Bank Lending Under Policy Uncertainty: Theory and Cross-Country Evidence *

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This draft: September28, 2018

Abstract

This paper provides comprehensive theoretical and empirical analyses on bank lending under uncertainty. Our theory differentiates uncertainty from risk and shows that uncertainty-averse banks demand a premium in loan contracting for their exposure to the uncertainty. This premium gets larger as the uncertainty soars. To test our theoretical prediction, we construct a cross-country sample of syndicated loan contracts in 19 major economies over 2000-2015 and proxy the uncertainty with the Economic Policy Uncertainty Index for the same objects and time span. Evidence confirms our theory: A positive relationship between loan spreads and the level of uncertainty is identified. The result is collaborated by an IV estimation with the inverse distance weighted EPU as an instrument.

*Corresponding author: Weixing Wu,School of Banking and Finance, University of International Business and Economics, Beijing 100029, China, wxwu@uibe.edu.cn.We thank Zhen Yan for excellent research assistance. We are grateful to Xi Dong (discussant), John Duca, Chunbo Liu, Kebin Ma, Lin Peng, Jason Smith, Juan Yao (discussant), Nan Zhou, and participants at the 2017 Cross Country Perspectives in Finance Conference, 2017 UIBE finance workshop and IFABS Asian conference for valuable comments and suggestions. This research has been supported by the National Natural Science Foundation of China (No.71803022, No.71803024), the National Social Science Foundation of China (No.16ZDA033). The views and interpretations expressed herein are those of the authors and should not be attributed to the Peoples Bank of China.

Keywords: Uncertainty, Uncertainty- averse, Loan Pricing, Uncertainty Premium
JEL Classification: G15, G21

1 Introduction

Does uncertainty at the macro level affect banks micro behavior of loan contracting? Existing literature suggests that uncertainty about monetary, tax, regulatory or government expenditure policies can affect agents microeconomic decisions. For instance, Rodrik (1991) shows that firms withhold their investments when there is uncertainty about the permanence of policy reforms in developing countries. Bloom (2009) derives a simulated result suggesting that higher uncertainty causes firms to temporarily pause their investment and hiring. Baker et al. (2016) develop an index of economic policy uncertainty (EPU) and further confirms Bloom (2009)s result. There are also studies conc erning macro policies impact on stock prices and stock return (Pastor and Veronesi, 2012, 2013; Ulrich, 2012; Brogaard and Detzel, 2015). In particular, Pastor and Veronesi (2013) develop a general equilibrium model of both government policy choice and stock prices respond to political news and shows that political uncertainty commands a risk premium whose magnitude is larger in weaker economic conditions. There are also papers predict policy uncertainty raises financial intermediation costs channeled by the depressed investor demand (Gungoraydinoglu et al., 2017), and increases corporates debt financing costs (Gao and Qi, 2013; Waisman et al., 2015). Although our understanding of how uncertainty can forge economic agents decisions has been continuously improved, there are still both theoretical and empirical gaps between macro-level uncertainty and banks lending behavior in the micro-level.

In this paper, our goal is to fill these gaps. First, we consider the distinction between (macro) uncertainty and (aggregate) risk in bank lending to be crucial. To fix the idea, we first present a simple model where banks optimize loan rates under uncertainty. In our model, there are multiple possible future states of nature, which affect the borrowing firms project return. When contracting occurs, neither banks nor firms observe the true state, yet there is an informative public signal can be contracted on. We further introduce Knightian uncertainty (Knight, 1921) to the informativeness of the signal. As a result, economic agents in our model do not have a single prior on the distribution of firms project return, which is in contrast to the case of risk where agents know the probability distribution of project return with certainty. In addition, as suggested by Keynes (1921) and Ellsberg (1961), we model agents aversion to uncertainty a la the classic minimum expected utility (MEU) approach proposed by Gilboa and Schmeidler (1989). We study banks loan contracting with firms in this framework. Uncertainty-averse banks will charge a premium for the presence of the uncertainty.[1] We show that this premium gets larger as uncertainty increases.

We take one step further than the pure theory to empirically test the existence of the aforementioned uncertainty premium in loan pricing and its relationship with uncertainty. For the firm-level bank loan contracts, we collect a cross-country sample of over 16,000 syndicated loans originated between the year 2000 and 2015 from Thomson Reuters LPC Dealscan. For the macro-level uncertainty, we employ a news-based, monthly index of policy-related economic uncertainty (henceforth, EPU) from Baker et al. (2016). This dataset has been widely used in the literature given its distinct coverage in the cross-country setting and long time-series dating back to decades ago.

The empirical test with EPU as uncertainty measure suggests a positive and significant relationship between macro-level policy-related uncertainty and loan spreads, controlling for a large set of loan, firm and macroeconomic covariates, and various fixed effects. We further confirm that the impact of uncertainty on loan pricing is economically sizable as a one standard deviation increase in uncertainty may raise the cost of borrowing by 12basis points, ceteris paribus. The empirical findings confirm our theoretical predictions of the uncertainty premium and its positive relationship with the macro uncertainty. Our results are robust to weighted OLS and a subsample removing loans extended to US firms to correct for the over-representation of US borrowers.

In our empirical tests with EPU, we carefully deal with the endogeneity issue. Reverse causality is unlikely to bias our results for three reasons. First, we use lagged EPU prior to the loan start date. Second, EPU is less likely to be affected by the news in the syndicated loan market, which is not as informationally transparent as stock or bond market (Dennis and Mullineaux, 2000). Third, a firm-level lending contract is less likely to drive nation-wide economic policy uncertainty. Nevertheless, we run regressions that remove large borrowers (or large deals) in each country to address the concern that announcement of

[1] Throughout the paper, we use the term uncertainty aversion and ambiguity aversion interchangeably.

syndicated loans to large firms and subsequent media coverage may impact EPU. On the other hand, we control for additional macroeconomic variables, such as domestic credit to private sector/GDP, total values of stocked traded/GDP, political stability, and rule of law, to correct for the plausible omitted variable bias. Last but not least, to address the remaining concern that country-level unobserved shocks could drive both a nations EPU and its loan pricing, we design a novel IV regression by instrumenting the countrys EPU with the inverse distance weighted average EPU of the rest of the sample countries. Our empirical results are not altered in relation to all of these concerns.

Our research is related to three strands of literature. First, to the best of our knowledge, our paper is the first attempt that theoretically examines how uncertainty shapes uncertainty-averse banks loan contracts and empirically tests the prediction of uncertainty premium that increases in the level of uncertainty.[2] In a banking context, our paper is most related to Gissler et al. (2016) where the authors also assume uncertainty-averse banks and find that regulatory uncertainty curbs US mortgage lending at the bank level. In comparison, our main focus is to study uncertainty-averse banks optimal loan contracting under uncertainty. Yet, our empirical analyses suggest banks charge higher loan rates when uncertainty increases, also confirming their result that uncertainty is adverse to bank lending.[3]

Second, our paper sheds light to the economic consequences of macro-level uncertainty on economic agents micro decisions and behaviors in a cross-country setting. Since the seminal work by Baker et al. (2016), a fast-growing body of literature studies the impact of EPU on international trade (Handley and Limo, 2017), mergers and acquisitions (Bonaime et al., 2017), credit growth (Bordo, Duca and Koch, 2016), stock returns (Pastor and Veronesi, 2012; Brogaard and Detzel, 2012), asset price volatility (Ulrich, 2012), risk spillovers (Colombo, 2013; Bernal, Gnabo and Guilmin, 2016), and CDS spreads (Wisniewski and Lambe, 2015). However, little attention has been paid to the impact of economic policy uncertainty on debt contract. In contrast to Nodari (2014) and Jiang and

[2]Wong (2015) examines the optimal production decision of an uncertainty-averse firm when there is uncertainty about the firms product price. Differing from his paper, our focus is on how uncertainty affects banks loan pricing. Moreover, we derive our theoretical prediction in a widely used multiple-priors model. Our modeling approach is much simpler than his KMM approach.

[3]Besides banking, there is an extant literature in behavior finance studies uncertainty aversion (Gallant et al., 2015; Gneezy et al., 2015), and its implication in asset pricing (Epstein and Schneider, 2008; Drechsler, 2013; Asparouhova et al., 2015). In particular, several papers, such as Hirshleifer (2001), Erba and Mirakhor (2007) and Ju and Miao (2012) consider uncertainty aversion as an important factor to explain the equity premium puzzle.

Tong (2016) which investigate how disaggregated (financial regulation policy uncertainty and monetary policy uncertainty) affect bond spreads in the US, respectively; we are interested in the impact of aggregate economic policy uncertainty on syndicated loans. Unlike Francis et al. (2014) which examines how political uncertainty influences a firms cost of bank loans in the US, we focus on the international syndicated lending and exploit both time-series and cross-country variations of economic policy uncertainty. More importantly, none of the prior studies ever mentioned the channel of ambiguity aversion.

Finally, unlike most studies that treat EPU as a measure of risk, we interpret economic policy uncertainty as Knightian uncertainty of economic policies, or more precisely, banks are uncertain about the informativeness of the signal of the future states.

The rest of the paper is organized as follows. Section 2 presents a theory of loan pricing under uncertainty. Section 3 presents methodology, data and summary statistics. Section 4 shows the baseline results and robustness checks. Section 5concludes.

2 Model

[OK] We consider a four-date (t=0,1,2,3) economy with three types of risk neutral agents, a continuum of measure 1 homogenous firms, a government and many banks. Each firm and each bank maximizes their respective utility functions and are protected by limited liability, while the government maximizes a social welfare function, which we define in details later. The risk free rate is normalized to be zero.

2.1 Firms and Investment Project

A representative firm starts out with cash assets A and has access to a variable-size project opportunity at $t = 0$. To expand the project size I beyond the level A, the firm needs to borrow the rest amount $I - A$ from a bank. On the other hand, each firm's project delivers either a verifiable financial return RI if the project succeeds or 0 if the project fails at $t = 3$. We assume the project is subject to the classic Holmstrom and Tirole approach of moral hazard, that is, each firm can behave (choose a high project success probability q_H) or shirk (choose a low project success probability $q_L > 0$ but earn a private benefit $BI > 0$) at $t = 2$. We also assume that $\Delta q = q_H - q_L > 0$. Besides the effort issue, a profit-friendly policy variable $\tau \in [0, \overline{\tau}]$ chosen by the government at $t = 1$ also affects the success probability of each firms project. In particular, each firms project success (or failure) probability is $q+\tau$ (or $1-q-\tau$) where $q \in \{q_H, q_L\}$ is each firms idiosyncratic choice and $\tau \in [0, \overline{\tau}]$ is the macro policy chosen by the government. We assume that $q_H + \overline{\tau} < 1$ to ensure an interior solution. In short, the profit-friendly policy improves the (unit) project performance.

2.2 Government and Policy Choice

The government makes the policy choice $\tau \in [0, \overline{\tau}]$ to maximize the social welfare at $t = 1$. For simplicity, we let the government have a utilitarian social welfare function that puts respective weights ω_f^T and ω_b^T on the firms and banks welfare,[4] where T denotes the governments type. Here we assume the government can be one of the two type, firm-friendly or bank-friendly, i.e., we let "$T = ff$" denote the former and "$T = bf$" denote the latter. Also for simplicity reason, we let $\omega_{ff}^f = 1+\alpha > 1 = \omega_{ff}^b$ and $\omega_{bf}^f = 1 < 1+\alpha = \omega_{bf}^b$.[5] In other words, the government puts higher weight on her objective on a party when she is the more friendly type to it. We further assume that the type of the government reveals at the beginning of $t = 1$, and becomes common knowledge.[6] We assume the aforementioned profit-friendly policy that increases the loan performance also comes with a social cost. And its per unit loan social cost of the policy is $\gamma(\tau)I$, with $\gamma(0) = 0$, $\gamma(\overline{\tau}) = \infty$, $\gamma' > 0$ and $\gamma'' > 0$. We let this unit social cost be borne by the two parties, i.e., firms and banks with the respective shares σ_f and σ_b in the form of capital tax. That is, a party will pay tax $\sigma_i \gamma(\tau) I$, $i = b$ and f only if they enter into a financing agreement.[7] Note that the optimal

[4]Note that the banks in our model can be thought as contractual agreements among consumers as in Diamond and Dybvig (1983). As will be presented later, their objective is to optimize loan contracts to maximize their owners utility. As this result, the governments objective represents its usual form that maximizes the weighted sum of consumers utility and firms profits.

[5]Note that the superscripts can be either b or f denoting the respective weights on banks or firms, while the subscripts can be either bf or ff denoting the government is a bank-friendly type or a firm-friendly type.

[6]The assumptions about governments policy, type and objective function can have broader interpretations. One motivation could be from political economics. Once the politicians being in power, they consider the needs of their own political constituency of higher hierarchy $(1+\alpha)$ in their policy function than the other constituency (1). A second motivation could be it reflects the governments current economic/financial policy objective. For instance, the financial system of the economy could be on verge of collapse at the beginning of $t = 1$, so the government who worries about the consumer welfare losses due to the inability of liquidity provision and facilitation of payments would like to save those banks by bailing them out.

[7]Tirole (2010) also consider the case where government policy is financed through an income tax, and show that the form of taxation is inconsequential to the analysis. So we simply focus on the capital tax case.

policy rule must be state (government-type) dependent, we let τ_T^* where $T \in \{ff, bf\}$ be it.

2.3 Banks and Bank Loan Contracting

Banks design their loan contracts with firms at $t = 0$ anticipating the events that will occur at the consecutive dates. We assume for simplicity that banks compete with each other in loan rates, and must break even in the lending business. Follow Holmstrom and Tiroles notations, for a loan with initial size $I - A$, we label i as the net loan rate charged by its issuing bank. So this loan rate can be computed as $R_b I = (1+i)(I - A)$, where R_b is the unit repayment to the bank and I is the project size. On the hand, the firms residual return is $R_f I = RI - R_b I$. At $t = 0$, banks design loan contract (i^*, I^*), i.e., the optimal loan rate and loan size.

We further assume there is a binary public signal realizes before loan contracting commerce. The signal $s \in \{s_{ff}, s_{bf}\}$ conveys information about the governments type at $t = 1$. We let

$$Pr(T = ff|s = s_{ff}) = Pr(T = bf|s = s_{bf}) = \frac{1+\mu}{2} \tag{1}$$

Here, $\mu \in (0, 1)$ naturally measures the informativeness of the signal, i.e., the signal has no information content when $\mu = 0$ and it perfectly predicts the governments future type when $\mu = 1$. For short, we denote those probabilities as $Pr(T|s)$, where $T \in \{ff, bf\}$ and $s \in \{s_{ff}, s_{bf}\}$. Note that agents observe the realization of signal s at the beginning of $t = 1$. So those probabilities can be seen as agents priors for the governments type even if they are Bayesian posterior probabilities based on the realization being s_{ff} or s_{bf}. And agents prior beliefs about the governments type can be denoted by the probability distribution $p_s = (Pr(T|s), 1 - Pr(T|s)) \in \Delta(\Omega)$ when they receiving signal s.

2.4 Uncertainty and Uncertainty Aversion

To analyze uncertainty and uncertainty aversion, we follow the approach pioneered by Gilboa and Schmeidler (1989) and assume agents have "Maxmin' Expected Utility" (MEU) instead of SEU. Each MEU agent now chooses an action a to maximize

$$U^M(a) = \min_{p \in C} \int_{\Omega} u(a) dp.^8 \tag{2}$$

Here Ω is the state space, which is a set including all relevant future contingencies or states. We denote $\sigma(\Omega)$ to be the σ-algebra on space Ω and define probability measure as $p : \sigma(\Omega) \to [0, 1]$ such that $p(\Omega) = 1$. We further let $\Delta(\Omega)$ to be set of probability measures on Ω, then set $C \subset \Delta(\Omega)$ characterizes the agents prior beliefs (probability measures) about the state Ω. The agent chooses an action a, which is a lottery over C. u is the vNM utility function defined on the outcomes of the lottery.[9][10] To be consistent with our model, we focus mainly on the low dimensional representation of the above definitions. We also impose an assumption that all agents hold a homogeneous uncertain prior belief. We will make a full characterization of MEU agents prior belief set C in our model in the following section. And it will be seen that only banks uncertain priors are relevant in determining the optimal loan rate and loan size.

Lastly, we impose the usual parameter assumption as

$$(q_H R - 1)I > 0 > [(q_L + \overline{\tau})R - 1 + B]I \tag{3}$$

This assumption is common, and means only the "good" contract is economically viable even if there is no profit-friendly policy, while the "bad" contract produces a non-viable outcome even if the government applies a most profit-friendly policy and does not pass its cost to the society.

2.5 Timing

The timing of the model is summarized in Figure 1. Events at $t = 1$ take place sequentially.

[9]Note that in the subjective expected utility framework, C is just a singleton. It degenerates to p, the agents unique prior in the above functional form. An agent who maximizes his/her subjective expected utility simply chooses action $a : \Omega \to \Delta(C)$ to maximize $U^S(a) = \int_\Omega u(a)dp$.

[10]An example from Epstein and Schneider facilitates our understanding could be: Denote $\Omega = \{R, B\}$, where $R(B)$ corresponds to a draw from a urn is the red (black) ball. $\Delta(\Omega)$ then contains all probability measures over Ω. C, for instance, could be $C = \{\frac{1}{3}, \frac{2}{3}\}$, meaning the draw is a red (black) ball with probability $\frac{1}{3}(\frac{2}{3})$. An action a could be a bet, say "the ball drawn from the urn is red". Then it corresponds to the lottery $\{1, 0\}$. Then u could be, for instance, the monetary utility over the outcome, say if the bet is right, the agent gets 100, otherwise he gets 0. In this example, the agents subjective expected utility of action a is: $\frac{1}{3} * 100 + \frac{2}{3} * 0 = \frac{100}{3}$.

Figure 1: Timing of the model

t = 0	t = 1	t = 2	t = 3
1.Public signal $s \in \{s_{ff}, s_{bf}\}$ realizes. 2.Banks design the optimal loan contract (i^*, I^*).	1. The government's type $T \in \{ff, bf\}$ reveals to the public. 2. The government chooses the optimal policy rule τ^*.	Firms made their effort decision $q \in \{q_H, q_L\}$.	Each loan pays off, claims are settled.

2.6 Model solution

2.6.1 Moral hazard

We solve the model backwards starting by firms moral hazard choice first. We consider a representative firm. Given an optimal loan size I^* and a policy rule τ_T^* chosen by the government, the firms expected profit when it chooses to behave is

$$[(q_H + \tau_T^*)R_f - \sigma_f \gamma(\tau_T^*)]\, I^*. \tag{4}$$

Note that the first term $(q_H + \tau_T^*)R_f I^*$ is the expected return of the firm, while the second term $\sigma_f \gamma(\tau_T^*) I^*$ is the capital tax levied. On the other hand, its expected profit when choosing to misbehave is

$$[(q_L + \tau_T^*)R_f + B - \sigma_f \gamma(\tau_T^*)]\, I^*. \tag{5}$$

Then the firm behaves if and only if his residual return in case of success $R_f I^*$ is large enough to resist the entice of private benefit if he misbehaves. So we have the usual incentive compatibility (IC) constraint:

$$(q_H + \tau_T^*)R_f - \sigma_f \gamma(\tau_T^*) \geq (q_L + \tau_T^*)R_f + B - \sigma_f \gamma(\tau_T^*) \tag{6}$$

It can be turned into its usual parsimonious form

$$(q_H - q_L)R_f \geq B \Leftrightarrow R_f \geq \frac{B}{\Delta q}. \tag{7}$$

To induce the firm to behave, its unit return must be sufficiently high to overcome its private benefit from misbehaving. Notice that the IC constraintis actually state-independent. This is due to the fact that the severity of firms moral hazard problem does not depend on the governments type T and its corresponding policy rule.

2.6.2 Optimal state-dependent policy rule

We then move to $t = 1$ to solve the governments optimal policy choice. After its type T being revealed, the government considers the ex-post utility functions of banks and firms as follows

$$U_f = u_f(\tau)I^* = [(q_H + \tau)R_f - \sigma_f \gamma(\tau)]I^* \tag{8}$$

and

$$U_b = u_b(\tau)I^* = [(q_H + \tau)R_b - \sigma_b \gamma(\tau)]I^* \tag{9}$$

Note that the government anticipates the firm will be induced to behave at $t = 2$ and also takes the contract (R_b, R_f, I^*) being optimally chosen by banks at $t = 0$. A type $T \in \{ff, bf\}$ government then assigns weights ω_T^f and ω_T^b on the respective utility U_f and U_b. Its objective function can be expressed as follows.

$$W(\tau) = \{\omega_T^f u_f + \omega_T^b u_b\}I^* \tag{10}$$

Then the optimal policy rule τ solves $\frac{dW(\tau)}{d\tau} = 0$, and is given by the following first order condition.

$$\gamma'(\tau_T^*) = \frac{\omega_T^f R_f + \omega_T^b R_b}{\omega_T^f \sigma_f + \omega_T^b \sigma_b} \tag{11}$$

Note that we can check easily that the second order condition is satisfied.

When the governments type $T = ff$, we have $\omega_{ff}^f = 1 + \alpha > 1 = \omega_{ff}^b$. So the first order condition can be further modified to

$$\gamma'(\tau_{ff}^*) = \frac{R + \alpha R_f}{1 + \alpha \sigma_f} \tag{12}$$

Note that we use $R_f + R_b = R$ and $\sigma_f + \sigma_b = 1$ in the above derivative. By the same token, the first order condition when $T = bf$ can be expressed as follows.

$$\gamma'(\tau^*_{bf}) = \frac{R + \alpha R_b}{1 + \alpha \sigma_b} \tag{13}$$

We will focus on interior solutions $\tau^*_T \in [0, \overline{\tau}]$, for both $T = ff$ and $T = bf$. We also restrict our attention to the interesting case where $\tau^*_{ff} \neq \tau^*_{bf}$. The following Lemma 1 then summarizes above discussion, make a comparison between τ^*_{ff} and τ^*_{bf}, and characterizes a necessary condition for interior solutions.

Lemma 1 *When the government is a firm-friendly type $T = ff$ (or a bank-friendly type $T = bf$), its optimal policy rule τ^*_{ff} (or τ^*_{bf}) is determined in equation (1) (or equation (2)). When $\frac{R_f}{\sigma_f} > \frac{R_b}{\sigma_b}$, we must have $\tau^*_{ff} > \tau^*_{bf}$, and a necessary condition for interior solutions is $\frac{R_f}{\sigma_f} > \gamma'(\tau^*_{ff}) > \gamma'(\tau^*_{bf}) > \frac{R_b}{\sigma_b}$. On the other hand,when $\frac{R_f}{\sigma_f} < \frac{R_b}{\sigma_b}$, we must have $\tau^*_{ff} < \tau^*_{bf}$, and the necessary condition for interior solutions is $\frac{R_f}{\sigma_f} < \gamma'(\tau^*_{ff}) < \gamma'(\tau^*_{bf}) < \frac{R_b}{\sigma_b}$*

Proof: See Appendix

A direct consequence of Lemma 1 will be $u_f(\tau^*_{ff}) > u_f(\tau^*_{bf})$ and $u_b(\tau^*_{bf}) > u_b(\tau^*_{ff})$ irrespective of how the gross return R and the social cost of policy are distributed between the firm and the bank. From Lemma 1, when $\frac{R_f}{\sigma_f} > \frac{R_b}{\sigma_b}$, we have $u'_f(\tau^*_{ff}) > 0$. And for all $\tau \in [0, \tau^*_{ff}]$, we must have $u'_f(\tau) > 0$, i.e., $u'_f(\tau)$ is increasing when $\tau \in [0, \tau^*_{ff}]$. In particular, we showed $\tau^*_{ff} > \tau^*_{bf}$ in this case, so $u_f(\tau^*_{ff}) > u_f(\tau^*_{bf})$ naturally holds. On the other hand, when $\frac{R_f}{\sigma_f} < \frac{R_b}{\sigma_b}$, we have $u'_f(\tau^*_{ff}) < 0$. Thus for all $\tau \in [\tau^*_{ff}, \overline{\tau}]$, we have $u'_f(\tau) < 0$, i.e., $u'_f(\tau) < 0$ is decreasing when $\tau \in [\tau^*_{ff}, \overline{\tau}]$. In particular, we showed $\tau^*_{ff} < \tau^*_{bf} < \overline{\tau}$ in this case, so $u_f(\tau^*_{ff}) > u_f(\tau^*_{bf})$ also holds. One can show that the argument is true for u_b as well. Intuitively, the bank-friendly type (or the firm-friendly type) government will choose a policy τ^*_{bf} (or τ^*_{ff}) that is more favorable to the bank (or the firm) because it assigns a higher weight $(1 - \alpha)$ on the bank (or the firm).

2.6.3 Full Characterization of Prior Belief Set and Objective

Lastly, we consider uncertainty-averse banks optimal loan contracting problem at $t = 0$.Banks design their loan contracts anticipating the governments state-dependent optimal policy choices and the firms moral hazard problem.

We first make a full characterization of uncertainty-averse agents optimization program and their belief set C. Epstein and Schneider (2010) propose two prominent characterizations for MEU agents set of priors C. We apply one of their notion of $\epsilon-contamination$ to construct the prior belief set in our model. Note that the set of future state is $\Omega = \{ff, bf\}$ in our model, i.e., the government being firm-friendly or bank-friendly. For a probability distribution $p_s \in P \subset \Delta(\Omega)$, its $\epsilon - contamination$ is defined as $(1-\epsilon)p_s^* + \epsilon p_s$. In this definition, p_s^* is a reference probability distribution also belonging to the set of possible probability distributions P, and ϵ is a parameter in the unit interval.[11] Note that a larger ϵ means more weight is given to the alternative probability distribution p_s^*. Then the agents prior beliefs set C can be expressed as:

$$C = \{(1-\epsilon)p_s^* + \epsilon p_s : p_s \in P\}. \tag{14}$$

Be specific to our model, p_s is agents prior beliefs about the governments type at $t = 0$ when they observe the signal s. A natural interpretation of reference probability distribution p_s^* is that it represents the agents unique pair of priors as if there were no uncertainty on it, or equivalently there were no uncertainty on the informativeness of the signal s. In this case, agents treat μ as a certain value $\mu^* \in (0,1)$. Based on the realized signal, they form a unique pair of priors about the future state. That is

$$Pr(T = ff|s = s_{ff}) = Pr(T = bf|s = s_{bf}) = \frac{1+\mu^*}{2}. \tag{15}$$

When the state $\Omega = \{ff, bf\}$, the reference prior probability distribution is $p^*_{s_{ff}} = (\frac{1+\mu^*}{2}, \frac{1-\mu^*}{2})$ when $s = s_{ff}$ and $p^*_{s_{bf}} = (\frac{1-\mu^*}{2}, \frac{1+\mu^*}{2})$

for this reference probability distribution.

Follow Dicks and Fulghieri (2018), we formally model uncertainty as the agents are uncertain about the true value of μ and assess it has the support $\mu \in [\mu^* - \delta, \mu^* + \delta] \subseteq (0,1)$.[12] A direct consequence is they have uncertain priors about state as well. For simplicity, we let $\underline{\mu} = \mu^* - \delta$ and $\overline{\mu} = \mu^* + \delta$ and express the aforementioned set as $[\underline{\mu}, \overline{\mu}]$. We then calculate the respective probability distributions $\overline{p}_s$ and $\underline{p}_s$.[13] We further define

[11] This definition of $\epsilon - contamination$ of probability measures has been extensively used in robust statistics. And Epstein and Wang (1994) also apply it to finance.

[12] Note that agents belief that $\mu \neq [0,1]$ can not be rationalized.

[13] When the economy starts with s_{ff}, $\overline{p}_{s_{ff}} = (\frac{1+\mu^*+\delta}{2}, \frac{1-\mu^*-\delta}{2})$ and $\underline{p}_{s_{ff}} = (\frac{1+\mu^*-\delta}{2}, \frac{1-\mu^*+\delta}{2})$, while the economy starts with s_{bf}, $\overline{p}_{s_{bf}} = (\frac{1-\mu^*-\delta}{2}, \frac{1+\mu^*+\delta}{2})$ and $\underline{p}_{s_{bf}} = (\frac{1-\mu^*+\delta}{2}, \frac{1+\mu^*-\delta}{2})$.

the probability set $\mathbf{P}_s$ to be

$$\mathbf{P}_s \stackrel{\text{def}}{=} \{\lambda \overline{p}_s + (1-\lambda)\underline{p}_s | 0 \leq \lambda \leq 1\} \tag{16}$$

Namely, $\mathbf{P}_s$ is the 1-simplex with $\overline{p}_s$ and $\underline{p}_s$ as its vertices. Note that it the convex hull, i.e., the smallest convex set containing $\overline{p}_s$ and $\underline{p}_s$. Further notice that [14]

Given the $\epsilon - \textit{contamination}$ of agents belief set characterized, the agents MEU in our model can be expressed as

$$U^M(a) = (1-\epsilon)\int_\Omega u(a)dp_s^* + \min_{p_s \in P_s} \int_\Omega u(a)dp_s \tag{17}$$

That is, an MEU agent maximizes a weighted average of its expected utility according to p_s^* and its "worst-case" expected utility when he/she believes the set of possible probability distribution to be P. Notice that MEU agents behave as if they have had extreme aversion, i.e., they always choose the worse-case scenario belief p_s about the states in the set of all logically possible priors $\mathbf{P}_s$.

Given the reference distribution p_s^*, the uncertainty-averse agents are not sure about the true probability distribution, instead they consider it could be one from the belief set C. Note that in the case of no uncertainty, $\mathbf{P}_s$ degenerates to a singleton. And not surprisingly, p_s^* would be the strongest candidate for the true distribution at this case. Intuitively, the extent of uncertainty could be characterized by the content/volume of the simplex, i.e., the Euclidean distance between $\overline{p}_s$ and $\underline{p}_s$.

$$\frac{1}{1!}|\overline{p}_s - \underline{p}_s| = \sqrt[2]{(\frac{1+\mu^*+\delta}{2} - \frac{1+\mu^*-\delta}{2})^2 + (\frac{1-\mu^*-\delta}{2} - \frac{1-\mu^*+\delta}{2})^2} = \sqrt{2}\delta \tag{18}$$

Consequently, δ naturally serves as a measure of uncertainty of agents prior distributions in our model.[15] Indeed, consider $\delta' > \delta$, both of which makes the probability distributions

[14] Note that we can also introduce uncertainty on the informativeness and the reference probability distribution as follows. Assume the agents are uncertain about μ, i.e., they assess it has the support $[\underline{\mu}, \overline{\mu}]$, then we let $\mu^* = \frac{\underline{\mu}+\overline{\mu}}{2}$. The rests are simply follows.

[15] Epstein and Schneider (2010) also discuss the role of ϵ, and consider it as a measure of agents uncertainty aversion. That is larger means agents are more uncertainty averse, thus they are more unsure about the 'correctness of p_s, thus they consider the alternative prior p_s^* being more relevant.

well defined. We have

$$|\overline{p}_s(\delta') - \underline{p}_s(\delta')| > |\overline{p}_s(\delta) - \underline{p}_s(\delta)| \tag{19}$$

And it also means that the prior sets $\mathbf{P}'_s \supset \mathbf{P}_s$.

Note that $\delta = 0$ corresponds to the case with no uncertainty, the 1-simplex degenerates to a 0-simplext containing only p^*_s. In this case, agents deem p^*_s as the sole prior as in the standard SEU models.

2.6.4 Optimal Loan Contracting of Uncertainty-averse Banks

We formally consider the optimal loan contracting between the representative bank and firm in our model. We will only discuss the case $s = s_{ff}$ in the main text and present the derivation for $s = s_{bf}$ in the appendix. Recall that the reference probability distribution is $p^*_{s_{ff}} = (\frac{1+\mu^*}{2}, \frac{1-\mu^*}{2})$ when $s = s_{ff}$.

In principal, the uncertainty aversion of both parties matter in the designing of the optimal contract. However, it should be pointed out that only the banks uncertainty aversion is relevant in our model setup. To see this, consider the representative firms (ex-ante) expected net utility

$$\begin{aligned} U_f^M &= (1-\epsilon)\{\frac{1+\mu^*}{2}u_f(\tau^*_{ff}) + \frac{1-\mu^*}{2}u_f(\tau^*_{bf})\}I \\ &+\epsilon \min_{p_{s_{ff}} \in P_{s_{ff}}} \{\frac{1+\mu}{2}u_f(\tau^*_{ff}) + \frac{1-\mu}{2}u_f(\tau^*_{bf})\}I - A \end{aligned} \tag{20}$$

Recall our definition that $u_f(\tau) = (q_H + \tau)R_f - \sigma_f \gamma(\tau)$. As we assume the government has a binary type at $t = 1$, the agentsexpectation degenerates to the above simple form. Note that the term inside the first parenthesis in the above equation can be understood as the unit expected net utility of the firm when its subjective prior is the reference distribution $p^*_{s_{ff}}$. On the other hand, the term inside the second parenthesis is the firms unit expected net utility when it has an uncertain belief about the prior distribution $p_{s_{ff}}$. Note that in our low dimensional parameterization, minimizing belief over the set of priors P actually equals to minimizing μ over the set $[\mu^* - \delta, \mu^* + \delta]$. We can also derive the representative banks (ex-ante) net utility

$$U_b^M = (1-\epsilon)\{\frac{1+\mu^*}{2}u_b(\tau_{ff}^*) + \frac{1-\mu^*}{2}u_b(\tau_{bf}^*)\}I$$
$$+\epsilon \min_{p_{s_{ff}} \in P_{s_{ff}}} \{\frac{1+\mu}{2}u_b(\tau_{ff}^*) + \frac{1-\mu}{2}u_b(\tau_{bf}^*)\}I - (I-A) \tag{21}$$

Recall also that $u_b(\tau) = (q_H + \tau)R_b - \sigma_b\gamma(\tau)$. Note that both banks and firms have the homogenous prior belief set. Recall that the risk free interest rate is normalized to 0, ex-ante competition among banks leads to the following break-even condition.

$$U_b^M = 0 \tag{22}$$

Consequently, inserting the break-even condition into the above firms net expect utility delivers the usual result that the firm extracts the entire expected NPV of the project as in Holmstrom and Tirole.

$$U_f^M = (1-\epsilon)\{\frac{1+\mu^*}{2}[(q_H + \tau_{ff}^*)R - \gamma(\tau_{ff}^*)]) + \frac{1-\mu^*}{2}[(q_H + \tau_{bf}^*)R - \gamma(\tau_{bf}^*)]\}I$$
$$+\epsilon \min_{p_{s_{ff}} \in P_{s_{ff}}} \{\frac{1+\mu}{2}[(q_H + \tau_{ff}^*)R - \gamma(\tau_{ff}^*)] + \frac{1-\mu}{2}[(q_H + \tau_{bf}^*)R - \gamma(\tau_{bf}^*)]\}I - I \tag{23}$$

Note that the result relies critically on first, the homogenous belief set assumption, and second, homogenous belief about the governments type across agents. Due to our assumption 1, the above expected NPV of the project is definitely positive. Then it is obvious that the firm is willing to enter into any loan contract such that it can secure a repayment $R_b \in [\frac{B}{\Delta q}, R]$. Its uncertainty aversion does not affect the optimal loan contracting.

To derive the optimal loan contract, a thorough analysis of the banks program is needed. Note that now uncertainty-averse banks loan contracting program can be expressed as follows.

$$\max_{(R_b, R_f, I)} U_b^M = \max_{(R_b, R_f, I)} (1-\epsilon)\{\frac{1+\mu^*}{2}u_b(\tau_{ff}^*) + \frac{1-\mu^*}{2}u_b(\tau_{bf}^*)\}I$$
$$+\epsilon \max_{(R_b, R_f, I)} \min_{p_{s_{ff}} \in P_{s_{ff}}} [\frac{1+\mu}{2}u_b(\tau_{ff}^*) + \frac{1-\mu}{2}u_b(\tau_{bf}^*)]I - (I-A) \tag{24}$$

We solve the program in two steps. First, we figure out the banks endogenous prior belief p_S on his prior belief set P for a given contact (R_b, R_f, I). Second, we determine the optimal contract (R_b^*, R_f^*, I^*).

Note that the bank endogenizes its prior belief by solving the following sub-program.

$$\min_{p_{s_{ff}}\in P_{s_{ff}}}\{\frac{1+\mu}{2}u_b(\tau^*_{ff})+\frac{1-\mu}{2}u_b(\tau^*_{bf})\}I \tag{25}$$

The following Lemma 2 characterizes the solution.

Lemma2 *After a signal s_{ff} being received at the beginning of $t=0$, the banks endogenous prior belief about the governments type at $t=1$ is:*

$$p_{s_{ff}}=\overline{p}_{s_{ff}}=(\frac{1+\mu^*+\delta}{2},\frac{1-\mu^*-\delta}{2}) \tag{26}$$

Proof: See Appendix

Intuitively, when the economy starts with a signal s_{ff}, the agents believe it is more likely the government to be $T=ff$. The only question is they are uncertain about "how exactly likely" the event will be, i.e., their prior belief about the event $T=ff$ takes a value in the set $\mathbf{P}_{s_{ff}}$ described above. The MEU approach then prescribes a way that uncertainty-averse agents determine their prior beliefs over this belief set $\mathbf{P}_{s_{ff}}$. That is, they always choose a worst-case scenario belief. In our model, the banks future expected utility is lower when $T=ff$, as the firm-friendly government chooses a policy rule τ_{ff}, that is less favorable to the bank. So the uncertainty-averse bank tends to believe the signal s_{ff} is most informative, i.e., it is most likely the future will be in the adverse case. Their endogenous prior distribution becomes $\overline{p}_{s_{ff}}$.

After characterizing the endogenous belief of the bank, we then move to the second step to determine the optimal loan contract. Note that the banks objective turns into the usual form a la Holmstrom and Tirole.

$$\begin{aligned}\max_{(R_b,R_f,I)}U_b^M&=\max_{(R_b,R_f,I)}(1-\epsilon)\{\frac{1+\mu^*}{2}u_b(\tau^*_{ff})+\frac{1-\mu^*}{2}u_b(\tau^*_{bf})\}I\\ &+\epsilon\max_{(R_b,R_f,I)}\{\frac{1+\mu^*+\delta}{2}u_b(\tau^*_{ff})+\frac{1-\mu^*-\delta}{2}u_b(\tau^*_{bf})\}I-(I-A)\end{aligned} \tag{27}$$

Note that in this expression, $u_b(\tau)$ is linear and increasing in R_b, and our parametric assumption guarantees the net return $u_b(\tau)-1$ is positive. So following the standard procedure in Holmstrom and Tirole (1997), we have the bank will maximize R_b by just giving the firm $R_f = \frac{B}{\Delta q}$ to satisfy the latters IC constraint for behaving. We then have

$$u^*_{b,T} = (q_H + \tau^*_T)(R - \frac{B}{\Delta q}) - \sigma_b \gamma(\tau^*_T), \tag{28}$$

where $\tau^*_T = \tau^*_{ff}$ or τ_{bf} in the optimal solution. So the banks net expected utility turns into

$$U^M_b = \{\frac{1 + \mu^* + \epsilon\delta}{2} u^*_{b,ff} + \frac{1 - \mu^* - \epsilon\delta}{2} u^*_{b,bf}\} I^* - (I^* - A) \tag{29}$$

And the ex-ante competition among banks leads to $U^M_b = 0$, which results the loan size as

$$I^* = \frac{A}{1 - \{\frac{1+\mu^*+\epsilon\delta}{2} u^*_{b,ff} + \frac{1-\mu^*-\epsilon\delta}{2} u^*_{b,bf}\}} = \kappa(\delta) A \tag{30}$$

Note that in this expression, $\kappa(\delta)$ is not a function of A. And the optimal loan size can be further expressed as

$$I^* - A = [\kappa(\delta) - 1]A \tag{31}$$

Recall that we obtain the traditional result a la Homlstrom and Tirole type of model, optimal loan size is equal to the firms own stake A times a multiplier $\kappa(\delta) - 1 > 0$. Of course, the multiplier $\kappa(\delta)$ is a function of the uncertainty δ.[16] Moreover, the net loan rate i^* is given in the following equation

$$i^* = \frac{I^*}{I^* - A}(R - \frac{B}{\Delta q}) - 1 = \frac{\kappa(\delta)}{\kappa(\delta) - 1}(R - \frac{B}{\Delta q}) - 1 \tag{32}$$

We summarize the above discussion and describe the full optimal characterization of our model in the following Proposition 1.

Proposition 1 *The optimal loan contract under uncertainty when the economy starts with $s = s_{ff}$ is given by (i^*, I^*). Under this optimal contract, the bank gets a unit repayment $R_b = R - \frac{B}{\Delta q}$ and earns an ex-ante zero expected utility, while the firm gets a repayment $R_f = \frac{B}{\Delta q}$ and earns the entire NPV of the project. The governments optimal policies are determined by equation (1) and (2) with (R_b, R_f) being inserted. The magnitude between τ^*_{ff} and τ^*_{bf} dependson the relative strength the return R and the private benefit B .*

Lastly, we are interested in how uncertainty affects the optimal loan contract. As

[16]Note that $\kappa(\delta)$ is also a function of the banks uncertainty aversion ϵ, the optimal policy choices, the social costs and the social burden borne by each party. We focus only on uncertainty as it is our sole and main target in the following empirical tests.

pointed out in the previous section, the change of uncertainty in the model can be parameterized by the variation of δ. A larger δ means that agents are more uncertain about the future state, i.e., the prior set $\mathbf{P}$ expands as δ becomes larger. We then have the following comparative static results.

Corollary 1 *When the uncertainty in the economy soars, i.e., δ becomes larger. We have the optimal loan rate increases $\frac{di^*}{d\delta} > 0$, andthe optimal loan size decreases $\frac{dI^*}{d\delta} < 0$.*

To see the comparative static result, it can be seen easily that $\kappa(\delta)$ is positively related to I^*, however affects inversely on i^*. Lets take a close look at $\kappa(\delta)$ and express it as the following.

$$\kappa(\delta) = \frac{1}{1 - \{\frac{1+\mu^*}{2}u^*_{b,ff} + \frac{1-\mu^*}{2}u^*_{b,bf}\} + \frac{\epsilon\delta}{2}\{u^*_{b,bf} - u^*_{b,ff}\}} \tag{33}$$

As we have already pointed out in Lemma 1, $u^*_{b,bf} - u^*_{b,ff} > 0$. So δ inversely affects the optimal loan size and positively affects the optimal loan rate. It can be checked that in our model, for $\delta' > \delta$, we indeed have $\mathbf{P'} \supset \mathbf{P}$, and $\min_{p_s \in P} \frac{1+\mu}{2}u_b(\tau^*_{ff}) + \frac{1-\mu}{2}u_b(\tau^*_{bf}) < \min_{p_s \in P'} \frac{1+\mu}{2}u_b(\tau^*_{ff}) + \frac{1-\mu}{2}u_b(\tau^*_{bf})$. Intuitively, given the agents attitude to uncertainty, i.e., fixing their aversion to uncertainty , an increase in δ means the worse-case scenario gets even worse. So the multiplier $\kappa(\delta)$ decreases as δ gets larger. Accordingly, the bank reduces the loan size and increases the required rate of return on loan to break even.

Note that one can follow the same procedure to derive the optimal loan contract and comparative statics when the economy starts with $s = s_{bf}$. In particular, one can show that the banks endogenous belief entails $p_{s_{bf}} = \underline{p}_{s_{bf}} = (\frac{1-\mu^*+\delta}{2}, \frac{1+\mu^*-\delta}{2})$. Same intuition applies, when the banks observe a signal indicating the future government type is more likely to be bank-friendly, it tends to believe the signal is least accurate, i.e., $\mu = \mu^* - \delta$. So they choose the most pessimistic belief $\underline{p}_{s_{bf}}$ from $\mathbf{P}_{s_{bf}}$. When the uncertainty about the informativeness of the signal increases, the banks endogenous prior belief will deteriorate. This means we will derive the same predictions as the ones in Corollary 1.

2.7 Discussion of the Model

2.7.1 Empirical Predictions of the Model

Our theory model makes predictions regarding to how uncertainty affects optimal loan contract. In particular, we can generate two empirical predictions:

Prediction: As uncertainty about the future economy/policy state increases, banks de-

mand higher return of return.

Note that the model clearly identifies the channel as banks uncertainty aversion. Moreover, our model shows that uncertainty affects loan rate and loan size through banks optimization program, i.e., a credit supply side story. Note that our theory also generates empirical prediction about how uncertainty affects loan size, i.e., as uncertainty about the future state increases, banks reduce their loan volume granted to the firms. Gissler et. al. (2016) has already provided empirical evidence that higher (regulatory) uncertainty constrains bank credit. Having measured uncertainty as the cross-sectional dispersion of shocks to bank-level variables, Buch, Buchholz and Tonzer(2015) also find that higher uncertainty in banking has negative effects on bank lending. So the main focus of our empirical test is about the correlation between economic or policy uncertainty and banks loan rates.

2.7.2 The empirical proxy for uncertainty

In Bloom (2014), the author points out that the modern definition of uncertainty comes from Knight (1921), and is different from the concept of risk. We quote the following: "uncertainty as peoples inability to forecast the likelihood of events happening" in contrast, "risk...describes a known probability distribution over a set of events...". However, the author also admits that the term "uncertainty" in his paper is "a stand-in for a mixture of risk and uncertainty", and "it should be unsurprising that there is no perfect measure but instead a broad range of proxies (for uncertainty)". The author further exemplifies "the volatility of the stock market or GDP", "forecaster disagreement", "mentions of uncertainty in news" and the dispersion of productivity shocks to firms as potential proxies for uncertainty. As a further attempt, the EPU index by Baker, Bloom and Davis is developed. The index can be considered as an aggregation of proxies for the policy-related uncertainty. And its indices serve as measurements for the extent of uncertainty.

As this reason, we consider EPU as a best suitable proxy for uncertainty in our theory model. In particular, the uncertainty in our model is about the future "type" of the government, so its future policies and economic consequences. Our signal s can be exactly considered as the media coverage, government reports for future policies or professional forecasts as the underline components of EPU. Moreover, the content δ of the belief set $\mathbf{P}_s$ can be read as the specific EPU index, measuring the extent of uncertainty. A high

EPU index then maps into our model as a signal s with higher δ. To be more precise, in our baseline regression, we use the average of monthly EPU index in the 12 months prior to the loan start date when adopting EPU as the proxy for uncertainty. Doing so is not just for an empirical consideration, but also better fit our theory explaining EPU as public signal s.

Of course, we admit there is still a gap between our theory and the empirics. Although it is easy to differentiate uncertainty from risk theoretically, it is quite difficult to do it empirically. And the EPU should also be treated as an index for a mixture of economic policy risk and uncertainty to the economic policy. We do realize and admit these constraints. Our paper attempts to read EPU more as an uncertainty index and try to derive some new implications in banking.

2.7.3 Policy Implications of the Model

Provided that our model predicts that loan rate increases and loan size decreases when uncertainty is elevated, uncertainty has real effects for the economy. Higher uncertainty premium demanded by banks implies higher cost of borrowing for firms. A smaller loan size may imply less credit supply or even severe credit rationing. Both adverse effects on financial intermediation on the real economy may contribute to the sluggish recovery following the Great Recession. This rationalizes the necessity for regulatory authorities to intervene and manage macro uncertainty.

3 The Empirical Tests: Methodology, Data and Sample

3.1 Methodology

Syndicated loan market provides a nice laboratory for testing our model. Implicitly assumed uncertainty averse, syndicate of lenders are uncertain about the future states, which determine the probability distribution of default events of the borrower. Therefore, we expect to see banks command a premium to compensate for exposing to uncertainty, and the premium increases in the level of uncertainty. In sum, we propose the following hypothesis:

Hypothesis 1: Loan spreads charged by the syndicate increases in the level of uncertainty of the borrower country.

To examine the impact of uncertainty on the cost of borrowing, we employ the following loan pricing model:

$$
\begin{aligned}
Loanspread_{f,l,t} = \alpha + \beta EPU_{c,t-1} + \sum_k \theta_k Loan_{k,l,t} + \sum_m \xi_m Firm_{f,m,t-1} \\
+ \sum_j \xi_j Macro_{j,c,t} + \sum_c \varphi_c C_c + \sum_t T_t + \varepsilon_{f,l,t}
\end{aligned}
\tag{34}
$$

where f, l, c, and t denote the firm, loan, borrower country, and year, respectively. Loanspread refers to the all-in-drawn spread. We adopt EPU as our proxy for uncertainty in the baseline regression. Specifically, we us the average of monthly EPU index in the 12 months prior to the loan start date (Kang et al., 2014).[17] The set of loan controls includes LogFacilitySize, Maturity, #Lenders, #Facilities, Revolver, Termloan, Senior, Collateral, and loan purpose dummies. In the set of firm controls, we control for LogFirmSize, Leverage, ROA, Tangibility, MktBook, and industry fixed effects.[18] We include Inflation, Growth rate of real GDP, Unemployment in the set of macroeconomic variables. In most specifications we include borrower country fixed effects, C_c, and year dummies, T_t. The unit of observations is a facility taken out by a single firm from a syndicate of lenders.

3.2 Data

3.2.1 Syndicated Loans

We obtain data on syndicated loans from Thomson Reuters Loan Pricing Corporations Dealscan, which offers detailed information on loan contracts, such as the pricing term, maturity, seniority, syndicated structure, borrower identity, lender identity and so forth. It has been used widely in cross-country studies (see, e.g., Giannetti and Laeven, 2012a; Giannetti and Yafeh, 2012). A syndicated loan is usually structured in a number of facilities. We treat multiple facilities in a deal as different loans, as spreads, identity of lenders, and

[17] Compared to annual value of EPU, the average monthly EPU in the 12 months leading up to the loan start date offers rich over-time variation in uncertainty.

[18] Unfortunately, Worldscope does not report credit rating for the firms. Hence, we are unable to directly control for credit risk. Nevertheless, our set of firm controls follows other well-established studies in this setting (see, for example, Bae and Goyal (2009)) and capture major borrower characteristics that reflect risk.

other contractual features often vary. An individual observation in our analysis is thus a loan facility extended by a syndicate to a single borrower.

Our sample contains syndicated loans taken out by firms in the 19countries where data on economic policy uncertainty is available. Table 1 tabulates the distributions of borrowers across countries. Although Dealscan dates back to the late 1980s, the coverage of loans to borrowers outside the US is sparse until 1990s (Qian and Strahan, 2007). Therefore, we include all loans originated between 2000 and 2015.[19] We exclude loans extended to borrowers in financial industries (SIC codes 6000 to 6400, finance and insurance).

Our dependent variable is the all-in-drawn spread over LIBOR measured in basis points (bps), which is a measure of the overall costs of the loan, accounting for both one-time and recurring fees. It is winsorized at the 1% and 99% levels.

In addition, we include a vector of loan controls that might affect loan pricing. First, we include LogFacilitySize, the log of the facility amount in millions of US dollars. Large loans are associated with greater credit risk and lower liquidity in underlying projects but could also be demanded by larger firms that tend to have lower risks. The relationship between loan size and loan pricing is hence ambiguous. We also include Maturity, the maturity of the facility measured in years. The effect of maturity on loan spreads is also ambiguous, for similar reasons to loan size. Next, as a proxy for the syndicated structure, we use the number of lenders in a facility (#Lenders) and the number of facilities within a deal (#Facilities). To measure the liquidity exposure of each facility, we classify a loan as a line of credit (Revolver) or a term loan (TermLoan). Moreover, we include dummy variables that indicate whether a loan is senior (Senior) in the borrowers liability structure. Seniority reduces the lenders exposure in the event of borrower default and therefore lowers the lending rates. Collateral is an important feature in loan contracts that reduces loss in the event of borrower default, but it is more likely to be required for risky borrowers. In our sample, 44% of the loans are secured by collateral, but borrowers do not pledge collateral for 22% of the sample. As more than 1/3 of the sample lacks information on collateral, we use a categorical variable as proxy. In particular, Collateral = 2 if a borrower pledges collateral, Collateral = 1 if no collateral pledged, Collateral = 0 if collateral information is missing.[20] Last, as the purpose of obtaining loans is likely to influence loan spreads, we

[19] Note that the time series of EPU started later than 2000 in India, Netherlands and Spain.

[20] The fact that a large fraction of our sample reports missing values for collateral may be caused by any systematic reasons that may bias our estimation. Hence, we keep the loans without collateral information

create five dummies to control for loan purposes: corporate purposes (CorpPurpose), debt repayment (Repayment), takeover (Takeover), working capital (WorkCapital), and other (OtherPurposes).

3.2.2 Economic Policy Uncertainty

We adopt the monthly, continuous index of economic policy uncertainty compiled by Baker et al. (2016). It is a country-specific index based on newspaper coverage frequency that reflects the movements in policy-related uncertainty. Baker et al. (2016) show a strong relationship between EPU index and other conventional measures of economic uncertainty and policy uncertainty. This index has been applied in academic research, industry practice, congressional testimony and central bank speeches.[21] The EPU data is available for 19 major countries, covering both developed countries and emerging economies. Several papers have employed this data set in cross-country studies (for example, see Gungoraydinoglu et al., 2017).

Figure 1 plots the trends of EPU for each country in our sample in the period 2000-2015. Note that EPU indices co-move over time. Several sharp spikes in our sample period correspond to events of the Subprime mortgage crisis and European sovereign debt crisis.

3.2.3 Control variables

To account for firm characteristics, we manually match borrowers of syndicated loans to their accounting data from Worldscope based on the ticker, firm name and location. Worldscope provides data on balance sheet and income statement for leading public and private firms. We use the accounting variables measured in the end of the year prior to loan origination, although our results are insensitive to the timing choice. Specifically, we include LogFirmSize, the logarithm of the firm's total assets in millions of US dollars. Large firms are more transparent, therefore we expect them to have lower spreads. Leverage is the ratio of total debt to total assets. Leveraged firms are more likely to default and hence are expected to be charged a higher lending rate. We include ROA (the return on assets) to measure profitability. As more profitable firms are safer, they should be charged a lower spread. We also include two controls for a firms loss given default (LGD). In addition,

and control for collateral. The estimated coefficient for the categorical variable, Collateral, should be interpreted with caution.

[21] Please visit the website of economic policy uncertainty: http://www.policyuncertainty.com/research.html.

Tangibility measures the fraction of tangible assets on the balance sheet. Borrowers with a more tangible assets are more informationally transparent (Morgan, 2002) and have higher values in the event of default. We hence expect them to exhibit lower spreads. We also control for the market-to-book ratio, MktBook, as a proxy of Tobin's q. We expect a firm with a higher market-to-book ratio to have lower spreads. We control for stock volatility, calculated as annual standard deviation of daily stock return from CRSP. Moreover, we include borrower industry dummies from Dealscan that classify borrowers into ten sectors based on two-digit SIC codes, as loss given default (LGD) is strongly correlated with industry characteristics (Hertzel and Officer, 2012; James and Kizilaslan, 2014).We winsorize all firm controls at the 1% and 99% levels to deal with potential outliers.

In addition, it is well-documented that business cycles appear to drive both economic policy uncertainty and loan spreads (Gulen and Ion, 2016; Bloom, 2014; Kaviani et al., 2014).For example, in recessions, banks tend to raise lending interest rates (Santos, 2011).On the other hand, deteriorating economic condition calls for changes in economic policies and shakes peoples confidence. Therefore, from the World Development Indicators we control for a couple of key macroeconomic variables, such as inflation, growth rates of real GDP, and unemployment rates.

Moreover, we include borrower country fixed effects and year fixed effects to absorb country-specific and time-specific shocks, respectively, as Bloom (2014) summarizes that uncertainty appears to be countercyclical and varies heavily across countries. Through all specifications, we employ robust standard errors clustered at the borrower level, which are reported in parentheses below the coefficient estimates. Definitions and sources of all variables are presented in Appendix Table A1.

3.3 Sample

We ultimately compile a sample of 16776 facilities taken out by 3131non-financial firms in 19 countries. Descriptive statistics in Table 2 show that, on average, a typical syndicated loan has loan spread of 182 bps, a maturity of 4 years, and facility size of 528 million USD. The structure of syndicated loans is often complex, consisting of on average9lenders in a syndicate and nearly 2 facilities in each deal. The primary form of syndicated loans is term loans (64%). Most loans are senior debt. The average firm size is 7969.164 million USD, with an average leverage ratio of 31.171%, ROA of 5.062%, tangible assets to total assets of 35.567%, market-to-book of 170.845%, and annual stock volatility of 0.438.

4 Empirical results: Economic policy uncertainty and loan pricing

4.1 Baseline regressions

We begin by estimating a pooled OLS regression in column 1 of Table 3. We document a positive coefficient of 0.318for EPU that is statistically significant at the 1% level, suggesting a rise in loan spreads at a time of high economic policy uncertainty. It is also economically sizable, as a one standard deviation increase in EPU (38.061) may raise loan spreads by 12 bps (0.318*38.061), accounting for 10% of the sample mean. In addition to the borrowers fundamental variables that roughly account for firm-specific risk, we further control for time-invariant, unobserved firm heterogeneity by estimating a panel regression with borrower fixed effects. The identification comes from comparing the pricing of loans originated by the same borrower at different point of time when economic policy uncertainty varies. Our results in column 2 are quantitatively and qualitatively similar to the baseline results in column 1. Moreover, our results continue to hold in a more stringent specification of firm*year fixed effects which better controls for time-varying firm specific risk. We discuss this in section 4.3.

Since the country distribution of our sample quite unbalanced, our estimation is plausibly biased by over-representation of US borrowers (78% of the sample). To address this concern, we use the number of observations in each country as a weight in a weighted OLS. The results in column 3 continue to confirm our findings. Moreover, we re-estimate the baseline regression using a subsample without US borrowers. The sample shrinks considerably but results hold in column 4.

As regards to control variables, we find loan spreads are positively related to loan maturity, the number of facilities in a deal, firm leverage, and unemployment rates, whilst negatively related to loan size, number of lenders, revolver dummy, seniority, firm size, ROA, asset tangibility, and market-to-book ratio.

In unreported tests, when standard errors are clustered at the borrower country level or the pair of borrower country and year level, we continue to find positive and statistically significant impact of EPU on loan spreads. When EPU is taken natural logarithm (Gulen and Ion, 2016), our results remain intact.

In sum, our results suggest that the cost of loans is positively and significantly associated with economic policy uncertainty, consistent with our hypothesis. In the next subsection, we will subject these results to robustness checks. Throughout all the specifications, we include all sets of controls, but for brevity we no longer report the corresponding estimates.

4.2 Endogeneity issues

Although we find consistent evidence that EPU may raise the cost of bank loans, one caveat may arise if economic policy uncertainty is endogenously influenced by contemporary credit supply of the banking sector (similar argument as in Waisman et al., 2015), or by omitted factors that determine cost of debt as well. In this subsection, we discuss the two issues of reverse causality and omitted variable bias.

4.2.1 Reverse causality

Our results are less likely to be biased by reverse causality that loan spread of a single loan contract influences the national EPU for three reasons. First, we use the average of monthly EPU indices one year leading up to the loan start date. Hence, ex post loan contracting is not likely to affect ex ante EPU. Second, syndicated loan is a hybrid of public and private debt (Dennis and Mullineaux, 2000). Hence, the market is not as transparent as stock or corporate bond market. It is hard to believe an event happened in this market would attract publics attention and therefore impact the uncertainty. Last, nation-wide EPU is less likely to be driven by a firm-level lending contract. A more realistic assumption is that banks take variations in economic policy uncertainty as exogenous shocks.

Nevertheless, we run the regressions that remove large borrowers in each country, for fear that media attention for the announcement of syndicated loans to a large firm may impact economic policy uncertainty. We define large borrower as firms of which relative size of total assets to the GDP of its jurisdiction is over 0.1%. Our results hold for this subsample without large firms in column 1 of Table 4. Alternatively, we remove large loans (facility size exceeding 1 billion USD) and continue to find consistent results in column 2.

4.2.2 Simultaneity bias: additional macroeconomic control variables

One caveat to our results is that omitted variables may simultaneously drive both economic policy uncertainty and loan spreads. Baker et al. (2016) argue a wide variety of global and domestic factors drive the trends and fluctuations of EPU measures. Although common global shocks may be captured by time fixed effects, it is necessary to control for domestic macroeconomic conditions that determine country-level policy-related uncertainty and also influence firm-level lending behavior (Bae and Goyal, 2009). In addition, the set of macroeconomic controls in the baseline specifications is inadequate to control for omitted variables other than business cycles.

Therefore, we control for additional macroeconomic variables from the World Development Indicators: domestic credit to private sector/GDP, which measures the financial development of financial intermediaries and importance of the banking sector, and total values of stocked trade/GDP, which measures the liquidity and depth of financial markets. The rationale is that not only development of financial institutions and markets matters for micro-level loan pricing, banking crisis and stock market crash also often widen economic policy uncertainty.

By the same token, governance drives both economic policy uncertainty and loan pricing (Qian and Strahan, 2007; Bae and Goyal, 2009). Hence, we adopt political stability and rule of lawas two proxies for governance from the Worldwide Governance Indicators. Both indices range from -2.5 (weak) to 2.5 (strong). Specifically, political stability measures the perception of the likelihood of political instability, and/or politically motivated violence/terrorism. Rule of law measures the perception of the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

Results reported in columns 3 to 6 of Table 4 show that the impact of EPU seems insensitive to the presence of the additional macroeconomic variables. Domestic credit to private sector/GDP obtains a positive and significant coefficient, whilst the value of stock traded/GDP obtains a negative though insignificant coefficient. In addition, both higher political stability and rule of law tend to reduce the cost of borrowing, though the effect of political stability is no statistically significant.[22] When including all four macroeconomic

[22] Our results hold without significant change when adding other dimensions of governance in the Worldwide Governance Indicators, for instance, voice and accountability, government effectiveness, regulatory quality, and control of corruption.

variables, our results continue to hold in column 7.

4.2.3 IV estimation

Despite the above effort to tackle endogeneity issues, our estimation remains prone to unobserved shocks that drive both uncertainty and the pricing of loans. For instance, debates over domestic tax reforms raise uncertainty over business and eventually influence the cost of borrowing.

We formally address the endogeneity issue by instrumenting the EPU of one country with the inverse distance weighted average EPU of the rest of the sample countries. On the one hand, uncertainty tends to co-move in various markets as Figure 1 suggests (Bloom, 2009) Balli et al. (2017) also confirm the cross-country spillover effects of EPU. Therefore, we expect EPU of the rest countries has non-negligible influence on the EPU of the borrower country. On the other hand, uncertainty shocks in country B are not likely to directly affect cost of borrowing for local companies in country A. Hence, the instrument is constructed as follows:

$$instrumentedEPU_i = \sum_{j \neq i} EPU_j * \frac{1}{distance_{ij}} \tag{35}$$

We weigh EPU of all other countries by the inverse distance between country i and country j, which ensures that uncertainty in countries far away imposes relatively small influence compared to uncertainty in a neighboring country. Data on physical distance between capitals of country pairs comes from CEPII database.

We report the IV estimation in Table 5. The first stage regression in column 1 presents a positive estimate for the instrumented EPU, which is statistically significant at the 1% level, suggesting that EPU of neighboring countries has strong influence on EPU of the borrower country. The F-statistic is larger than 10, and the Cragg-Donald F-statistic is significant at the 1% level, suggesting the instrumented EPU is not a weak IV. Column 2 reports the second stage regression where EPU remains significant at the 1% level. In addition, we include the instrumented EPU directly into the second stage regression as an additional explanatory variable in column 3, and the coefficient is insignificant. In sum, the IV regression confirms the positive relationship between EPU and loan spreads while assuaging the endogeneity concerns.

4.3 Alternative story of demand shock?

Julio and Yook (2012), Cao et al. (2013), Kang et al. (2014), Gungoraydinoglu et al. (2017) find that firms tend to de-leverage and cut investment during heightened uncertainty periods. Therefore, extant prior empirical evidence does not support the demand-driven channel that higher demand for external finance may drive up loan pricing when uncertainty looms. In unreported regressions, we nevertheless test the demand-driven channel by adding borrower*year fixed effect to absorb any demand shock. The identification comes from comparing the pricing of loans originated in the same year by the same borrower, where its demand for loans is assumed to be fixed in that year. The variations in monthly EPU indices allow for identification. Our baseline results remain intact when controlling for the demand effect, suggesting that demand effect cannot explain the pricing.

5 Conclusion

In this paper we theoretically and empirically analyze the impact of uncertainty on bank lending. We model Knightian uncertainty to the informativeness of signal observed by uncertainty averse banks following the maxmin expected utility. Our theory suggests that uncertainty-averse lenders command a premium for uncertainty exposure. The uncertainty premium increases in the level of uncertainty. We fit our model to syndicated loan contracts and examine the impact of economic policy uncertainty on bank lending in 19 major countries. We find strong evidence that economic policy uncertainty is positively associated with loan spreads. A battery of robustness checks of reverse causality, omitted variable bias, and instrumentation strategy further confirm our results.

Our findings suggest that economic policy uncertainty has real effects on the economy. Firms taking out loans have to pay extra 12bps when economic policy uncertainty rises by a one standard deviation, translated into 633,829US dollar of annual interest payment for a typical loan (12bps * 528.191 million). Heavy debt burden may impair the growth and investment of the firm, and eventually become a challenge to the macroeconomic performance.

1.jpg

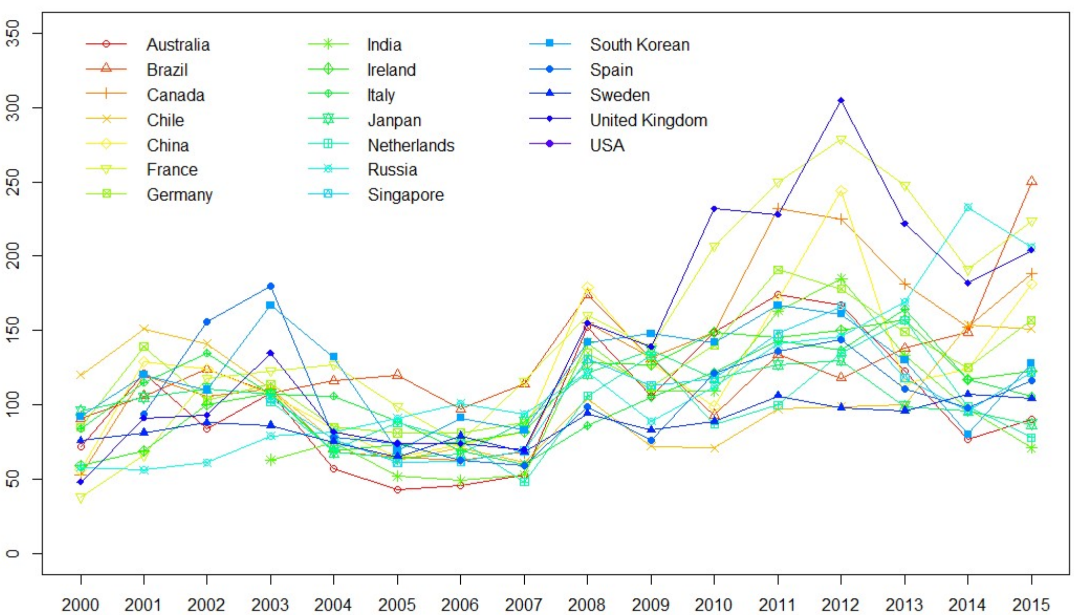

Figure 2: Economic policy uncertainty in 19 countries during 2000-2015.

Table 1: Sample distribution across countries

Country	# of Loans	# of Borrowers	average facility amount (million USD)	average all-in-drawn (bps)	average EPU
Australia	272	55	416.781	148.989	96.905
Brazil	42	9	501.956	192.083	107.162
Canada	7	2	167.353	335.714	202.638
Chile	31	9	283.631	108.79	110.623
China	35	15	149.229	282.8	149.753
France	341	74	767.047	161.462	134.917
Germany	351	60	1448.295	156.829	114.106
India	147	49	91.529	324.748	115.087
Ireland	35	8	599.406	278.157	89.183
Italy	125	31	566.2	206.288	108.415
Japan	612	133	80.242	78.575	110.347
South Korea	163	37	86.527	165.484	111.295
Netherlands	124	26	590.157	244.254	92.469
Singapore	51	23	94.859	187.412	95.727
Spain	260	38	1596.913	164.888	93.668
Sweden	49	18	426.999	215.663	84.896
USA	13144	2287	491.981	185.554	114.848
UK	987	257	802.66	190.882	140.684
Full Sample	16776	3131	528.19	182	116.22

Table 2: Descriptive statistics

	Obs	Mean	STD	p1	p50	p99
EPU	16776	116.220	38.061	28.238	114.739	317.295
All-in-drawn spread	16776	182.001	129.120	15.000	150.000	700.000
LogFacilitySize	16776	5.109	1.956	-10.053	5.416	10.800
FacilitySize	16776	528.191	861.817	0.244	225.000	5345.142
Maturity	16776	4.034	2.087	0.083	5.000	60.417
#Lenders	16776	9.121	8.320	1.000	7.000	108.000
#Facilities	16776	1.921	1.491	1.000	1.000	18.000
Revolver	16776	0.642	0.479	0.000	1.000	1.000
Term loan	16776	0.309	0.462	0.000	0.000	1.000
Senior	16776	0.995	0.070	0.000	1.000	1.000
Collateral	16776	1.049	0.876	0.000	1.000	2.000
LogFirmSize	16776	7969.164	17226.578	26.039	1903.327	116678.516
FirmSize	16776	7.571	1.776	3.260	7.551	11.667
Leverage	16776	31.171	19.500	0.000	30.310	90.913
ROA	16776	5.062	8.457	-36.059	5.367	29.139
Tangibility	16776	35.567	26.996	0.439	28.483	93.770
MktBook	16776	170.845	98.716	65.336	139.406	663.523
StockVol	16776	0.438	0.279	0.138	0.358	1.733
Inflation	16776	2.234	1.345	-1.353	2.270	14.715
Growth of real GDP	16776	2.203	1.674	-5.619	2.458	25.557
Unemployment	16776	6.260	2.239	1.690	5.780	26.090
Credit	16715	171.660	31.143	27.686	179.065	212.269
Stock	16661	188.434	72.995	3.083	199.187	355.420
Political stability	16776	0.472	0.391	-1.520	0.560	1.490
Rule of law	16776	1.522	0.249	-0.550	1.580	2.040

Table 3: Baseline regression
The dependent variable in all the regressions is the all-in-drawn spread. Column 1 presents the results for pooled OLS. Column 2 runs panel regression, controlling for borrower fixed effects. Column 3 reports the results using weighted OLS, where the number of syndicated loans in each country is used as the weight. Column 4 restrains the sample to non-US countries. See Appendix Table A1 for the variable definitions. Loan purpose dummies and year FE are included throughout all the specifications. Robust standard errors are clustered at the borrower level and are reported in parentheses below the coefficient estimates. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Pooled OLS 1	Borrower FE 2	Weight OLS 3	No USA 4
EPU	0.318***	0.298***	0.249***	0.250***
	-0.065	-0.066	-0.088	-0.092
LogFacilitySize	-4.036***	-2.328**	-6.266***	-1.721
	-1.258	-1.006	-1.331	-2.058
Maturity	2.097***	1.920***	3.081***	2.208**
	-0.582	-0.539	-0.713	-0.901
#Lenders	-1.031***	-0.665***	-1.194***	-0.204
	-0.172	-0.145	-0.186	-0.337
#Facilities	6.530***	4.133***	3.508**	12.381***
	-1.634	-1.432	-1.613	-1.93
Revolver	-	-	-	-
	63.514***	60.184***	69.748***	44.652***
	-6.328	-5.505	-7.746	-9.508
Term loan	-	-	-	-11.558
	19.206***	27.632***	23.008***	
	-6.55	-5.568	-7.994	-10.014
Senior	-	-	-	-
	260.057***	278.981***	339.220***	255.372***
	-34.29	-26.867	-39.282	-33.439
Collateral	28.432***	11.503***	27.335***	23.961***
	-1.718	-1.694	-1.63	-4.277
LogFirmSize	-	-	-9.983***	-
	12.936***	16.607***		15.536***
	-1.331	-3.043	-1.49	-2.297
Leverage	0.978***	0.721***	0.955***	0.854***
	-0.076	-0.121	-0.077	-0.187
ROA	-1.921***	-1.371***	-1.652***	-1.703***
	-0.183	-0.203	-0.196	-0.424
Tangibility	-0.205***	-0.252*	-0.142**	-0.491***
	-0.063	-0.151	-0.072	-0.113
MktBook	-0.078***	-0.073***	-0.084***	-0.065*
	-0.013	-0.017	-0.013	-0.037
StockVol	82.128***	65.488***	116.121***	38.111***
	-7.297	-7.569	-8.08	-11.314

Table 4: Endogeneity

The dependent variable in all the regressions is the all-in-drawn spread. Column 1 and 2 present the results for the sample excluding large borrowers or large loans, respectively, to control for the reversal impact of large borrowing on country-level economic policy uncertainty. Columns 3 to 6 control for additional macroeconomic variables that may drive both economic policy uncertainty and loan spreads. Column 7 controls for all four additional macroeconomic variables. See Appendix Table A1 for the variable definitions. Loan controls, firm controls, macro controls, loan purpose dummies, borrower industry FE, borrower country FE, and year FE are included throughout all the specifications. Robust standard errors are clustered at the borrower level and are reported in parentheses below the coefficient estimates. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Reverse causality		Omitted macro variables				
	Drop large borrowers	Drop large loans	Credit	Stock	Political stability	Rule of law	All additional macro controls
	-1	-2	-3	-4	-5	-6	-7
EPU	0.341***	0.351***	0.333***	0.316***	0.326***	0.330***	0.351***
	-0.079	-0.072	-0.066	-0.067	-0.064	-0.065	-0.068
Credit			0.666***				0.660***
			-0.162				-0.171
Stock				0.056			0.123
				-0.062			-0.076
Political stability					7.217		11.482
					-8.547		-10.252
Rule of law						- 105.234***	- 106.953***
						-28.793	-31.588
Loan controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Purpose Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5: IV estimation
Column1 reports the first stage estimation where dependent variable is EPU.Column2reports the second stage regression where the dependent variable is the all-in-drawn spread. Column 3 includes the IV directly into the second stage regression as an addition explanatory variable. See Appendix Table A1 for the variable definitions. Loan controls, firm controls, macro controls, loan purpose dummies, borrower industry FE, borrower country FE, and year FE are included throughout all the specifications. Robust standard errors are clustered at the borrower level and are reported in parentheses below the coefficient estimates. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	1st stage (1)	2nd stage (2)	2nd stage (3)
EPU		0.341***	0.266***
		-0.126	-0.094
Inverse distance weighted EPU	104.344***		7.799
	-4.617		-17.624
Loan controls	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes
Loan Purpose Dummy	Yes	Yes	Yes
Borrower Industry FE	Yes	Yes	Yes
Borrower Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Standard errors clustered at firms	Yes	Yes	Yes
Observations	14761	14761	14761
R2	0.846	0.537	0.537
F-statistic	510.80***		
Cragg-Donald F-statistic	7735.03***		

A Appendix: Proof of Lemma 1

Proof We first suppose the conditions guaranteeing interior solutions are satisfied. Recall our assumption that $\gamma'' > 0$, so we have $\tau^*_{ff} > \tau^*_{bf}$ if and only if $\frac{R+\alpha R_f}{1+\alpha\sigma_f} > \frac{R+\alpha R_b}{1+\alpha\sigma_b}$. Use $R_f + R_b = R$ and $\sigma_f + \sigma_b = 1$, we have:

$$\frac{R+\alpha R_f}{1+\alpha\sigma_f} > \frac{R+\alpha R_b}{1+\alpha\sigma_b} \Leftrightarrow (\alpha^2+2\alpha)(\sigma_b R_f - \sigma_f R_b) > 0 \tag{36}$$

Conditional on the fact that $\alpha > 0$, a sufficiently condition that guarantees $\tau^*_{ff} > \tau^*_{bf}$ is simply

$$\sigma_b R_f > \sigma_f R_b \Leftrightarrow \frac{R_f}{\sigma_f} > \frac{R_b}{\sigma_b} \tag{37}$$

On the other hand, it follows the same token to argue $\frac{R_f}{\sigma_f} < \frac{R_b}{\sigma_b}$ suffices to guarantee $\tau^*_{ff} < \tau^*_{bf}$.

We now treat the above sufficient conditions as exogenous at this stage (already determined at $t = 0$), and derive necessary conditions to ensure the interior solutions.

Note that the first order condition for interior solutions requires

$$\omega^f_T \frac{du_f(\tau)}{\tau} + \omega^b_T \frac{du_b(\tau)}{\tau} = 0 \tag{38}$$

Consequently, at the optimal solution τ^*_T, we must have $sgn(\frac{du_f(\tau^*_T)}{d\tau}) \neq sgn(\frac{du_b(\tau^*_T)}{\tau})$ or $\frac{du_f(\tau^*_T)}{d\tau}) = sgn(\frac{du_b(\tau^*_T)}{\tau}) = 0$,Note that the latter is true if and only if $\frac{R_f}{\sigma_f} = \frac{R_b}{\sigma_b}$, which we rule out for triviality. Recall also that

$$\frac{du_f(\tau)}{d\tau} = R_f - \sigma_f\gamma'(\tau) and \frac{du_d(\tau)}{d\tau} = R_b - \sigma_b\gamma'(\tau) \tag{39}$$

So When $\frac{R_f}{\sigma_f} > \frac{R_b}{\sigma_b}$, we must have $\gamma'(\tau^*_{ff}) > \gamma'(\tau^*_{bf})$. To guarantee $sgn(\frac{du_f(\tau^*_T)}{d\tau}) \neq sgn(\frac{du_b(\tau^*_T)}{\tau})$ is true then requires

$$\frac{R_f}{\sigma_f} > \gamma'(\tau^*_{ff}) > \gamma'(\tau^*_{bf}) > \frac{R_b}{\sigma_b} \tag{40}$$

On the other hand, When $\frac{R_f}{\sigma_f} < \frac{R_b}{\sigma_b}$, we must have $\gamma'(\tau^*_{ff}) > \gamma'(\tau^*_{bf})$. To guarantee τ^*_T, we must have $sgn(\frac{du_f(\tau^*_T)}{d\tau}) \neq sgn(\frac{du_b(\tau^*_T)}{\tau})$ is true then requires

$$\frac{R_f}{\sigma_f} < \gamma'(\tau^*_{ff}) < \gamma'(\tau^*_{bf}) < \frac{R_b}{\sigma_b} \tag{41}$$

Q.E.D.

B Appendix: Proof of Lemma 2

Proof: Note that the bank is uncertainty-averse, and has multiple prior beliefs about the governments type belonging to the set P. Gilboa and Schmeidler (1989) argues that such a bank chooses its belief p_S according to the following program.

$$\min_{p_{s_{ff}} \in P} \{ \frac{1+\mu}{2} u_b(\tau^*_{ff}) + \frac{1-\mu}{2} u_b(\tau^*_{bf}) \} I \tag{42}$$

Further notice that in our low dimensional parameterization, $\min_{p_{s_{ff}} \in P}$ is equal to $\min_{\mu \in [\mu^* - \delta, \mu^* + \delta]}$. This is because the bases of former set are calculated with the informativeness $\mu^* - \delta$ and $\mu^* + \delta$, which expand the latter set $\mu \in [\mu^* - \delta, \mu^* + \delta]$. Indeed, we can find a one-to-one mapping as $f : \mu \in [\mu^* - \delta, \mu^* + \delta] \to P$, for each $\mu \in [\mu^* - \delta, \mu^* + \delta]$ we have $f(\mu) = (\frac{1+\mu}{2}, \frac{1-\mu}{2}) \in P$. So we transfer the above program into

$$\min_{\mu \in [\mu^* - \delta, \mu^* + \delta]} \{ \frac{1+\mu}{2} u_b(\tau^*_{ff}) + \frac{1-\mu}{2} u_b(\tau^*_{bf}) \} I \tag{43}$$

It can be seen easily that the objective is linear in μ, so we take the first order derivative with respect to μ and obtain

$$\frac{1}{2}[u_b(\tau^*_{ff} - u_b(\tau^*_{bf})] < 0 \tag{44}$$

following the discussion from Lemma 1. As this result, the uncertainty-averse bank always considers $\mu = \mu^* + \delta$. Then, the corresponding prior distribution is $p_s = (\frac{1+\mu^*+\delta}{2}, \frac{1-\mu^*-\delta}{2}) = \overline{p_s}$ in this case of $s = s_{ff}$.

Q.E.D.

Table 6: Definitions and sources of variables

Variable	Definition	Source
EPU	The average of monthly economic policy uncertainty index in the year prior to the loan start date.	Baker, Bloom and Davis (2016)
All-in-Drawn spread	The all-in-drawn spread over LIBOR measured in basis points.	Dealscan
LogFacilitySize	Logarithm of the face amount of the loan (in millions of US dollars).	Dealscan
Maturity	Maturity of the loan contract in years.	Dealscan
#lenders	Number of lenders in a syndicated loan.	Dealscan
#facilities	Number of facilities in each package.	Dealscan
Revolver	Dummy variable that equals one if the specific tranche type is a line of credit and zero otherwise.	Dealscan
Termloan	Dummy variable that equals one if the syndicated loan is a term loan and zero otherwise.	Dealscan
Senior	Dummy variable that equals one if the syndicated loan is senior debt and zero otherwise.	Dealscan
Collateral	Collateral = 2 if a borrower pledges collateral. Collateral = 1 if a borrower does not pledge collateral. Collateral = 0 if collateral information is missing.	Dealscan
LogFirmSize	Natural log of total assets in million US dollars.	Worldscope
Leverage	Total liabilities to total assets.	Worldscope
ROA	Return on assets.	Worldscope
Tangibility	Net property, plant, and equipment/total assets.	Worldscope
MtkBook	Market value of assets/book value of assets.	Worldscope
StockVol	Annual standard deviation of daily stock return.	CRSP
Inflation	Consumer prices (annual %).	World Development Indicators
Growth of real GDP	Growth of real GDP.	World Development Indicators
Unemployment	Unemployment, total (% of total labor force).	World Development Indicators
Credit	Domestic credit to private sector (% of GDP).	World Development Indicators
[illegible]	[illegible]	[illegible]