies saw a rise in share price. Pfizer’s share price rose from the $30s in late 2020 to the $50s in late 2022.

The real options theory suggests that since R&D investment is not reversible and involves adjustment costs (which are nonlinear and asymmetric with inputs cost), firms will prefer to defer R&D investment under periods of high uncertainty (Atanassov et al. 2015), but other theoretical studies have looked at some other mechanisms that could limit a firm's option of waiting and encourages immediate investment. According to Bloom and Reenen (2002), investment in R&D that finally results in a patent can be reversible either fully or partially by selling intellectual property rights. Patents provide the firm with a legal right to restrict copying and discourage newcomers into the product market and hence serve insurance-like protection for the firm to be the sole beneficiary of the outcome of the long period of research and development. This somewhat compensates for the irreversibility of R&D investment and encourages R&D investment in uncertain times. Thus, the strategic growth option theory suggests a positive relationship between firm-level political risk and Investment.

2.3.2.1 Related Literature and Hypothesis Development

Some of the studies that found a positive relationship between R&D investment and firm-level political risk are Stein and Stone (2013); Atanassov et al. (2015), and Van and Le (2017).

In contrast to the negative relationship found between uncertainty and investment by the current studies. Stein and Stone (2013) argued that the difficulty in measuring uncertainty has been the cause of the debate over how uncertainty affects corporate investment. [1]They addressed this challenge by using the expected volatility of a firm's stock price as a measure of the firm's forward-looking uncertainty. With the assumption that there might be a reverse causality between uncertainty and investment, they developed an instrumental variable strategy that looks at the degree of every firm's exposure to currency and energy price volatility. In their paper, they analyzed the impact of uncertainty on firm behavior. They used the ordinary least squares regression and the two-stage least square regression to suggest that during periods of high uncertainties, firms decrease their capital investment, advertising expenditure, and hiring of new employees. They surprisingly found that an increase in uncertainty increases a firm's investment in R&D. Using the Compustat world data they concluded that one-third of the decline in the world capital investment within 2008-10 was because of increased uncertainty which was caused by the global financial crisis.

Atanassov et al. (2015) used the timing of US gubernatorial elections obtained from CQ Press Electronic Library as a source of plausibly exogenous variation in uncertainty to examine the relationship between political uncertainty and R&D investment. They used COMPUSTAT North America with observations from 1976 to 2013 to account for a firm's R&D expenses and firm characteristics. They argued that the exact impact of political uncertainty depends on the features of the investment and the degree of competition in the product market, and so the entire effect of political

[1] There have been criticisms that proxying uncertainty with volatility in stock returns is inappropriate. According to Shiller (1989) and Schwert (1989), stock market volatility may be caused by speculative bubbles the same way it is driven by fluctuations in economic variables.

uncertainty on an economy's long-run growth is unknown. Their study used ordinary least square regression, quantile linear regression, and generalized method of moments to provide empirical evidence that companies respond to heightened political uncertainty by investing more in R&D ahead of time during election years.

They found that during election years, firms invest 4.6 percent more in research and development than in non-election years. They also noted that the positive relationship between political uncertainty and investment is stronger among firms that face higher product market competition and have higher growth opportunities. They argued that political uncertainty has a strong positive relationship with investment in a fiercely contested election and in industries that are sensitive to political activities and hard-to-innovate industries. Hence, their study contributed to the strategic growth option theory of investment under uncertainty.

Van Vo and Le (2017) argued that firms in highly competitive industries with less market power tend to invest more in R&D in periods of uncertainty. Their study used idiosyncratic return volatility as a measure of uncertainty to investigate the effect of uncertainty on R&D investment. They used the ordinary least square regression and the two-stage least square regression to conclude that firms increase their investment in R&D under heightened uncertainty. Just as Stein and Stone (2013); and Atanassov et al. (2015), Van Vo and Le (2017) found a positive relationship between uncertainty and R&D investment. Based on the strategic growth option theory, I propose the following:

Hypothesis: There is a significant positive relationship between firm-level political risk and R&D Investment

2.4 Moderating role of Industry Characteristics: Product Market Competition

I expect the positive relationship between firm-level political risk and R&D investment to vary depending on the competitive nature of the industry in which the firm finds itself. In general, firms that are in very competitive industries tend to invest more in R&D under uncertainty as compared to firms in industries that are less competitive. The rational is that the more the number of firms in an industry the more each firm tries to capitalize on an invention and try to produce something unique from its competitors. And since investment opportunities cannot be monopolized, it creates the fear of preemption in highly competitive industries such that firms in this industry would like to act first by investing in R&D and entering into an innovation race with its competitors.

Prior studies such as (Atanassov et al. 2015; Khan et al. 2020; Van Vo and Le, 2017), argued that firms in low-concentrated industries invest more in R&D in periods of uncertainty. Following early research, I used Herfindahl Hirschman Index (HHI) as a measure of product market competition. By its nature, HHI measures product market concentration, and a higher value indicates low competition in the industry and vice versa (Haushalter, Klasa & Maxwell, 2007).

Hypothesis: Product market competition increases the positive and mitigates the negative relationship between Firm-level political risk and R&D investment intensity**.**

2.5 Moderating role of Firm Characteristics: Growth opportunities

A growing firm invests more in R&D to sustain and maintain its growth. Studies such as Li et al. (2022), Hasan et al. (2022), Atanassov et al. (2017), and Van Vo & Le (2017) found that firms with higher growth potential invest more in R&D in a period of uncertainty. While Hasan et al. (2022) and Li et al. (2022) suggested that a firm's growth opportunities are ways of mitigating the negative relationship between uncertainty and Investment, Van Vo &Le (2017) and Atanassov et al. (2015) suggested that growth opportunities of firms are ways of amplifying the positive relationship between uncertainty and R&D investment. These two classes of researchers are arguing in the same direction but drawing their conclusions from different theories on investment under uncertainty.

Hypothesis: Firms' growth opportunities increase the positive and mitigate the negative relationship between Firm-level political risk and R&D investment intensity**.**

2.6 Moderating role of Firm Characteristics: Firm's Liquidity

A firm's liquidity shows its operational efficiency. Firms with more liquid assets are better positioned for business growth because they have enough cash reserves. It is expected that more liquid firms will have the ability to finance their R&D project even in periods of uncertainty. For example, a more liquid firm can convert some of its assets into cash to finance its R&D investment even when the firm is not making enough sales to support the R&D project.

Hypothesis: Firms' liquidity increases the positive and mitigates the negative relationship between Firm-level political risk and R&D investment intensity**.**

2.7 Moderating role of Industry Characteristics: Politically Sensitive Industries

Firms that belong to industries that are highly sensitive to political pressures tend to face move political risks (Atanassov et al. 2015). These politically sensitive industries are defined by Herron et al. (1999) and Julio and Yook (2012) using Fama French 48 industries classification.

Hypothesis: The degree of the industries' sensitivity to political uncertainty increases the positive relationship between Firm-level political risk and R&D investment intensity**.**

CHAPTER THREE

DATA AND METHODOLOGY

This section discusses the methodology that is adopted in carrying out the study. The section starts with the sources of data, proceeds to the definition and justification of variables, and is followed by the sample selection process and measurement of each variable used in the study, and then it specifies the empirical model to be estimated as well as the techniques of data analysis employed in the study.

3.1 Data Source

To examine the association between R&D investment and firm-level political risk, I rely on four sources for my data. These are COMPUSTAT North America, Hassan, et al. (2019) data on Firm-level Political Risk, US Bureau of Economic Analysis (BEA), and Economic Policy Uncertainty Index.

3.2 Dependent Variable: R&D investment

R&D investment is the amount of money a firm spends on the development of new products, services, or technologies and the improvement of existing products or technologies. Firms undertake R&D investment to gain new knowledge and use it to improve their existing products and introduce new ones. In this study, the dependent variable is R&D intensity, which is measured as the ratio of a firm's R&D investment expenditure divided by the total sales.

3.3 Independent variable: Firm-level political risk

Hassan et al. (2019), firm-level political risk is important to a firm's corporate decisions because it is the mother of all other risks firms face. Prior researchers have generally relied on other proxies of political risk such as stock return volatility, elections, wars, terrorism, oil price volatility, confiscatory taxation, and expropriation.

The possible limitations of the existing proxies are that they only looked at an aspect of political risk and failed to look at the aggregate political risk firms face. According to Hassan et al. (2019), firm-level factors explain less of the variations in national-level political risk such as elections, war, terrorism, and oil price volatility. To solve this concern, they developed a robust measure of firm-level political risk. As of the time of this study, the index covers from 2002q1 to 2021q4.

To measure firm-level political risk, Hassan et al. (2019) employ a pattern-based sequence-classification method developed in computational linguistics to distinguish political and non-political texts. They use a training library of political text that captures typical political discussions ($\mathbb{P}$) and a training library of non-political text that represents typical non-political discussions ($\mathbb{N}$). Each training library consists of bigrams found within political and non-political texts respectively. They then analyzed the quarterly earnings conference call transcript of firm *i* in quarter *t*, breaking it down into a list of bigrams contained within the transcript ($\mathrm{b} = 1, \ldots, B_{it}$). Next, they tallied the number of times bigrams relate to specific political topics within the set of ten words surrounding a synonym for "risk" or "uncertainty". Then, the count is divided by the total number of bigrams in the transcript. This calculation is shown below mathematically:

$$PRisk = \frac{\sum_{b}^{B_{it}}\left(1[\mathrm{b} \in \mathbb{P} \setminus \mathbb{N}] \times 1[|b-r|<10] \times \frac{f_{b,p}}{B_p}\right)}{B_{it}} \times 100{,}000 \qquad (1)$$

In the equation above, the function 1[•] acts as an indicator, the set $\mathbb{P} \setminus \mathbb{N}$ represents bigrams found in $\mathbb{P}$ but not $\mathbb{N}$, and *r* indicates the position of the closest synonym for risk or uncertainty. $f_{b,p}$ represents the frequency of bigram *b* in the political training library. B_p is the total number of bigrams in the political training library and B_{it} is the total number of bigrams in the transcript.

As a robustness check, Hassan et al. (2019) argued that their index is strongly correlated with stock market volatility. The time average of their political risk index is also highly correlated with the news-based economic policy uncertainty. Using their index, they assert that firms that are exposed to political risk reduce investment and hiring and ardently engage in campaign donations and lobbying of politicians.

In summary, firm-level political risk is measured as the proportion of a firm's earning conference call devoted to the discussion of risk or uncertainty emanating from politics that affects the firm. In my paper, firm-level political risk is derived by using Hassan et al. (2019) methodology.

3.4 Control Variables and Justification

I account for a variety of firm-level factors that have been employed in the existing literature to assess firms' investment prospects. Thus, to identify how political uncertainty impacts a firm's R&D policies, I followed Atanassov et al. (2015) to account for other firm variables that may have an association with a firm's R&D investment decisions. Some of the control variables used in this paper are leverage, Tobin's q, capital expenditure, and tangibility. The leverage ratio was included to capture how the capital structure of the firm and its internal financing decisions affect R&D intensity. Tobin's q was added to control for the effect of a firm's growth potential on R&D intensity. Also, capital expenditure and tangibility are included to assess how a firm's total investment expenditure and fixed assets influence its R&D policies.

I also followed Van Vo & Le. (2017) and added dividend payout and total sales to my empirical model. The dividend payout was included to account for how the dividend policies of firms impact their R&D investment decisions. Again, total sales are included to account for the firm size. I used the Herfindahl-Hirschman index derived at the 3-digit SIC level to adjust for industry concentration, as proposed by Aghion et al. (2008). HHI is a metric that evaluates the degree of competition in the product market. The HHI can have a minimum value of zero and a maximum value of 10,000, where a zero HHI means perfect market competition and a 10,000 HHI means a monopoly market. According to the US Department of Justice, HHI less than 1,500 indicates a low market concentration; from 1500 to 2500 signifies a moderate market concentration, and above 2500 means a high market concentration. The lower the concentration in the market, the higher the market competition in the 3-digit SIC industry and vice versa.

I included liquidity to capture the ease with which a firm can convert its asset into cash and how it affects the firm's R&D financing. The quarterly change in state-level GDP and Economic Policy Uncertainty are included in the empirical model to explain the overall economic conditions within a state and how these state-level macroeconomic variables play a role in a firm's R&D investment decisions.
I included quarter and industry-fixed effects in the empirical model to account for the time variations in firm characteristics and unobserved heterogeneity in the industry. I clustered the standard errors by the firm to control for heteroscedasticity and serial correlations in the error term.

3.5 Sample Selection Process

The main data come from two sources. These are COMPUSTAT North America and Hasan et al. (2019) data on Firm Political Risk. My final sample contains 74,643 firm-quarter observations for 3,337 firms in 43 industries from 2005q1 through 2021q2. Below I illustrate how I arrived at my usable sample.

The Compustat quarterly data began in 1979. Since 1979, the total observations are 1,531,011. I destringed the SIC (Standard Industrial Classification) code to create the Fama-French 48 industry classification and I dropped all missing SIC codes. This left me with a total of 1,531,002 out of 1,531,011 observations. I dropped all the missing quarters, the sample was left with 1,530,738 observations. However, firm-level political risk data begins in 2002q1 and ends in 2021q4, leading me to drop all observations before 2002q1 and after 2021q4. After deleting the pre-2002 and post-2021 quarterly financial reports, the Compustat data decreased to 748,803 observations.

Next, I dropped all financial and utility firms. Thus, firms with SICs range (from 6000 through 6999) and (4900 through 4999) leading to 459,847 observations for 43 industries under the Fama-French 48 industry classification. I dropped all duplicates associated with gvkey (firm) and fyearq (year-quarter) and my observations reduced to 459,503.

The firm-level political risk quarterly data has a total observation of 348,272 from 2002q1 to 2021q4. I sorted the two datasets by gvkey fyearq and merged them using the gvkey fyearq. I merged the two data sets and kept only the matched observations and the number of observations was 203,431 (to be sure this sample is robust, I used all the merging commands in STATA, from 1:1, 1:m, and m:1, I had the same sample). I dropped negative R&D values because it does not make intuitive sense and my observations were 203,380.

I merged state-level macroeconomic variables and kept only the matched observations. This led to a total observation of 146,897 from 2005q1 to 2021q2. That is the state-level GDP available at BEA as of June 10, 2022, at 1:42 pm begins

2005q1. I finally dropped all missing values, and this led to firm-quarter observations of 74,643 for 3,337 unique firms.

3.6 Measurement of Variables

See appendix I for Variables definition and measurement.

3.7 Empirical Model

Following the theoretical framework and the reviewed literature, the paper will estimate the following baseline empirical models using both the pooled OLS and panel fixed effect regression.

$$R\&D_{ijt} = \alpha_i + \beta_1 Political\ risk_{ijt} + \beta_k control_{ijt} + \varepsilon_{ijt} \qquad (2a)$$

$$R\&D_{ijt} = \alpha_i + \beta_1 Political\ risk_{ijt} + \beta_k control_{ijt} + \text{Industry FE} + \text{Quarter FE} + \varepsilon_{ijt}$$

(2b)

Where $R\&D_{ijt}$ stands for the R&D investment intensity made by firm i in industry j at quarter t. $Political\ risk_{ijt}$ is the firm-level political risk faced by firm i in industry j at quarter t. ε_{ijt} is the random error. Following Fama-French's 48 industrial classifications, my study will use non-financial and non-utility firms in 43 industries.

CHAPTER FOUR

RESULTS AND DISCUSSION

In this section, I present and discuss the results of the study. It starts with descriptive statistics of the variables used in the main regressions. I proceed to conduct a mean difference analysis. I examine the relationship between firm-level political risk and corporate R&D investment with different model specifications (Pooled OLS with and without fixed effect). Some firm and industry characteristics were used as moderators to further explore the relationship between the dependent and independent variables. To authenticate and validate the directionality that exists between the two main variables. First, I adopt non-parametric approaches (Quantile regression and Propensity Score Matching) to analysis the relationship between firm-level political risk and corporate R&D investment. Second, I employ the two-stage least squares and the one-step difference GMM methods. Finally, I use other proxies for the dependent and the independent variables.

4.1 Descriptive Statistics

Table 1 provides correlations and descriptive statistics. The descriptive statistics show the total sample of firms used in the study. The average R&D investment intensity is 0.251, this implies that on average firms spend 25.1% of their sales revenue on R&D investment. At the 25^{th}, 50^{th}, and 75^{th} percentile R&D investment intensity are 1.5%, 8.2%, and 19.5% of a firm's sales revenue respectively. The correlation matrix provides early evidence that R&D investment is positively correlated with political risk This also provides preliminary support for the strategic growth option theory. Additionally, R&D investment is positively correlated with market value or growth opportunities (Tobin's Q) with a correlation coefficient of r=0.260. This correlation coefficient suggests that businesses with high growth and investment opportunities tend to invest more of their sales revenue in R&D. Again, R&D Investment Intensity is positively correlated with a firm's liquidity, the correlation coefficient is r=0.367. Firms that have more liquid assets tend to invest more of their sales revenue in R&D.

Table 1: Summary Statistics and Correlation

Summary Statistics

VARIABLES	N	Mean	p25	Median	p75	Std. Dev.	min	max
R&D	74643	.251	0.015	.082	.195	.509	0	2.169
Political risk	74643	94.746	16.869	56.476	131.418	106.531	0	391.763
Tobin’s q	74643	2.448	1.349	1.927	3.035	1.525	.703	6.523
Sales	74643	1060.274	25.724	115.668	499.98	4850.88	.001	152079
Leverage	74643	.2	0.004	.149	.331	.202	0	.657
Liquidity	74643	3.043	1.513	2.302	3.842	2.187	.429	8.935
Capital Expenditure	74643	.022	0.006	.014	.03	.022	0	.08
Tangibility	74643	.171	0.055	.117	.24	.152	.005	.554
Dividend	74643	.006	0.000	0.000	.002	.028	0	1.459
Asset	74643	4772.657	153.271	539.19	2262.859	19098.254	.132	551669
Herfindahl Index	74643	.167	0.106	.134	.18	.124	.049	1
State level EPU	74643	269.324	147.894	218.831	332.848	174.789	54.988	762.729
State level GDP	74643	91545.971	30717.301	49549.699	197229.3	76337.469	4688.8	221107.09

Correlation Matrix

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) R&D	1.000												
(2) Political risk	0.135*	1.000											
(3) Tobin's q	0.260*	0.046*	1.000										
(4) Sales	-0.084*	0.011*	-0.032*	1.000									
(5) Leverage	-0.064*	0.000	-0.071*	0.071*	1.000								
(6) Liquidity	0.367*	0.080*	0.170*	-0.134*	-0.325*	1.000							
(7) Capital Expenditure	-0.178*	-0.069*	0.001	0.062*	0.012*	-0.171*	1.000						
(8) Tangibility	-0.233*	-0.066*	-0.182*	0.129*	0.271*	-0.300*	0.549*	1.000					
(9) Dividend	-0.067*	-0.011*	0.054*	0.070*	0.040*	-0.045*	0.075*	0.055*	1.000				
(10) Asset	-0.080*	0.026*	-0.032*	0.798*	0.090*	-0.124*	0.029*	0.070*	0.088*	1.000			
(11) EPU	0.063*	0.112*	0.053*	-0.002	0.062*	0.051*	-0.138*	-0.056*	-0.026*	0.022*	1.000		
(12) Herfindahl Index	-0.118*	0.003	-0.099*	0.040*	0.039*	-0.089*	0.019*	0.093*	0.019*	0.054*	-0.017*	1.000	
(13) GDP	0.088*	0.008*	0.138*	-0.035*	-0.119*	0.113*	-0.065*	-0.178*	-0.042*	0.001	0.220*	-0.065*	1.000

* *p<0.05*

4.2 Mean Difference

Table 2 reports the mean difference in how firm-level political risk and firm-level characteristics vary among high R&D intensity firms (firms whose R&D intensity is greater than the median R&D intensity of the industry they belong to) and low R&D intensity firms (firms whose R&D intensity is below the median R&D intensity of their industry). From the table, it can be inferred that high R&D investment firms on average are more exposed to political risk as opposed to low R&D investment firms. On average, firms that invest more in R&D tend to gain more growth and investment opportunities as compared to firms that invest less in R&D. R&D investment strips off a firm's capacity to build its fixed assets since it pushes a lot of money to finance the R&D project and thus will have less cash to purchase fixed assets and to spend on capital expenditure. Generally, the profitability of a firm at time t is negatively affected by the firm's R&D investment at time t. Hence, firms that invest a lot of their sales revenue in R&D will tend to have a high decline in profit at time t as compared to firms that invest less in R&D. This leads to high R&D firms paying lower average dividends at the end of each fiscal quarter t.

Table 2: Stark Difference in High vs. Low R&D Investment Firms

VARIABLES	Low R&D	High R&D	difference	St Err	t-value
Political risk	89.602	102.101	-12.499	.799	-15.65
Tobin's q	2.193	2.812	-.618	.012	-53.65
Leverage	0.227	.162	.065	.002	44.4
Capital Expenditure	0.025	.018	.007	0	41.65
Tangibility	0.208	.117	.092	.001	91.2
Sales	1435.396	523.961	911.436	32.334	28.2
Dividend	0.007	.005	.003	0	11.05
Liquidity	2.571	3.72	-1.15	.017	-69.35
Herfindahl Index	0.171	.163	.007	.001	8.5

Note: Two-sample t-test with unequal variances was used. There are 43,922 observations for low R&D and 30,721 observations for high R&D.

4.3 Main Regression Results

I use the econometric model outlined above to run a series of tests. However, I winsorize all the variables at the one percentile and the 99 percentile and also transform the variables (except for capital expenditure and tangibility) into log forms to minimize skewness and improve the normality of distribution properties. All variables' transformations were based on the distribution properties of the variables.

4.3.1 Contemporaneous Effect of Firm-level Political Risk on R&D Intensity

Table 3 shows the contemporaneous effect of firm-level political risk on R&D investment intensity. The first column shows the regression of R&D investment on firm-level political risk without any control variables, industry, and year-quarter fixed effects. Column 2 shows the results of how firm-level political risk affects R&D investment intensity when firm characteristics are accounted for with no industry and year-quarter fixed effect. Column 3 reports the results of the effect of firm-level political risk on R&D investment intensity when firm characteristics and state-level macroeconomic variables are taken into account with no industry and quarter-fixed effect. In columns 4 to 5, I included industry and quarter fixed effects, all estimates reported in columns 1 to 5 represent the baseline regression models.

The coefficients for political risk are positive and statistically significant across all models' specifications. This implies that in periods of high-level political risk, firms invest a lot of their sales revenue in R&D investment. The conditional expectation of political risk on R&D investment intensity ranges from 0.009 to 0.019 and the unconditional expectation of political risk on R&D investment intensity is

0.030. All these coefficients are statistically significant at a 1% significance level. Also, political risk has economic significance on R&D investment intensity. From column 5, which is the full model and also the key baseline regression, a one standard deviation increase in political risk will lead to a 0.01 (0.009×$\frac{106.531}{94.746}$) increase in R&D intensity. From the sample, the average R&D intensity is 0.251, a rise of 0.01 denotes a 3.98% (=$\frac{0.01}{0.251} \times 100$) increase in R&D intensity.

$$R\&D\ Intensity = \frac{R\&D\ expenditure}{Sales}$$

Given the average sales of 1060.274 million, a 3.98% rise in R&D Intensity, will imply that R&D investment expenditure will rise by an average of approximately $\frac{3.98}{100} \times \frac{R\&D\ expenditure}{Sales} \times sales = \frac{3.98}{100} \times 0.251 \times 1060.274m$=10.6million. This is also equivalent to 0.01×1060.274m. The economic significance is relatively large, as it is about 67% of the median R&D investment expenditure of the sampled firms. My baseline regression results are all consistent with the strategic growth option model. These results are also consistent with early research such as (Van Vo and Le, 2017; Stein and Stone 2013; Kulatilaka and Perotti, 1998).

The growth opportunities of firms are consistently positive in all regressions. This signals that a firm’s growth opportunity is crucial to its R&D intensity. Later in this section, I will discuss the moderating role of some firm characteristics including the firm’s growth opportunities in the relationship between firm-level political risk and R&D investment.

Table 3: Contemporaneous effect of firm-level political risk on R&D Investment

VARIABLES	(1)	(2)	(3)	(4)	(5)
Political risk	0.030***	0.019***	0.018***	0.009***	0.009***
	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)
Tobin's q		0.207***	0.205***	0.121***	0.116***
		(0.016)	(0.004)	(0.016)	(0.016)
Leverage		0.370***	0.372***	0.138***	0.141***
		(0.035)	(0.009)	(0.032)	(0.032)
Capital Expenditure		-1.404***	-1.394***	-0.739***	-0.749***
		(0.200)	(0.085)	(0.224)	(0.223)
Tangibility		0.013	0.021	0.003	0.017
		(0.043)	(0.013)	(0.055)	(0.055)
Sales		-0.113***	-0.113***	-0.097***	-0.097***
		(0.005)	(0.001)	(0.005)	(0.005)
Liquidity		0.169***	0.168***	0.071***	0.070***
		(0.015)	(0.004)	(0.014)	(0.014)
Dividend		-0.150	-0.134**	-0.156	-0.129
		(0.180)	(0.065)	(0.132)	(0.129)
Herfindahl Index		-0.187***	-0.184***	-0.026	-0.025
		(0.051)	(0.012)	(0.029)	(0.029)
State level EPU			0.005*		0.021*
			(0.003)		(0.011)
State level GDP			0.009***		0.016**
			(0.002)		(0.007)
Constant	0.143***	0.261***	0.140***	0.446***	0.158
	(0.009)	(0.035)	(0.022)	(0.034)	(0.097)
Observations	74,643	74,643	74,643	74,643	74,643
R-squared	0.011	0.368	0.368	0.512	0.513
Industry FE	NO	NO	NO	YES	YES
Year-Quarter FE	NO	NO	NO	YES	YES

Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$
NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity, State-level EPU, and GDP).

4.3.2 The Impact of Current Firm-level Political Risk on Future R&D Intensity

Table 4 reports how political risk affects the future R&D intensity of firms. The positive effect of political risk does not wash away after time t, but it can go as far as time t+4. Intuitively, this makes sense since R&D intensity is not a once and for all investment. Firms must keep on spending on their R&D project to ensure it is successful. From the results in table 4, firms consistently allocate some amount of their sales revenue to R&D investment in each quarter. In column 4, a one standard deviation increase in political risk in quarter t caused firms to increase their R&D intensity by 0.009 (=0.008×$\frac{106.531}{94.746}$) in quarter t+2. This implies 3.59% (=$\frac{0.009}{0.251} \times 100$) increase in R&D intensity in quarter t+2. In monetary terms, high political risk in time t influences firms to spend an average of approximately $\frac{3.59}{100} \times 0.251 \times 1060.274m = 9.5million$ of their sales revenue in R&D at time t+2. Comparing the results in table 3 column 5 and table 4 column 4, we can say that the positive impact of firm-level political risk on R&D intensity diminishes after time t+1.

Table 4: The effect of firm-level political risk on future R&D Investment

VARIABLES	(1) time t+1	(2) time t+2	(3) t+1 FE	(4) t+2 FE
Political risk	0.018***	0.017***	0.009***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)
Tobin's q	0.201***	0.203***	0.110***	0.109***
	(0.016)	(0.017)	(0.016)	(0.017)
Leverage	0.351***	0.341***	0.116***	0.108***
	(0.036)	(0.037)	(0.034)	(0.034)
Capital Expenditure	-1.343***	-1.360***	-0.901***	-0.937***
	(0.204)	(0.205)	(0.222)	(0.225)
Tangibility	0.004	0.002	0.014	0.014
	(0.043)	(0.043)	(0.055)	(0.055)
Sales	-0.105***	-0.101***	-0.089***	-0.086***
	(0.005)	(0.005)	(0.005)	(0.005)
Liquidity	0.175***	0.170***	0.081***	0.077***
	(0.016)	(0.016)	(0.015)	(0.015)
Dividend	-0.192	-0.214	-0.209*	-0.222*
	(0.170)	(0.165)	(0.121)	(0.116)
Herfindahl Index	-0.186***	-0.183***	-0.020	-0.025
	(0.051)	(0.051)	(0.029)	(0.028)
State level EPU	0.002	0.001	0.022**	0.023**
	(0.006)	(0.006)	(0.011)	(0.011)
State level GDP	0.009	0.009	0.016**	0.015**
	(0.008)	(0.008)	(0.007)	(0.007)
Constant	0.116	0.113	0.117	0.111
	(0.094)	(0.095)	(0.098)	(0.099)

Observations	71,306	68,160	71,306	68,160
R-squared	0.350	0.342	0.496	0.488
Industry FE	NO	NO	YES	YES
Year-Quarter FE	NO	NO	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity, State-level EPU, and GDP).

4.3.3 The Moderating Effect of Growth Opportunities

Table 5 shows the moderating role of firms' growth opportunities (Tobin's q) in the association between firm-level political risk and corporate R&D intensity. To do this, I created tobin's q dummy. I grouped the firms into a high tobin's q and a low tobin's q. Since a firm's tobin's q is not static and can vary from quarter to quarter, the tobin's q dummy created is on a year-quarter basis.

A high tobin's q firm is the one with a tobin's q value greater than the industry median value of tobin's q at time t. On the other hand, a firm is said to have a low growth opportunity if its tobin's q at time t is lower than the median tobin's q at time t of the industry it belongs into. I proceed to interact with the tobin's q dummy with political risk. Based on the results in table 5, a firm with low growth opportunities (low tobin's q) tends to engage in less R&D intensity as compared to firms with high growth opportunities (high tobin's q) during periods of political uncertainty.

The estimate in column 1 suggests that one standard deviation increase in political risk will increase R&D intensity by 0.007 ($=0.006\times\frac{106.531}{94.746}$) for firms with low growth opportunities as compared to an increase of 0.015 ($=0.013\times\frac{106.531}{94.746}$) for firms with high growth opportunities. When faced with high political pressures, firms with low growth opportunities spend an average of approximately $7.4 million (=0.007× $1060. 274m) of their sales revenue on R&D investment while firms with high growth opportunities spend $16 million (=0.015×1060.274m) on R&D investment.

In general, from column 3, a one standard deviation increase in political risk increases R&D intensity by 0.009 more for firms with high growth opportunities than firms with low growth opportunities. The finding is consistent with Atanassov et al. (2015).

Additionally, I did a sensitive test by looking at the marginal effect of political risk on R&D intensity conditioned on the firm's growth opportunities. As suggested by Meyer, van Witteloostuijn, and Beugelsdijk (2017) on best practices for conducting and reporting hypothesis-testing, I show the moderating effects of growth opportunities in Figure 2. A study by Li et al., (2022) adopted this approach to suggest the marginal effect of terrorism on a firm's R&D investment conditioned on the patent right, cash flow, firm size, multinationality, and political constraint. From figure 2, the effect of firm-level political risk on R&D intensity increases as the firm's growth opportunities increase.

Table 5: The Moderating role of Industry Characteristics: Growth Opportunities

VARIABLES	(1) Low Tobin's q	(2) High Tobin's q	(3) Interacted
Political risk	0.006***	0.013***	0.006***
	(0.002)	(0.002)	(0.002)
Tobin's q dummy			0.035***
			(0.010)
Political risk × Tobin's q dummy			0.008***
			(0.003)
Leverage	0.124***	0.127***	0.147***
	(0.045)	(0.039)	(0.032)
Capital Expenditure	-0.518*	-0.522*	-0.523**
	(0.280)	(0.308)	(0.224)
Tangibility	-0.031	0.041	-0.008
	(0.066)	(0.074)	(0.055)

Sales	-0.089***	-0.105***	-0.097***
	(0.005)	(0.006)	(0.005)
Liquidity	0.113***	0.042**	0.073***
	(0.017)	(0.019)	(0.014)
Dividend	-0.099	0.015	-0.053
	(0.194)	(0.142)	(0.123)
Herfindahl Index	-0.043	0.005	-0.016
	(0.029)	(0.050)	(0.030)
State level EPU	0.034***	0.009	0.022**
	(0.013)	(0.014)	(0.011)
State level GDP	0.020***	0.017*	0.017**
	(0.008)	(0.009)	(0.007)
Constant	0.073	0.428***	0.247**
	(0.113)	(0.122)	(0.098)
Observations	38,022	36,621	74,643
R-squared	0.495	0.527	0.511
Industry FE	YES	YES	YES
Year-Quarter FE	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity, State-level EPU, and GDP).

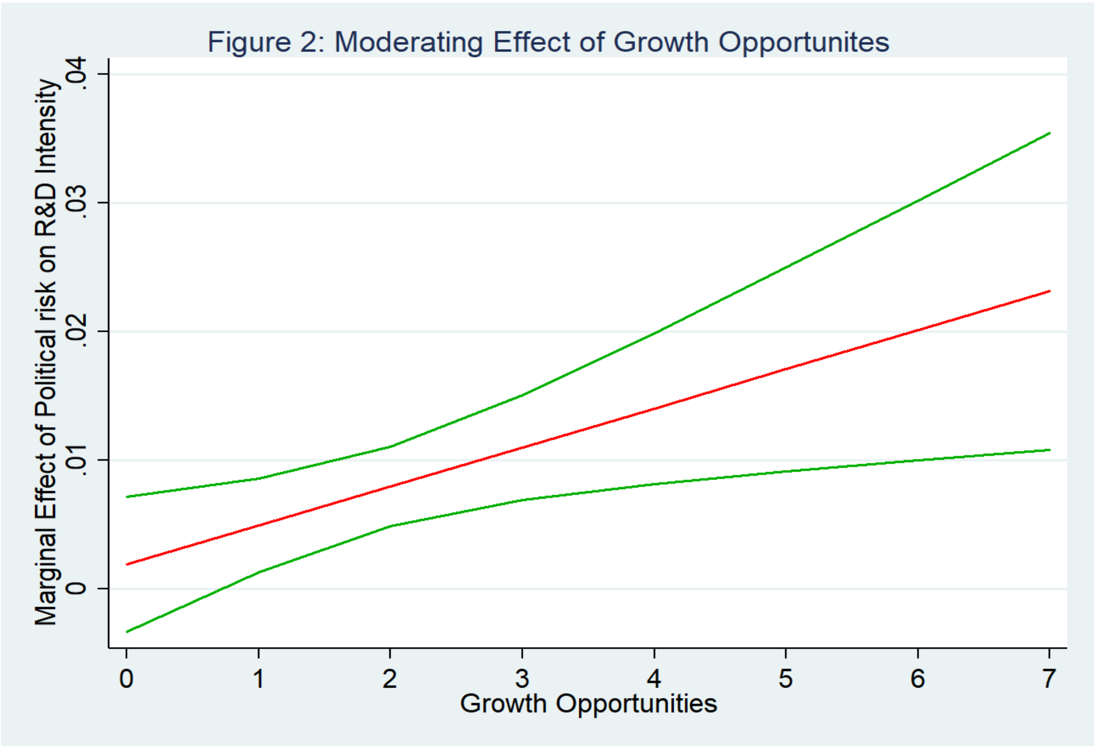


Figure 2: Moderating Effect of Growth Opportunities.

Note: *The red line represents the estimated marginal effect of firm-level political risk on R&D investment intensity. The green lines represent the upper and lower bound of the 95% confidence interval*

4.3.4 The Moderating Effect of Product Market Competition

Table 6 reports the moderating role of product market competition in the relationship between firm-level political risk and corporate R&D intensity. I grouped industries into high and low-competitive industries using the Herfindahl Hirschman Index (HHI). HHI measures product concentration and a higher HHI means less competition and a lower HHI means high competition.

According to the US Departement of Justice's classification of HHI, markets in which the HHI is between 1,500 (or 0.15) and 2,500 (or 0.25) points are said to be moderately concentrated (moderately competitive), but HHI above 2,500 (or 0.25) points means the market is highly concentrated (low competitive). Given this classification and what has been documented in the extant literature (such as Pavic, Galetic & Piplica, 2016; Buthelezi, Mtani & Mncube, 2019) a high competitive market has HHI less than 1500 (0.15) points. I created a dummy variable, the HHI dummy, where firms that belong to industries with HHI less than 1,500 (or 0.15) at time t are assigned 1 and are classified as firms in a high competitive market. In creating the HHI dummy I assume there is free entry and free exit of firms at each year-quarter. Firms that belong to industries with HHI greater than or equal to 1,500 (or 0.15) are assigned 0 and classified as firms in a market with low competition. I extract all firms that belong to industries with low market competition to get the regression results in column 1 and vice versa for the regression results in column 2.

From columns 1 and 2, it can be inferred that firms in a highly competitive industry invest more of their sales revenue in R&D projects in the face of high political uncertainty as compared to firms in a low competitive industry. All values are statistically significant in the 1% alpha level. In terms of economic significance, it can be said that one standard deviation increase in political risk will increase firms in a competitive industry's R&D intensity by 0.013 (=0.012×$\frac{106.531}{94.746}$) and 0.004 (=0.004×$\frac{106.531}{94.746}$) for firms in a low competitive industry. During periods of high political uncertainties, firms in highly competitive industries spend an average of $9.54 million [(0.013-0.004) ×1060.274m] of their sales revenue on R&D investment more than firms in low competitive industries.

Results in column 3 are also consistent with results in columns 1 and 2. These results are consistent with studies such as (Van Vo and Le, 2017; Atanassov et al., 2015). In Figure 3, the lower the competition in the market (higher values of product market concentration) the lower sales revenue is invested in R&D during periods of political uncertainties. In the case where there is only one firm in the industry (product market concentration is 1), political pressures actually reduce R&D intensity. Intuitively, in a monopoly market, preemptive strategy during periods of uncertainty may not apply since the firm is not in any technological and market competition.

Table 6: The Moderating role of Product Market Competition

VARIABLES	(1) Low Competition (High HHI)	(2) High Competition (Low HHI)	(3) Interacted
Political risk	0.004***	0.012***	0.006***
	(0.001)	(0.002)	(0.002)
HHI dummy			-0.015
			(0.011)
Political risk × HHI dummy			0.006**
			(0.003)
Tobin's q	0.107***	0.130***	0.116***
	(0.019)	(0.020)	(0.016)
Leverage	0.099***	0.141***	0.141***
	(0.035)	(0.041)	(0.032)
Capital Expenditure	-0.309	-1.050***	-0.745***
	(0.215)	(0.312)	(0.223)
Tangibility	-0.015	0.026	0.016
	(0.046)	(0.083)	(0.055)
Sales	-0.049***	-0.127***	-0.097***
	(0.005)	(0.006)	(0.005)

Liquidity	0.031**	0.095***	0.070***
	(0.015)	(0.019)	(0.014)
Dividend	-0.297***	0.029	-0.127
	(0.102)	(0.180)	(0.129)
State level EPU	0.009	0.029*	0.021*
	(0.008)	(0.016)	(0.011)
State level GDP	0.019***	0.015	0.016**
	(0.005)	(0.010)	(0.007)
Constant	-0.065	0.255*	0.163*
	(0.076)	(0.136)	(0.096)
Observations	29,854	44,789	74,643
R-squared	0.299	0.538	0.513
Industry FE	YES	YES	YES
Year-Quarter FE	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity, State-level EPU, and GDP)

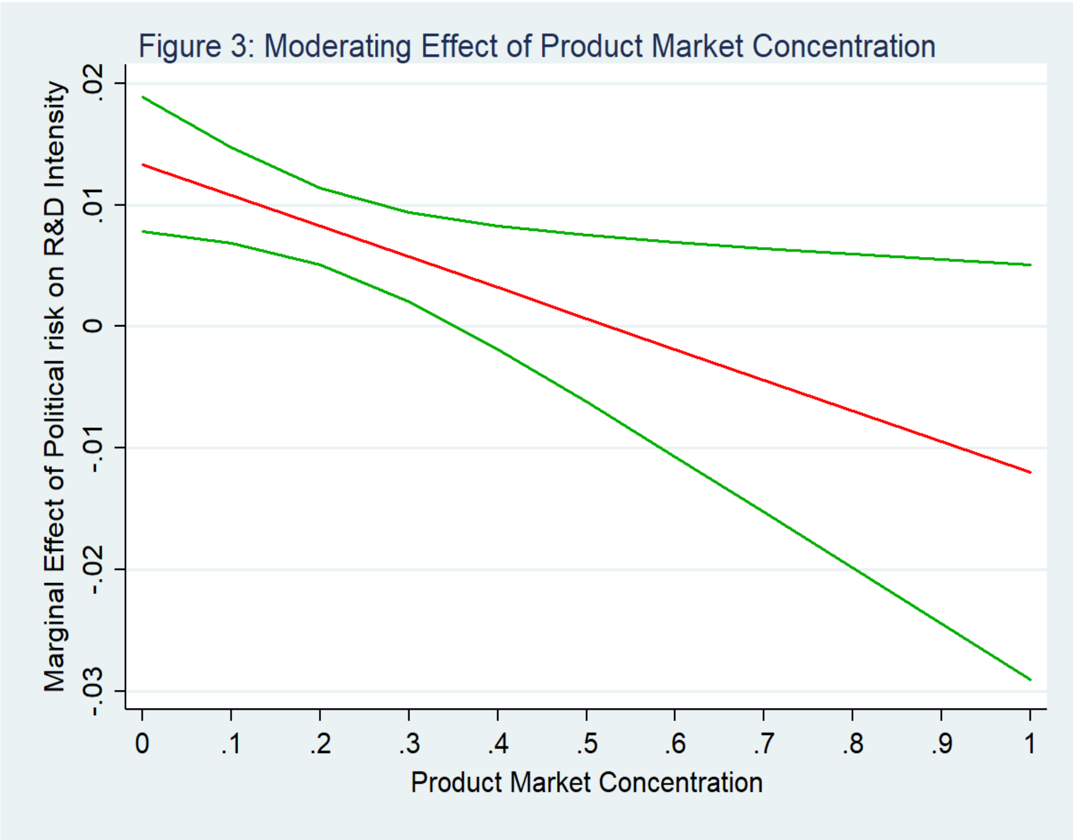


Figure 3: Moderating Effect of Product Market Concentration

Note: *The red line represents the estimated marginal effect of firm-level political risk on R&D investment intensity. The green lines represent the upper and lower bound of the 95% confidence interval.*

4.3.5 The Moderating Effect of Firms' Liquidity

Table 7 shows that the more liquid assets a firm has the more it can finance its R&D investments in periods of higher political uncertainty. A firm is said to be more liquid if its liquidity ratio is above its industry median liquidity ratio at time t and vice versa for less liquid firms. Columns 1 and 2 seem to show no significant difference in how political risk affects the R&D intensity of both more liquid and less liquid firms. Column 3, suggests that a one standard deviation increase in political risk will lead to a 0.009 ($=0.008\times\frac{106.531}{94.746}$) increase in R&D intensity for firms with high liquid assets more than firms that are less liquid. This translates to a $9.54 million (0.009×$1060.274) increase in R&D investment. The evidence in figure 4 supports the results in table 7.

Table 7: The Moderating role of Firms' Liquidity

VARIABLES	(1) High Liquidity	(2) Low Liquidity	(3) Interacted
Political risk	0.009***	0.009***	0.005***
	(0.002)	(0.002)	(0.002)
Liquidity dummy			-0.005
			(0.011)
Political risk ×Liquidity dummy			0.008***
			(0.003)
Tobin's q	0.095***	0.165***	0.119***
	(0.019)	(0.020)	(0.016)
Leverage	0.233***	0.097***	0.106***
	(0.051)	(0.034)	(0.032)
Capital Expenditure	-0.227	-0.976***	-0.751***
	(0.284)	(0.263)	(0.224)
Tangibility	-0.079	0.078	-0.003
	(0.071)	(0.062)	(0.055)
Sales	-0.132***	-0.078***	-0.099***
	(0.008)	(0.005)	(0.005)
Herfindahl Index	-0.077	-0.001	-0.025
	(0.049)	(0.029)	(0.029)
Dividend	-0.295*	0.162	-0.117
	(0.169)	(0.184)	(0.127)
State level EPU	0.037**	0.007	0.022**

	(0.015)	(0.012)	(0.011)
State level GDP	0.023***	0.013*	0.016**
	(0.008)	(0.008)	(0.007)
Constant	0.280**	0.193*	0.256***
	(0.123)	(0.100)	(0.094)
Observations	36,623	38,020	74,643
R-squared	0.587	0.446	0.511
Industry FE	YES	YES	YES
Year-Quarter FE	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity, State-level EPU, and GDP).

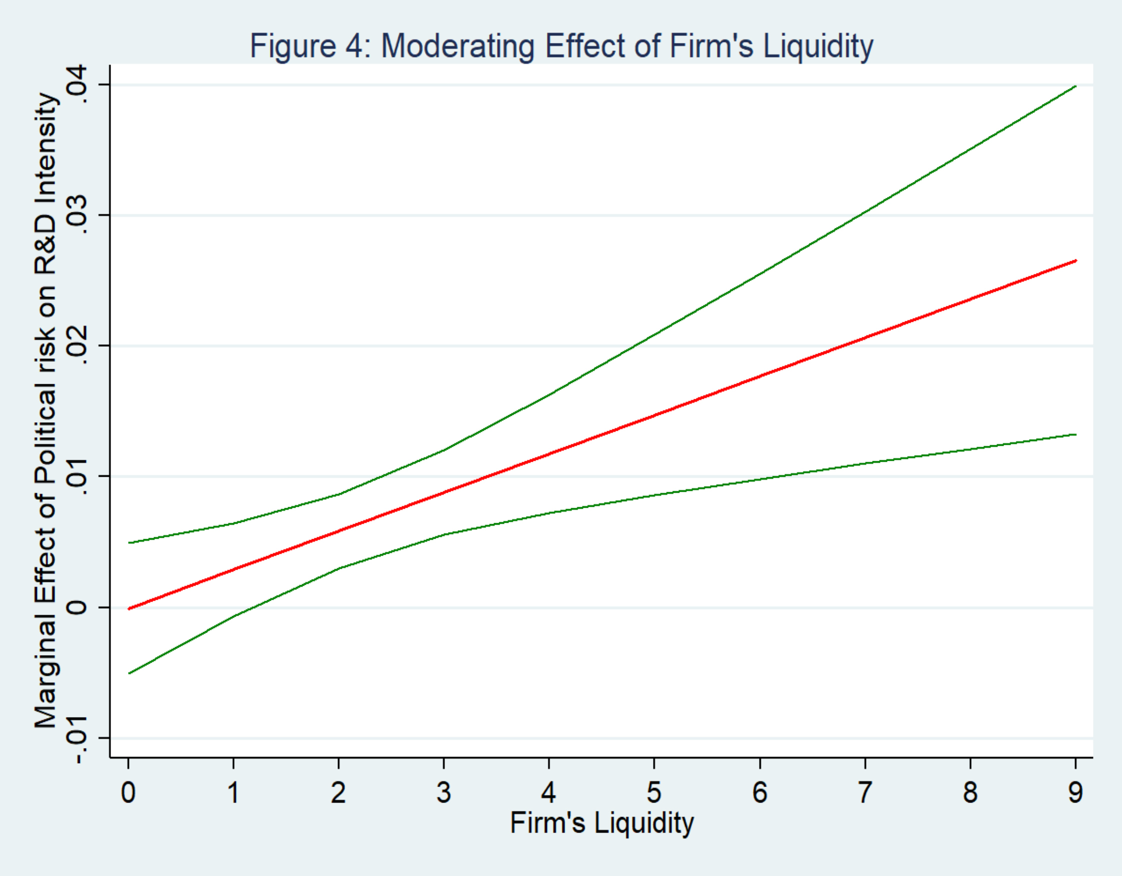


Figure 4: Moderating Effect of Firm's Liquidity

Note: *The red line represents the estimated marginal effect of firm-level political risk on R&D investment intensity. The green lines represent the upper and lower bound of the 95% confidence interval.*

4.3.6 The Moderating Effect of Politically Sensitive Industries

Table 8 shows the effect of firm-level political risk on R&D investment for firms in both politically sensitive and non-politically sensitive industries. According to Herron et al. (1999) and based on Fama-French 48 Industry classification, firms in these industries (Telecommunication, Health Care Services, Petroleum and Natural Gas, Defense, Pharmaceuticals, Transportation, and Tobacco products) are said to be politically sensitive industries (PSI). PSI is set to one when a firm belongs to the listed industry and zero if otherwise. One major characteristic of PSI is that it does not vary much over time. The results in table 8, suggest that the positive effect of firm-level political risk on R&D intensity is more pronounced for firms in politically sensitive industries. A one standard deviation increase in political risk will increase R&D investment intensity by 0.028 (=0.025×$\frac{106.531}{94.746}$) for firms in a politically sensitive industry and 0.006 (=0.005×$\frac{106.531}{94.746}$) for firms in non-politically sensitive industries. Firms in PSI will spend an average of $29 million (=0.028×1060.274m) of their sales revenue on R&D investment while non-PSI firms will spend 6.4 million (0.006×1060.274m) in periods of heightened political pressures.

Table 8: The Moderating role of Politically Sensitive Industry

VARIABLES	(1) Non-PSI	(2) PSI	(3) Interacted
Political risk	0.005***	0.025***	0.005***
	(0.001)	(0.006)	(0.001)
PSI dummy			0.309***
			(0.037)
Political risk × PSI dummy			0.027***
			(0.007)
Tobin's q	0.104***	0.132***	0.146***
	(0.015)	(0.047)	(0.016)
Leverage	0.083***	0.133*	0.177***
	(0.025)	(0.075)	(0.033)
Capital Expenditure	-0.298*	-2.847***	-1.300***
	(0.169)	(0.789)	(0.246)
Tangibility	0.004	0.240	0.030
	(0.040)	(0.187)	(0.046)
Sales	-0.054***	-0.213***	-0.098***
	(0.005)	(0.012)	(0.005)
Liquidity	0.025**	0.153***	0.108***
	(0.012)	(0.039)	(0.013)
Dividend	-0.268***	2.017**	-0.040
	(0.066)	(0.847)	(0.143)
Herfindahl Index	-0.011	0.021	-0.296***
	(0.032)	(0.108)	(0.065)
State level EPU	0.006	0.065	0.019*
	(0.007)	(0.044)	(0.011)
State level GDP	0.018***	-0.004	0.015**
	(0.004)	(0.028)	(0.007)
Constant	0.009	0.704**	0.088
	(0.068)	(0.331)	(0.096)
Observations	60,514	14,129	74,643
R-squared	0.266	0.549	0.461
Industry FE	YES	YES	NO
Year-Quarter FE	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity, State-level EPU, and GDP).

4.4 Robustness Checks

4.4.1 Quantile Linear Regression

Here, I examine the relationship between firm-level political risk and the different quantiles of the R&D intensity distribution. The goal is to ensure that the positive relationship found in the early results (see table 3) is consistent at all the different quantiles of the R&D intensity distribution. From the descriptive statistics, the average R&D intensity is 25.1% while the median is 8.2%, this signals that the mean is largely driven by firms with above-median R&D intensity. It also shows the R&D intensity distribution is skewed to the right. The presence of these extremely high R&D intensity firms may bias the Ordinary Least Square (OLS) regression estimates. Quantile regression is known to be a robust econometric approach in examining relationships between variables, due to its less sensitivity to outliers (John, 2015). Quantile regressions are increasingly used in empirical research on R&D activities, firm performance, and firm growth. Studies such as Gui-long et al. (2017), Falk (2012), and Zimmermann (2009) have used the approach to examine firm performance and R&D intensity. Zhu et al. (2021) and Chung et al. (2019) have also employed the quantile regression approach to assess the impact of R&D intensity on firm growth.

I adopt this approach as a further robustness check of my results. The findings from table 9 indicate that the impact of firm-level political risk on corporate R&D investment increases as we move from the 25^{th} percentile to the 75^{th} percentile. While a one standard deviation increase in political risk will increase R&D intensity by 0.001 ($=0.001\times\frac{106.531}{94.746}$) for firms in the 25^{th} and 50^{th} R&D intensity percentiles, it is 0.002 ($=0.002\times\frac{106.531}{94.746}$) for firms in the 75^{th} R&D intensity percentile. The positive relationship is consistent in all the different percentiles (see Figure 5). The results (see Table 9 and Figure 5) also suggest that the effect of firm-level political risk on R&D intensity is more pronounced at the high end of the R&D intensity distribution (i.e 75th percentile) than at the lower end (i.e 25th percentile).

Table 9: Firm-level Political Risk and Different Quantiles of R&D Intensity

VARIABLES	(1) 25th Percentile	(2) 50th Percentile	(3) 75th Percentile
Political risk	0.001***	0.001***	0.002***
	(0.000)	(0.000)	(0.000)
Tobin's q	0.029***	0.046***	0.053***
	(0.000)	(0.001)	(0.001)
Leverage	0.010***	0.031***	0.019***
	(0.001)	(0.002)	(0.002)
Capital Expenditure	-0.162***	-0.262***	-0.370***
	(0.007)	(0.011)	(0.021)
Tangibility	-0.021***	-0.033***	-0.015***
	(0.001)	(0.002)	(0.003)
Sales	-0.006***	-0.015***	-0.024***
	(0.000)	(0.000)	(0.000)
Liquidity	0.013***	0.026***	0.029***
	(0.000)	(0.001)	(0.001)
Dividend	-0.068***	-0.125***	-0.100***
	(0.004)	(0.011)	(0.018)
Herfindahl Index	-0.005***	-0.013***	-0.011***
	(0.001)	(0.001)	(0.004)
State level EPU	0.006***	0.008***	0.014***
	(0.000)	(0.000)	(0.001)
State level GDP	0.006***	0.010***	0.012***
	(0.000)	(0.000)	(0.000)
Constant	-0.014***	0.020***	0.084***
	(0.004)	(0.006)	(0.022)
Observations	74,643	74,643	74,643
Industry FE	YES	YES	YES
Year-Quarter FE	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity, State-level EPU, and GDP).

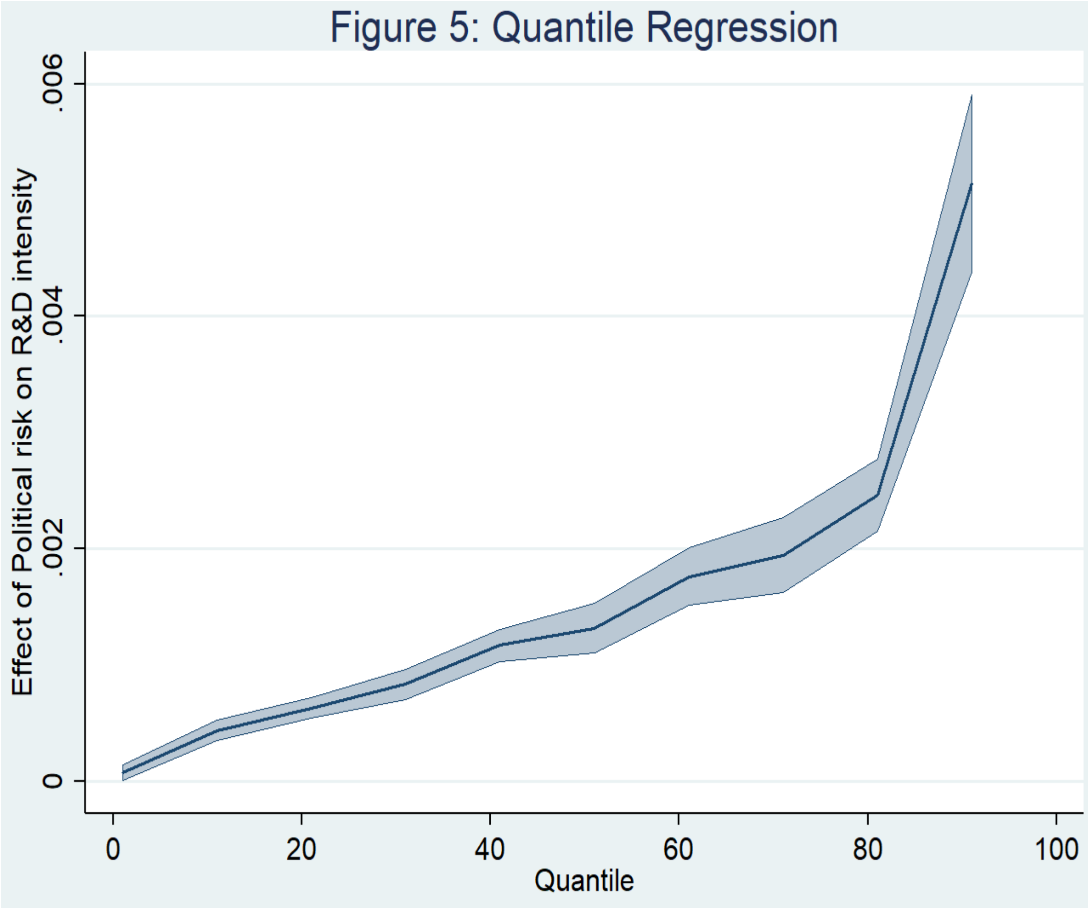


Figure 5: Quantile Regression

***Note**: The solid blue line shows the estimated effect of firm-level political risk on R&D intensity at the various percentiles (quantiles) of the R&D intensity distribution.*

4.4.2 Two Stage Least Squares (2SLS) and One-step Difference GMM

To identify a causal effect, I perform 2SLS and the one-step difference GMM analyses to address the issue of endogeneity. Up until this point, all the results from the analyses conducted show a significant positive relationship between firm-level political risk and R&D intensity. However, the issue of measurement errors or omitted variables might bias the findings of the study.

The 2SLS is used to address the endogeneity issue with the assumption that only firm-level political risk is endogenous in the model with all other predictors assumed to be exogenous. Gyimah et al. (2022), and Karavitis and Kazakis (2022) used the industry's average of political risk and political exposure as an instrumental variable for firm-level political risk and political exposure respectively.

When new legislation increases the perceived political exposure or risk of a certain industry, it is likely that individual firms in such industry will also face high political uncertainties. Hence, it is expected that the industry average of political risk will affect the firm's political risk but is not likely to influence the individual firm's R&D expenditure. Thus, the industry average political risk is likely exogenous to firm characteristics as it is beyond any single firm's control. As a robustness check for the instrumental variable selection as well as to justify the assumption that firm-level political risk is endogenous, I did a post-estimation test for weak instrument and also tested for endogeneity. The result of the tests suggests the null hypothesis of a weak instrument is rejected. Hence, the industry's average political risk is a valid instrument for firm-level political risk. The post-estimation test also shows that treating firm-level political risk as an endogenous variable is better.

I present the results in table 10. In column 1, I report the first-stage regression. The coefficient of industry political risk is positive and statistically significant at a 1% alpha level. This implies that on average an increase in industry political risk increases firm political risk. In column 2 of table 10, I report the second-stage regression. The coefficient of firm political risk is positive and significant at a 1% alpha level. This affirms this paper's early result that firms will invest more in R&D in periods of heightened political risk.

The one-step difference GMM was also used to address endogeneity. In this analysis, the endogenous and exogenous variables are based on theoretical and intuitive reasoning. These predictors, tobin's q, product market competition, sales, tangibility, and state-level GDP are classified as both endogenous and exogenous. These variables are exogenous because they are influenced by factors, decisions, or policies that are outside the firm's control. Furthermore, lag 1 of R&D intensity is also included in the model. R&D investment is not a once and for all investment project. Firms have to continue pushing resources into their R&D project. Firms that extensively invest in R&D at time t-1 typically increase or maintain a consistent level of R&D spending over time (Brown & Petersen, 2011) to keep their technological competitiveness.

The findings of the study still hold under the GMM model specification in column 3 of table 10. The AR(1) and AR(2) tests for first-order and second-order autocorrelation in the first-differenced residual show no autocorrelation in the residuals. I fail to reject the null hypothesis of no autocorrelation (see the p-value of AR (2)).

Table 10: Results of 2SLS and GMM Models

VARIABLES	(1) IV-First stage	(2) IV-Second Stage	(3) GMM
Industry political risk	0.990***		
	(0.060)		
R&D Intensity (lag 1)			0.276***
			(0.041)
Political risk		0.382***	0.014**
		(0.034)	(0.007)
Tobin's q	0.171***	0.097***	-0.024**
	(0.042)	(0.023)	(0.011)
Leverage	-0.023	0.244***	0.082
	(0.085)	(0.043)	(0.115)
Capital Expenditure	-1.051	-0.855**	0.101
	(0.770)	(0.378)	(0.178)
Tangibility	0.101	0.159**	-0.202***
	(0.138)	(0.066)	(0.076)
Sales	0.037***	-0.116***	-0.386***
	(0.009)	(0.005)	(0.024)
Liquidity	0.091**	0.088***	-0.036
	(0.037)	(0.019)	(0.024)
Dividend	-0.515	0.163	0.133
	(0.448)	(0.233)	(0.098)
Herfindahl Index	-0.057	-0.218***	0.002
	(0.109)	(0.076)	(0.012)
State level EPU	-0.011	0.014	-0.009
	(0.031)	(0.016)	(0.014)
State level GDP	0.023	0.008	0.025
	(0.019)	(0.010)	(0.049)
Constant	-0.790**	-0.959***	
	(0.345)	(0.159)	
Observations	74,643	74,643	59309
Wu-Hausman F-statistics		199.838	
Kleibergern-Paap rk Wald F stataistic		267.967	
Cragg-Donald Wald F statistic		2041.220	
Stock-Yogo critical values		16.38	
Anderson-Rubin chi square		209.94	
AR (1) p-value			0.000
AR (2) p-value			0.165
Sargan p-value			0.000
Industry FE	NO	NO	NO
Year-Quarter FE	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity, State level EPU, and GDP).

4.4.3 Propensity Score Matching

To ensure the issue of endogeneity is highly addressed, I use propensity score matching (PSM) to mitigate endogeneity by minimizing the effect of confounding factor(s). Following Chatjuthamard et al. (2021), I divide the firm-level political risk into four quartiles. I created a political risk dummy, where the high political risk – treatment group (firms in the top quartile) equals one and the low political risk – control group (firms in the remaining quartile) equals zero. Using the nearest neighbor (1) matching, I match each firm in the treatment group with a firm in the control group that has similar firm characteristics (based on the covariates in the model) such that firms in the treatment and the control groups are indistinguishable in every observable excluding the level of political risk.

In column 1 of table 11, I run a logistic regression with the political risk dummy as the dependent variable using the original sample (prematch). The result in column 1 suggests the treatment and control groups differ in two main characteristics: capital expenditure and sales. Thus, firms in the treatment group tend to undertake less capital investment and also have lower sales revenue as compared to firms in the control group. These differences could confound the results. Another logistic regression is performed in column 2 with the political risk dummy as the dependent variable using the matched sample (postmatch). It can be seen from column 2 that none of the covariates is significant. Hence, the PSM is successful as the treatment and the control groups cannot be distinguished. A detail on the propensity score balance is shown in Appendix III.

Finally, I run a fixed effect model on the matched sample. The dependent variable is R&D intensity with all the covariates used in the previous model. The result in column 3 shows a significant positive relationship between firm-level political risk and R&D intensity. This implies more political risk results in significantly more R&D investment. Additionally, the average treatment effect is calculated (see table in Appendix III). The coefficient of the average treatment effect suggests that firms that are highly exposed to political risk increase their R&D intensity by 0.022 more than firms that are less exposed. Thus, highly politically exposed firms will spend an additional $26.23 million ($0.022 \times \frac{106.531}{94.746} \times \$1060.274m$) on R&D investment as compared to less politically exposed firms.

Table 11: Results of PSM and Diagnostic tests

VARIABLES	(1) Prematch	(2) Postmatch	(3) R&D
Political risk			0.011***
			(0.003)
Tobin's q	0.017	-0.008	0.126***
	(0.051)	(0.053)	(0.022)
Leverage	-0.074	-0.044	0.190***
	(0.094)	(0.102)	(0.044)
Capital Expenditure	-2.978***	0.854	-1.035***
	(0.944)	(1.096)	(0.317)
Tangibility	0.091	-0.071	0.010
	(0.194)	(0.207)	(0.080)
Sales	-0.027**	0.003	-0.123***
	(0.012)	(0.012)	(0.006)
Liquidity	0.015	0.006	0.094***
	(0.043)	(0.045)	(0.019)
Dividend	0.320	0.331	0.055
	(0.479)	(0.627)	(0.196)
Herfindahl Index	-0.018	0.114	-0.070*
	(0.164)	(0.200)	(0.041)
State level EPU	-0.015	-0.031	0.031*
	(0.036)	(0.044)	(0.017)
State level GDP	0.021	0.010	0.012
	(0.022)	(0.024)	(0.010)
Constant	-1.029**	0.025	0.269*
	(0.420)	(0.413)	(0.140)
Observations	74,643	37318	37,318
R-squared	0.046	0.002	0.541
Industry FE	YES	YES	YES
Year-Quarter FE	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin’s q, Leverage, Sales, Liquidity, State level EPU, and GDP).

4.4.4 Other proxies of firm-level political risk and R&D Intensity

To check the consistency of the positive relationship between firm-level political risk and R&D intensity, I constructed alternative measures of R&D intensity namely R&D capital to asset ratio and R&D expenditure to asset ratio. I follow Chan et al., (2001) and Chan et al., (2015) to construct R&D capital. They computed R&D intensity as the cumulative R&D expenditure from the current and preceding quarters as a ratio of the total asset at time t (see appendix I).

Political sentiment is used as an alternative measure of political risk. Political sentiment is managers’ and market participants’ subjective perception of political exposure and it reflects an essential part of political uncertainty (Giambona et al. 2017). Managers' optimistic and pessimistic views originating from political events and decisions could have profound effects on corporate decision-making given that government policies and political decision-making processes have significant effects on aggregate, sectoral, and firm-level outcomes (Hassan et al., 2019). I used the Hassan et al. (2019) political sentiment data, which captures positive or negative news on a firm's exposure to political events.

Hassan et al. (2019) use the same methodology to create the political sentiment index, but instead of using synonyms for risk or uncertainty, they instead condition on proximity to positive and negative words. This is shown mathematically below:

$$PSentiment_{i,t} = \frac{1}{B_{it}} \sum_{b}^{B_{it}} \left(1[\mathrm{b} \in \mathbb{P} \setminus \mathbb{N}] \times \frac{f_{b,p}}{B_p} \times \sum_{c=b-10}^{b+10} S(c) \right) \times 100{,}000 \qquad (3)$$

In equation (3), b = 1,..., B_{it} represent a transcript for firm i in quarter t. $\mathbb{P}$ is the training library that contains political texts, whereas $\mathbb{N}$ is the training library that contains the non-political text. $\mathbb{P} \setminus \mathbb{N}$ is a collection of bigrams in the political library but not in the non-political library. The c stands for a bigram, and S(c) equals + 1 when a particular bigram is associated with positive sentiment (from the Loughran & McDonald (2011)'s sentiment dictionary), -1 when bigram c is related to negative sentiment, and zero (0) otherwise. If positive words outnumber negative words, then there is a higher value of political sentiment.

From table 12, the relationship between firm-level political risk and R&D investment is consistent with other measures of R&D intensity. Furthermore, the alternative measure of political risk (political exposure) is positively related to all measures of R&D intensity. Columns 1 to 2 of table 12 show how other measures of R&D intensity relate to firm-level political risk (the measure used in the study). Columns 3 to 4 of table 12 report how the alternative measure of political risk relates to other measures of R&D intensity. Column 5 of table 12 presents how the alternative measure of political risk (political exposure) relates to this study's measure of R&D intensity (R&D expenditure as a ratio to total sales). The magnitude of the coefficients in these alternative measures is lower than the main measure of R&D intensity used in the early analysis. But the results are consistent with the strategic growth option theory.

Table 12: Alternative Measures of R&D Intensity and Political Risk

VARIABLES	(1) R&D/Asset	(2) R&D Capital/Asset	(3) R&D/Asset	(4) R&D Capital/Asset	(5) R&D Capital/Asset
Political risk	0.0002*	0.001*			
	(0.0001)	(0.000)			
Political exposure			0.001***	0.003***	0.009***
			(0.000)	(0.001)	(0.003)
Tobin's q	0.0254***	0.068***	0.025***	0.067***	0.113***
	(0.0019)	(0.006)	(0.002)	(0.006)	(0.016)
Leverage	0.0097*	0.037**	0.009*	0.034*	0.133***
	(0.0051)	(0.017)	(0.005)	(0.018)	(0.033)
Capital Expenditure	-0.0127	-0.108*	-0.006	-0.085	-0.734***
	(0.0220)	(0.065)	(0.023)	(0.066)	(0.229)
Tangibility	-0.0052	-0.007	-0.005	-0.007	0.020
	(0.0042)	(0.012)	(0.004)	(0.012)	(0.055)
Sales	-0.0074***	-0.021***	-0.007***	-0.021***	-0.097***
	(0.0004)	(0.001)	(0.000)	(0.001)	(0.005)
Liquidity	-0.0155***	-0.050***	-0.016***	-0.050***	0.070***
	(0.0017)	(0.006)	(0.002)	(0.006)	(0.015)
Dividend	-0.0316***	-0.087***	-0.037***	-0.102***	-0.105
	(0.0119)	(0.034)	(0.009)	(0.027)	(0.133)
Herfindahl Index	0.0030	0.007	0.003	0.007	-0.027
	(0.0024)	(0.008)	(0.003)	(0.008)	(0.030)
State level EPU	0.0023***	0.008***	0.002***	0.008***	0.020*
	(0.0008)	(0.002)	(0.001)	(0.002)	(0.011)
State level GDP	0.0024***	0.007***	0.002***	0.007***	0.017**
	(0.0006)	(0.002)	(0.001)	(0.002)	(0.007)
Constant	0.0123	0.040*	0.006	0.021	0.126

	(0.0079)	(0.024)	(0.008)	(0.024)	(0.098)
Observations	74,643	74,643	67,869	67,869	67,869
R-squared	0.3682	0.286	0.368	0.282	0.513
Industry FE	YES	YES	YES	YES	YES
Year-Quarter FE	YES	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity, State level EPU, and GDP).

4.4.5 The Effect of the 8 topic-specific measures of political risk on R&D Investment

To further ensure the robustness of the positive relationship between political risk and R&D intensity, I disaggregate political risk by topics and the result is still consistent with the strategic growth option theory (see table 13). The result in table 13 shows that the positive relationship between the various topics of political risk and R&D intensity is more evident in institution, health, and security topics.

Table 13: Topic-Specific Measures of Political Risk and R&D Intensity

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Economic	0.005***							
	(0.001)							
Environment		0.005***						
		(0.001)						
Trade			0.004***					
			(0.001)					
Institution				0.007***				
				(0.001)				
Health					0.007***			
					(0.001)			
Security						0.007***		
						(0.001)		
Tax							0.005***	
							(0.001)	
Technology								0.005***
								(0.001)
Tobin's q	0.117***	0.117***	0.117***	0.116***	0.116***	0.116***	0.117***	0.117***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Leverage	0.140***	0.140***	0.140***	0.139***	0.139***	0.140***	0.140***	0.140***
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
Capital Expenditure	-0.750***	-0.750***	-0.755***	-0.749***	-0.749***	-0.750***	-0.755***	-0.755***
	(0.223)	(0.223)	(0.223)	(0.223)	(0.223)	(0.223)	(0.223)	(0.223)
Tangibility	0.017	0.017	0.017	0.018	0.017	0.017	0.017	0.018
	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)
Sales	-0.097***	-0.097***	-0.097***	-0.097***	-0.097***	-0.097***	-0.098***	-0.097***

	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Liquidity	0.070***	0.070***	0.070***	0.070***	0.070***	0.070***	0.070***	0.070***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Dividend	-0.130	-0.130	-0.130	-0.125	-0.123	-0.126	-0.127	-0.131
	(0.128)	(0.128)	(0.129)	(0.129)	(0.129)	(0.128)	(0.129)	(0.128)
Herfindahl Index	-0.026	-0.026	-0.027	-0.025	-0.025	-0.025	-0.025	-0.026
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
State level EPU	0.021**	0.021**	0.021*	0.022**	0.022**	0.022**	0.022**	0.021**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
State level GDP	0.016**	0.016**	0.016**	0.016**	0.016**	0.016**	0.016**	0.016**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Constant	0.153	0.153	0.167*	0.145	0.147	0.145	0.155	0.157
	(0.097)	(0.097)	(0.097)	(0.097)	(0.096)	(0.096)	(0.097)	(0.097)
Observations	74,643	74,643	74,643	74,643	74,643	74,643	74,643	74,643
R-squared	0.513	0.513	0.512	0.513	0.513	0.513	0.513	0.513
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Year-Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin’s q, Leverage, Sales, Liquidity, State-level EPU, and GDP).

CHAPTER FIVE

5.0 Conclusion

This paper investigates the effect of firm-level political risk on corporate R&D investment. Since corporate decisions depend on internal and external factors, I argue that firm-level political risk is one of the external factors firms have to consider in their decision-making about their R&D investment strategy. As firm-level political risk is a form of uncertainty, there are two competing theories on how uncertainties affect firms' investment decisions. I lend the lens of these two theories to examine the relationship. These are the real option and the strategic growth option theories. While the real option suggests that firms undertake less investment during periods of high uncertainty, the strategic growth option indicates the reverse.

This study finds a positive relationship between firm-level political risk and R&D investment intensity. The effect is more pronounced for firms with higher growth opportunities and more liquid assets. Also, firms in competitive and politically sensitive industries tend to see more of this positive impact of political risk on R&D investment Intensity. I adopt multiple estimation techniques to address endogeneity and misspecification issues: the two-stage least square, generalized method of moments, and propensity score matching, and the results hold.

In addition, I adopt alternative measures for R&D investment intensity and firm-level political risk to address concerns of misspecification due to the proxies I chose, and the evidence remains consistent. To the best of my knowledge, this study is the first empirical work that uses the Hassan et al. (2019) firm-level political risk to examine its effect on R&D Investment explicitly. These findings contribute to the strategic growth option theory. The results also suggest that in periods of high political risk, firms can hedge against any possible loss in their R&D investment by purchasing more liquid assets instead of fixed assets.

5.1 Limitations of the Study and future research

This study measured R&D intensity from the firm's financial statement. At the same time, this is a robust measure, other papers (Pandit, Wasley & Zach (2011); Hall et al. (2005); Lev (1999); Trajtenberg (1990)) have also sought to measure R&D intensity from the innovation perspective using patent and citation counts. As such, an area of future empirical research might be to explore how firm-level political risk affects R&D using patent and citation count as a proxy measure of R&D. On the other hand, the conversation on firm-level political risk has not been widely explored. Future studies can explore how firm-level political risk affects other corporate strategies and activities. The unavailability of quarterly state GDP prior to 2005 also made this study restrict its sample to 2005 and post-2005. Future studies in this area can opt for different macroeconomic variables and extend the study period.

APPENDIX

Appendix I: Variable Definitions

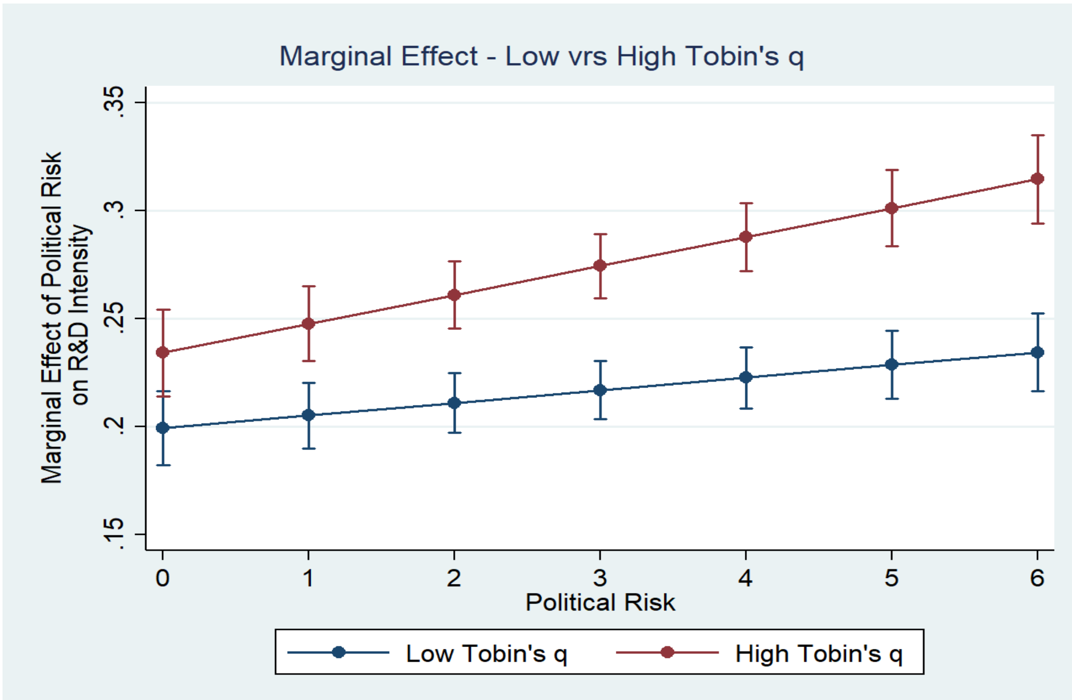
Variables	Measurement	Source
R&D intensity	1. The firm's R&D expenditure is divided by its total sales, measured at the end of each fiscal quarter t. 2. The firm's R&D expenditure is divided by its total assets, measured at the end of each fiscal quarter 3. R&D capital as a ratio of total assets, where I followed Chan et (2001) and Chan et al., (2015) to compute R&D capital as: $R\&D\ expenditure_t + 0.8 \times R\&D\ expenditure_{t-1} + 0.6 \times R\&D\ expenditure_{t-2} + 0.4 \times R\&D\ expenditure_{t-3} + 0.2 \times R\&D\ expenditure_{t-4}$	COMPUSTAT
Political Risk	The proportion of a firm's earnings conference calls devoted to discussing political risk, measured at the end of each fiscal quarter t.	Hassan et al., (2019)
Dividend	The amount of cash dividend the firm pays at each quarter divided by its total asset at the end of each fiscal quarter t.	COMPUSTAT
[2]Tobin's Q	Market capitalization (share price multiplied by the number of outstanding shares) plus total assets minus total equity divided by total assets at each fiscal quarter t.	COMPUSTAT

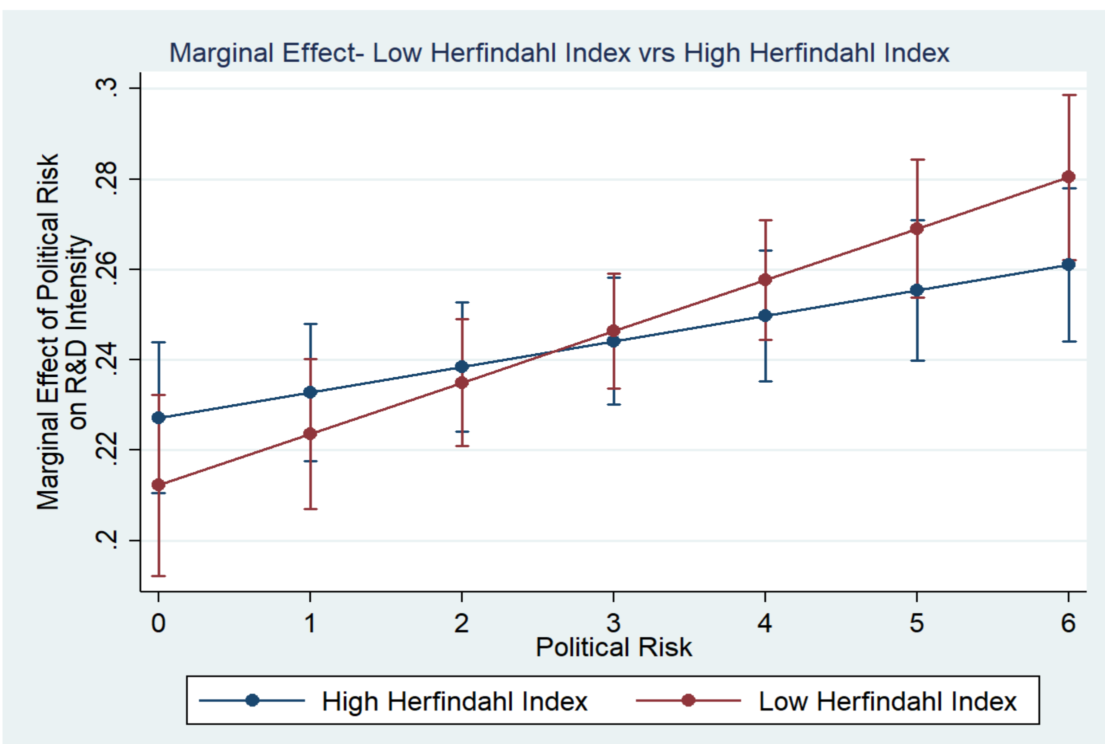
[2] Q : $\frac{Total\ Asset + Market\ Capitalization - Total\ Equity}{Total\ Asset}$

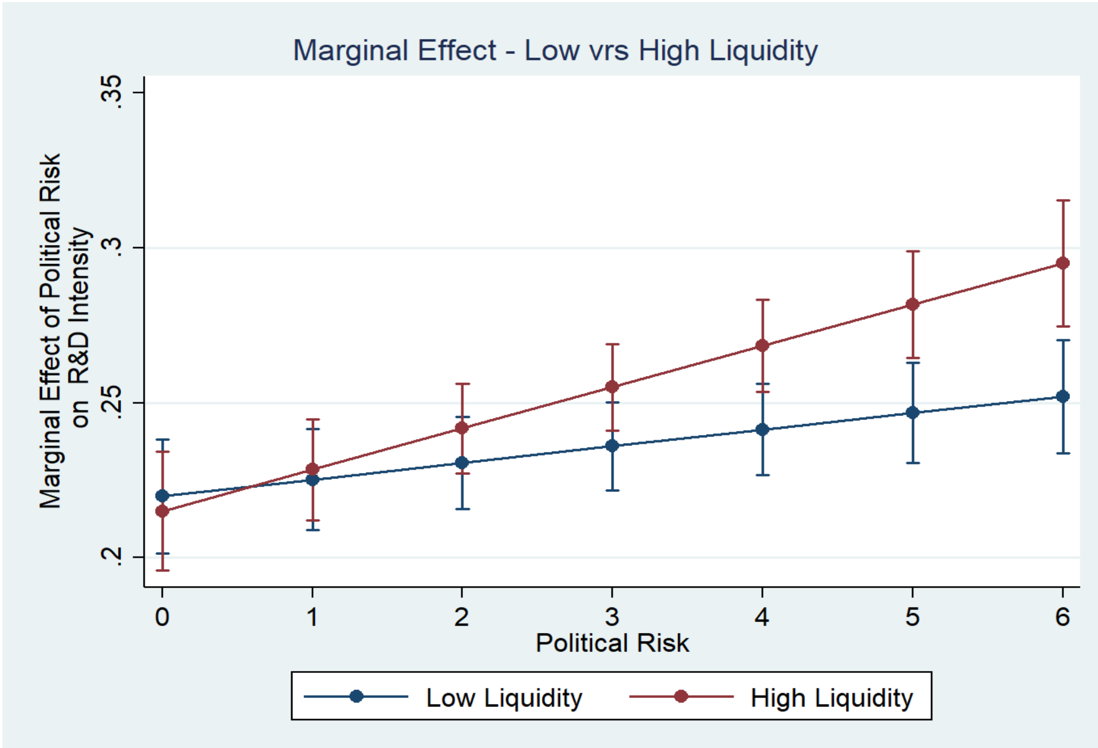
Liquidity	A firm's total current assets as a ratio of its current liabilities at each fiscal quarter t.	COMPUSTAT
Tangibility	Net property, plant, and equipment (PPENT) divided by total assets, measured at the end of each fiscal quarter t.	COMPUSTAT
Leverage	Total current liabilities plus total long-term debt, divided by total assets. Measured at the end of each fiscal quarter t.	COMPUSTAT
Sales	Firm's total sales, measured at the end of each fiscal quarter t	COMPUSTAT
Capital expenditure	Capital expenditure divided by total assets, measured at the end of fiscal quarter t.	COMPUSTAT
GDP	Quarterly state-level GDP.	BEA
EPU	Quarterly state-level economic policy uncertainty.	Economic Policy Uncertainty
Herfindahl Hirschman Index (HHI)	$HHI = \sum_{i=1}^{N} s_{ijt}^{2}$, where s_{ijt} is firm i's market share within the 48 Fama-French industry classification in quarter t.	COMPUSTAT

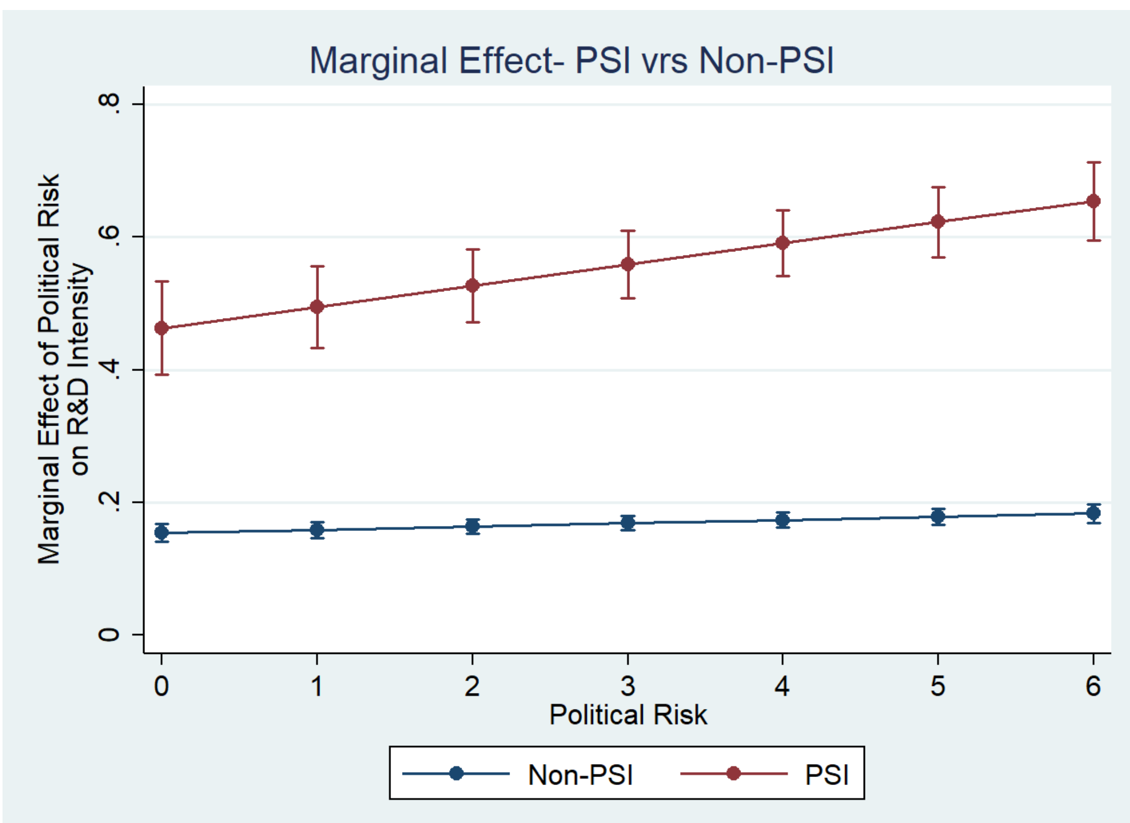
NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity,state level EPU, and GDP).

Appendix II: Moderators effect of Political risk on R&D Intensity






Marginal Effect - Low vrs High Liquidity
Marginal Effect of Political Risk on R&D Intensity
.2
.25
.3
.35
0
1
2
3
4
5
6
Political Risk
Low Liquidity
High Liquidity


Marginal Effect- PSI vrs Non-PSI
Marginal Effect of Political Risk on R&D Intensity
0
.2
.4
.6
.8
0
1
2
3
4
5
6
Political Risk
Non-PSI
PSI

Appendix III: Propensity-Score Matching

Treatment-effects estimation Number of Observations: 74,643

Estimator: Propensity-Score Matching Matches: Requested= 1

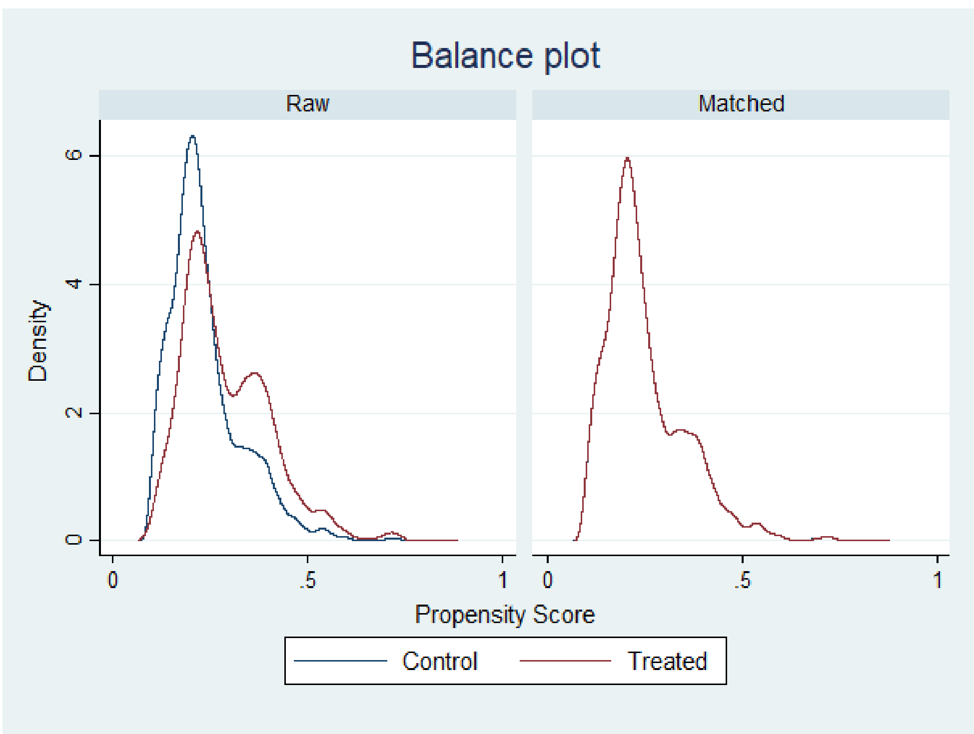
Outcome Model: Matching Min= 1

Treatment Model: Logit Max= 1

R&D	Coef.	AI Robust Std. Err.	z	P>t
ATE (Political risk dummy)	0.022	0.003	6.10	0.000

NB: The regression analysis used the natural logarithm of these variables (Political risk, Dividend, Tobin's q, Leverage, Sales, Liquidity, EPU, and GDP).

Propensity Score Balance



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