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Economic Policy Uncertainty, Cost of Capital, and Corporate Innovation

Zhaoxia Xu*

Abstract

We examine the impact of government economic policy uncertainty (GEPU) on corporate innovation and identify a cost-of-capital transmission channel. We find that GEPU increases firms' cost of capital, which translates into lower innovation. As economic policy uncertainty rises, firms with more exposure to such uncertainty face a higher weighted average cost of capital and innovate less. Innovations of financially constrained firms and firms relying on external finance in a competitive environment are affected more. Our study provides novel evidence that higher economic policy uncertainty hinders innovation not only through the traditional investment irreversibility channel, but also through the cost-of-capital channel.

Key Words: Economic Policy Uncertainty, Implied Cost of Equity, Cost of Debt, Innovation.

JEL No: G31, G32, G38, O30, M41.

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1 Introduction

The intensified uncertainty about government policies in recent years highlights the importance of understanding its impacts on the real economy. Most of the theoretical and empirical studies investigate the influence of uncertainty on investment within the framework of irreversible investment.[1] With costly reversibility, uncertainty changes the optimal timing of investment because of the real-option feature of investment. However, firms need to consider not only reversibility of investment, but also funding costs when making investment decisions in an uncertain world with financial frictions.[2] To the extent that external finance is relevant for funding innovation, an aggregate uncertainty shock that affects firms' financing costs would have an impact on investments in innovation. In this study, we investigate a crucial but underexplored transmission mechanism, cost of capital, through which government economic policy uncertainty (GEPU) affects corporate innovation activities.[3] Understanding the underlying transmission channels of GEPU is essential for policy makers to assess the impacts of their policies.

Despite its intuitive appeal, there is not yet empirical evidence on the effect of economic policy uncertainty on firm-specific cost of capital and innovation activities. We fill in this gap by directly examining whether GEPU affects individual firms' cost of equity, cost of

[1]See, for example, Bernanke (1983), McDonald and Siegel (1986), and many others for the theoretical framework. Bloom, Bond, and van Reenen (2007), Bloom (2009), Julio and Yook (2012), and Gulen and Ion (2016) among others provide empirical evidence supporting the investment irreversibility channel.

[2]The theoretical literature demonstrates that firms alter their financing and investment decisions in the presence of financial frictions (Hennessy and Whited (2005)).

[3]The cost of capital channel differs from financial constraints. A rising cost of capital can reduce investments in innovation even in the absence of financial constraints, since the higher discount rate turns positive net present value projects into negative ones. We do not claim that the cost of capital is the only transmission channel through which economic policy uncertainty affects the real economy. This study provides empirical evidence on the relevance of financing costs in shaping the relation between economic policy uncertainty and innovation.

debt, weighted average cost of capital (WACC), and innovation. The impacts likely vary across firms because of firms' differential exposure to policy uncertainty and different capital structures. Recent studies show that policy uncertainty commands an equity risk premium due to the undiversifiable political risk (Pastor and Veronesi (2012, 2013)). An increase in equity risk premium caused by rising policy uncertainty should have different impacts on firm-level cost of equity capital because firms differ in their exposure.[4] In addition, uncertainty might affect the cost of debt through its influences on firms' default risk (Greenwald and Stiglitz (1990)). The impact on the weighted average cost of capital, consisting of the cost of debt and the cost of equity, also depends on the financing mix.

The cost of capital may shape firms' investments in two ways. First, an increase in the cost of capital can turn a positive net present value project into a negative one, which will consequently affect firms' investment decisions. This impact is independent of whether or not a firm is financially constrained. Second, higher external financing costs may lower investments because of increased difficulty in raising capital to fund profitable projects. Even though it is theoretically unambiguous that investment is negatively affected by the cost of capital, empirical evidence supporting this notion has been surprisingly difficult to document due to the unobservability of the cost of capital. Earlier studies find little response of investment to cost of capital at the aggregate level (Jorgenson (1971) and Abel and Blanchard (1986)). More recently, firms' capital expenditures are found to be affected by fluctuations in bond price (Gilchrist and Zakrajsek (2007)) and the weighted average cost of capital, although the direction of the impact depends on the measure of cost of equity

[4] Firms differ in their sensitivities to changes in government policy. For example, politically-connected firms or firms with more government contracts may be affected more by uncertainty in government policy. However, the competitors of a firm that loses its political connections or government contracts may benefit from it.

(Frank and Shen (2016)). In spite of these two recent studies showing the relevance of firm-level cost of capital for investment decisions, the empirical evidence on the impact is far from conclusive. Our study provides direct evidence on the influence of cost of capital on investments in innovation.

We investigate how economic policy uncertainty affects individual firms' financing costs and their subsequent innovation activities.[5] We focus on innovation for several reasons. First, although previous studies show that uncertainty influences firms' investment and hiring decisions, less is known about its impact on corporate innovation. Second, increasing evidence shows that economic factors affect innovation and other investments differently, owing to the unique features of research and development (R&D).[6] Third, R&D investment is more susceptible to uncertainty because it often takes a long time to yield fruitful results and involves a substantial amount of investment in human capital, which is hard to recoup.

Although the cost of capital affects investment in physical assets as well, financing costs are especially important for investment in innovation. Studies have shown that financing is essential for developing, implementing, and commercializing new technologies (Rajan (2012) and Kerr and Nanda (2015)). Financing innovation tends to be costlier because of the high

[5]Pastor and Veronesi (2012, 2013) develop general equilibrium models featuring government policy uncertainty and use S&P 500 index return data and the Baker, Bloom, and Davis (2016) index to show that policy uncertainty commands an equity risk premium at the aggregate level. Based on the time-series analysis of Fama-French size-momentum portfolio returns, Brogaard and Detzel (2015) show that economic policy uncertainty is an important risk factor. Kelly, Pastor, and Veronesi (2016) use equity index option prices around national elections and global summits to show that political uncertainty is priced. However, none of these studies examine the impact of economic policy uncertainty on firm-level cost of capital and subsequent investments.

[6]Market factors, such as stock liquidity, short selling, coverage by financial analysts, and market sentiment are found to have varying effects on R&D and capital expenditures (Becker-Blease and Paul (2006), Fang, Tian, and Tice (2014), Grullon, Michenaud, and Weston (2015), He and Tian (2013, 2014), Derrien and Kecskes (2013), and Dang and Xu (2018)). Unlike capital expenditures that produce tangible assets, R&D investments generate intangible assets that are more difficult to serve as collateral. Furthermore, the outcome of innovation investments is more uncertain.

uncertainty of investment outcomes (Hall and Lerner (2010)).

To analyze the real effects of uncertainty related to the U.S. economic policy, we measure innovation by its inputs (R&D) and outcomes (patents) and estimate each firm's annual cost of equity, cost of debt, and weighted average cost of capital. The cost-of-capital transmission channel is identified by exploring cross-sectional variation across firms with varying exposure to economic policy uncertainty. If cost of capital is an underlying transmission mechanism through which GEPU affects innovation, we expect that the cost of capital and innovation of firms with more exposure to GEPU would be affected more.

One of the main challenges in our analysis is to measure GEPU. Previous studies use proxies such as volatility in stock returns or the dispersion in analyst forecasts to measure firm-specific uncertainty. However, these measures cannot capture uncertainty attributable to the government economic policy and also suffer from reverse causality problems. Recent studies use national election years or gubernatorial elections to represent periods of political uncertainty.[7] Unfortunately, these proxies do not reflect policy uncertainty in non-election years. In this study, we use a continuous economic policy uncertainty (EPU) index developed by Baker, Bloom, and Davis (2016) to capture uncertainty about the government's future policy.[8] A continuous measure is particularly important in exploring the dynamic effect of fluctuations in policy uncertainty on firms' financing and investment. To ease the

[7]See, for example, Bloom, Bond, and van Reenen (2007) and Bond and Cummins (2004) for firm-specific uncertainty and Julio and Yook (2012), Bhattacharya, Hsu, Tian, and Xu (2017), and Jens (2017) for election-related political uncertainty.

[8]The economic policy uncertainty index of Baker, Bloom, and Davis (2016) is a weighted average of uncertainty related to taxation, government spending, and inflation, as well as the frequency of major newspaper articles discussing uncertainty in economic policy. The index exhibits substantial variation over time and tends to spike during high economic policy uncertainty periods, such as debt-ceiling crises, budgetary disputes, and tight presidential elections. This EPU index has been used in numerous academic studies (e.g., Pastor and Veronesi (2012, 2013), Brogaard and Detzel (2015), Gulen and Ion (2016), and Colak, Gungoraydinoglu, and Oztekin (2018), among many others), as well as by practitioners and policy makers.

concern that the EPU index may reflect economic conditions in general, we extract the exogenous component from the index by purging the components that capture macroeconomic situations and use it to measure additional uncertainty beyond economic conditions.

Another challenge is to estimate individual firms' cost of capital, because the cost of equity and the cost of debt are not observable. Previous studies use average realized returns to estimate the cost of equity capital (Campbell (1987)). This approach uses *ex post* realized stock returns as a proxy for *ex ante* expected returns. However, realized returns are shown to be a poor measure of expected returns (Elton (1999)). In addition, the capital asset-pricing model (CAPM) and Fama and French (1993) three-factor model are found to be imprecise in measuring the cost of equity (Fama and French (1997), Pastor and Stambaugh (1999)). Thus, we estimate the cost of equity capital using an *ex ante* proxy developed by recent accounting and asset-pricing research, namely the implied cost of equity.[9]

The implied cost of equity is defined as the discount rate that equates a stock's present value of expected cash flows to its current price. Recent studies show that the implied cost of equity capital is a good proxy for a stock's conditional expected return (Pastor, Sinha, and Swaminathan (2008), Lee, Ng, and Swaminathan (2009), Chava and Purnanandam (2010), and Li, Ng, and Swaminathan (2013)). We derive the implied cost of equity from Gebhardt, Lee, and Swaminathan (2001) and three alternative models and estimate a firm's cost of debt as the actual yield on the debt carried by the firm and an alternative approach. The cost of capital is then measured as the weighted average cost of capital, which comprises a

[9]The implied cost of equity capital has been used in various accounting studies. See Easton (2007) for a review of the implied cost of equity estimations in the accounting literature. In the asset-pricing literature, implied cost of capital is used as a proxy for expected stock returns to test the risk–return relationship (Pastor, Sinha, and Swaminathan (2008), Lee, Ng, and Swaminathan (2009), Chava and Purnanandam (2010)).

firm's cost of equity and after-tax cost of debt, with its market leverage ratio as the weight.[10]

The third challenge is identification, because confounding factors such as overall economic conditions or investment opportunities may cause a spurious relationship. We adopt several approaches to isolate the effect of economic policy uncertainty. First, we follow the recommendation by Bernanke, Gertler, and Gilchrist (1996) and investigate cross-sectional differences in the cost of capital and innovation in response to economic policy uncertainty. Second, we use political polarization as an instrumental variable to ease the endogeneity concern. Third, we exploit close congressional elections and close presidential elections as two plausible exogenous shocks to policy uncertainty. Since the timing of elections is independent from economic conditions and the outcomes of close elections are difficult to predict, close elections provide a natural experiment framework to isolate the impact of uncertainty related to general government policies. Fourth, we control for the time-varying first-moment factors that capture aggregate-level growth opportunities, as well as control for observable and unobservable factors that reflect firm-level investment opportunities. This helps disentangle the impact of second-moment shocks from first-moment effects associated with business cycles and investment opportunities. Fifth, we perform a fixed-effect estimation to control for time-invariant omitted variables. Sixth, we conduct the tests using the component of the EPU index beyond general economic conditions.

We find that investments in innovation and the quantity and quality of innovation outcomes are negatively associated with GEPU. Economic policy uncertainty has a quick impact on R&D investments and a delayed impact on patent productions.[11] The impacts are sig-

[10] Frank and Shen (2016) estimate the cost of equity using the Gordon growth model and measure the WACC through a similar approach. Their study evaluates the impact of WACC on firms' capital expenditures, while this study investigates how economic policy uncertainty affects firms' financing costs.

[11] The delayed impact on patent production is consistent with the fact that it takes time for R&D invest-

nificant while controlling for stock market uncertainty, economic growth, market sentiment, general economic uncertainty, and firm-level factors. Our robustness analyses confirm that investment opportunities or macroeconomic conditions are less likely to be the main factor driving the relationship between economic policy uncertainty and innovation.

Consistent with the prediction of the cost of capital channel, we observe that the cost of capital on average rises as GEPU intensifies. Firms invest less in innovation when the cost of capital increases. Facing higher economic policy uncertainty, firms have a lower propensity to issue equity and debt and raise less capital. Using a regulatory exposure index as a measure for firms' exposure to policy uncertainty, we observe that economic policy uncertainty has a stronger impact on the cost of capital and innovation activities for firms with more exposure to uncertainty than those with less exposure. Since we control for stock market uncertainty throughout our analyses, it is less likely that the changes in cost of capital is simply driven by variation in stock market volatility. The results establish an explicit link between economic policy uncertainty and financing costs: uncertainty makes financing innovation costlier for firms.

To further establish the cost-of-capital channel, we explore several cross-sectional variations in the impact of economic policy uncertainty on innovation. We find that innovation activities of financially constrained firms decline more as policy-related uncertainty increases. Since innovation can also be strategically motivated depending on the relative rents from innovation in a competitive environment (Aghion, Bloom, Blundell, Griffith, and Howitt (2005)), we consider the influence of product market competition, especially when firms rely on external capital to finance their investments. We find that product market competi-

ment to develop into patents (Hall, Jaffe, and Trajtenberg, 2001).

tion exacerbates the negative impact of economic policy uncertainty on innovation for firms relying on external finance, but not for firms relying on internal finance. External capital appears to affect firms' innovation activities when facing competition and uncertainty. These results lend support to the cost-of-capital transmission channel perspective. In addition, we find that the cost-of-capital channel still plays an important role in shaping firms' R&D investments under uncertainty, controlling for the investment irreversibility mechanism.

To the best of our knowledge, this study represents the first empirical attempt to demonstrate a cost-of-capital channel that is distinct from the transmission mechanism previously documented in the literature on the relation between uncertainty and the real economy. The literature has emphasized that investment irreversibility shapes the relation between uncertainty and investments.[12] By directly examining firms' cost of capital, we are able to provide novel evidence on the importance of the cost of capital in transmitting aggregate uncertainty shocks to firms' innovation activities. Our study adds to the nascent literature on finance and innovation by examining how uncertainty about government economic policy affects corporate innovation. We find that high policy-related uncertainty has a detrimental effect on innovation by driving up firms' financing cost.

2 Related Literature

Our study is related to two strands of literature. First, there is a growing literature investigating the effects of uncertainty on the real economy. The theoretical predictions on the uncertainty-investment relationship is contradictory. On the one hand, the literature

[12]See Bernanke (1983), McDonald and Siegel (1986), Abel, Dixit, Eberly, and Pindyck (1996), Bloom, Bond, and van Reenen (2007), Baker, Bloom, and Davis (2016), Julio and Yook (2012), Gulen and Ion (2016), and Jens (2017) among many others

suggests that it is optimal for firms facing uncertainty to defer investment because reversing investment is costly and uncertainty increases the value of the option to wait (Bernanke (1983) and McDonald and Siegel (1986)). On the other hand, Carballero (1991) and Weeds (2002) argue that the option to wait is less valuable when firms face competition or when investments can create valuable growth opportunities. Uncertainty increases investments if firms have an option to resell the assets later (Abel, Dixit, Eberly, and Pindyck (1996)) or if the marginal revenue product of capital is convex (Abel (1983)).

Further, the empirical evidence on the real effects of uncertainty is mixed.[13] In terms of investment, Gulen and Ion (2016) and Jens (2017) find that firms delay spending on fixed assets when facing policy uncertainty or electoral uncertainty. Using implied volatility from equity options to capture firm-specific uncertainty, Stein and Stone (2013) document that implied volatility reduces capital investment but increases R&D investment. A recent working paper, Atanassov et al. (2018), find that firms within the affected states spend more on R&D during gubernatorial election years. Differing from Stein and Stone (2013) and Atanassov et al. (2018)'s focus on firm-level or gubernatorial election risk that is diversifiable, we investigate uncertainty about government economic policies that affects the general economic environment within which businesses operate. Such uncertainty goes beyond firm-specific uncertainty or the potential changes in local leadership in the midst of elections.[14]

[13]Bernanke (1983), Bloom, Bond, and van Reenen (2007), Baker, Bloom, and Davis (2016), Julio and Yook (2012), Gulen and Ion (2016), and Jens (2017) document that uncertainty has a negative impact on fixed-asset investments and employment. However, Ghosal and Lougani (1996) find no impact of uncertainty on investment in U.S. manufacturing industries, except for competitive industries. Driver, Temple, and Urga (2008) show that the negative effect of uncertainty on investment is offset by the first-mover advantage. Using the Poisson jump to model tax changes, Hassett and Metcalf (1999) demonstrate when and how uncertain tax policy can increase investment even in the presence of irreversibility.

[14]For example, events such as debt ceiling crises, budgetary disputes, and debates over the stimulus package dramatically elevated uncertainty about government policies, but they were unrelated to elections. Gubernatorial elections in most states take place every four years, except for New Hampshire and Vermont. Election years do not capture the variation in policy uncertainty that may occur between elections. An

We find that such aggregate policy risk, which is hard to diversify, has a negative impact on firms' innovation activities. Additionally, innovations that may be strategically motivated to escape competition in a competitive and uncertainty environment are constrained by firms' dependence on external financing.

Second, the emerging literature on firm innovation shows that firm innovation is affected by various economic factors such as the development of financial markets (Hsu, Tian, and Xu (2014)), access to stock markets (Acharya and Xu (2017)), credit supply (Chava, Oettl, Subramanian, and Subramanian (2013) and Cornaggia, Mao, Tian, and Wolfe (2015)), organizational form (Li, Qiu, and Wang (2018)), and law and legal systems (Acharya, Baghai, and Subramanian (2013) and Francis, Kim, Wang, and Zhang (2018)). In a cross-country analysis, Bhattacharya, Hsu, Tian, and Xu (2017) show that overall uncertainty resulting from national elections rather than a country's policy itself affects technological innovation. Unlike their focus on comparing the relative importance of policy and policy uncertainty around national elections, we are interested in understanding the real effects of time-varying uncertainty related to economic policy and uncovering the cost-of-capital transmission mechanism. We find that the influence of economic policy uncertainty on innovation through firms' financing costs is stronger for firms with higher exposure to such uncertainty.

election dummy variable also does not take into account the fact that elections at different points in time may have different implications for the level of policy uncertainty in the economy. Moreover, Gubernatorial elections may affect firms that operate within the state. Given that most firms operate and compete in the national or international market, the impacts of Gubernatorial elections might be diversified away to an extent. This is especially the case when firms often have R&D centers in locations different from the headquarters. The local shocks to political power might also create opportunities for firms with weaker political connections.

3 Data and Measures

3.1 Data

To measure innovation activities, we use patent and citation data from Kogan, Papanikolaou, Seru, and Stoffman (2017) and technology class data from the United States Patent and Trademark Office. The granted patent data for U.S. firms are available up to 2010. The patent data are then matched with the firm-level financial data from the merged CRSP-Compustat database and the stock price data from the Center for Research in Security Prices (CRSP) monthly stock database. The sample period is from January 1, 1985 to December 31, 2007, because the average time lag between the patent application date and grant date is two to three years (Hall, Jaffe, and Trajtenberg (2001)).[15] An advantage of focusing on innovation before the 2008 financial crisis is that it minimizes the influence of deteriorating macroeconomic conditions on firms' innovation performance.

Firms in financial and utilities industries (SIC code 6000-6999 and 4900-4999) are excluded. We require firms to have complete data on total assets and a positive value on sales. Firm-year observations with missing R&D are set to zero.[16] Variables are winsorized at 1 percent and 99 percent to avoid the effect of outliers. We merge patent data with our financial data. Following the innovation literature, the patent and citation counts are set to zero when no patent and citation information is available. Including firm-year observations with no patent alleviates the sample selection concern. The final sample consists of 12,408

[15] We find similar results using the National Bureau of Economic Research (NBER) Patent Citation database that covers patent data until 2006. The results are also robust to sub-sample period analysis.

[16] We keep observations missing R&D because Koh and Reed (2015) find that 10.5% of firms with missing R&D expenditures in financial statements file and receive patents. Using a sample of firms that have any R&D investment during the sample period yields similar results.

firms and 101,502 firm-year observations.

3.2 Innovation Measure

To gauge a firm's innovation activities, we follow the literature and measure innovation input by using R&D spending and innovation output by using patent-based metrics (Hall, Jaffe, and Trajtenberg (2001, 2005)). The quantity of innovation output is measured by the number of patents applied by a firm in a given year that are eventually granted. The patent application year rather than the grant year is used because the former is closer to the time of the actual innovation (Griliches, Pakes, and Hall (1987)).

We measure the quality of patents on the basis of the citation count that each patent receives in the subsequent years. Patent citations are subject to truncation biases because patents created in later years have less time to accumulate citations than those established in earlier ones. Additionally, the citation intensities of patents might vary across industries. To adjust for truncation bias, following Hall, Jaffe, and Trajtenberg (2001, 2005), we scale the raw citation counts of a patent by the average citation counts of patents applied in the same year and technology class.

3.3 Government Economic Policy Uncertainty

To capture uncertainty attributable to government economic policy, we use two measures: the time-varying economic policy uncertainty index developed by Baker, Bloom, and Davis (2016) (EPU index) and the exogenous component of the index. The EPU index is a weighted average of a news-based policy uncertainty index, tax expirations, inflation forecast disagreement, and government purchase disagreement. The news-based policy index is a normalized monthly count of the number of articles that contain terms related to economic policy uncertainty in 10 of the largest newspapers. The tax expirations measure the discounted dollar-weighted sum of expiring federal tax code provisions. Forecast disagreement about inflation and government purchases captures uncertainty associated with monetary policy and government spending through forecast dispersion by participants of the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters. Figure 1 plots the monthly EPU index and NBER recession periods between January 1985 and December 2016. Uncertainty spikes during the debt-ceiling crisis of 2011, budgetary disputes, tight presidential elections, the 9/11 terror attack, and recessions.

Since the EPU index may be correlated with macroeconomic conditions, we extract the exogenous component from the index to capture uncertainty attributable to economic policies. Specifically, we purge the components that reflect macroeconomic conditions from the EPU index and use the residuals to measure additional information beyond economic uncertainty. The economic conditions are measured by the set of macroeconomic indicators used by Baker and Wurgler (2007) to orthogonalize the investor sentiment index.

We regress the monthly EPU index on macroeconomic uncertainty index and six macroeconomic variables as follows:

$$\begin{aligned} EPU_t = \alpha + \beta_1 IndProd_t + \beta_2 Recession_t + \beta_3 DurGrowth_t \\ + \beta_4 NonDurGrowth_t + \beta_5 ServGrowth_t + \beta_6 EmpGrowth_t + \varepsilon_t, \end{aligned} \tag{1}$$

where $IndProd$ is growth in industrial production, $DurGrowth$ is real growth in durable goods, $NonDurGrowth$ is real growth in non-durable goods, $ServGrowth$ is real growth in services consumption, $EmpGrowth$ is growth in employment, and $Recession$ is an NBER recession indicator. The residuals from the equation (1) are then used to capture additional unpredictability beyond macroeconomic forces. The residual component is used as an alternative measure for economic policy uncertainty (*Exog. EPU*). We average *Exog. EPU* over the length of the fiscal year for each firm and then match the average index to our sample by fiscal year. Since the two government economic policy uncertainty measures yield similar results, the main results are reported using *Exog. EPU* index.

Baker, Bloom, and Davis (2016) employ various approaches, such as human audit and comparison with alternative measures of economic uncertainty, to ensure accuracy and reliability of the index. A potential measurement error in the EPU index would bias against finding a statistically significant effect of economic policy uncertainty. Nevertheless, we use the instrumental variable approach to ease the concern about measurement error in Section 7.1.

3.4 Cost of Capital Components

The cost of capital, defined as the weighted average cost of equity and cost of debt, is an important component in firms' capital budgeting decisions. We measure the cost of equity by using the implied cost of equity approach, which estimates the *ex ante* expected return by using market prices and accounting data (Gebhardt, Lee, and Swaminathan (2001), Pastor, Sinha, and Swaminathan (2008), Lee, Ng, and Swaminathan (2009)). Specifically, the implied cost of equity is the discount rate that equates the current stock price to the present value of expected future cash flows. According to the discounted cash flow model, the stock price of a firm at time t is

$$P_t = \sum_{n=1}^{\infty} \frac{E_t(FCFE_{t+n})}{(1+r_e)^n}, \tag{2}$$

where P_t is the market value of the stock at time t, $E_t(FCFE_{t+n})$ is the expected free cash flow to equity at time $t+n$, and r_e is the implied cost of equity capital.

To estimate the cost of equity, we follow the Gebhardt, Lee, and Swaminathan (2001) (GLS) approach to derive the implied cost of equity. The GLS approach uses the residual income valuation model under the assumption of clean-surplus accounting.[17] This approach has been applied in several asset-pricing studies, for example, Pastor, Sinha, and Swaminathan (2008), Lee, Ng, and Swaminathan (2009), and Chava and Purnanandam (2010). The stock price in equation (2) can be written as the sum of the book value and the discounted residual income (economic profits) earned by a firm:

$$P_t = B_t + \sum_{n=1}^{\infty} \frac{E_t(NI_{t+n} - r_e B_{t+n-1})}{(1+r_e)^n} = B_t + \sum_{n=1}^{\infty} \frac{E_t[(ROE_{t+n} - r_e) B_{t+n-1}]}{(1+r_e)^n}, \tag{3}$$

where B_t is the book value of equity at time t, NI_{t+n} is the net income for period $t+n$, $NI_{t+n} - r_e B_{t+n-1}$ is the residual income (economic profit) for period $t+n$, ROE_{t+n} is the after-tax return on equity for period $t+n$, and r_e is the cost of equity capital.

We use the Institutional Brokers' Estimate System (I/B/E/S) consensus analyst forecasts to predict future earnings per share (EPS). The residual income model is estimated by forecasting earnings explicitly for the first three years and then implicitly thereafter, assuming that the ROE of each firm would revert to the industry median ROE by the terminal period. The split-adjusted stock price is obtained from CRSP. We solve for the discount rate r_e in equation (3).

As a robustness check, we estimate the implied cost of equity capital using alternative models: Gode and Mohanram (2003) (GM) and Easton (2004) (PEG). These models rely

[17] Under the clean-surplus assumption, earnings include all gains and losses that affect book value. Thus, the change in the equity book value at $t+1$ equals net income during $t+1$ minus net dividends paid during $t+1$ ($b_{t+1} = b_t + NI_t - D_t$).

on analyst forecasts for future EPS, which are not available for all firms. To circumvent this disadvantage, Hou, van Dijk, and Zhang (2012) (HVZ) estimate future earnings from cross-sectional regressions using total assets, dividends, earnings, and accruals as the independent variables. Although the HVZ model can provide earnings forecasts for more firms, Li and Mohanram (2014) show that the HVZ model underperforms a naive random walk (RW) model that sets future earnings to past earnings. Li and Mohanram (2014) propose two other cross-sectional models: the earning persistence (EP) and residual income (RI) models, showing that the RI model outperforms the HVZ, RW, and EP models in forecasting future EPS. Therefore, we use the Li and Mohanram (2014) RI model approach to forecast future EPS and estimate the implied cost of equity from the Claus and Thomas (2001) model. See Online Appendix for details on estimating the implied cost of equity.

We estimate the WACC as follows:

$$WACC_{i,t} = \frac{Debt_{i,t}}{MVA_{i,t}} CoD_{i,t}(1 - TaxRate) + (1 - \frac{Debt_{i,t}}{MVA_{i,t}})CoE_{i,t}, \tag{4}$$

where $WACC_{i,t}$ is the WACC for firm i in year t. $\frac{Debt_{it}}{MVA_{it}}$ is the market leverage ratio. $CoD_{i,t}$ is the cost of debt for firm i in year t, measured as the actual yield on the debt carried by the firm, as in Frank and Shen (2016). The actual yield is defined as the ratio of interest expenses to the sum of long-term debt and debt in current liabilities. Alternatively, the cost of debt is measured using BofA Merrill Lynch US Corporate Effective Yields for different rating classes and firms' credit ratings.[18] $TaxRate$ is the effective tax rate defined as a ratio of total income tax to taxable income. $CoE_{i,t}$ is the cost of equity for firm i in year t.

[18]Since we are interested in variation in the cost of debt over time within each firm and firms do not issue bonds every year, the actual bond issue data are not suitable for our analysis.

4 Economic Policy Uncertainty and Innovation

Table 1 Panel A reports the summary statistics of characteristics and innovation activities by the sample firms. The average R&D spending as a percentage of total assets at the beginning of the year is 5.7%. The mean of the natural logarithm of one plus the number of patents is 0.51, that is, 0.67 number of patents on an average. The mean of the natural logarithm of one plus truncation bias adjusted citations is 0.99. The average cost of equity is 13.09%, while the cost of debt is about 7.06%. The weighted average cost of capital is 11.76%.

The correlations between *Exog. EPU* and macroeconomic variables are reported in Panel B. *Exog. EPU* is weakly correlated with most of the variables, except for stock market uncertainty (*MktUnc*). The correlations between *Exog. EPU* and investor sentiment (*Sent*), GDP growth rate (*GDP Growth*), and economic uncertainty (*EcoUnc*) are statistically insignificant. *Exog. EPU* and *MktUnc* is moderately correlated at the 10% significance level.

To test the effect of economic policy uncertainty on innovation activities of individual firms, we estimate the following panel data model:

$$Y_{i,t+n} = \alpha + \beta Exog.EPU_t + \gamma X_{i,t} + \eta_i + \varepsilon_{i,t}, \quad (5)$$

where $Y_{i,t+n}$ is the measure of innovation activities including the R&D ratio, natural logarithm of one plus the number of patents, and natural logarithm of one plus truncation bias-adjusted citations for firm i in year $t + n$. Since it takes time to generate patents from R&D investments, we estimate the baseline model from $t + 3$ to $t + 4$. *Exog. EPU* is the average of the exogenous component of economic policy uncertainty index from the equation (1) over the past 12 months until fiscal year end. The coefficient β captures the effect of $Exog.\ EPU$ on innovation. The impact of economic policy uncertainty may potentially be confounded by the difference in the first-moment effects of investment opportunities. Particularly, firms with higher growth opportunities may invest more in R&D and innovate more. Therefore, we use Tobin's Q to capture variations in investment opportunities and also control for the distinctness in firm attributes. The control variable set, X, includes $Size$, PPE, CF, ROA, $Tobin's\ Q$, and $Leverage$.

Further, equation (5) includes a set of variables that directly control for economic growth, investment opportunities, or general uncertainty in economic conditions. The first variable is the GDP growth rate ($GDP\ Growth$), a proxy for economic growth, from the Federal Reserve Bank of St. Louis. The second variable is investor sentiment index of Baker and Wurgler (2007) ($Sent$), which reflects optimism about stocks in general. We also control for general uncertainty that may affect firms' innovation activities. We use the forecast dispersion for the nominal GDP growth rates for the following year from the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters as a proxy for uncertainty in economic growth ($EcoUnc$). Forecast dispersion is larger when economic uncertainty rises.

Stock market uncertainty also potentially affects firms' financing costs, and thereby, innovation activities. To isolate the influence of economic policy uncertainty from stock market uncertainty, we use the standard deviation of value-weighted composite index returns over the past 12 months as a proxy for uncertainty in the stock market ($MktUnc$). Monthly returns of value-weighted index are obtained from the CRSP. Additionally, firm fixed effects η_i are included to control for unobserved differences across firms. We also use Chicago Board Options Exchange (CBOE) Volatility Index (VIX) as an alternative measure to capture stock market uncertainty and find similar results. We report the results using the standard deviation of value-weighted composite index returns over the past 12 months as the proxy, since VIX is available from 1990.

As shown in Table 2, firms spend less on R&D as government economic policies become more uncertain. In terms of the magnitude of the impact, one unit increase in the uncertainty index is associated with an approximately 1.02% decline in R&D as a percentage of the beginning-of-the-year total assets in year $t+1$. The coefficients on *Exog. EPU* in the patent and citation specifications are negative and significant from year $t+3$, which is consistent with the time lag between R&D investments and patent production. A high level of economic policy uncertainty today will cause firms to spend less on R&D, which will generate fewer and lower quality patents.

5 Cost-of-Capital Channel

5.1 Cost of Capital and Economic Policy Uncertainty

To explore the cost-of-capital channel, whereby economic policy uncertainty affects innovation, we first investigate how the cost of raising external capital varies with economic policy uncertainty. To this end, we estimate the cost of equity, cost of debt, and WACC for each firm in each year. In specifications (1)–(3) of Table 3, we estimate the sensitivity of the cost of capital with respect to economic policy uncertainty while controlling for several factors that directly influence the cost of capital.

The reported results are based on the implied cost of equity estimated using the GLS model and the cost of debt as actual yield. The estimates of the implied cost of equity from the alternative models and bond yields provide similar results (Section 7.3). The coefficients of *Exog. EPU* are positive and significant while controlling for other determinants of the cost of capital. The cost of equity, cost of debt, and WACC increase with rising economic policy uncertainty. The weighted average cost of capital increases 248 basis points for one unit increase in *Exog. EPU*.

5.2 Financing Decisions and Economic Policy Uncertainty

As a further investigation, we test whether economic policy uncertainty affects firms' financing decisions. Since external capital becomes costlier as uncertainty increases, the cost-of-capital channel predicts that firms are less likely to issue equity and debt when uncertainty is high. We test this conjecture by examining whether the probability of equity and/or debt issuance is negatively associated with economic policy uncertainty.

We estimate a logit model with an equity (debt) issuance dummy as the dependent variable. Following the securities issuance literature, a firm is considered as issuing equity (debt) if the amount of equity (debt) issuance as a percentage of total assets at the beginning of the fiscal year is over 5%. Equity issuance is defined as a change in stockholders' equity minus change in retained earnings divided by the beginning-of-the-year total assets. Debt issuance is defined as a change in long-term debt scaled by the beginning-of-the-year total assets.[19] The independent variables are the *Exog. EPU* index and factors affecting a firm's financing decision. Columns (4) and (5) of Table 3 show that the coefficients of *Exog. EPU* are negative and significant, which is consistent with the hypothesis that firms are less likely to raise external capital in the case of higher policy uncertainty.

Next, we examine whether economic policy uncertainty also affects the amount of securi-

[19]Similar results are found using cash flow statement data to define debt and equity issuance.

ties issues. Our empirical specification uses equity or debt issuance as the dependent variable and tests the influence of economic policy uncertainty while controlling for the confounding factors and firm-fixed effects. Columns (6) and (7) show that the coefficients of *Exog. EPU* are negative and statistically significant. In other words, as uncertainty increases the cost of capital, we observe that firms reduce their equity and debt issuances. We expect to see a 2.59% decrease in equity issuance and a 5.02% decrease in debt issuance for a one-unit increase in *Exog. EPU*.[20] The results are consistent with the financing cost view that firms have a lower propensity to raise external capital when capital becomes more expensive owing to higher uncertainty.

5.3 Exposure to Economic Policy Uncertainty

To provide further evidence for the cost-of-capital transmission mechanism of the economic policy uncertainty, we employ the strategy of exploiting the cross-sectional heterogeneity across firms. If economic policy uncertainty affects innovation through its influence on firms' financing costs, then the cost of capital and innovation of firms with higher exposure to such uncertainty should be more affected. To test this conjecture, we estimate firms' exposure to economic policy uncertainty by the extent to which their industry is exposed to government regulations and examine whether firms with higher uncertainty exposure face a higher cost of capital.

To capture an industry's exposure to regulations, we use industry regulation data from RegData that quantifies regulatory restrictions from the US Code of Federal Regulation. The industry regulation data measure the regulatory restrictiveness to different industries

[20]This result is consistent with the finding that firms are less likely to raise capital through IPOs and SEOs during gubernatorial election years (Colak, Durnev, and Qian (2017) and Jens (2017)).

by counting binding constraints in the wording of the regulatory code and estimating the probability that it is about or affects each industry. The restrictions and probability weights are then aggregated to produce an index of regulatory stringency by industry and year.[21] We construct the uncertainty exposure measure *Exposure* as percentile ranking of the industry average of regulatory stringency index. A higher value of *Exposure* indicates that firms are more subject to government policies.

We examine whether uncertainty about economic policy has a stronger impact on the cost of capital of firms with higher exposure while controlling for the confounding factors. We regress our proxies for the cost of capital on *Exog. EPU*, the uncertainty exposure measure, and their interaction. The estimation results in Table 4 Panel A show that the coefficients of the interaction between the uncertainty index and uncertainty exposure are positive and significant for cost of equity and weighted average cost of capital. The results indicate that economic policy uncertainty leads to a larger increase in the cost of equity and WACC for firms with higher uncertainty exposure than for firms with lower exposure. The coefficient of the interaction term is not statistically significant in the cost of debt estimation.

We further explore cross-sectional heterogeneity in the impacts of economic policy-related uncertainty on innovation among firms with different exposure to economic policy uncertainty. Panel B shows that the coefficients on the interaction term between *Exog. EPU* and uncertainty exposure are negative and significant. The result indicates that firms with more exposure to economic policy uncertainty reduce their investments in *R&D* more and slow down their patent production as policy uncertainty increases. Collectively, these results provide evidence in support of the cost-of-capital transmission channel.

[21] See Al-Ubaydli and McLaughlin (2017) for the construction of index and RegData.

5.4 Cost-of-Capital vs. Investment Irreversibility Channel

The results thus far support the prediction that uncertainty about economic policy increases firms' cost of capital, which reduces innovation activities. Another possible explanation is that managers, who face uncertainty, have an incentive to postpone investments until more information is revealed if investments are costly and (partially) irreversible. It is interesting to see whether cost of capital affects R&D investment after controlling for the investment irreversibility channel.

To investigate the marginal effect of the cost-of-capital channel, we control for the degree of irreversibility in investment using several industry-level proxies as in Gulen and Ion (2016). The first proxy is the inverse of the asset redeployability measure proposed by Kim and Kung (2017). We use the 1997 Bureau of Economic Analysis capital flow table to construct the proxy. The table contains expenditures on 180 asset categories by firms in 123 industries.[22] The first irreversibility measure is constructed in three steps. First, a redeployability score for each asset category is computed as the number of industries using the asset scaled by 123. An asset is considered as being used by an industry if the industry's expenditure on the asset is more than 0.1% of the total expenditure on the asset by all industries. Second, an industry-level redeployability index is constructed as a weighted average of the redeployability scores of the invested asset categories. The weight for each asset category is an industry's expenditure on the asset divided by the industry's total expenditures. Firms in industries with a higher redeployability index have more redeployable assets and are more likely to

[22]The 123 industries in the Bureau of Economic Analysis capital flow table are based on the four-digit North American Industry System (NAICS). We match these industries with the sample firms using NAICS code.

recover a higher fraction of investment. Third, the irreversibility measure for each industry is calculated as the inverse of redeployability index ($NonRedeployability$).

The second irreversibility measure is constructed based on cyclicality of firms' sales following Sharpe (1994) and Almeida and Campello (2007). We first calculate the correlation between each firm's sales and gross national product over the sample period. The firm-level correlations are then averaged at the three-digit SIC level. The industry-level irreversibility measure is a dummy variable that is one for industries with correlations above the median, and zero otherwise. It is harder for firms in cyclical industries to recover their investments because potential buyers of their assets are likely to be also affected by negative shocks during economic downturns.

The third proxy of irreversibility is an industry-level measure of sunk costs as in Farinas and Ruano (2005). Investments in industries with more sunk costs are harder to reverse. We first measure firm-level sunk costs using three proxies: rent expense, depreciation expense, and past sale of PPE, all normalized by the beginning-of-fiscal-year PPE. The industry-level means of these three proxies in each year are then obtained at the three-digit SIC level. Firms with a higher proportion of rented assets, faster depreciated capital, more active resale markets for assets have lower sunk costs. We then create three indicator variables that equal one if the firm-level sunk cost is higher than the industry mean, and zero otherwise. A sunk-cost index is constructed as a combination of the three indicators. The sunk-cost index is set to take a value of 0 if the three indicators all equals zero; 2 if the three indicators are all equal to one; and 1 for the remaining. A higher value of sunk-cost index indicates a higher degree of investment irreversibility.

In Table 5, we examine the relative importance of the cost of capital and investment irreversibility by including the proxies for the cost of capital and investment irreversibility to the baseline regression. We do not control for firm-fixed effects, since the investment irreversibility proxies are time invariant. A potential concern about this test is that the cost of capital may also be affected by other factors not included in the model. It is possible that more innovative firms may have higher cost of capital. To ease the concern, we estimate the model using the instrumental variable approach. We use readability of firms' public disclosures as an instrument for individual firms' cost of capital. The intuition is that higher readability of the prospectuses, security registrations, or 10-K filings helps investors extract and assess information from the documents, which will affect a firm's cost of capital.[23] However, readability of firms' financial disclosures does not directly affect a firm's R&D investment other than through the firm's financing costs. We use the plain language measure developed by Loughran and McDonald (2014) to measure readability of public filings to Securities and Exchange Commissions (SEC). The plain language measure is a standardized statistic that aggregates six writing components identified by the SEC's plain language rule: average sentence length, average word length, passive voice, legalese, personal pronouns, and negative/superfuous phrases. The measure is constructed annually using textual analysis to examine firms' compliance with the SEC's plain language mandates in Form 424, S-1, and 10-K filings over 1994-2009.

The second-stage results from the two-stage least square estimation are reported.[24] The coefficients on $WACC$ and the two proxies of investment irreversibility: *Cyclycality*, and

[23]Previous studies find that readability of financial documents affects investor trading behavior, investors' reaction to information content of 10-K documents, and analyst forecasts (Miller (2010), You and Zhang (2009), and Lehavy, Li, and Merkley (2011)).

[24]The first-stage F statistic exceeds 10, indicating that the instrumental variable satisfies the relevance condition.

SunkCost are negative and significant. The coefficient on *NonRedeployability* is negative but insignificant. To evaluate the relative importance of *WACC* and *NonRedeployability*, we report the standardized beta coefficients in parentheses. The standardized coefficients are not reported for the estimation using cyclicality of firms' sales and sunk costs as proxies for investment irreversibility, since these two measures are categorical variables. The standardized coefficient on *WACC* is −0.2727, which is larger in magnitude than the standardized coefficient on *NonRedeployability* (−0.0297). The result indicates that the cost of capital is relatively more important in affecting firms' R&D investments than the investment irreversibility. The investment irreversibility channel proposed in the literature cannot fully explain away the economic policy uncertainty effect.

6 Further Evidence

6.1 Financial Constraints

To further strengthen the cost-of-capital channel, we investigate cross-sectional variations in the effects of GEPU on innovation based on financial constraints faced by a firm. If economic policy uncertainty affects firm innovation through financing costs, more financially constrained firms are likely to be affected more. Lack of financing could prevent firms from investing in innovative projects.

We use the textual analysis-based measure developed by Hoberg and Maksimovic (2015) to capture the degree of financial constraint faced by a firm.[25] This measure is constructed using mandated disclosures regarding firm liquidity in the Management's Discussion and

[25]The popular financial constraint indices (the Kaplan and Zingales (1997), Whited and Wu (2006), and Hadlock and Pierce (2010) indices) have been shown not to identify plausibly constrained firms (Farre-Mensa and Ljungqvist (2016)). Constrained firms identified based on these proxies are found to have no difficulty obtaining external capital.

Analysis (MD&A) section in 10-K filings. In the MD&A section, managers discuss potential delay in investment due to constraints in financing. This financial constraint measure captures firms' inability to obtain financing for planned investments. A higher value of the financial constraint measure indicates that a firm is at risk of delaying investment plans due to financial issues.

Using this financial constraint measure, we examine whether more financially constrained firms innovate less as economic policy uncertainty increases. In Table 6, we include the financial constraint measure and its interaction with *Exog. EPU* to the baseline regression model. The estimated coefficients on the interaction term are negative and significant for R&D investment and patent production. The results indicate that the effect of economic policy uncertainty on innovation is stronger for more financially constrained firms, which is consistent with the view that the cost of capital is an underlying channel through which policy uncertainty shapes firms' innovation activities.

6.2 Product Market Competition

Weeds (2002) argues that it is costly for firms to delay their investments when facing competition. Uncertainty about government economic policy could potentially create opportunities for firms to make strategic investments gaining competitive advantages. Hence, it is interesting to investigate whether the impact of economic policy uncertainty on innovation is shaped by product market competition.

The literature documents that product market competition affects firms' innovation incentives (Aghion, Bloom, Blundell, Griffith, and Howitt (2005)). On the one hand, competition may encourage R&D investments when the incremental profits earned by the technology leader from innovating are relatively larger than other firms in the industry (Aghion, Bloom, Blundell, Griffith, and Howitt (2001)). On the other hand, competition could discourage innovation by reducing the flow and expected duration of rents from innovation (Aghion and Howitt (1992)). Therefore, it is unclear *ex ante* whether product market competition will amplify or mitigate the impact of economic policy uncertainty on firm innovation.

We adopt two product market competition measures to examine the influence of product market competition. The first measure is Hoberg and Phillips (2016) industry concentration measure that is constructed using firms and their rivals identified from the business descriptions of 10-K filings. Industry concentration is measured by the Herfindahl-Hirschman index (HHI) based on Text-Based Network Industry Classification. A lower degree of product market concentration indicates more competition. The second competition measure is Hoberg, Phillips, and Prabhala (2014) product market fluidity measure, constructed based on textual analysis of firms' business descriptions from 10-K filings. This firm-level fluidity measure focuses on product space dynamics and captures similarity of a firm's product and its rivals. A higher value of the fluidity measure reflects more product market threats from competitors.

We include a *Competitive* indicator that equals one if the industry concentration (product market fluidity) measure is below (above) the median and an interaction term between *Competitive* dummy and *Exog. EPU* to the baseline model. The estimation results based on the industry concentration measure and product market fluidity are reported in Panel A and Panel B of Table 7, respectively. The negative coefficients on the interaction term indicate that product market competition generally exacerbates the negative effects of economic policy uncertainty on firms' innovation activities.

6.3 External Finance Dependence

It is well documented that financing is crucial for costly innovation activities (Hall and Lerner (2010) and Kerr and Nanda (2015)). In a world with financial frictions, firms' innovation efforts depend on not only technological standing and product market structure, but also the availability of capital. A firm's capacity to engage in innovation to escape competition could be constrained by its ability to secure the capital needed for innovation. The ability to access external capital market is particularly important during the uncertain periods when financing generally becomes more expensive. To the extent that external capital is relevant for financing innovation, firms' strategic motive of innovation in a competitive and uncertain environment might be affected by firms' reliance on external finance.

To understand the importance of financing for strategic innovation, we classify firms into external finance dependent (EFD) and internal finance dependent (IFD) industries. To determine an industry's dependence on external finance, we follow Rajan and Zingales (1998) and measure a firm's need for external finance in a year as the fraction of investment not financed through internal cash flows.[26] The time series industry-level external finance dependence is constructed as the median value of the external finance needs of all firms in the three-digit SIC code industry in each year. We then measure each industry's external finance as its time series median.[27] An industry with a positive value of external finance dependence relies more on external capital to finance its investment.

We separately estimate the regression model in Table 7 for firms in external and internal

[26]We include capital expenditures, R&D, and acquisition expenses as investments to construct the external finance dependence measure. Our results are robust to alternative measures that do not include acquisition expenses.

[27]Hsu, Tian, and Xu (2014) and Acharya and Xu (2017) use a similar approach to measure an industry's dependence on external finance.

finance dependent industries. The reported results in Table 8 are based on the product market fluidity measure. Similar results are found when Herfindahl index is used. For firms in industries dependent on external finance, the coefficients on the interaction term between *Competitive* dummy and *Exog. EPU* remain negative and significant (Panel A). For firms in industries dependent more on internal finance, the coefficients on the interaction term between *Competitive* dummy and *Exog. EPU* become insignificant (Panel B). Product market competition mitigates the negative impact of economic policy uncertainty on firm innovation when firms rely less on external capital to finance innovation. The cross-sectional difference between firms depending more and less on external finance is consistent with the view that financing cost plays a role in shaping the influence of economic policy uncertainty on firms' innovation efforts.

7 Robustness

7.1 Instrumental Variable

A potential concern about the economic policy uncertainty index is endogeneity. Bloom (2014) documents that uncertainty fluctuates counter-cyclically with business cycles. High policy uncertainty may coincide with diminishing growth opportunities during bad economic conditions, which could induce fewer innovations. Although we include a set of firm-level and aggregate-level variables to control for investment opportunities and economic conditions in our analyses, the effect of economic policy uncertainty on innovation may still be confounded by other unobserved factors. We adopt several strategies to further ease this concern.

The first strategy to alleviate the endogeneity problem is the instrumental variable approach. We use the political polarization in the House of Representatives as an instrument for policy uncertainty. When the political parties in the Congress are more polarized, it becomes increasingly difficult for policy makers to reach a consensus, which creates more uncertainty. Baker, Bloom, Canes-Wrone, Davis, and Rodden (2014) point out that increased political polarization is a reason for the rise in policy-related economic uncertainty in the United States since 1960. Therefore, political polarization is likely to satisfy the relevance condition as an instrument. However, it is not obvious that political polarization affects corporate innovation through a channel other than policy uncertainty, which satisfies the exclusion restriction.

To construct the political polarization measure, we obtain the U.S. House roll-call vote data from the Political Institutions and Public Choice House Roll-Call Database. We focus on two types of legislation, bills and joint resolutions, that may affect laws or constitutions. We measure political polarization as an average disagreement about bills or joint resolutions considered in the House.[28] Specifically, polarization is defined as $\frac{1}{n}\sum_{n=1}^{N} 1 - |Yea_{n,t}\% - Nay_{n,t}\%|$, where $Yea_{n,t}\%$ ($Nay_{n,t}\%$) is the percentage of Yea (Nay) votes among all votes for bill n in year t. N is the total number of bills or joint resolutions in year t. We look at bills regarding economy, taxes, budget, appropriations, defense and foreign policy. A higher value of this variable indicates a higher degree of polarization.

We estimate the baseline panel data model by using the political polarization measure as an instrument for government policy uncertainty. The second-stage results from the

[28] The dynamic weighted nominal three-step estimation (DW-NOMINATE) scores in Poole and Rosenthal (2007) are also widely used to measure political polarization in the political science literature. The DW-NOMINATE scores locate a legislator's ideological position in latent ideological space within each Congress. The scores are computed by analyzing the legislators' roll-call voting behavior through the spatial model. The distance between the Democratic and Republican legislators for each chamber denotes political polarization. The DW-NOMINATE scores remain constant within each Congress. We find similar results using this political polarization measure as an instrument.

two-stage least square estimation are reported in Panel A of Table 9. The coefficients of the economic policy uncertainty measure remain negative and statistically significant. Our results are robust to the instrument variable estimation. The first-stage F statistic exceeds 10, indicating that the instrument satisfies the relevance condition.

7.2 Close Elections

As the second strategy to mitigate the endogeneity concern, we use close congressional elections to capture policy-related uncertainty. Democrats and Republicans differ in their ideological positions and economic policies, ranging from R&D spending to regulation. Democrats tend to focus on specific goals, such as producing safe and clean energy or exploring space, and are also willing to subsidize early-stage innovation in private sector. Republicans, on the other hand, prefer to focus on the general conditions, such as low corporate taxes, and create incentives to encourage innovation, such as R&D tax credit (Kahin and Hill (2010)). Polarization in the Congress reduces congressional productivity in legislation and incentives for bipartisan cooperation, which can have a significant impact on the economic environment. For example, the fight in the Congress over whether or not to raise the debt ceiling in August 2011 led to a U.S. government credit rating downgrade by Standard&Poor's (S&P). Congressional elections contribute to possible changes in government policies that may directly or indirectly affect firms' business activities.

Since the timing of elections is independent from macroeconomic conditions, congressional elections provide a natural experiment framework to disentangle the influences of political uncertainty from other economic factors on investments. Close elections with unpredictable outcomes create plausible exogenous shocks to policy uncertainty, which helps establish a causal effect of policy uncertainty on innovation.

We collect congressional election outcome data from the U.S. Federal Election Commission. The sample is restricted to general elections for the House of Representatives and the Senate. We focus on close elections when the difference in the percentage of votes between the Democrats and Republican is 5% or less. We run the baseline regression with *Exog. EPU* replaced with a close congressional election dummy (*Congressional Election*) that equals one if there is a close election in year t, and zero otherwise. We examine the impact on firms' R&D investments leading up to the time when uncertainty regarding congressional election outcomes resolves in November. We also control for election cycles, as congressional elections occur in even-number years. Panel B in Table 9 reports the estimation results. The coefficients of *Congressional Election* are negative and statistically significant. To the extent that close congressional elections capture uncertainty about government policy, firms' innovation activities are adversely affected by policy uncertainty.

Following Julio and Yook (2012), we use close presidential elections as another plausible exogenous shock to government policies. Elections help isolate the impact of uncertainty associated with national leadership and policies from other confounding factors. The close presidential elections reflect potential changes in government policies beyond economic policies. During the sample period, there were two close presidential elections: the 2000 and 2004 elections. We run the baseline regression with *Exog. EPU* replaced with a close election dummy (*Presidential Election*) that equals one if there is a close presidential election in year t, and zero otherwise. We also control for election cycles. Panel C in Table 9 reports the estimation results. The coefficients of *Presidential Election* are negative and statistically significant, which is consistent with the finding that high uncertainty in government policy hinders innovation.

7.3 Alternative Measures of the Cost of Capital

In this section, we use alternative models to estimate the implied cost of equity and cost of debt. We estimate equation (4) by using the alternative implied cost of equity measures. Table 10 shows that the coefficients of *Exog. EPU* remain positive and significant, indicating that the cost of equity goes up as uncertainty surges. The magnitude of the impact using the Li and Mohanram (2014) approach is relatively larger, since this estimation includes smaller firms without analyst coverage. In Column (4), we use corporate bond yields for different rating classes as an alternative measure for the cost of debt. The yields are BofA Merrill Lynch US Corporate Effective Yields for AAA, AA, A, BBB, BB, B, CCC, or below ratings. The data are obtained from the Federal Reserve Bank of St. Louis website. We obtain S&P crediting ratings data from Compustat and match them with financial data by GVKEY and Datadate. We assume that firms maintain the same credit rating until a change in rating occurs. For firms without credit ratings, we compute the synthetic rating using the Damondaran (2012) approach. The interest coverage ratio, defined as earnings before interest and taxes divided by interest expenses, is used to obtain the synthetic rating.[29] We use the yield for each rating category as the cost of debt for firms in that credit rating class. Since the BofA Merrill Lynch US Corporate Effective Yields data are only available since 1997, the estimation period is from 1997 to 2007 for this specification. The estimation result shows that GEPU still has a positive and significant influence on firms' borrowing costs using

[29]When their market capitalization is over $5 billion, firms with interest coverage ratio greater than 8.5; between 6.5 and 8.5, 3 and 6.5, 2.5 and 3, 2 and 2.5, 1.25 and 2; or below 1.25 is classified as AAA, AA, A, BBB, BB, B, CCC, or below, respectively. When their market capitalization is below $5 billion, firms with interest coverage ratio greater than 12.5; between 9.5 and 12.5, 4.5 and 9.5, 4 and 4.5, 3 and 4, 1.5 and 3; or below 1.5 is classified as AAA, AA, A, BBB, BB, B, CCC, or below, respectively.

the alternative measure of the cost of debt.

We then compute the WACC by using the after tax cost of debt and implied cost of equity estimated with the Gode and Mohanram (2003) model. Column (5) shows that the coefficient of the uncertainty index is positive and significant. Our results are robust to alternative measures of the cost of capital.

8 Conclusions

This study examines how economic policy uncertainty affects individual firms' innovation and identifies an alternate transmission channel—cost of capital. We show that uncertainty about economic policy has a negative impact on corporate innovation activities. The effect on R&D takes place relatively quick, while the effect on patent portfolios is delayed. The result is robust to various identification strategies that address the endogeneity concern.

We provide novel evidence on the cost of capital as a driving force underlying the relationship between economic policy uncertainty and innovation. We find that firms' cost of capital on average rises as uncertainty escalates. Consequently, firms are less likely to raise external capital when economic policy uncertainty is high. Firms with more exposure to uncertainty face a larger increase in funding costs and innovate less than those with less exposure during the period of high uncertainty. Economic policy uncertainty also has a larger impact on innovation activities of financially more constrained firms and firms dependent more on external finance in a competitive environment. Since the cost of capital underpins firms' investment decisions, our results lend support to the view that policy uncertainty affects innovation through its impact on firms' cost of capital.

Our results indicate that economic policy uncertainty affects the real economy not only through the classic investment irreversibility channel but also through the cost-of-capital channel. The cost of capital channel plays a relatively more important role than the investment irreversibility channel in shaping firms' investments in innovation. An implication of our findings is that efforts by policy makers to reduce policy uncertainty are desirable to create a good investment environment for corporations.

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Figure 1: EPU Index: 1985–2016

This figure presents the monthly EPU index and NBER recession periods from January 1985 to December 2016. The EPU index data are from Baker, Bloom, and Davis (2016) and recession indicator data are from the Federal Reserve Bank of St. Louis.

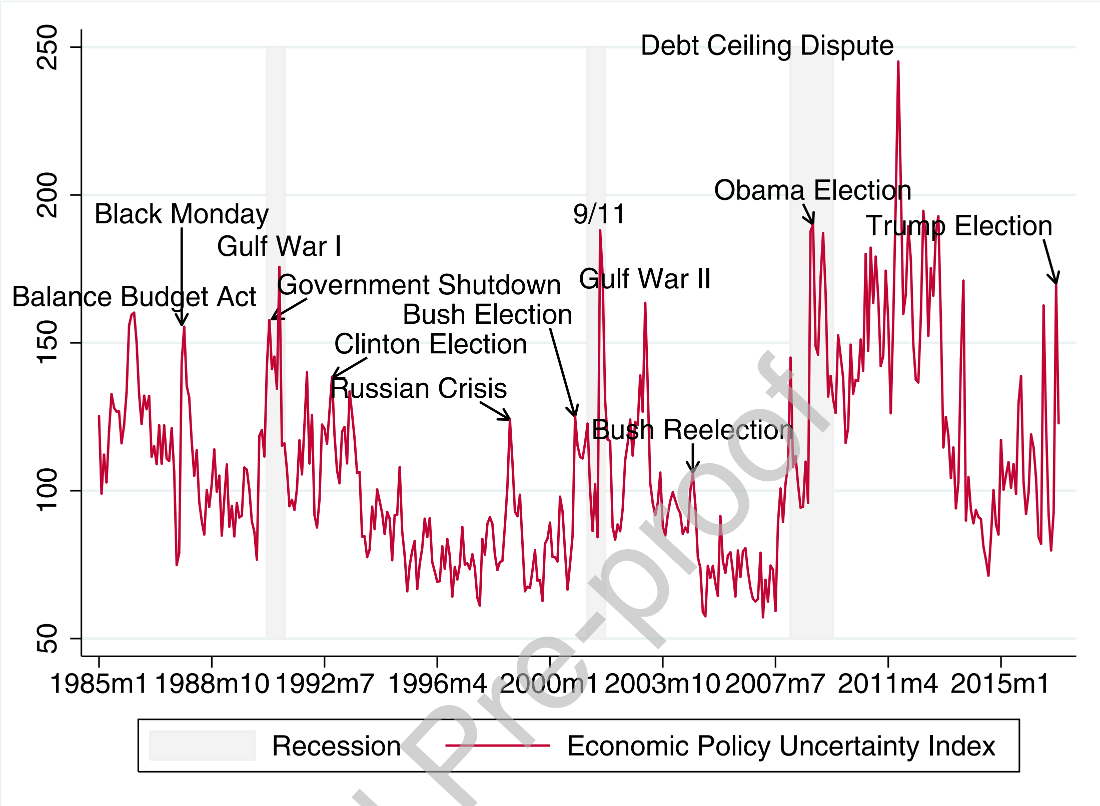

Table 1:
Summary Statistics

This table reports the summary statistics of firm characteristic variables and innovation activities (Panel A) and correlation between economic policy uncertainty index and macroeconomic variables (Panel B). *Size* is defined as the natural logarithm of total sales. *PPE* is the investment in property, plant, and equipment scaled by total assets. *CF* is operating cash flow defined as operating income before depreciation scaled by the beginning-of-the-year total assets. *ROA* is net income divided by total assets. *Leverage* is long-term debt and debt in current liabilities scaled by total assets. Tobin's Q is defined as the ratio of the market value to book value of assets. *R&D* is the ratio of research and development expenditures to the beginning-of-the-year total assets. *ln*(*Patent*) is the natural logarithm of one plus the number of patents applied by a firm in a given year. *ln*(*Citations*) is the natural logarithm of one plus citations per patent adjusted for truncation bias. *GDP Growth* is GDP growth rate. *EcoUnc* is economic uncertainty. *MktUnc* is stock market uncertainty. *Sent* is investor sentiment. *Exog. EPU* is the exogenous component of Baker, Bloom, and Davis (2016) economic policy uncertainty index. *CoE* is cost of equity estimated using Gebhardt, Lee, and Swaminathan (2001) method. *CoD* is cost of debt based on the actual yield on debt. *WACC* is weighted average cost of capital. *PPE*, *CF*, *ROA*, *Leverage*, *R&D*, *CoE*, *CoD*, and *WACC* are reported in percentage. The mean and standard deviation of the variables are reported. In Panel B, variables are at the annual frequency. P-value is reported in parentheses.

Panel A: Summary Statistics				
	Mean	Std. Dev.	P25	P75
Size	4.568	2.405	3.077	6.160
PPE	27.455	22.436	9.626	39.286
CF	6.707	24.802	0.966	19.490
ROA	-7.357	30.637	-8.240	7.170
Tobin's Q	2.110	1.907	1.070	2.308
Leverage	23.060	22.011	2.970	36.053
R&D	5.705	11.170	0.000	6.629
Exog. EPU	0.003	0.124	-0.070	0.041
GDP Growth	5.729	1.225	5.190	6.344
EcoUnc	0.867	0.294	0.620	1.000
MktUnc	0.040	0.017	0.027	0.053
Sent	0.429	0.555	0.012	0.681
ln(Patent)	0.510	1.077	0.000	0.693
ln(Citations)	0.989	1.924	0.000	0.693
CoE	13.094	6.460	9.291	15.693
CoD	7.059	4.617	3.691	10.459
WACC	11.756	5.295	8.627	13.880

Panel B: Correlations					
	Exog. EPU	Sent	GDP Growth	EcoUnc	MktUnc
Exog. EPU	1.00				
Sent	-0.04	1.00			
	(0.87)				
GDP Growth	-0.11	-0.25	1.00		
	(0.62)	(0.25)			
EcoUnc	0.10	-0.24	0.49	1.00	
	(0.66)	(0.28)	(0.02)		
MktUnc	0.39	0.33	-0.22	-0.14	1.00
	(0.07)	(0.13)	(0.31)	(0.51)	

Table 2:
Impact of GEPU on Innovation

The table reports the effect of GEPU on innovation. The dependent variables are the measures of innovation activities: R&D ratio, natural logarithm of one plus the number of patents ($ln(Patent)$), and natural logarithm of one plus truncation bias adjusted citations ($ln(Citations)$). *Exog. EPU* is the exogenous component of Baker, Bloom, and Davis (2016) economic policy uncertainty index. We control for a set of characteristic variables that affect a firm's innovation activities, including *Size* (log of total assets), *PPE* (investment in property, plant, and equipment scaled by total assets), *CF* (income before extraordinary items plus depreciation and amortization scaled by total assets), *ROA* (net income divided by total assets), *Tobin's Q* (market value to book value of assets), *Leverage* (long-term debt and debt in current liabilities divided by total assets), *GDP Growth*, *EcoUnc* (economic uncertainty), *MktUnc* (stock market uncertainty), *Sent* (investor sentiment). Firm-fixed effects are also controlled. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	$R\&D_{t+1}$	$ln(Patent)_{t+3}$	$ln(Patent)_{t+4}$	$ln(Citations)_{t+3}$	$ln(Citations)_{t+4}$
Exog. EPU	-1.0160***	-0.1760***	-0.2036***	-0.4752***	-0.3743***
	[0.1391]	[0.0162]	[0.0176]	[0.0374]	[0.0394]
Size	-0.5973***	0.0628***	0.0529***	-0.1156***	-0.1376***
	[0.0607]	[0.0077]	[0.0080]	[0.0125]	[0.0136]
PPE	0.0378***	0.0010**	0.0010**	0.0089***	0.0082***
	[0.0041]	[0.0004]	[0.0004]	[0.0009]	[0.0010]
CF	-0.0077**	-0.0008***	-0.0002	0.0029***	0.0036***
	[0.0037]	[0.0003]	[0.0003]	[0.0006]	[0.0006]
ROA	-0.0450***	0.0006***	0.0002	0.0014***	0.0013***
	[0.0031]	[0.0002]	[0.0002]	[0.0004]	[0.0004]
Tobin's Q	0.9669***	0.0226***	0.0223***	0.0224***	0.0148**
	[0.0462]	[0.0029]	[0.0031]	[0.0062]	[0.0066]
Leverage	-0.0250***	-0.0012***	-0.0014***	-0.0030***	-0.0034***
	[0.0028]	[0.0003]	[0.0003]	[0.0006]	[0.0006]
GDP Growth	-0.0333**	0.0018	0.0071***	0.0320***	0.0466***
	[0.0166]	[0.0016]	[0.0018]	[0.0036]	[0.0040]
EcoUnc	-0.0644	-0.0133*	-0.0153*	0.0074	0.0090
	[0.0642]	[0.0076]	[0.0082]	[0.0176]	[0.0180]
MktUnc	-0.4181	0.3301**	-0.4557***	-1.4180***	-3.8615***
	[1.2997]	[0.1408]	[0.1523]	[0.3022]	[0.3344]
Sent	-0.2498***	0.0304***	0.0153***	0.0702***	0.0132*
	[0.0339]	[0.0032]	[0.0033]	[0.0067]	[0.0068]
N	77,726	59,647	52,394	59,647	52,394
Adj. R^2	0.8087	0.8617	0.8697	0.7600	0.7698

Table 3:
Cost of Capital, Financing Decisions, and GEPU

This table presents the estimation results of the impact of GEPU on firm-level cost of capital and financing decisions. In Columns (1)-(3), we regress the cost of equity, cost of debt, and WACC on *Exog. EPU*, respectively. The cost of equity (CoE) is estimated from the residual income valuation model using the Gebhardt, Lee, and Swaminathan (2001) approach. The cost of debt (CoD) is the actual yield on the debt carried by the firm. The cost of capital is the WACC with market leverage at the beginning of the fiscal year as the weight. In Columns (4) and (5), we estimate a logit model that the dependent variable is a dummy variable that equals one if a firm issues equity (debt) and zero otherwise. In Columns (6) and (7), we regress the size of equity issuance and debt issuance on firm characteristics that affect securities issuance. Factors that influence firms' cost of capital and financing decision and firm-fixed effects are controlled. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	CoE	CoD	WACC	D_{Equity}	D_{Debt}	Equity	Debt
Exog. EPU	3.1552***	0.2358**	2.4759***	-0.7099***	-0.2531***	-2.5904***	-5.0188***
	[0.2114]	[0.1059]	[0.1855]	[0.0828]	[0.0675]	[0.4082]	[1.3261]
Size	-1.3570***	-0.1355***	-1.2396***	-0.1721***	-0.0932***	-2.1728***	-1.7273***
	[0.0839]	[0.0345]	[0.0766]	[0.0068]	[0.0053]	[0.1178]	[0.3731]
PPE	0.0163**	0.0301***	0.0134**	-0.0021***	0.0019***	0.0630***	0.1694***
	[0.0064]	[0.0026]	[0.0056]	[0.0007]	[0.0005]	[0.0091]	[0.0289]
CF	0.0036	-0.0021	0.0095**	-0.0072***	-0.0356***	-0.0326***	-0.6554***
	[0.0049]	[0.0018]	[0.0046]	[0.0009]	[0.0010]	[0.0091]	[0.0290]
ROA	-0.0093*	-0.0028**	-0.0132***	-0.0157***	-0.0077***	-0.1403***	-0.0566**
	[0.0048]	[0.0014]	[0.0045]	[0.0008]	[0.0008]	[0.0086]	[0.0254]
Tobin's Q	-0.7644***	-0.2258***	-0.6867***	0.4284***	0.0448***	3.1821***	-0.3337
	[0.0447]	[0.0190]	[0.0469]	[0.0119]	[0.0069]	[0.0953]	[0.2793]
Leverage	0.0270***	0.0776***	-0.0090**	0.0084***	0.0031***	0.1195***	-0.4337***
	[0.0042]	[0.0019]	[0.0037]	[0.0006]	[0.0005]	[0.0069]	[0.0213]
GDP Growth	0.2282***	0.2436***	0.1595***	-0.0804***	0.0485***	-0.3864***	1.0551***
	[0.0233]	[0.0116]	[0.0199]	[0.0083]	[0.0074]	[0.0460]	[0.1476]
EcoUnc	0.9477***	0.5871***	0.7340***	-0.1523***	-0.0493	-0.0714	-4.0713***
	[0.1093]	[0.0503]	[0.0945]	[0.0376]	[0.0311]	[0.1883]	[0.6318]
MktUnc	2.8947	8.9181***	-1.5098	-5.6273***	0.1674	-9.4431***	12.8222
	[1.8687]	[0.8954]	[1.5907]	[0.6379]	[0.5105]	[3.1889]	[10.3810]
Sent	0.5618***	-0.0274	0.3985***	-0.1131***	0.1423***	-1.0817***	3.4912***
	[0.0479]	[0.0241]	[0.0408]	[0.0182]	[0.0145]	[0.0969]	[0.3227]
N	35,871	69,965	33,946	77,434	77,434	77,434	77434
Adj. R^2	0.4814	0.5305	0.4733			0.5359	0.4773

Table 4:
Exposure to Uncertainty

This table reports the impact of economic policy uncertainty on cost of capital (Panel A) and innovation (Panel B) based on firms' exposure to GEPU. We measure firm's exposure to economic policy uncertainty by the extent to which their industries are exposed to government regulations. CoE is estimated from the residual income valuation model using the Gebhardt, Lee, and Swaminathan (2001) approach. CoD is the actual yield on the debt carried by the firm. WACC is the weighted average cost of capital with market leverage at the beginning of the fiscal year as the weight. In Panel A and B, we regress the cost of capital and innovation measures respectively on *Exog. EPU*, exposure measure, the interaction term between the policy uncertainty index and the exposure measure, control variables, and firm-fixed effects. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	Panel A: Cost of Capital		
	(1)	(2)	(3)
	CoE	CoD	WACC
Exog. EPU	0.0021	-0.0038*	-0.001
	[0.0034]	[0.0022]	[0.0032]
Exog. EPU×Exposure	0.0189**	0.0019	0.0182***
	[0.0075]	[0.0037]	[0.0067]
Controls	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	17,411	33,547	16,394
Adj. R^2	0.4597	0.5244	0.4492

	Panel B: Innovation Activities		
	(1)	(2)	(3)
	$R\&D_{t+1}$	$ln(Patent)_{t+4}$	$ln(Citations)_{t+4}$
Exog. EPU	0.0032	-0.0017***	-0.0035***
	[0.0034]	[0.0004]	[0.0008]
Exog. EPU×Exposure	-0.0132*	-0.0022***	-0.0025*
	[0.0076]	[0.0007]	[0.0014]
Controls	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	37,727	25,686	29,146
Adj. R^2	0.7966	0.8764	0.7688

Table 5:
Cost of Capital vs. Investment Irreversibility Channel

This table presents the impacts of cost of capital and investment irreversibility on firms' R&D investments. We regress R&D ratio on weighted average cost of capital, proxies for investment irreversibility, and control variables. We measure investment irreversibility based on asset redeployability (*NonRedeployability*), cyclicality of firms' sales (*Cyclicality*), and sunk costs (*SunkCost*). The standardized beta coefficients are reported in parentheses. The standardized coefficients are not reported in the estimations using cyclicality of firms' sales and sunk costs as proxies for investment irreversibility, since these two measures are categorical variables. We control for *Size*, *PPE*, *CF*, *ROA*, *Tobin's Q*, *Leverage*, *GDP Growth*, *EcoUnc*, *MktUnc*, and *Sent*. The model is estimated using two-stage least square method. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	(1)	(2)	(3)	(4)
WACC	-0.4400*	-0.5281**	-0.2838*	-0.4580*
	[0.2613]	[0.2456]	[0.1594]	[0.2494]
	(-0.2727)			
NonRedeployability	-0.1528***			-0.1923***
	[0.0507]			[0.0564]
	(-0.0297)			
Cyclicality		-3.2753***		-3.0394***
		[0.1982]		[0.1907]
SunkCost			-1.9215***	-1.6875***
			[0.0803]	[0.1285]
Controls	Yes	Yes	Yes	Yes
N	15,774	16,471	16,471	15,774

Table 6:
Financial Constraints

This table presents the impacts of economic policy uncertainty on innovation of financially more constrained and less constrained firms. *Constraint* is a financial constraint measure developed by Hoberg and Maksimovic (2015) based on textual analysis of the Capitalization and Liquidity Subsection of the Management's Discussion and Analysis section in 10-Ks. A higher value of *Constraint* indicates that a firm is at risk of delaying their investments due to challenges in financing. We control for *Size*, *PPE*, *CF*, *ROA*, *Tobin's Q*, *Leverage*, *GDP Growth*, *EcoUnc*, *MktUnc*, *Sent*, and firm fixed effects. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	$R\&D_{t+1}$	$ln(Patent)_{t+4}$	$ln(Citations)_{t+4}$
Exog. EPU	-0.8923**	-0.1695***	-0.5592***
	[0.4284]	[0.0591]	[0.1169]
Constraint	0.3269	0.0091	0.0548
	[0.2168]	[0.0211]	[0.0436]
Exog. EPU×Constraint	-1.5856*	-0.3535***	-1.0292***
	[0.9203]	[0.1230]	[0.2298]
Controls	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	30,389	16,777	16,777
Adj. R^2	0.8383	0.8916	0.7764

Table 7:
Product Market Competition

This table examines whether product market competition affects the impact of economic policy uncertainty on innovation. We measure industry competition based on Hoberg and Phillips (2016) industry concentration measure (Panel A) and Hoberg and Phillips (2016) product market fluidity measure (Panel B). *Competitive* is an indicator equal to one if the industry concentration measure (product market fluidity) is below (above) the median and zero otherwise. We control for *Size*, *PPE*, *CF*, *ROA*, *Tobin's Q*, *Leverage*, *GDP Growth*, *EcoUnc*, *MktUnc*, *Sent*, and firm fixed effects. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	Panel A: Herfindahl-Hirschman Index		
	$R\&D_{t+1}$	$ln(Patent)_{t+4}$	$ln(Citations)_{t+4}$
Exog. EPU	-1.2259***	-0.3285***	-1.1814***
	[0.2412]	[0.0395]	[0.0812]
Competitive	-0.0653	-0.0113	-0.0394*
	[0.0972]	[0.0104]	[0.0226]
Exog. EPU×Competitive	-0.9928**	-0.1218**	-0.3546***
	[0.4358]	[0.0620]	[0.1301]
Controls	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	39,751	22,523	22,523
Adj. R^2	0.8345	0.9049	0.7933

	Panel B: Product Market Fluidity		
	$R\&D_{t+1}$	$ln(Patent)_{t+4}$	$ln(Citations)_{t+4}$
Exog. EPU	-1.3297***	-0.2268***	-0.7633***
	[0.2291]	[0.0401]	[0.0810]
Competitive	0.0038	-0.0058	-0.0076
	[0.0974]	[0.0117]	[0.0241]
Exog. EPU×Competitive	-1.0968**	-0.3244***	-0.8559***
	[0.4706]	[0.0690]	[0.1332]
Controls	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	34,603	19,062	19,062
Adj. R^2	0.8381	0.9071	0.7975

Table 8:
External Finance Dependence

This table compares the influences of product market competition based on firms' dependence on external finance. Industry competition is measured based on Hoberg and Phillips (2016) product market fluidity measure. *Competitive* is an indicator equal to one if the product market fluidity is above the median and zero otherwise. Panel A (Panel B) reports the results for firms depending more on external (internal) finance. Industries with internal cash flows lower (higher) than their investments are considered external finance dependence (internal finance dependence). We control for *Size*, *PPE*, *CF*, *ROA*, *Tobin's Q*, *Leverage*, *GDP Growth*, *EcoUnc*, *MktUnc*, *Sent*, and firm fixed effects. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	Panel A: External Finance Dependence		
	$R\&D_{t+1}$	$ln(Patent)_{t+4}$	$ln(Citations)_{t+4}$
Exog. EPU	-1.9447***	-0.3005***	-0.9724***
	[0.3360]	[0.0539]	[0.1088]
Competitive	-0.0072	-0.0139	-0.0207
	[0.1141]	[0.0131]	[0.0271]
Exog. EPU×Competitive	-0.9506*	-0.2996***	-0.8055***
	[0.5594]	[0.0811]	[0.1547]
Controls	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	27,118	14,779	14,779
Adj. R^2	0.8271	0.9080	0.7989

	Panel B: Internal Finance Dependence		
	$R\&D_{t+1}$	$ln(Patent)_{t+4}$	$ln(Citations)_{t+4}$
Exog. EPU	-0.0959	-0.1014	-0.4965***
	[0.0836]	[0.0618]	[0.1174]
Competitive	0.1071*	0.0359	0.0356
	[0.0576]	[0.0238]	[0.0407]
Exog. EPU×Competitive	-0.6007	-0.1153	0.0665
	[0.5151]	[0.1284]	[0.2703]
Controls	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
N	7,485	4,283	4,283
Adj. R^2	0.8746	0.8905	0.7686

Table 9:
Robustness Checks

This table reports the impact of electoral uncertainty or economic policy uncertainty on innovation while controlling for overall economic conditions and/or investment opportunities. In Panel A, we estimate the baseline model using political polarization as an instrument. In Panel B, *Congressional election* is an indicator variable that equals one if the absolute difference in the percentage of votes between Democrats and Republicans is less than 5% and zero otherwise. In addition to the control variables in the baseline regressions, election cycle indicator variables are included to control for the fact that Congressional elections occur in even-number years. In Panel C, *Presidential election* is a dummy variable that is one for close presidential elections and zero otherwise. The control variables and election cycle indicators are included in the estimation. We estimate the model using firm fixed effects with standard errors clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	Panel A: Instrumental Variable Approach		
	$R\&D_{t+1}$	$ln(Patent)_{t+4}$	$ln(Citations)_{t+4}$
Exog. EPU	-2.3813***	-0.1913***	-0.6230***
	[0.5650]	[0.0619]	[0.1585]
N	77,726	52,394	52,394

	Panel B: Close Congressional Elections		
	$R\&D_{t+1}$	$ln(Patent)_{t+4}$	$ln(Citations)_{t+4}$
Congressional Election	-0.1300***	-0.0129***	-0.0723***
	[0.0352]	[0.0038]	[0.0087]
N	77,726	52,394	52,394
Adj. R^2	0.8106	0.8565	0.7702

	Panel C: Close Presidential Elections		
	$R\&D_{t+1}$	$ln(Patent)_{t+4}$	$ln(Citations)_{t+4}$
Presidential Election	-0.4889***	-0.1007***	-0.4310***
	[0.0746]	[0.0098]	[0.0193]
N	77,726	52,394	52,394
Adj. R^2	0.8070	0.8720	0.7874

Table 10:
Alternative Measures of the Cost of Capital

This table presents the estimation results of the impact of GEPU on the firm-level cost of capital using the alternative measures of the cost of capital. We regress the cost of equity (specifications (1)–(3)), cost of debt (specification (4)), and WACC (specification (5)) on the policy uncertainty index. We control for firm-fixed effects and factors that affects firms' cost of capital. The cost of equity is estimated using the Gode and Mohanram (2003) (GM), Easton (2004) (PEG), and Claus and Thomas (2001) models. The Claus and Thomas (2001) is estimated using EPS forecasted from the Li and Mohanram (2014) residual income model (RI). See Online Appendix for the details on computing the CoE. CoD is estimated using (synthetic) crediting ratings and BofA Merrill Lynch US Corporate Effective Yields for different rating categories during the period 1997–2007. The cost of capital is the WACC with market leverage at the beginning of the fiscal year as the weight for the cost of equity (GM) and the cost of debt. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	(1)	(2)	(3)	(4)	(5)
	GM	PEG	RI	CoD	WACC
Exog. EPU	1.4677***	1.3303***	1.9597***	3.0898***	0.8839***
	[0.1441]	[0.1668]	[0.1785]	[0.1889]	[0.1896]
Controls	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
N	32,356	32,339	37,009	39,242	17,091
Adj. R^2	0.4579	0.5032	0.5156	0.5178	0.4260